

**CITY OF YUCAIPA
AGENDA REPORT**

TO: Honorable Mayor and City Council

FROM: Fermin Preciado, Director of Development Services/City Engineer 
Landon Kern, Assistant City Engineer 
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FOR: City Council Meeting of May 13, 2024

SUBJECT: FY24/25 Draft Pavement Management Program

RECOMMENDATION:

That the City Council:

- 1) Review and approve the FY24/25 Draft Pavement Management Program; and
- 2) Approve the recommended pavement maintenance and rehabilitation projects for FY24/25.

BACKGROUND/DISCUSSION:

The Pavement Management Program (PMP) was initially prepared and approved by the City Council in 1998. It has since been updated on an annual basis and “recalibrated” through field testing and analysis every five years in 2003, 2008, 2013, 2018 and the most recent analysis completed in 2023. The recalibration process is performed in order to provide an updated Citywide assessment of the current street network pavement conditions and has historically been the primary resource used as the basis for prioritizing the streets to be maintained or rehabilitated.

One of the goals approved by the City Council in 2023 was a to ‘Take a more inclusive and aggressive approach to road maintenance’. To accomplish this goal, additional equipment and resources were authorized by the City Council to address potholes and asphalt failures as part of the City’s Public Works operations. In addition, staff logged and included input provided by the public related to asphalt street conditions throughout the City during the process of developing the FY2024/2025 PMP Update.

To further meet this goal, on February 5, 2024, the City Council conducted a public workshop and field trip to visit various public streets with varying asphalt conditions to correlate the results of the 2023 analysis with real-world examples. Staff provided explanations of asphalt maintenance and rehabilitation options and identified specific asphalt failures that contributed to the results of the analysis. As part of that workshop, the City Council directed staff to use the information learned and the input received from the public to provide a PMP Update for FY2024/2025 at a future City Council meeting.

Utilizing the results of the 2023 analysis and incorporating a more inclusive and aggressive approach, a five-year plan of prioritized streets to be maintained and rehabilitated has been prepared for City Council consideration. The recommended maintenance and rehabilitation treatments are based on the measured pavement condition of the streets, or Pavement Condition Index (PCI). Staff is recommending the following asphalt pavement maintenance and rehabilitation treatments to be utilized over the next five-year cycle:

- Microsurface:
The application of a thin layer of an asphalt mixture that provides a new roadway surface across the entire street while leaving the remaining asphalt pavement in place. This “surface treatment” method is recommended for streets that have small, shallow cracks, and will protect and seal the asphalt from water penetration to extend the life of the pavement while providing a rideability and aesthetic enhancement.
- Edge Mill and Overlay:
The removal or milling of 1 to 2 inches of the top section of pavement along the outer edges of roads (Edge Mill), followed by the placement of a 1.5-inch thick layer of new asphalt over the entire roadway surface (Overlay). This method is recommended where a new layer of asphalt pavement can repair larger/deeper cracks and seal the roads from water damage while providing a new roadway surface.
- Full Width Mill and Overlay:
The removal or milling of 1 to 2 inches of the top section of pavement, followed by the placement of a 2 to 3 inch layer of new asphalt over the entire roadway surface (Overlay). This method is recommended where a new thicker layer of new asphalt pavement can repair streets with more significant cracking and raveling providing for a better structural section and new roadway surface.
- Full Removal and Rehabilitation:
The removal and milling of the entire existing asphalt pavement as well as the top layer of base soil beneath the roadway. After milling the asphalt grindings are blended into the soil and compacted to form a new structural base for the new asphalt section. This method is recommended when the street is not repairable with the other treatment methods and this process results in a new paved street.

The FY24/25 Draft PMP includes these treatment recommendations by street segment and is being presented for City Council consideration.

Funding for the FY24/25 PMP includes Road Maintenance and Rehabilitation Account funds (RMRA), Measure I funds, Highway User Tax Account (Gas Tax) funds and funding provided by other agencies as part of paving agreement funding commitments as identified in the table below:

Proposed Funding Source	Proposed Amount
RMRA	\$1,850,000
Measure I	2,182,388
Gas Tax	85,000
Inter-Agency Paving Agreements	<u>\$40,000</u>
Total Funding for FY24/25	\$4,157,388

The proposed expenditures for the FY24/25 PMP include:

Proposed Sub-Programs	Proposed Amount
FY24/25 Street/Pavement Rehab Program	\$2,058,694
FY24/25 Surface Treatment Program	1,152,868
FY24/25 Crack Seal Program	205,869
FY24/25 AC Berm Program	82,348
FY24/25 Patching Program	226,456
FY24/25 Concrete Program	205,869
FY24/25 Understreet Drain Pipe Program	41,174
FY24/25 Striping Program	82,348
FY24/25 Neighborhood Traffic Calming Program	<u>61,761</u>
Total Proposed Expenses for FY2024/2025	\$4,117,388

FISCAL IMPACT:

The recommendations approve the FY24/25 PMP with the use of restricted funding of \$4.1 million. The use of unrestricted funding is not proposed. These amounts are included in the forthcoming FY25 proposed budget.

Attachments:

1. 2023 Pavement Management Report
2. FY24/25 Pavement Management Plan Update

Approved by: _____

ATTACHMENT 1

Yucaipa, CA

Pavement Management Report

November 2023

CITY OF



IMS
Infrastructure Management Services
an ICC Company

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1.0 EXECUTIVE SUMMARY

1.1 Project and Methods Overview

In May of 2023, IMS Infrastructure Management Services, LP (IMS) utilized a cutting-edge Integrated Road Information System (IRISpro Pave) (**Figure 1**) to capture continuous, high-resolution pavement and right of way images that was used to assess pavement cracking, rutting, and roughness on 202.6 centerline miles of predominantly asphalt roadways in Yucaipa, CA (City). IMS followed the American Society for Testing and Materials (ASTM) D6433 standard to analyze the images and distress data collected by the Road Surface Tester (RST) to determine the Pavement Condition Index (PCI) for each segment of the road. PCI values were recorded to provide an indication of the surface conditions and structural integrity of a pavement.

Using the ESA pavement management system, IMS developed multi-year pavement maintenance and rehabilitation (M&R) recommendations for the roadways surveyed. The recommendations take into account the severity, quantity, and type of pavement distresses, surface type, pavement strength, and functional class. By utilizing these recommendations, the City can make informed decisions on how best to allocate their resources to ensure the longevity and safety of their roadways.



Figure 1 - IMS Integrated Road Information System platform (IRISpro Pave)

The Pavement condition index (PCI) method was used in accordance with the American Society for Testing and Materials (ASTM) D6433 to assess the condition of the City's pavements. This method is considered a standard, objective, and repeatable approach to assess pavement condition, which is preferable to alternative methods that rely upon potentially biased human ratings. Based on the PCI results, ESA prioritizes funding using a cost-of-deferral approach, recommending M&R activities that optimize funding by selecting rehabilitation candidates only when they approach the critical point where a heavier maintenance activity will soon be needed to restore the roadway to full service.

IMS also conducted a comprehensive pavement condition survey for the city of Yucaipa in 2018. The results indicated that the overall PCI was 64, with a backlog of 12%. Crack detection was conducted using the Ramboll-based RST, using a total of 11 lasers directed at the pavement surface to capture cracking

densities and rutting profiles. Compared to the current methodology, the old system was not capable of detecting unique pavement distresses, such as raveling, shoving, and potholes, which can be accurately measured by the modern Laser Crack Measurement System (LCMS-2). As a result, the LCMS-2 cameras allowed the 2023 survey to capture distresses more accurately than the survey completed in 2018, and the repeatability of distress identification was higher in 2023 as well.

The analysis and data presented in this report are based on the inspections performed by IMS in May 2023 on the City’s pavement network, using available work history and other assumptions that are elaborated on later in this report.

1.2 Results Overview and Recommendations

PCI values provide an indication of the surface conditions and structural integrity of a pavement. The 0–100 PCI range is commonly divided into categories using descriptive terms: *Very Poor*, *Poor*, *Marginal*, *Fair*, *Good*, *Very Good*, and *Excellent*. Divisions between the terms are not fixed but are meant to reflect common perceptions of pavement conditions. These divisions are discussed in more detail in Section 3.0.

The City’s roadways were found to be in *Fair* condition **with an average PCI of 51**. **Figure 2** provides a visual breakdown of the distribution of pavement area across different PCI categories at the time of analysis. Approximately 29.6% of the City’s roadways were found to be in *Excellent* or *Very Good* condition. If structurally sound, these pavements are often suitable candidates for cost-effective preventive maintenance treatments. On the other hand, pavements with a PCI below 40 (i.e., pavements in *Poor* or *Very Poor* condition) comprise the City’s “backlog” of M&R. **The City’s backlog was found to be 34.3%**. These pavements typically require full or partial reconstruction. Pavements falling within the middle categories, such as *Fair* or *Marginal* condition, often benefit from mill and overlay projects. It's important to note that these are general recommendations, and the specific M&R strategy may vary based on factors such as distress types, soil conditions, structural adequacy, and other project-specific details.

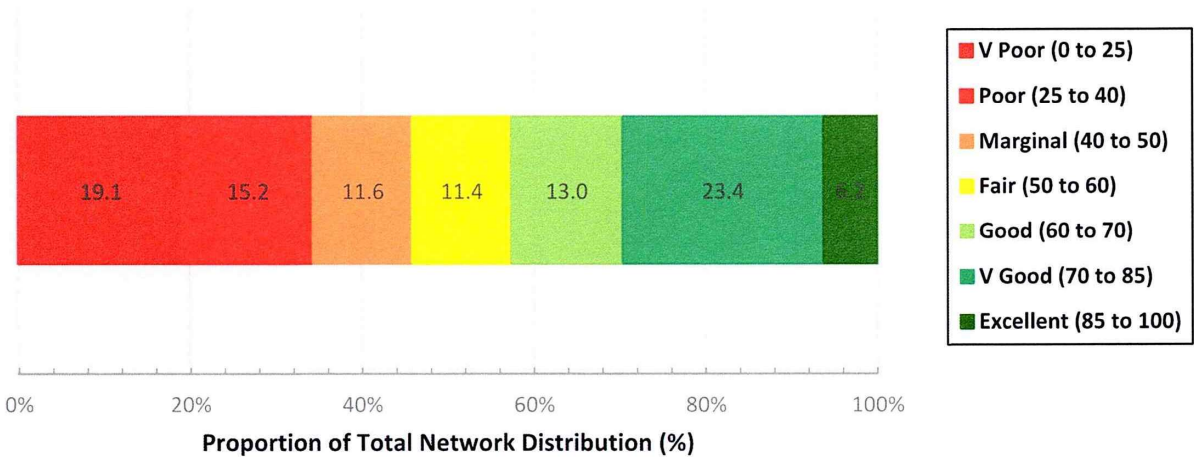


Figure 2 - Distribution of the City's Pavement System on a Condition Scale

Metrics of Health

Yucaipa did not meet any of the three metrics used to evaluate the quality of pavement networks:

- **Avg. PCI** – The network’s average PCI score is a good global indicator of its overall health.
 - The City’s average PCI of 51 is below the national average currently seen by IMS of 65.2.
- **Percentage of *Excellent* Roads** – The percentage of pavements in *Excellent* condition.
 - The percentage of *Excellent* roads is below the recommended target of 15%.
- **Backlog** – The percentage of pavements with a condition category of *Poor* or *Very Poor*.
 - The backlog (34.3%) is above the national average currently seen by IMS of 10.6%.

The analysis conducted by IMS using the ESA Pavement Management System has provided the City with valuable insights into the condition of its roadways. To assess the effect of annual budget on PCI over a five-year period, **Figure 3** has been generated to depict the anticipated PCI in five years relative to different annual budget allocations. The blue line allows the user to assess the effect of a given annual budget on the PCI in five years, serving as a valuable tool for understanding the potential effects of budget decisions on future pavement conditions.

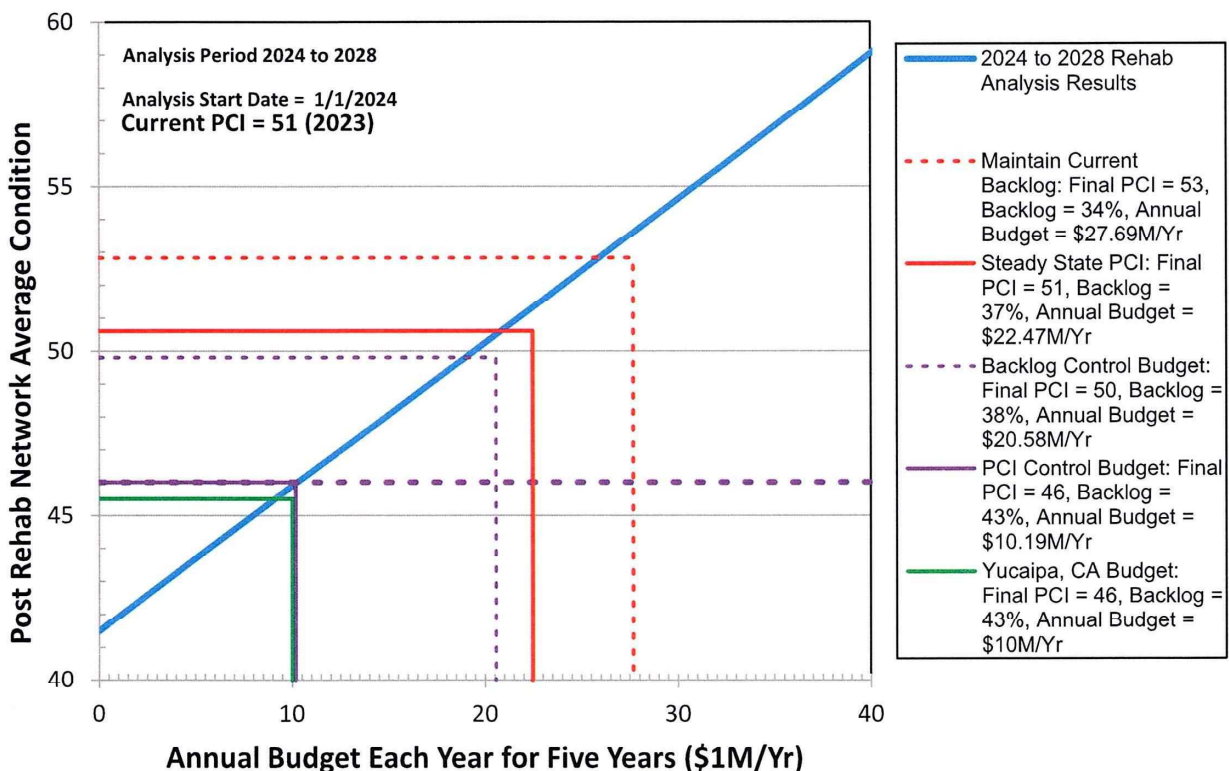


Figure 3 - PCI Based on Five-Year Annual Budget Funding Models

To get the most return on investment, IMS presents the following recommendations:

- Continue dedicating a portion of funding to inexpensive preventive maintenance activities, such as slurry, crack, and chip seals; and continuously monitor their short- and long-term benefits in the network. On these activities, make sure to apply them on good roads with minimal structural defects or properly address the structural deficiencies through localized patching and crack sealing prior to slurry seal application.
- Concentrate rehabs on the critical PCI candidates selected by ESA. These recommendations are focused on the cost of deferral and offer an efficient use of City funds.

This two-pronged approach allows for a gradual increase of the network's average PCI and decrease of the percentage of roads in *Poor* or worse condition over time.

It is important to note that the information presented in the Executive Summary is condensed from various sections of this report. Reviewers are encouraged to familiarize themselves with the detailed information provided in subsequent sections of the report prior to making any specific decisions based on these results. This will ensure that decisions regarding M&R activities are based on a comprehensive understanding of the conditions of the roadways and the recommendations provided in the report.

2.0 PRINCIPLES OF PAVEMENT MANAGEMENT

This section provides an overview of pavement management, including its objectives and the best practices for M&R planning throughout the lifecycle of a pavement. It also highlights the integration of these concepts in the ESA pavement management system, which was used in this report to develop recommendations and analyze the City's pavement network. This context is important for understanding the content and findings of the report.

2.1 Pavement Management Principles

Pavement management is the process of assessing, prioritizing, and preserving or rehabilitating pavements through a logical system that attempts to use available funds in the most cost-effective manner possible. The process is iterative, and as more data becomes available, prediction models are refined to improve accuracy. **Figure 4** illustrates that pavements typically start deteriorating rapidly once they hit a specific threshold. Therefore, it is more cost-effective to invest in cheaper surface treatments during the first 40% of a pavement's lifespan than to defer maintenance until heavier overlays or reconstruction is required just a few years later. Streets that are repaired while in good condition will have an extended lifespan and will cost less to maintain over their lifetime than those left to deteriorate to a poor condition. Without an adequate routine pavement maintenance program, streets will require more frequent reconstruction, thereby requiring significantly greater funding.

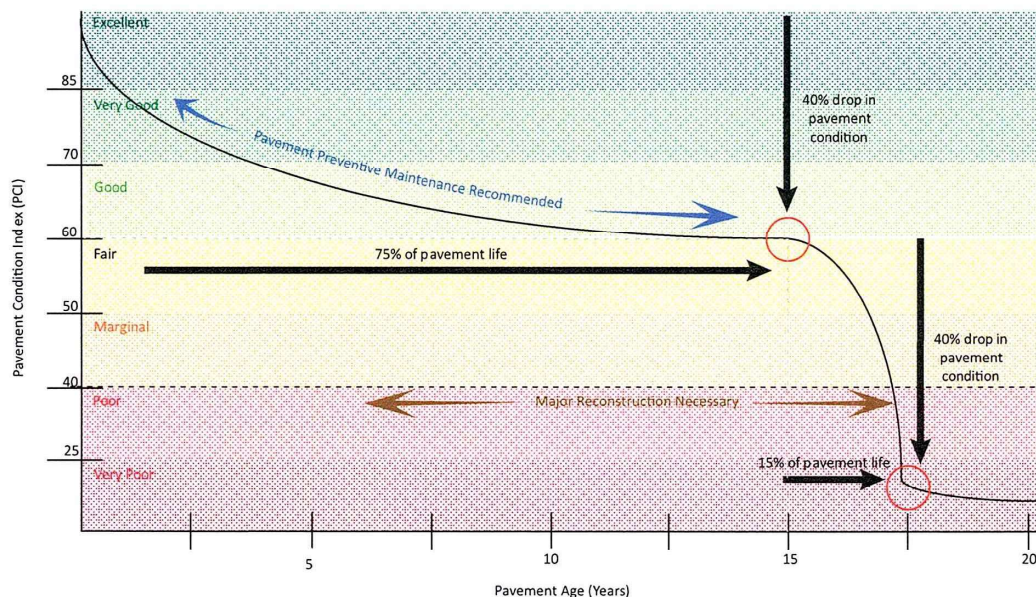


Figure 4 - Pavement Deterioration and Life Cycle Costs

The types of rehabilitation activities that the City chooses to deploy can have a significant effect on the longevity of a pavement. Depending on the PCI zone in which a pavement falls, a detailed rehabilitation strategy needs to be formed. Common rehabilitation types include localized preventive or stop gap activities (e.g. crack sealing, joint sealing, and patching), global preventive maintenance (e.g. fog seals, rejuvenators, slurry seals, microsurfacing, chip seals, cape seals, and thin overlays), major Rehabilitation

(e.g. thin or thick mill and overlays), and major Reconstruction (e.g. surface reconstruction or full reconstruction). Popular examples of cost-effective preventative activities include:

- Crack and Joint Sealing
- Microsurfacing
- Fog Seal and Rejuvenators
- Patching
- Slurry and Chip Seals
- Thin Overlays

A proactive Pavement management program focuses on the Preventative Maintenance category and advocates proper incorporation and application of cost-effective preventative activities. These activities help maintain and repair the surface integrity which can slow deterioration and, depending on the treatment, also extend the life of a pavement. The outcome of this exercise is to increase long-term cost savings and network-level pavement quality over time. **Figure 5** illustrates the concept of extending pavement life through the application of timely M&R activities.

When completed within the target zone for preventative maintenance, a pavement's lifespan can be conveniently extended. The dashed curves in **Figure 5** show the typical lifespan of a pavement that does not undergo any preventative maintenance. Major reconstruction becomes necessary after approximately 20 years. The blue curves show the benefits of preventive maintenance during the first 40% of a pavement's lifespan. The gray lines demonstrate how pavement rehabilitation, when a pavement's condition crosses into the *Fair* or *Marginal* category, can extend the pavement's lifespan as well. Eventually, all pavements will need to undergo reconstruction; however, proactive maintenance and rehabilitation can delay this process for up to an additional 40 years.

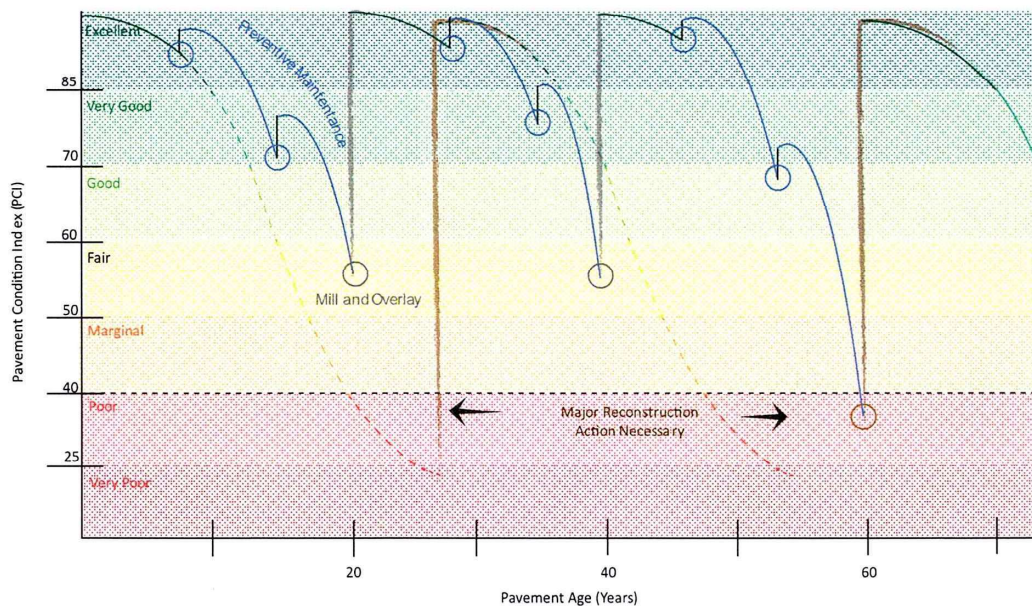


Figure 5 - Pavement Life Cycle Curve

The most effective approach to ensure optimal usage of available funds or to determine the necessary funding to achieve a predetermined level of service is by using a pavement management system. An effective pavement management system can assist agencies in developing an organized catalog of pavement assets, storing periodic condition assessments, and tracking spending and costs. This enables the City to compare trends in data to assess the effectiveness of maintenance activities and new technologies.

3.0 DATA COLLECTION AND ANALYSIS

3.1 Field Survey Methodology

IMS deployed one of its IrisPro Pave Integrated Road Information Systems for data collection. IrisPro Pave integrates industry-leading subsystems, including 3D Pavement Imaging systems, lasers, accelerometers, right-of-way cameras, GPS antenna, Distance Measurement Instruments (DMI), computers and more. All collected data is captured with Drive™ data collection software, which is designed to simplify the collection of quality road data with built-in calibration schedules, real-time quality control, GIS maps, section tracking, audible alerts and voice memos, fly-by events, and exception reporting. The custom-designed hardware and software on IrisPro Pave provides sub-millisecond synchronization between all subsystems.

Ramboll System vs LCMS-2 System

IMS conducted a pavement condition assessment survey and analysis for the City previously in 2018, adhering to the ASTM D6433-11 standard for distress protocols and PCI calculation. The field survey employed an older Ramboll-based RST that used dated point laser technology and lower-quality forward image cameras. The results of the survey showed that the City's network average PCI was 64 with a backlog of 12% at the time of survey.

An in-depth review of the distress data found that the current LCMS-2 system was able to provide more accurate and verifiable detailed data than the previous point laser system. The LCMS-2 system has several advantages over the old system. It is equipped with a single-pass 3D sensor capable of automated geo-tagging at 1mm resolution and a 28,000 Hz frequency. This enables the system to detect special pavement surface features like surface treatments, crack seals, potholes, raveling, bleeding, delamination, shoving, pavement markings, the edge of pavement, rumble strips, etc. The LCMS-2 can collect pavement data seamlessly all day and night at a free-flow traffic speed. Moreover, the 4K resolution camera used in the LCMS-2 enhances the collection of detailed pavement features.

3D Pavement Imaging

The LCMS-2 captures continuous 2D and 3D images at 1 mm resolution in the lane of travel up to 4 m (13 ft) wide at highway speeds, allowing for the visualization and characterization of all features on the road surface. The system allows for collection rates up to 28,000 profiles per second, five times faster than the first edition of LCMS. This allows smaller cracks, especially transverse cracks, to be detected more consistently than in the past. The vertical accuracy has also improved from 0.50 mm to 0.25 mm.

Right-of-way Imaging

The Ladybug 5+ captures high quality 30MP spherical images using six cameras for a 360-degree view of the roadway and surroundings. The images can be viewed in panoramic mode, 360 mode, or individual directional images can be extracted at any desired camera angle. An overview of the vehicle is provided in **Figure 6**. Both the Pavement imaging and right of way cameras are triggered on a fixed-distance basis, image capture is precisely synchronized to GPSTime and DMI, and cameras are calibrated for asset inventory and geo-referenced image measurements.

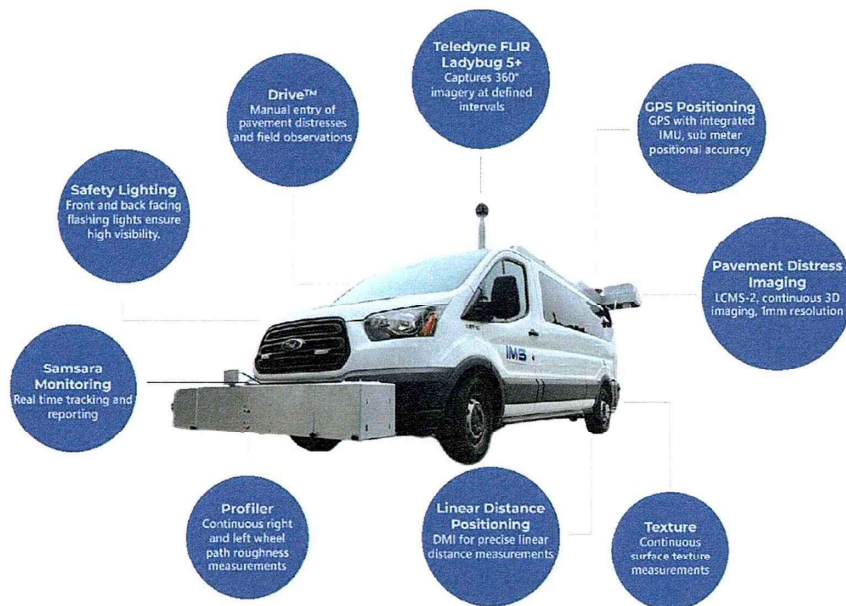


Figure 6 – LCMS-2 data collection vehicle

3.2 Data Quality Assurance

The collected data is processed in the office using the Connect™ software. Connect provides a perfectly synchronized multi window platform to view and alter all collected data including profile, distress, slope, International Roughness Index (IRI), events, images, and GPS map. **Figure 7** some examples of how data can be viewed in Connect. Using Connect, the LCMS-2 3D pavement images are analyzed to identify and classify distresses, and the longitudinal profile of the road is analyzed to determine the IRI and ride quality under the wheel paths according to industry standards. All processed data is matched to the segment ID of the roadway.

To ensure the accurate determination of PCI scores, the field data undergoes a rigorous series of processing phases and quality checks. These checks encompass synchronized assessment of both processed and raw data streams. The automatic distress identification and classification process involves various steps: First, different rules and processing parameters are applied on different pavement types; next, the auto detected lane markings are manually adjusted to exclude non-pavement areas and limit the assessment area for cracking and rutting to between the lane markings and invalidation rules are applied to exclude additional anomalies (e.g. near railroad crossing or bridge decks) from the assessment area. Finally, a team of highly trained pavement raters who are well-versed in both the distress standards and the data in its digital format review images and make the necessary corrections on areas with gross under/over detection.

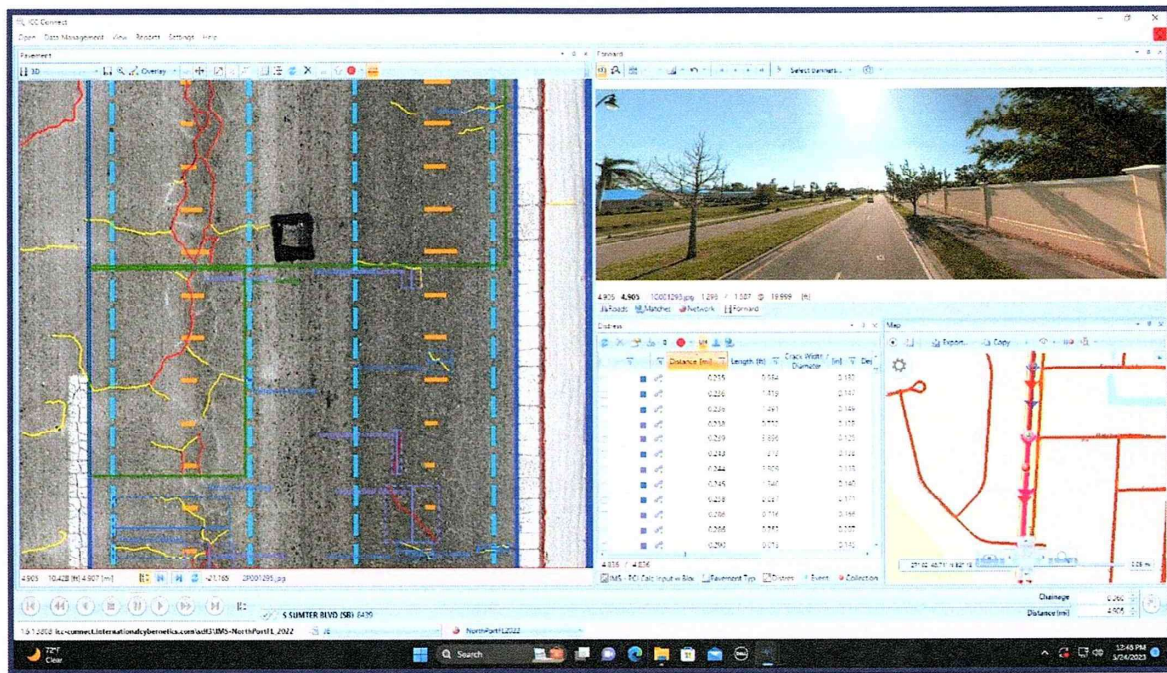


Figure 7 - QC Image from Connect™ Software

To further confirm the accuracy of our condition data, spot checks are conducted on a network-wide basis by both the QC team and engineering staff. These spot checks are carried out on a random selection of road sections across the entire network to verify that the condition data is consistent and accurate. They also help to identify any potential issues that may have been missed during the initial data collection and review process.

Once the QC team and engineering staff have established the integrity of the data, an initial condition spreadsheet with detailed data and summary tables and charts is prepared and submitted for review by the Client. This review process involves a careful examination of the condition data and includes a comprehensive analysis of the data's completeness, accuracy, and consistency before preparing data for import to City's pavement management system.

3.3 Pavement Condition Survey

The goal of the pavement condition survey is to determine an accurate rating for each pavement section. The process of collecting and assessing data involves both automated and manual observations that originate from the data collected with the IrisPro Pave equipped with LCMS-2 downward imaging lasers, an array of 4k cameras, and trained rating personnel.

Within the "Network Analysis" tab in ESA, IMS has populated values for Surface Distresses, Roughness score, and Strength Rating. These three indices form the foundation on which ESA operates. They allow weighing factors to be uniquely specified for PCI calculation.

Surface Distress Index (SDI)

ASTM D6433 provides a method of categorizing surface distress observations for both asphalt and concrete pavements, based on the extent and severity of distresses along the roadway. The Surface Distress Index (SDI) is used to represent the observed pavement defects on a scale from 0 to 100. However, not all surface distresses are given equal weight. Load-associated distresses (LAD), such as

rutting or alligator cracking on asphalt streets, and divided slabs on concrete streets, have a greater impact on the SDI than non-load associated distresses (NLAD), such as raveling or longitudinal and transverse cracking. Even when present in low extents and moderate severity, LAD can significantly decrease the SDI. The SDI inputs are shown in **Figure 8**. As discussed earlier in **Section 3.1**, the more upgraded LCMS-2 facilitated IMS engineers in capturing a broader range of distress varieties with enhanced precision through powerful lasers and an intelligent detection system. In comparison to the 2018 survey results, the 2023 assessment reported a PCI score of 51 and a Backlog of 34.3%, reflecting a decrease from the previous scores of 64 and 12%, respectively. This large decline in PCI scores can be at least partially attributed to the improved detection capabilities of distresses and the identification of a higher quantity of distresses in the more recent survey.

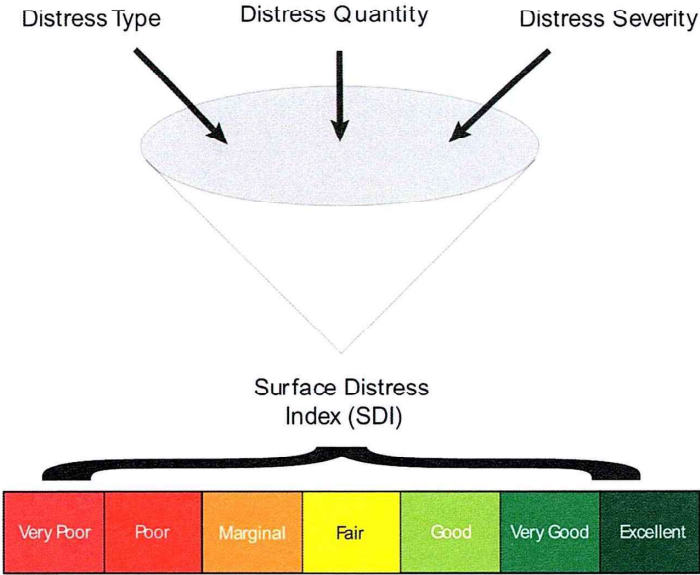
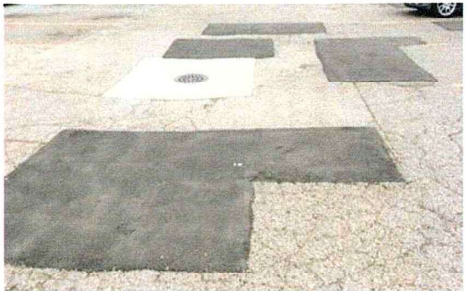


Figure 8 - SDI Inputs and Detailed Scale

ASTM D6433 covers nearly forty unique distress types that may or may not be present in an agency’s road network. For that reason, IMS uses a modified approach that collects the most common and relevant distresses. The descriptions in **Table 1** outline some of the distresses collected for the City:

Table 1 - Distress Descriptions

Distress Type	Pavement Type	Description	Example
Alligator Cracking	Asphalt	• Quantified by severity and square footage • Caused by the repeated bending from vehicle loads • Propagate from the bottom, meaning that structural failure has occurred • An LAD with significant impact on the condition score, even at low extents	
Rutting	Asphalt	• A minimum depth of ¼ inch • Quantified by their depth and square footage • Caused by the permanent deformation of the pavement and/or subgrade layers • Low densities can have a large impact on the final condition score due to their implication of possible structural failure	
Longitudinal & Transverse Cracking	Asphalt	• Quantified by their length and width • Results from pavement shrinkage due to natural daily and seasonal temperature cycles, construction issues, or other factors	

Block Cracking	Asphalt	• Quantified by their width and square footage • Form interconnected longitudinal and transverse cracks • Divides the pavement into rectangular pieces • Results from aging and environmental factors	
Patching	Asphalt	• Quantified by the square footage and severity • Always considered a surface defect • Affects ride quality and condition of a pavement	
Raveling	Asphalt	• Loss of coarse aggregate on pavement surface • Measured by severity and square footage affected	
Bleeding	Asphalt	• Presence of free asphalt binder on the roadway surface • Caused by either an excess of asphalt in the pavement or insufficient voids in the matrix	

		• Results in a pavement surface with reduced skid resistance • Measured by severity and square footage	
Edge Cracking	Asphalt	• Run parallel to the road, usually within 1 to 2 feet of the outer edge of the pavement • Caused by traffic loading and weakened base conditions resulting from poor drainage • Measured in linear feet	
Distortion	Asphalt	• Includes various localized unevenness in the surface • Examples include bumps and sags, depressions, swell, corrugation, and shoving • Caused by several factors, such as construction issues, subgrade failure, mixture failure, environmental influence, etc.	
Weathering	Asphalt	• Wearing away of asphalt binder and fine aggregate matrix • Quantified by severity and square footage	

Divided Slab	Concrete	• Slab divided by cracks into four or more pieces • Caused by overloading, inadequate support, or both • Categorized as a severe corner break if all pieces or cracks are contained within a corner break	
Corner Breaks	Concrete	• Crack that intersects with a joint at less than $\frac{1}{2}$ the slab length • Cracking extends vertically through the entire slab thickness • Typically caused by repeated load on a surface with a failing base	
Joint Spalling	Concrete	• A breakdown of the edges of a slab within 2ft of a joint • The depth of the cracking and area affected determine the severity	
Faulting	Concrete	• Identified by a difference in elevation across a joint • Severe faults have a $>\frac{3}{4}$ inch elevation difference between two adjacent concrete slabs	
Durability Cracking	Concrete	• Caused by the freeze-thaw expansion of the large aggregate • Breaks down concrete over-time • Typically runs parallel to a joint or linear crack	

		• A high severity “D” crack covers more than 15% of the overall slab	
Scaling	Concrete	• A result of the surface layer of concrete being worn away over time by weathering • A ¼ to ½ inch breakdown in the surface • Measured by severity and total area affected	
Punchouts	Concrete	• A localized, broken area of the slab • Caused by heavy and repeat loads, inadequate slab thickness, and a deterioration of the base foundation • Measured by severity and number of individual cracks within the distress	

Roughness Index (RI)

The Roughness Index (RI) provides a quantifiable measure of ride quality, which is determined using the industry-standard ASTM E1926 for calculating the International Roughness Index (IRI). This value is derived from the longitudinal profile captured by the LCMS as it records the change in elevation over a distance. Once calculated, it is expressed as a slope and reported in millimeters per meter (mm/m). Typical IRI levels for new, older, and damaged pavements are displayed in **Figure 9**. The IRI is lower on average for roads or pavements that are normally used for higher speed travel.

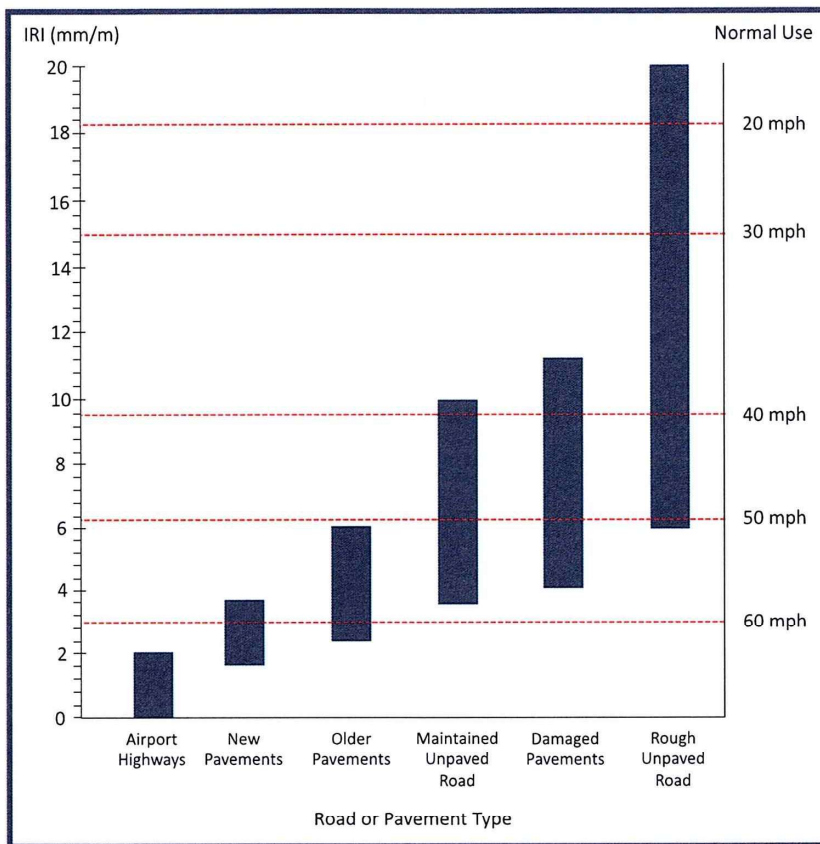


Figure 9 - IRI Scale Definitions

To enable the use of a blended condition score that incorporates both PCI and IRI scores, the IRI value is converted to an equivalent scale for analysis purposes. This is achieved by converting the IRI value into a score on a scale from 0 to 100 and reporting it as the Roughness Index (RI) using the following formula:

$$RI = (11 - 3.5 \times \ln(IRI)) \times 10$$

$\ln(IRI)$ is the natural logarithm of IRI.

To provide some context, a newly constructed street would typically have an RI value of above 85, whereas a street that requires an overlay would fall within the range of 40 to 70. Roadways in poor condition generally have RI values below 40, although they may achieve higher blended scores if the distresses responsible for the low RI score are not due to structural failure or other severe causes. For instance, rapid construction can lead to a pavement surface with less-than-optimal smoothness, resulting in a low RI value. However, since the distress or imperfection is not caused by severe failures within the pavement structure, the blended PCI value may not be significantly affected.

Structural Index (SI)

Structural adequacy testing was not requested by the City. Instead, IMS investigated the relationship between the PCI and the number of LAD observed in each pavement section to generate structural indices. Based on this analysis, each section was assigned a rating of *Weak*, *Moderate*, or *Strong* in terms of its strength. These ratings were represented by an SI of 30, 60, or 80, respectively. The established SI

was not used in calculating the overall pavement condition score but rather to help determine appropriate rehabilitation strategies based on the pavement strength rating.

Pavement condition index (PCI) – Following the field surveys, the condition data was imported to ESA for calculating the overall PCI. The PCI for each segment was calculated using the following percentages of weighing factors:

$$PCI = 100\% SDI$$

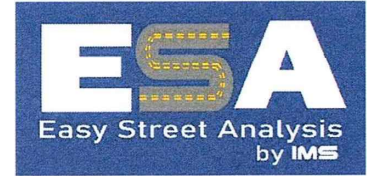
Table 2 presents each PCI category along with a brief description of the typical distresses and recommended treatments for each.

Table 2 – Pavement Condition Categories

Category	Typical Distresses and M&R Recommendations	PCI Range
Excellent	Like new condition – little to no maintenance required. Monitor condition or preventive maintenance.	85<PCI≤100
Very Good	Minor cracking, raveling, and other NLAD Routine or preventive maintenance. <i>E.g., Crack sealing, surface treatment</i>	70<PCI≤85
Good	Minor to moderate cracking and low severity LAD such as alligator cracking and rutting. Surface treatments with localized repairs and overlays <i>E.g., Surface treatments, localized surface patching, thin overlay</i>	60<PCI≤70
Fair	More extensive and severe longitudinal and transverse cracking, as well as moderate severity LAD Localized repairs or major rehabilitation. <i>E.g., Localized surface and/or full-depth patching, moderate overlays</i>	50<PCI≤60
Marginal	Localized high-severity alligator cracking, and rutting Major rehabilitation. <i>E.g., Localized full-depth patching, mill and overlay, traditional overlay</i>	40<PCI≤50
Poor	A greater extent of severe alligator cracking, rutting Major rehabilitation. <i>E.g., More extensive full-depth patching, mill and overlay, traditional overlay</i>	25<PCI≤40
Very Poor	Extensive and severe alligator cracking, more extensive and deeper rutting, and potholes. Major rehabilitation. <i>E.g., Full-depth reclamation, reconstruction</i>	0<PCI≤25

3.1 ESA Pavement Management System

The ESA software provides all the functionalities of a standalone software package while being user-friendly. It provides the City with a tool that can effectively catalog, classify, assess, track, and analyze condition data to aid in the processes of budget planning and pavement rehabilitation.



More specifically the program helps the City streamline its pavement management by giving structure to the basic information required for a management system:

- Pavement Section Inventory
- Inspection Data
- Pavement Deterioration Modeling
- Rehabilitation Selections & History
- Prioritization
- Work Planning
- Funding Analysis
- Reporting

The following pages will briefly detail the reasoning behind why this information is collected and used within the management program.

Pavement Section Inventory

An accurate inventory of all **city-owned** streets is necessary to make any determinations, assumptions, or projections within a management system. Individual attributes such as length, width, location, traffic use, surface type, condition, and other factors may be tracked and tied back to a single management segment within ESA. Thereafter, they are given a unique ID within the program. These attributes are critical in determining appropriate rehabilitation activities, prioritizing the management segments within the system, and facilitating placement and sorting during reporting.

Inspection Data

ESA provides the City with the flexibility to use a blended condition index that can be tailored to meet specific goals and requirements. The inputs for this index rely on inspection data from the field survey. This custom reporting value is built based on various aspects considered while ranking the condition of a pavement. The inputs for this index are derived from inspection data collected during the field survey, including PCI and International Roughness Index (IRI) data. Details on the individual components of the inspection are available earlier in Section 3.0.

Pavement Deterioration Modeling

Inspection data by itself is only capable of representing conditions at the time of collection. Nevertheless, within ESA there are customizable curves that can predict the rate of pavement deterioration based on a streets functional class, pavement type, and strength rating. These deterioration curves are critical in predicting future pavement conditions and determining appropriate rehabilitation strategies. The model assumes that pavements with similar attributes and usage will deteriorate at similar rates. For instance, high volume asphalt arterials that are already in poor condition are expected to deteriorate faster and are represented in **Figure 10** by a purple line. In contrast, low volume concrete local streets are expected to deteriorate slowly and are represented by a blue dashed line.

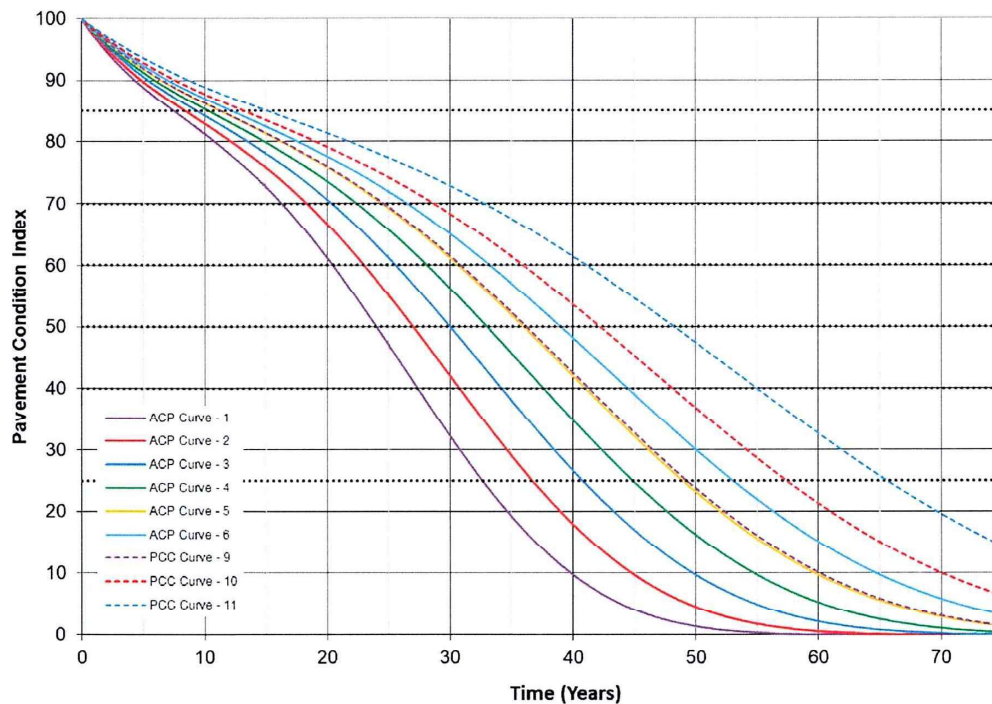


Figure 10 - Asphalt Concrete Pavement (ACP) and Portland Cement Concrete (PCC) Deterioration Curves

Rehabilitation Work Selections & History

ESA uses a set of protocols that allow for activities to be assigned to PCI ranges based on filter criteria that give the City the ability to create detailed rehabilitation strategy sets for each functional class and pavement type according to the best practices determined for that pavement.

As planned rehabilitation work is completed, a record of the work should be added to the pavement management system. This ensures that conditions are up to date for future selections and creates a repository of information to aid in planning.

Prioritization

Within ESA, the option is available to prioritize pavement projects for rehabilitation based on six main criteria: PCI, Cost of Deferral, Pavement Strength, Pavement Type, Functional Class, and the Area of a segment. Depending on the goals set forth at the beginning of the project, these criteria can be weighted differently based on their definition to create an overall priority factor for a project. Additional details on these factors are available in Section 5.

Project planning

The ability to plan work as needed allows the management program to better reflect the realities of a paving program. Certain constraints may be applied to funds that require their use within a certain year and activities relating to other assets may dictate the time and type of work to be performed. ESA allows for predefined projects to be entered into the management plan to account for work that is known. This ensures that the outcome is consistent with overall town planning and accurately reflects current funding allocations.

The preferred basis of rehabilitation candidate selection is to examine the cost of deferral of a street against increased life expectancy.

The actual process of determining where and when to spend funds is a function of the inputs mentioned in this section. Information from the street section inventory, condition survey, deterioration modeling, rehabilitation activity protocols, prioritization, and project planner are all assessed to predict the potential outcomes of funding scenarios. These can either be goal-based or budget-based. A more detailed description is available in Section 5.0.

ESA has the ability to generate basic reports for common data requests through a set of predefined layouts. This allows for quick access to section condition summaries, inspection data, budget scenario summaries, and data charts. The GIS data used to generate this report is also linked to the section summary information to allow for quick and easy visualizations of the data if imported into a GIS utility. An example of data, as presented in ESA, can be seen in **Figure 11**.



This section outlined the fundamental concepts of pavement management and described the implementation process for the City's pavement management system. The operating parameters of ESA were reviewed, and the inputs provided by the LCMS-2 technology were explained to provide context for calculating PCI, Roughness Index, and Pavement Strength.

4.0 PAVEMENT CONDITION SURVEY RESULTS

This section will review the results of the pavement condition survey performed in May 2023. This section includes a summary of conditions in the functional classes used in the City's analysis, followed by a review of network photos taken from the RST. A series of charts will then summarize the findings of the condition survey and provide an overview of the PCI distribution across the City's pavement network.

4.1 City Street Inventory and Condition Summary

The City of Yucaipa is currently responsible for approximately 202.6 centerline miles of pavement with an overall PCI of 51 and a backlog of 34.3%. On the following page, **Table 3** presents the City's inventory and pavement condition breakdown across different functional classes. Detailed information for each management section is available in **Appendix A**.

Table 3 - Network Inventory Summary by Functional Class and Pavement Type

	Pavement Type	Network	Arterial	Collector	Residential
Segment (Block) Count	All Streets	1998	299	424	1275
	Asphalt	1976	283	422	1271
	Concrete	22	16	2	4
Network Length (mi):	All Streets	202.6	42.3	50.6	109.6
	Asphalt	201.1	41.7	50.2	109.3
	Concrete	1.4	0.7	0.5	0.3
Average Width (ft):	All Streets	39.0	48.2	37.1	36.2
	Asphalt	39.0	48.3	37.3	36.3
	Concrete	31.7	42.4	20.3	26.4
Network Area (yd2):	All Streets	4,630,085	1,198,405	1,102,170	2,329,510
	Asphalt	4,603,205	1,182,007	1,096,472	2,324,726
	Concrete	26,880	16,398	5,698	4,784
Current Pavement Condition Index (CPCI) 5/28/23	All Streets	51	48	49	54
	Asphalt	51	47	49	54
	Concrete	82	88	65	82
Current Backlog (%)	All Streets	34	Percentage of Network with a PCI < 40		
Current Surface Distress Index (SDI) 5/28/23	All Streets	51	48	49	54
	Asphalt	51	47	49	54
	Concrete	82	88	65	82
Current Roughness Index (RI) 5/28/23	All Streets	66	70	65	64
	Asphalt	66	70	65	64
	Concrete	52	52	56	49

4.2 City Network Condition Imagery

The images presented in this section provide a sampling of the City's streets that fall into various condition categories. A discussion of potential rehabilitation strategies is included for each category.

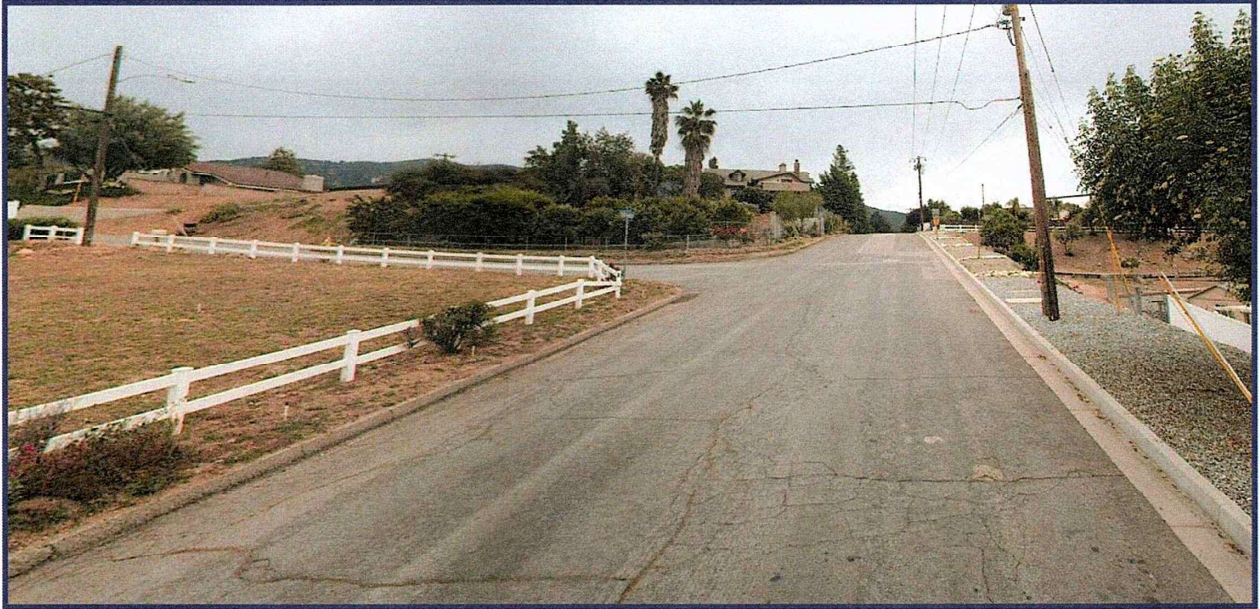
Very Poor (PCI = 0 to 25) – Complete Reconstruction



Ave B from End of Pavement to 2nd St (GISID 21276, PCI = 3) – Rated as *Very Poor*, this street displays a large quantity of alligator cracking severe enough to suggest that the pavement structure is inadequate for current traffic loads. The rehabilitation of roads in this condition through a mill and overlay is generally ineffective, as the failures usually extend to the bottom of the pavement layer. Streets in this condition require rehabilitation that involves removal and replacement of the asphalt layer, base stabilization, or complete reconstruction based on design requirements.

Deferral of reconstruction of streets rated as Very Poor will not cause a substantial decrease in overall pavement quality. The streets have passed the opportunity for overlay-based strategies, meaning that reconstruction, which can be expensive, is the most suitable solution. Thus, Very Poor streets are often deferred in favor of rehabilitating more streets at lower costs, resulting in a greater net benefit to the Town. This strategy, however, must be sensitive to citizen complaints that may demand the prioritization of these street repairs. In addition, this type of street can pose a safety hazard for motorists since severe potholes and distortions may develop. It is important to consistently monitor these streets and check for potholes or other structural deficiencies until the street is eventually rebuilt.

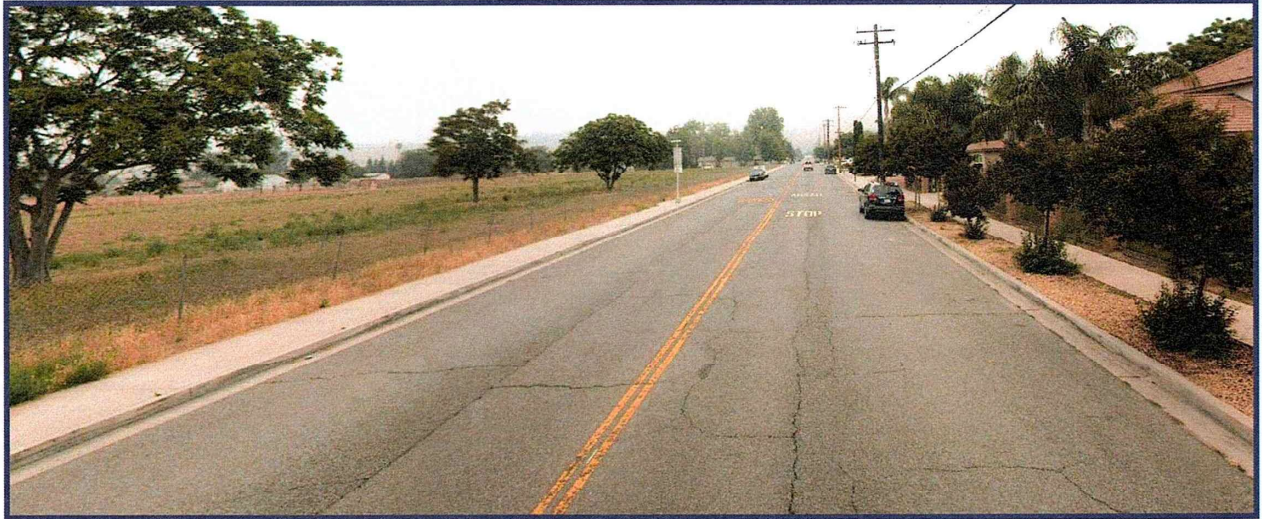
Poor (PCI = 25 to 40) – Last Opportunity for Surface Base Rehabilitation



Casa Blanca Ave from Acropolis Dr to Oak Glen Rd (GISID 20062, PCI = 28) – Rated as Poor, this segment contains alligator cracking and dispersed longitudinal and transverse cracking across the pavement. If left untreated, a partial to full reconstruction would be required within a short period of time.

On heavily trafficked roadways, Poor streets often require partial to full reconstruction. On local roadways, they generally require removal of the pavement surface through grinding or excavation, base repairs, restoration of the curb line and drainage, and then placement of a new surface.

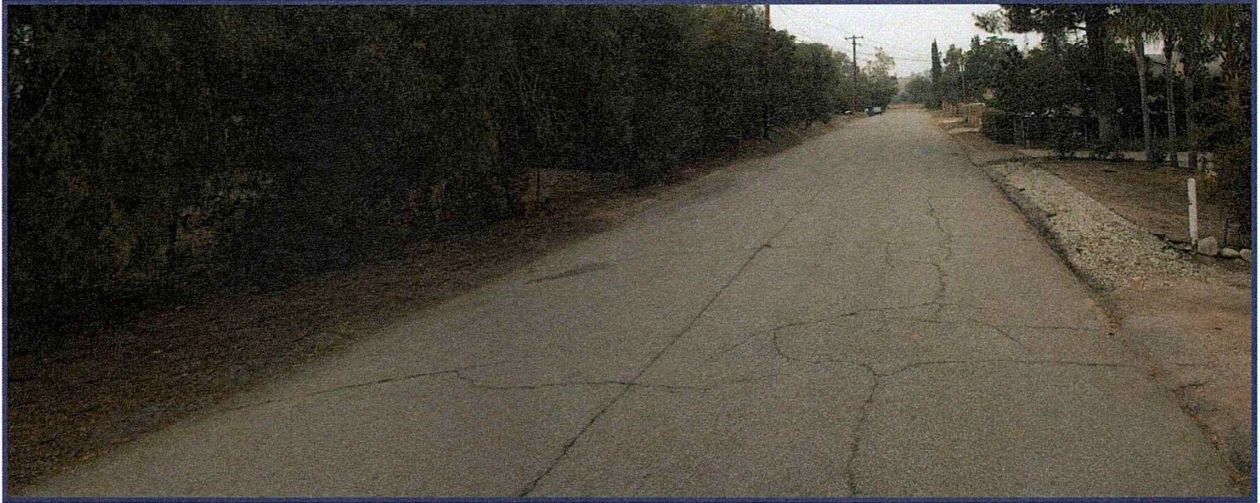
Marginal (PCI = 40 to 50) – Thicker Overlays



12th St from Avenue E to Avenue D (GISID 20654, PCI = 46) – This street displays deep transverse and longitudinal cracking throughout the entirety of the pavement.

Marginal streets that display high amounts of load associated distresses (LAD) are selected as a high priority for rehabilitation as they generally provide the best cost/benefit ratio to the City. If left untreated, Marginal streets with high amounts of LAD will deteriorate to become partial reconstruction candidates. Marginal streets that are failing due to materials issues or non-load associated failures may become suitable candidates for thick overlays if deferred, without a significant cost increase.

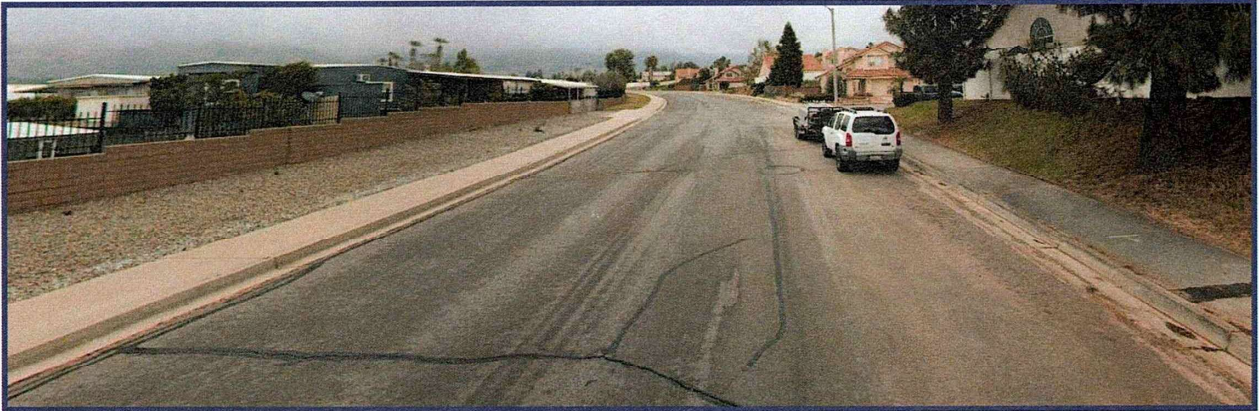
Fair (PCI = 50 to 60) – Thin to Moderate Overlays



Kentucky St from 13th St to 12th St (GISID 21439, PCI = 54) – Fair streets have similar characteristics to Marginal streets in that the distresses present tend to be localized and moderate in severity; however, the distresses will predominately be non-load related (i.e., caused by environmental or other factors). This street displays moderate amounts of longitudinal and transverse cracking, with some cracks being deep but localized.

Like Marginal streets, Fair streets can provide a good cost/benefit ratio to an agency if addressed with an adequate rehabilitation technique. Stretching the application for surface treatments into this range can pose a cheap alternative to overlays but does not provide the appropriate renewal to the structural capacity of the pavement and may allow load related deterioration to continue unabated.

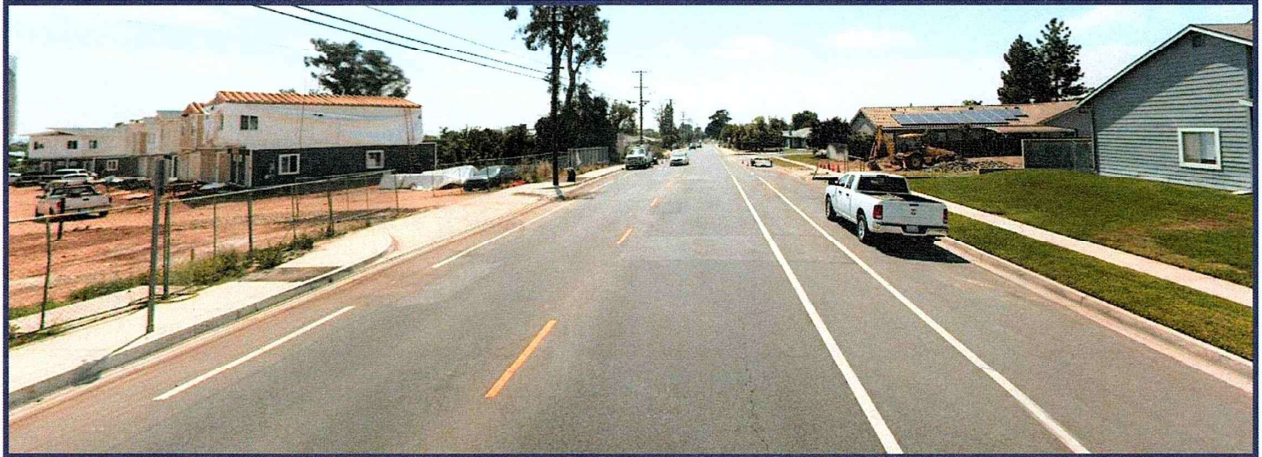
Good (PCI = 60 to 70) – Surface Treatments



Fir Ave from Sandalwood Way to Larkspur Way (GISID 21936, PCI = 65) – Rated as Good, the primary cause of deterioration for this street is the longitudinal and transverse cracking. The pavement surface shows signs of spot patching; however, some crack patches have failed and could be restored with additional patching or surface treatments to remedy the more heavily distressed areas.

Preventive measures on streets considered Good can have a positive impact on the City's funding needs. While the expected life of a slurry seal is not as long as that of an overlay, its ability to slow deterioration and relatively low cost can free up funding for streets in worse condition.

Very Good (PCI = 70 to 85) – Surface Treatments and Localized Rehabilitation



Avenue E from Birch St to Avenue E (TC) (GISID 21176, PCI = 75) – Rated as Very Good, this street displays minor amounts of transverse cracking. It is an example of a candidate for preventive maintenance to extend the life of the roadway.

Also, routine maintenance prevents water intrusion by sealing and slowing crack growth. By keeping water out of the base layers, the pavement life is extended without the need for heavier rehabilitations.

Excellent (PCI = 85 to 100)



Cornell Dr from Grant Dr to Holmes St (GISID 21195, PCI = 97) – Rated as Excellent, this pavement displays little to no surface distresses. The ride is smooth, and the surface and the base are intact. Excellent roads should be periodically assessed for crack development that would trigger routine maintenance activities.

4.3 City Network Condition Distribution

Figure 12 shows the distribution of pavement condition for the roadway network in Yucaipa.

- Just over six percent (6.2%) of the network can be considered in *Excellent* condition and should be closely monitored to ensure timely application of early localized preventive measures.
- Approximately twenty-three percent (23.4%) of the network falls into the PCI range considered *Very Good*. These are roads that benefit most from preventive maintenance techniques, such as spot patching and slurry seals.
- Thirteen percent (13.0%) of the streets are rated as *Good* and may still be candidates for slurry seals or thin overlays.
- Twenty-three percent (23.0%) of the network can be considered in *Fair to Marginal* condition and represents candidates for progressively thicker overlay-based rehabilitation. If left untreated, they will decline rapidly into reconstruction candidates.
- Approximately thirty-four percent (34.3%) of the network is rated as *Poor* or *Very Poor*, meaning these roadways have deteriorated to the point where surface rehabilitation can no longer restore the pavement to a point of structural adequacy. Rehabilitation of the entire pavement structure is required for these segments.

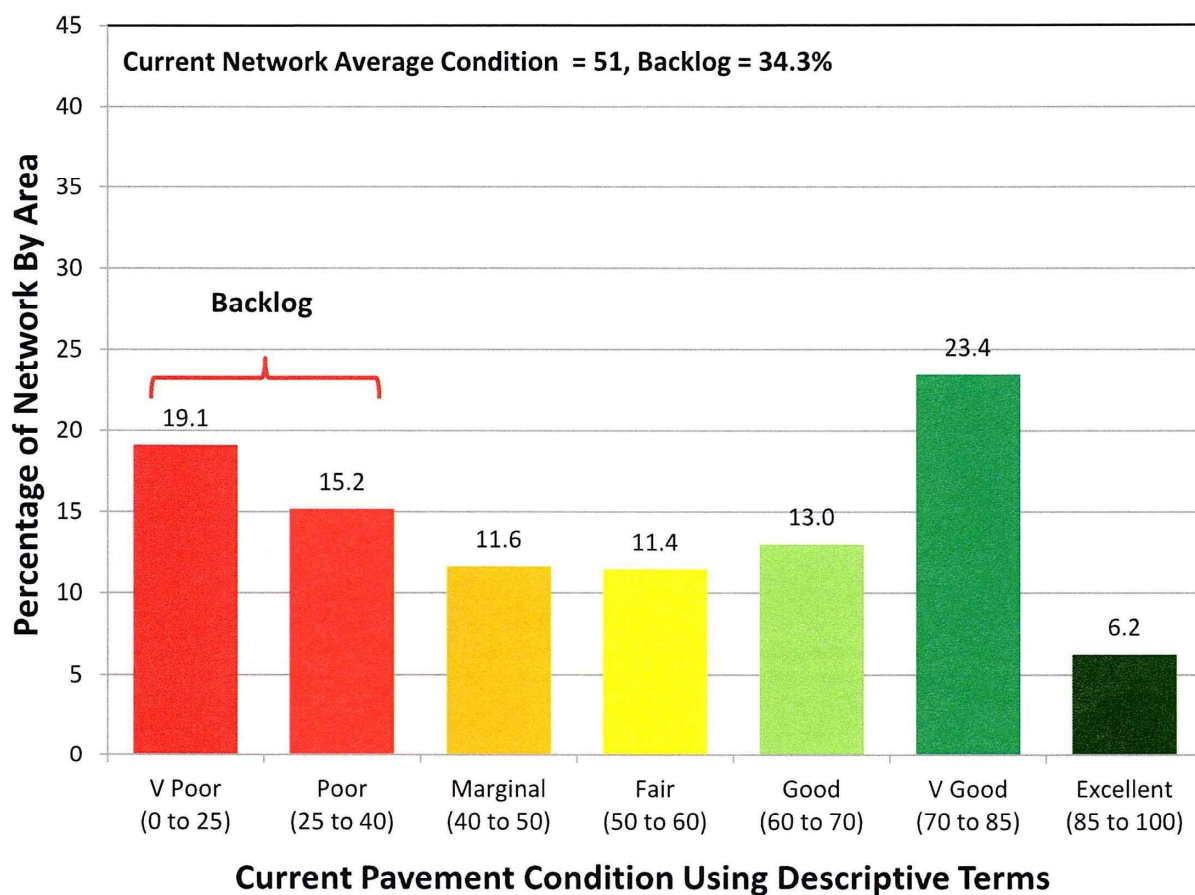


Figure 12 - Roadway Network Present Status Using Descriptive Terms

National and State Comparisons

The current national average PCI as measured by IMS and its clients is **65.2**. The City was found to have a lower than average PCI of **51**. When the current recorded average for the state of California is calculated using IMS data, the City again scored lower with an average PCI of **51 compared to 67.7**.

The City's backlog is higher than the national average, **34.3% compared to 10.6%**. The state of California also has a lower overall average backlog of **7%**.

4.4 Condition By Functional Classification

Analyzing subsets of data in addition to the overall pavement condition can provide a better understanding of where an agency should focus its resources. **Figure 13** displays the distribution of pavement conditions for each functional class, revealing that arterial and collector roads contribute almost equally to the portion of the City's network categorized as *Marginal* or below in condition (under 50 PCI). Although residential roads have the highest average PCI of the three functional classes and 41.3% of roads in this class are categorized as *Very Good* or *Excellent*, 32.5% are still categorized as part of the network backlog.

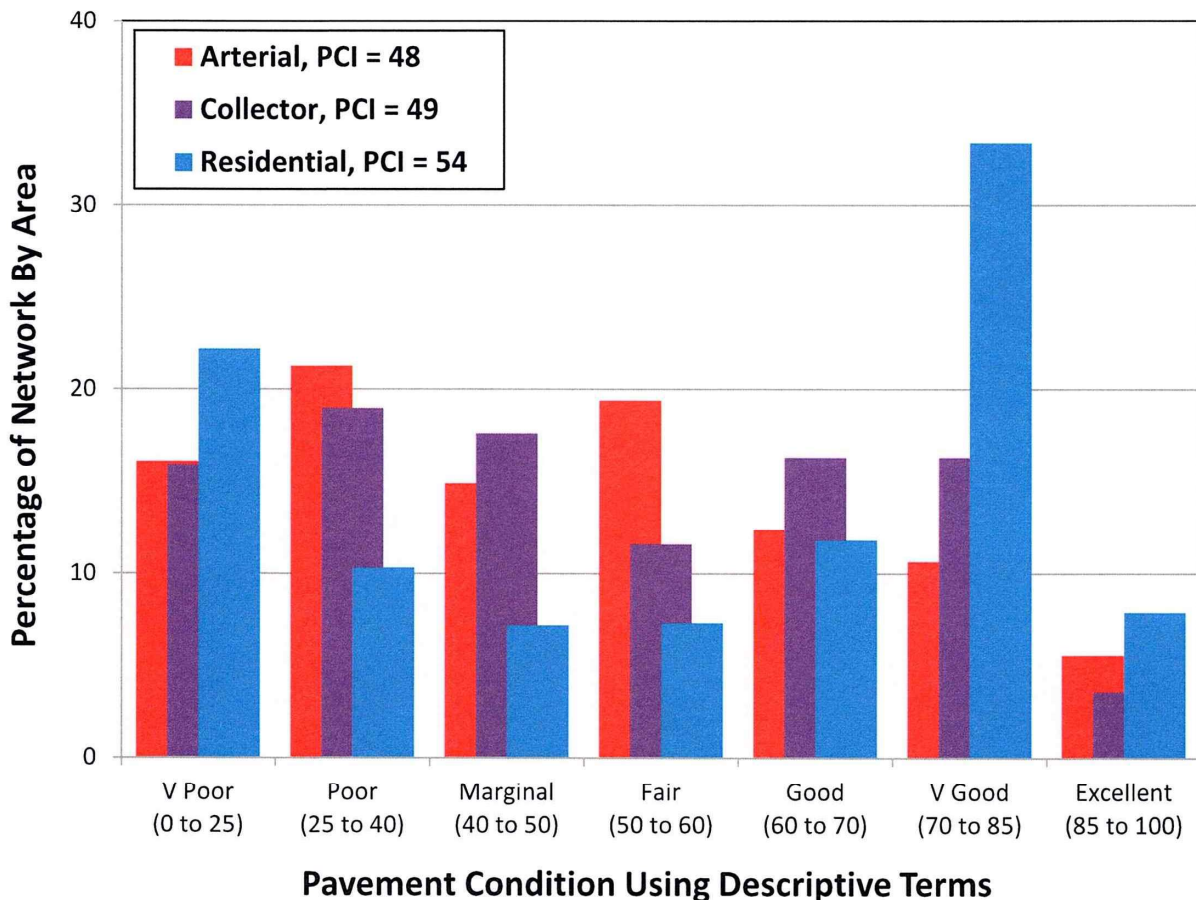


Figure 13 - Condition Rating by Functional Classification

When evaluating the condition of pavement based on the percentage of network it covers, the proportion of each class in the overall network must also be considered. This distribution is illustrated in **Figure 14**. Local and minor arterial roads have the lowest PCI out of the four functional classes. Even so, minor arterials make up only 6% of the total network, so their condition will likely affect fewer citizens compared to a larger class like local roads. Therefore, the City should focus its preventive maintenance efforts on the class types that contribute to a greater degree to the overall network.

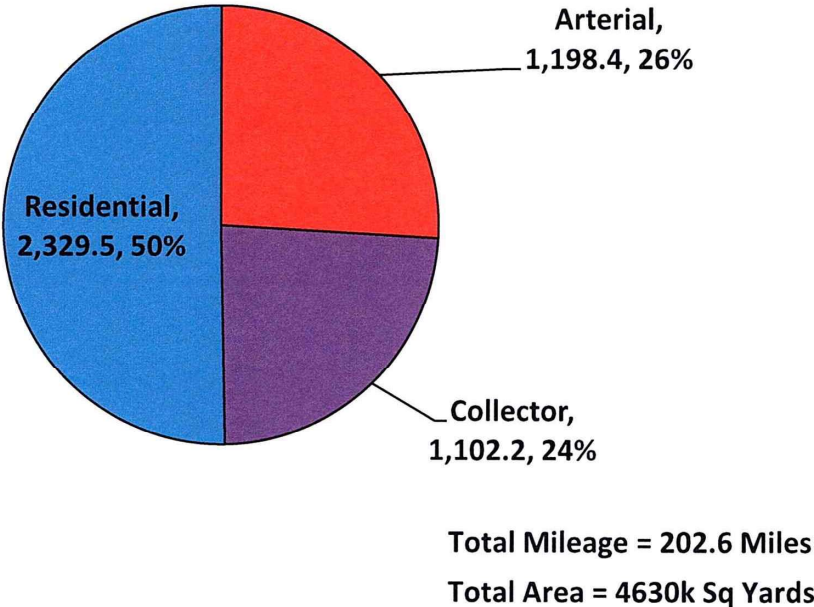


Figure 14: Functional Classification Distribution By Area

4.5 Condition By Pavement Type

The maintenance and improvement of asphalt and concrete pavements may require different rehabilitation activities that come at different costs. **Figure 15** displays the distribution of pavement conditions for each pavement type.

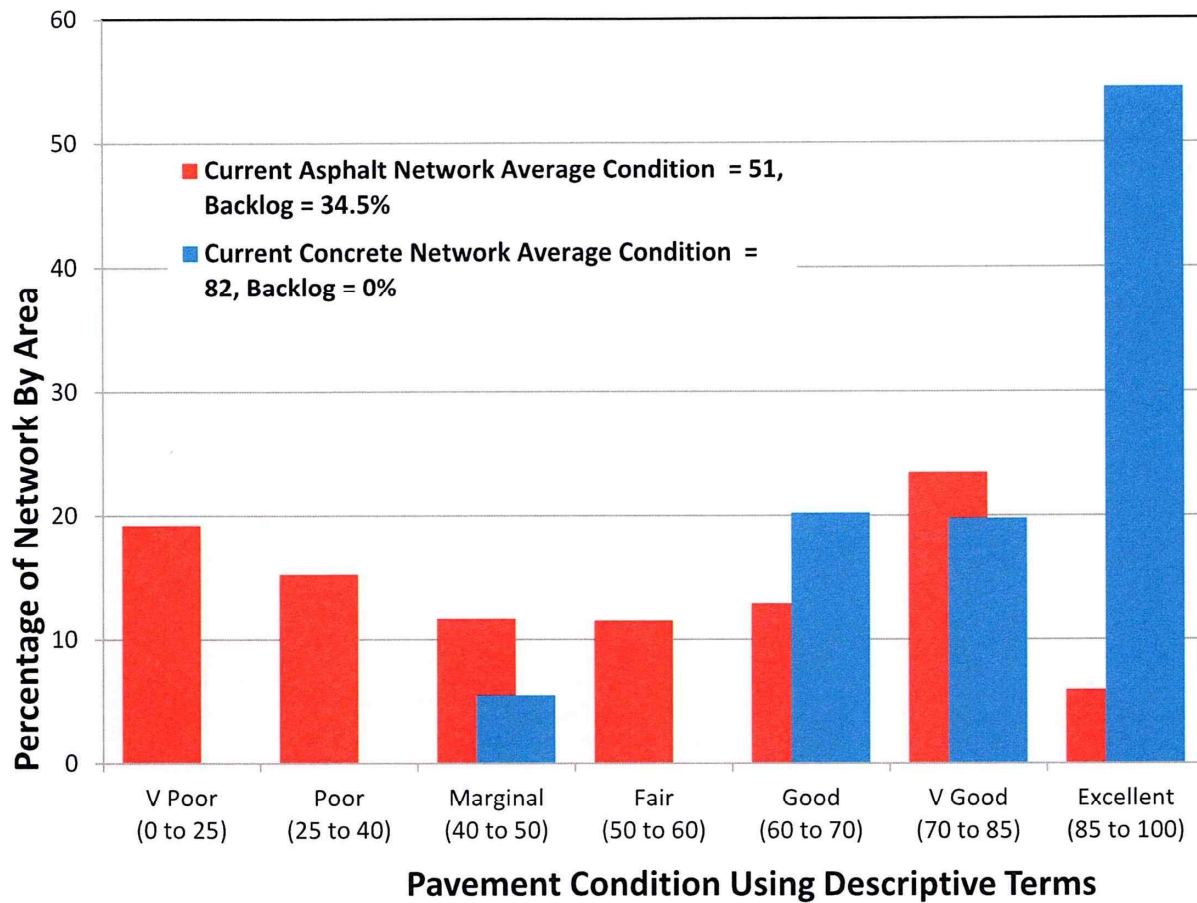


Figure 15: Current Pavement Condition By Pavement Type

The graph shows that the City’s concrete network has a higher average PCI than its asphalt network. A total of 74.3% of the concrete network was categorized as being in *Very Good* or *Excellent* condition, while only 29.5% of the asphalt network falls into these categories. It is important to note that concrete pavements make up only 1% of the City’s total network. This means that the average PCI of the asphalt pavement type has a greater impact on the overall PCI of the network.

4.6 Summary

Section 4.0 of the report provided a detailed analysis of the results obtained from the pavement condition survey conducted in the City of Yucaipa. The section covered the three functional classifications in the City and their respective PCI values, which were further illustrated with pavement photographs taken during the survey. Additionally, the section provided a breakdown of the pavement condition distribution for each functional class and pavement type. **Overall, the network average PCI for Yucaipa was found to be 51 with a backlog of 34.3%.**

5.0 REHABILITATION PLAN & BUDGET DEVELOPMENT

This section discusses the results of the pavement management analysis that was performed using the ESA pavement management system, starting with an overview of the assumptions that were used when implementing the system, such as the unit rates and the selection methodology for rehabilitation candidates. The subsequent section, 5.2, details the results of each of the various five-year budget runs beginning in January 2024, along with their predicted conditions. This is highlighted further through a series of charts that are used to demonstrate the advantages and disadvantages of various funding models.

5.1 Key Analysis Set Points and Assumptions

Pavement management analysis requires user input to complete its condition forecasting and prioritization. A series of operating parameters were developed to create an efficient program that is tailored to the City's needs.

Selecting Segments for Rehabilitation

The selection of rehabilitation candidates through a worst-first approach or subjective committee input is neither efficient nor cost effective. It is important to establish a set of criteria and determine their importance in the selection process. ESA has defined commonly used criteria within the program that allows different weighting factors to be applied depending on the City's goals. This approach can lead to more objective and effective selection of rehabilitation candidates.

- **PCI** – As mentioned earlier in this section, the results of the pavement condition survey are used to generate a PCI that ranges from 0-100 where 0 is considered the worst and 100 the best. This factor can be given a higher weight to give greater priority to poor condition streets.
- **Cost of Deferral** – As time passes a pavement will deteriorate and require more costly repairs as it ages. ESA can be configured to prioritize streets nearing the point where this cost increase occurs.
- **Pavement Strength** – Through the use of deflection testing or the prevalence of LAD, the relative strength of a pavement can be determined. A prioritization factor can be applied that gives preference to streets that may deteriorate faster in order to apply more cost-effective rehabilitation early in the life cycle.
- **Pavement Type** – Depending on costs, design life, and the City's goals, a weighting factor can be applied based on the materials used to construct the pavement.
- **Functional Class** – Generally higher volume streets are given the greatest priority within a program since they serve the most vehicles.
- **Area** – Project selection can consider the size of a project when determining rehabilitation priority. The City can decide to select large groups of streets over small ones if that approach suits the goals set forth at the beginning of the project.
- **Planned or Committed Projects** – When developing the rehabilitation plan, projects that are already scheduled to be completed are taken into consideration. This is done by adjusting the PCI scores to reflect the expected improvement resulting from these projects.

For the City, the weighting factors for these categories were established with the aim of maximizing the cost savings associated with the concept of deferred maintenance and addressing Weak pavements with lower PCI scores. The goal is to minimize the growth of the backlog.

Rehabilitation Strategies and Unit Rates

The funding requirements for the City are mainly determined by the rehabilitation strategies and unit rates used in the budget analysis. **Table 4** presents a breakdown of the costs associated with different pavement rehabilitation activities and their application. The table also suggests a recommended rehabilitation funding sequence based on the cost of deferral. A lower number in this column indicates a higher priority for rehabilitation based on the cost of deferral.

The parameters to consider when forming rehabilitation strategies include:

- **Rehab Activity** – This includes the assigned identifier and name of each rehabilitation strategy. Various degrees of slurry sealing are outlined to highlight the increasing cost associated with additional patching requirements for lower PCI streets.
- **Min, Max, and Critical PCI** – The PCI range for the application of a specific rehabilitation activity is determined by the Min and Max values that set the upper and lower limits, while the Critical PCI indicates the threshold at which rehabilitation becomes a higher priority to leverage the cost of deferral factor. There can be overlap in the PCI range to allow for further differentiation based on pavement strength.
- **Unit Rates** – The cost of rehabilitation is presented per square yard for each combination of pavement type, functional class, and rehabilitation activity. A base unit rate is set for the lowest assumed cost of a work type, and it is adjusted for each functional class to account for additional work such as traffic control, intersection improvements, landscaping, utility adjustments, and right-of-way (ROW) infrastructure. IMS worked closely with the City to determine rates that accurately represent the cost of work.

Table 4 – Rehabilitation Rates

Pavement Type	Rehab Activity	Min PCI	Critical PCI (Need Year)	Max PCI	BUR ¹	AUR	CUR	RUR	Reset PCI	Rehab Priority
All	Routine Maintenance	85	100	100	0.00	0.00	0.00	0.00		
Asphalt	Slurry Seal / Seal Coat	80	82	85	4.29	4.70	4.60	4.50	85	15
Asphalt	MicroSurface / Chip Seal	70	73	80	6.50	7.25	7.00	6.75	88	1
Asphalt	MicroSurface / Chip Seal + Structural Patch				7.15	8.00	7.75	7.50	88	4
Asphalt	Edge Mill + Thin Overlay (1.5 - 2.0)	60	63	70	47.97	53.00	51.50	50.50	92	12
Asphalt	Edge Mill/Full Width Mill (FWM) + Moderate Overlay (2.0 - 3.0)	50	54	60	53.73	62.00	60.00	58.00	94	11
Asphalt	FWM + Thick Overlay (> 2.0 - 3.0)	40	44	50	58.31	70.50	67.50	64.50	96	2
Asphalt	Surf Recon + Base Rehab / FWM + Structural Patch + Overlay	25	30	40	106.93	129.00	124.00	118.00	98	3
Asphalt	ACP Full Depth Reconstruction	0	15	25	170.63	188.00	183.00	179.00	100	4
Concrete	PCC Joint Rehab & Crack Seal	80	82	100	5.00	5.50	5.50	5.25	83	11
Concrete	PCC Localized Rehab	70	73	80	11.00	12.75	12.25	11.75	85	3
Concrete	PCC Slight Panel Replacement (<10%)	60	63	70	22.50	27.25	26.00	24.75	88	1
Concrete	PCC Moderate Panel Replacement (< 20%)	50	54	60	34.50	44.00	41.50	39.00	90	6
Concrete	PCC Extensive Panel Replacement (<33%)	40	44	50	47.50	63.00	59.00	55.00	94	8
Concrete	PCC Partial Reconstruction	25	30	40	65.50	83.00	78.50	74.00	96	5
Concrete	PCC Full Depth Reconstruction	0	15	25	99.50	132.50	123.50	115.00	100	10

5.2 Network Budget Analysis Models

The pavement management analysis using the ESA system involved combining the condition assessment, deterioration model, prioritization factors, and rehabilitation assignments to conduct a budget analysis. With this information, the program can predict the outcomes of different funding levels or suggest the funds necessary to achieve specific goals. To model network trends and estimate the funding levels needed to reach certain condition and distribution targets, IMS conducted an analysis using a series of budgets. The results of this analysis are detailed in this section.

Budget Targets

The following scenarios were generated to forecast the outcomes of the current estimated City budget compared to City's target PCI goals over the next five years. The models determine what level of funding may be appropriate going forward. The values for backlog and PCI have been rounded to the nearest whole number to improve legibility. Varying budget figures will have slightly different outcomes that are visible in the charts but may not be completely represented in the legend text.

¹ Unit rate names were shortened in the table to conserve space. All unit rates are provided in dollar per square yard (\$/yd²). Please refer to the following list for the complete names: Base Unit Rate (BUR), Arterial Unit Rate (AUR), Collector Unit Rate (CUR), and Residential Unit Rate (RUR).

Five-year Models:

- **Yucaipa Budget** (Green Line) – This represents the City’s current average annual budget of **\$10M/Yr.** dedicated to pavement preservation and rehabilitation. This level of funding will result in a network average PCI score of **46** and a backlog of around **43%** after five years.
- **Maintain Current Backlog** (Red Dashed Line)– The Maintain Current Backlog budget was developed in order to maintain the current backlog of around 34%. This results in a budget value of **\$27.69M/Yr.** and a PCI increase to **53** after five years.
- **Steady State PCI** (Red Line) – This is simply the funds required to maintain the current network average PCI at around **51**. The annual budget required to do so is approximately **\$22.47M/Yr.** Backlog will increase to **37%** of the network after five years.
- **Backlog Control** (Purple Dashed Line) – The Backlog Control budget was developed in order to restrict the backlog to a maximum of **38%**. The funding required to achieve this backlog goal is **\$20.58M/Yr.** and will also decrease the PCI to **50** after five years.
- **PCI Control** (Purple Line) – The PCI Control model determines the funding required to maintain the PCI at a minimum level of **46**. This budget is **\$10.19M/Yr.** and will result in a backlog of **43%** after five years.

The results of the analysis are summarized in **Figure 16**. The x-axis highlights the annual budget, while the y-axis plots the five-year Post Rehab Network Average PCI values. The diagonal blue line is the network trend model developed to show estimated PCI along with a funding range up to \$40M/Yr.

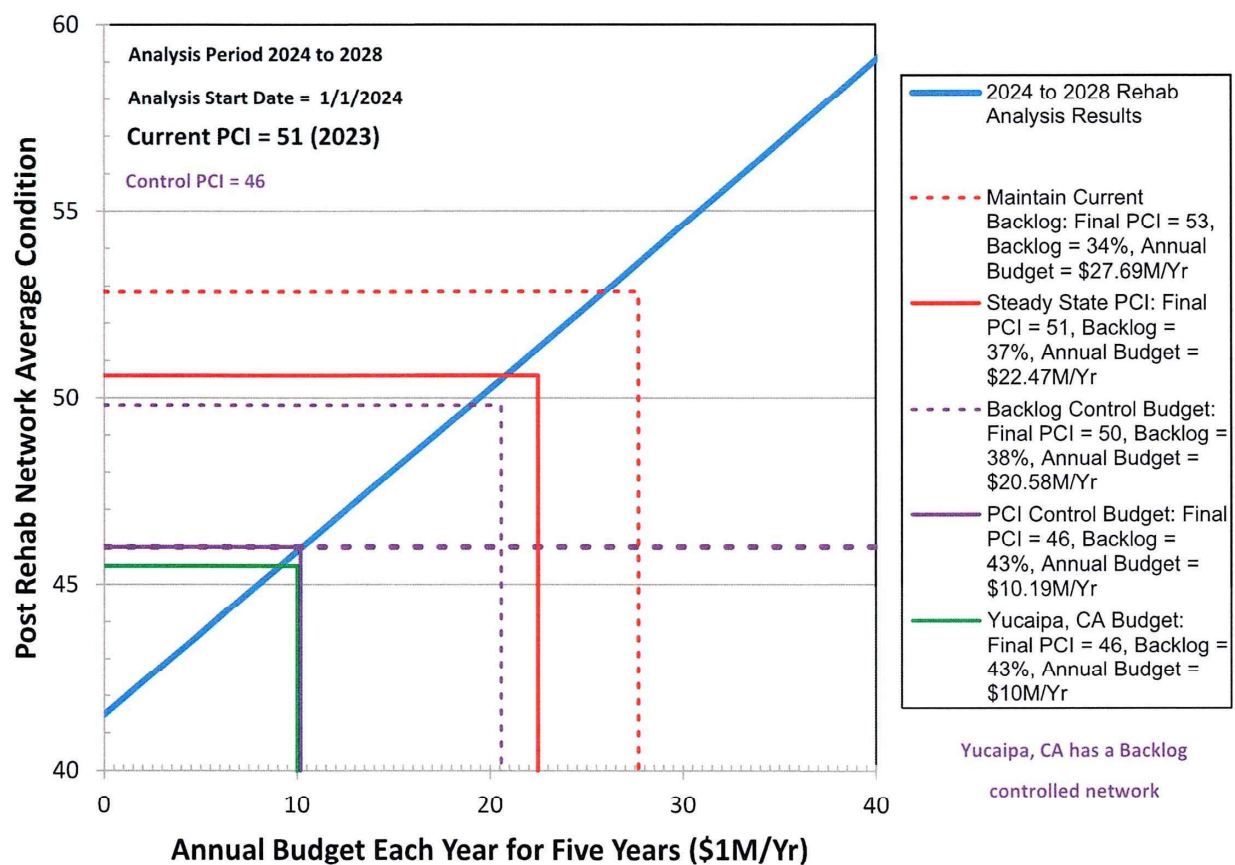


Figure 16 – Five-year Post Rehab Network PCI Analysis Results

Figure 17 presents the resultant network backlog against the annual budget. It is similar to **Figure 16**, but instead of plotting the average PCI score, it displays the total backlog after five years with a blue diagonal line. The City currently maintains a backlog of 34.3%. As the backlog grows, the funding required to return to the current level will increase.

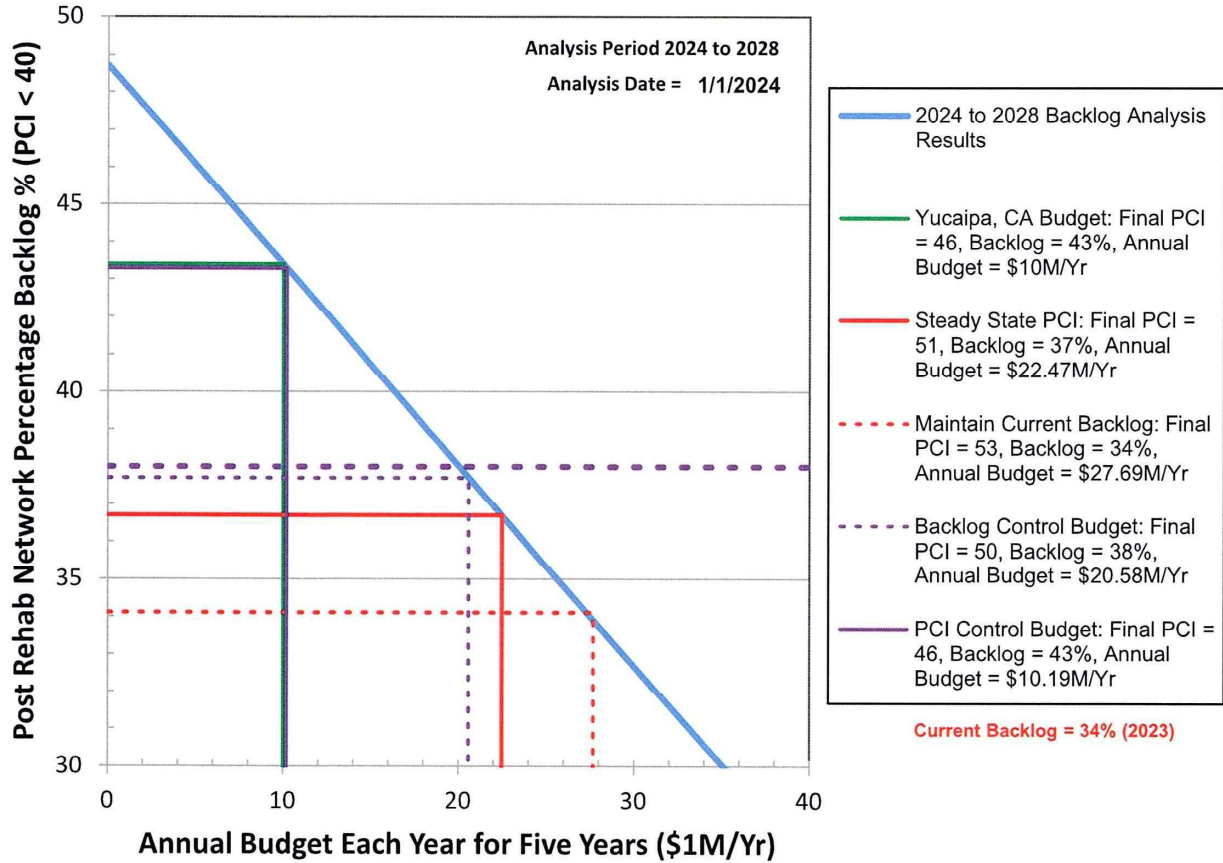


Figure 17 – Five-year Post Rehab Network Backlog Results

Figure 18 presents the analysis results on an annual basis. This shows that if the budget falls below \$22.47M/Yr. (Steady State PCI Budget), over time the overall condition of the roads is expected to deteriorate as the backlog grows. The City's current budget of \$10M per year follows the same pattern as the backlog control budget and the majority of the green line representing the budget is covered by the solid purple; however, it is still possible to see that a budget of \$10M is not enough to keep the condition of the City's network from declining.

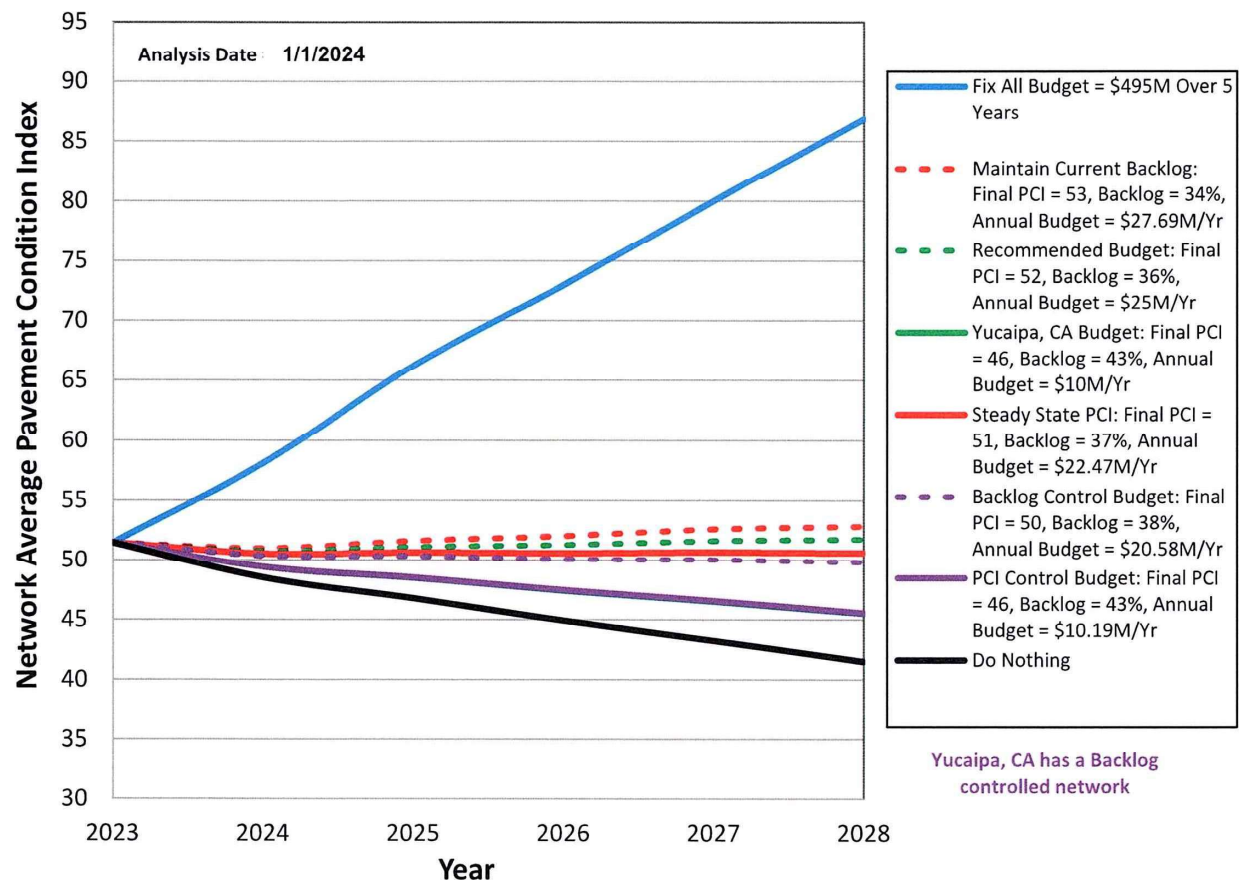


Figure 18 – Five-year Annual PCI

1.1 Post Rehabilitation Condition

Figure 19 compares the percentage of the City's network area separated into each pavement condition category for two scenarios: the current network average condition (shown in red) and the projected condition in five years with the City's budget (shown in blue). The analysis shows that if the City's current budget is maintained, the average PCI is expected to decrease to 46 by the end of the five-year analysis period, and the backlog is projected to decrease to approximately 43.4%. The total percentage of *Very Good* and *Very Poor* pavements are predicted to be affected the most, with the total percentage of *Very Good* decreasing by almost 10% and *Very Poor* increasing by approximately 8%.

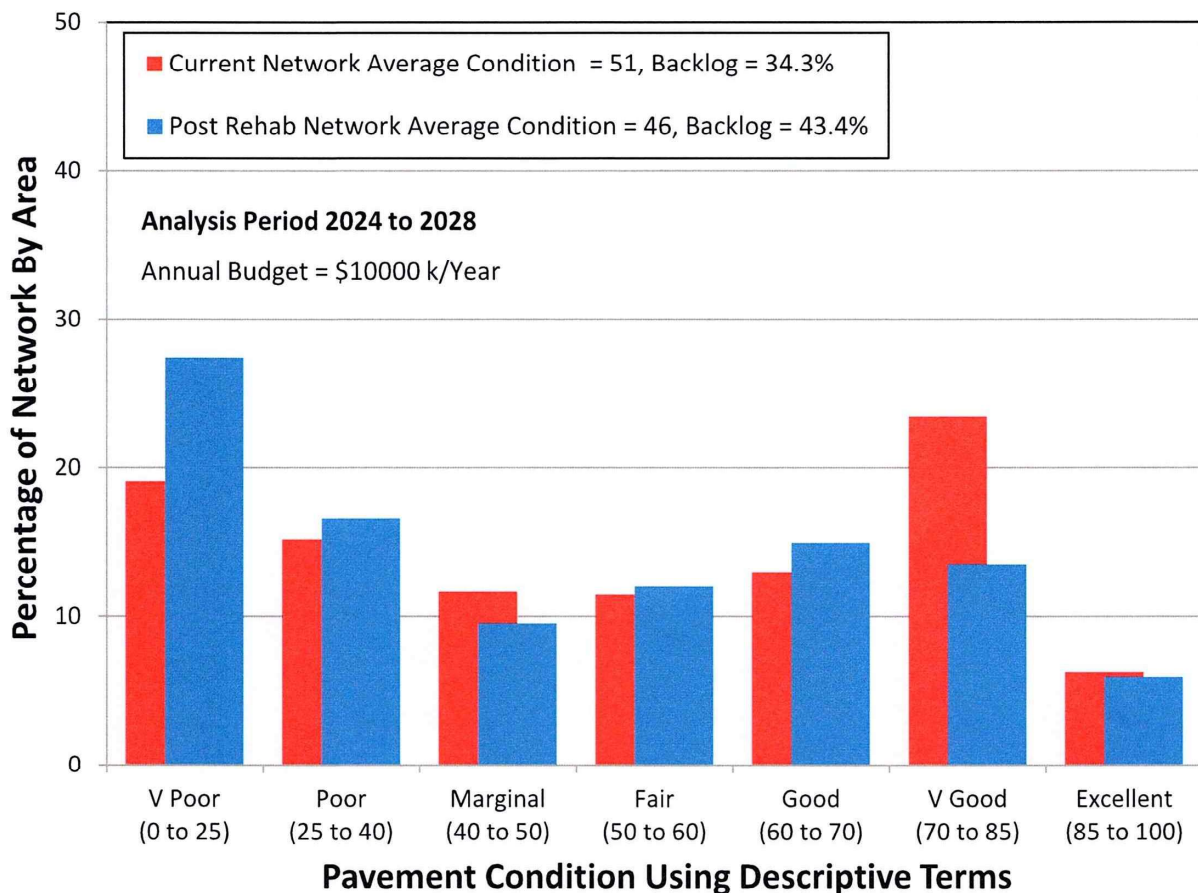


Figure 19 – Comparison of Pavement Condition Outcome of Two Potential Budgets over Five Years

5.3 Summary

The pavement analysis models conducted using the ESA program showed that the current annual budget of \$10M for pavement management would result in negative change in pavement condition over a period of five years, resulting in a five-year post rehab PCI of 46 and a backlog of 43.4%. Maintaining the current backlog level at 34.3% would require an annual budget of approximately \$27.69M and increase the PCI to 53. These findings highlight the importance of adequate funding for pavement management to maintain the quality and safety of the City's roads.

6.0 PROJECT RECOMMENDATIONS & COMMENTS

6.1 Project Summary and Recommendations

A pavement condition survey was performed in May 2023 on the full City pavement network. The results of the condition survey were aggregated into the ESA pavement management system. This system facilitated the creation of a georeferenced pavement inventory, enabled the development of a precise model of the network's current condition and anticipated future deterioration, and provided recommendations for funding to meet various level-of-service objectives.

The following broad recommendations are presented to the City as an output from the pavement analysis and must be read in conjunction with the previous sections.

- The City should make efforts to keep the ESA spreadsheet up to date.
 - By maintaining and updating the rehabilitation unit rates, work history of the segments, and accuracy of the inventory, the City will be able to reliably forecast funding needs for future years. This allows the City to be proactive in maintaining the condition of the pavement network at an acceptable level.
- The City should periodically resurvey the pavement network.
 - Pavement performance over time involves many variables, such as traffic volumes, environmental factors, maintenance timing, and design standards. As these variables change, the rate at which a pavement deteriorates will change with them. The periodic resurvey of pavement conditions allows the City to track these changes and update models accordingly, ensuring that appropriate rehabilitation measures are being planned.
- The City should investigate new and additional rehabilitation activities.
 - Advancements in pavement rehabilitation technology are constantly being made, and it is recommended that the City periodically update its planned rehabilitation activities in the ESA program to take advantage of these advances
- The City should strive to maintain or better its current condition if possible.
 - Maintaining a pavement network in good condition is more cost-effective than restoring conditions after deterioration. The City's current pavement network has an overall PCI of 51 with a backlog value of 34.3%. If the current annual budget of \$10M is maintained, the models show the PCI will decrease to 46 and the backlog will increase to 43% after five years.

6.2 Closing

The IMS Team greatly appreciates the opportunity to work with the City on this pavement management update. Over the course of this project, the team has observed the City staff's dedication to offering the best possible service to their community. IMS stands ready to assist the City with training and technical support as necessary and welcomes the opportunity to work with the City on future pavement management projects.

ATTACHMENT 2

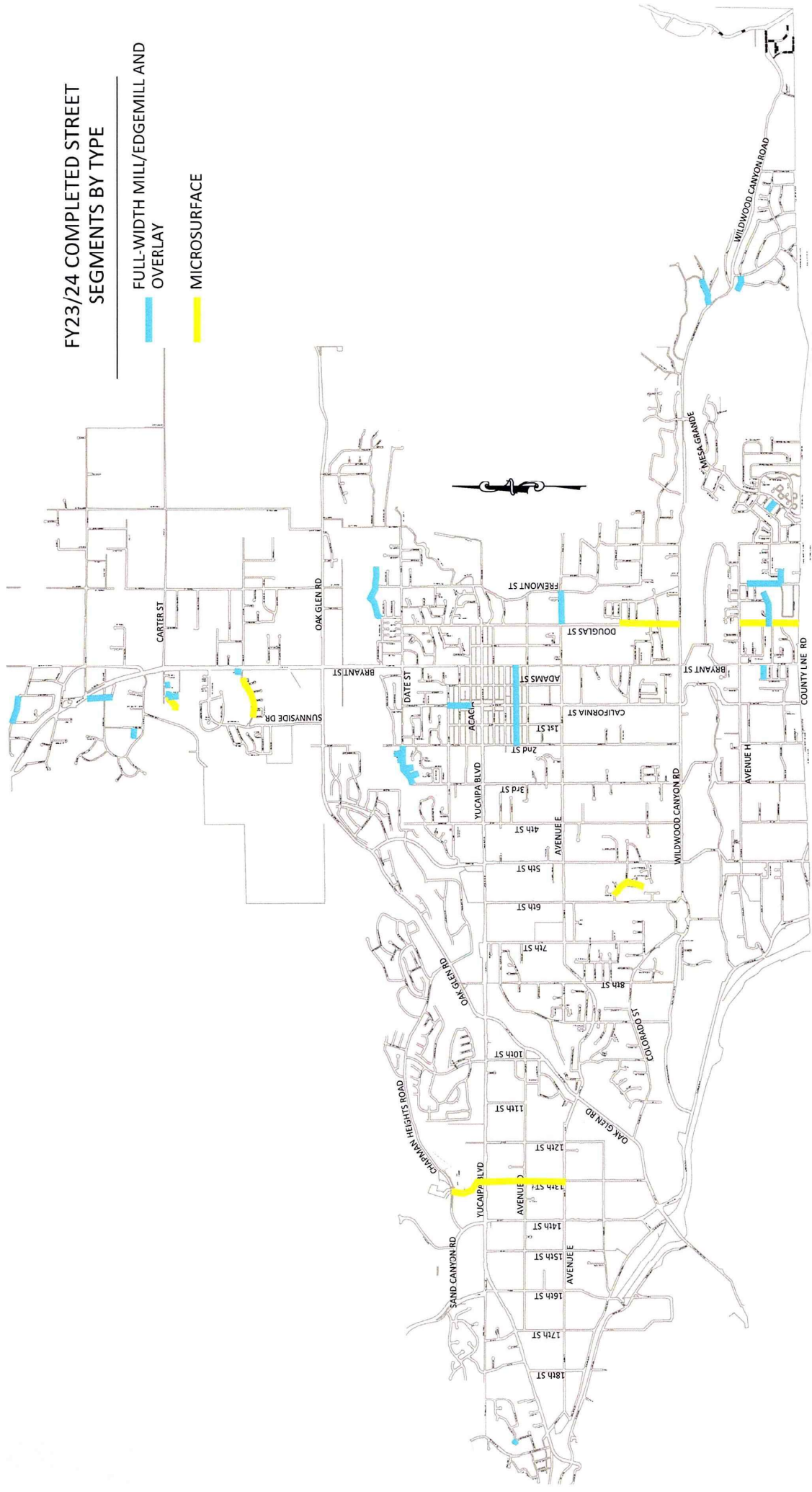
FY24/25 PAVEMENT MANAGEMENT PROGRAM

**FY23/24THROUGH FY28/29 PMP
BUDGET SUMMARY TABLE**

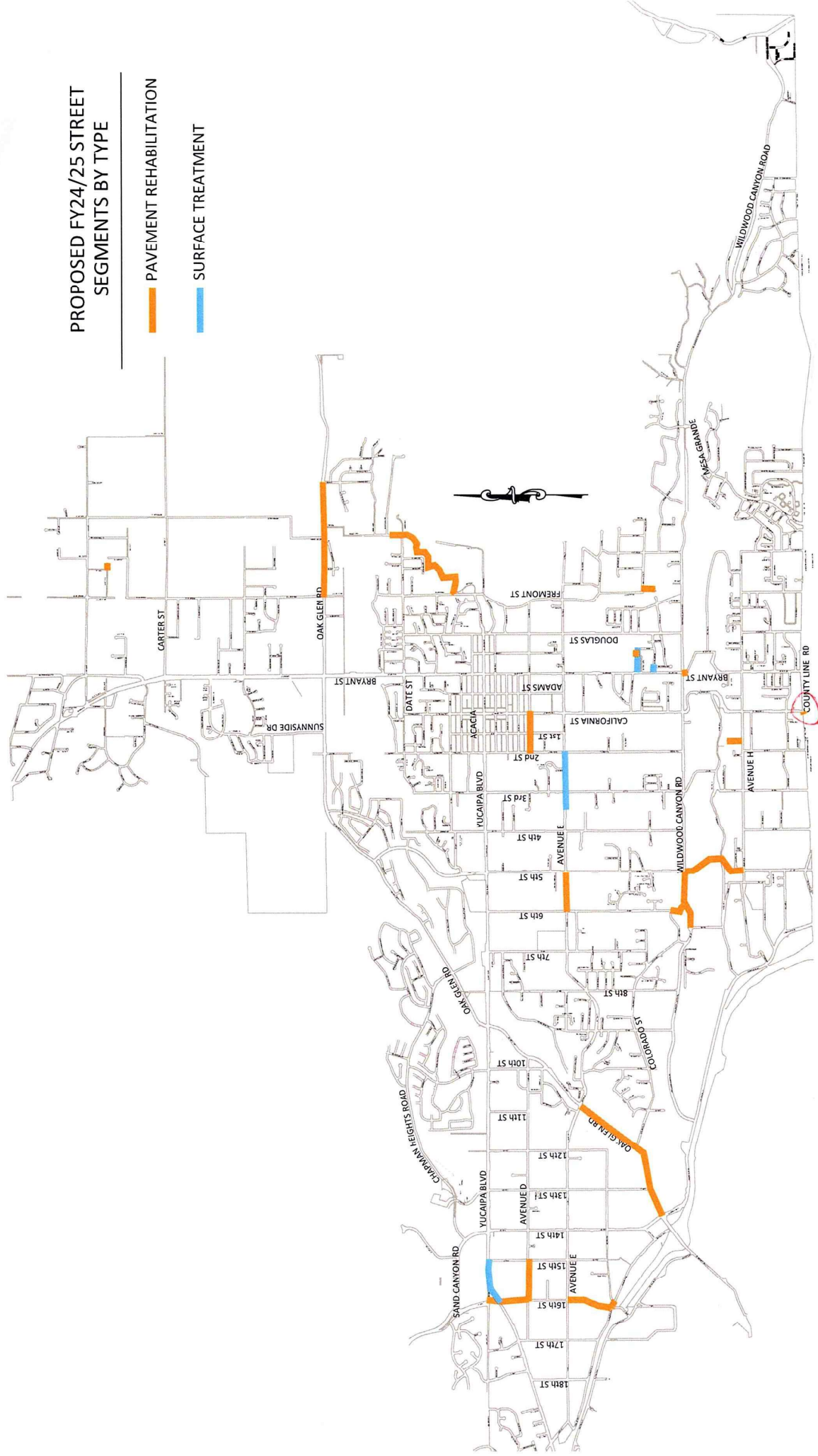
Pavement Maintenance Item Description	FY 23/24	FY 24/25	FY 25/26	FY 26/27	FY 27/28	FY 28/29
Pavement Rehabilitation (Residential and Arterial/Collector)	\$2,181,790	\$2,058,694	\$1,808,694	\$1,619,611	\$1,493,555	\$1,367,500
Surface Treatment (Microsurface)	\$140,000	\$1,152,868	\$1,085,216	\$906,982	\$896,133	\$765,800
Patching (subgrade failed areas)	\$94,920	\$226,456	\$198,956	\$178,157	\$164,291	\$150,425
Crack Seal	\$49,000	\$205,869	\$180,869	\$161,961	\$149,355	\$136,750
Additional Maintenance Programs						
AC Berm Replacement	\$0	\$82,348	\$0	\$64,785	\$0.00	\$54,700
Concrete Replacement	\$80,000	\$205,869	\$180,869	\$161,961	\$149,357	\$136,750
Understreet Drain Pipe Repair	\$30,000	\$41,174	\$36,174	\$32,392	\$29,871	\$27,350
Striping/Pavement Markings	\$30,000	\$82,348	\$72,348	\$64,784	\$59,742	\$54,700
Neighborhood Traffic Calming	\$30,000	\$61,761	\$54,261	\$48,588	\$44,807	\$41,025
Interagency Paving Agreements (Utility Companies)	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000	\$40,000
Street Maintenance Total	\$2,675,710	\$4,157,387	\$3,657,387 ⁽⁴⁾	\$3,279,221	\$3,027,111	\$2,775,000
Revenues & Transfers of Revenues From Other Funds						
Inter-Agency Paving Agreements (YWWD)	40,000	40,000	40,000	40,000	40,000	40,000
Measure I - Sales Tax ⁽¹⁾	900,000	2,182,387	2,182,387	1,804,221	1,552,111	1,300,000
Gas Tax/Prop 42 ⁽²⁾	130,000	85,000	85,000	85,000	85,000	85,000
SB1 ⁽³⁾	1,000,000	1,850,000	1,350,000	1,350,000	1,350,000	1,350,000
General Fund	876,800	0	0	0	0	0
Total Transfers & Revenues:	\$ 2,946,800	\$ 4,157,387	\$ 3,657,387 ⁽⁴⁾	\$ 3,279,221	\$ 3,027,111	\$ 2,775,000
Annual Recommended PMP Expenses:	\$ 2,675,710	\$ 4,157,387	\$ 3,657,387	\$ 3,279,221	\$ 3,027,111	\$ 2,775,000
Projected Year-End Fund Balance:	\$271,090	\$0	\$0	\$0	\$0	\$0

⁽¹⁾ Includes one-time carryover balance of \$2,521,107⁽²⁾ Includes one-time carryover balance of \$38,965⁽³⁾ Includes one-time carryover balance of \$659,941⁽⁴⁾ Does not include costs or funding for rehabilitation of County Line Road between Bryant Street and Calimesa Boulevard

STREETS COMPLETED FY23/24 MAP



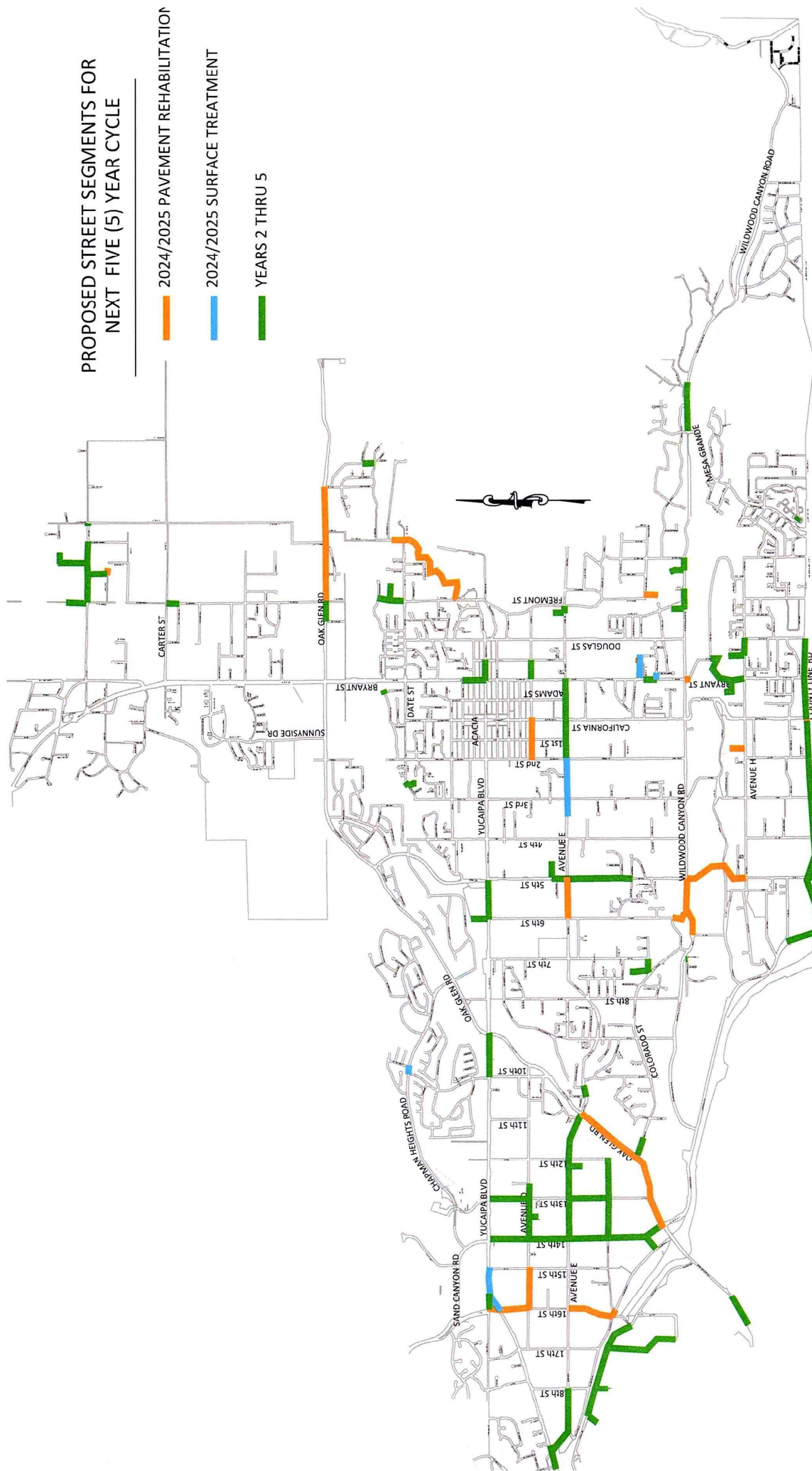
PROPOSED FY24/25 PMP MAP AND STREET LIST



On Street	From Street	To Street	FunCL	Pavement Width (ft)	Pavement Length (ft)	Pavement Area (yd2)	Current Segment PCI (CPCI)	Segment Rehab Results	Rehab Activity
Arterial/Collector Streets (Classification 1-4)									
BRYANT ST	WILDWOOD CANYON RD	WILDWOOD CANYON RD	Arterial	24	6	17	46	Non-Ctrl Yr 1	FWM + Thick Overlay (> 2.0 - 3.0)
WILDWOOD CANYON RD	6TH PL	6TH ST	Arterial	41	779	3,725	47	Non-Ctrl Yr 1	FWM + Thick Overlay (> 2.0 - 3.0)
WILDWOOD CANYON RD	6TH ST	5TH ST	Arterial	43	1,159	5,812	41	Selected Yr 1	FWM + Thick Overlay (> 2.0 - 3.0)
AVENUE E	6TH ST	5TH ST	Arterial	51	1,316	7,828	44	Selected Yr 1	FWM + Thick Overlay (> 2.0 - 3.0)
5TH ST	AVE H	AVE G	Arterial	30	913	3,197	21	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
5TH ST	AVE G	WILDWOOD CANYON RD	Arterial	40	1,344	5,271	29	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
COUNTY LINE RD (TC)	COUNTY LINE RD	CALIFORNIA ST	Arterial	50	68	397	26	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
16TH ST	DUNLAP BLVD	AVENUE E	Collector	39	1,519	5,910	36	Non-Ctrl Yr 1	EM/FWM + Moderate Overlay (2.0 - 3.0)
16TH ST	AVE D	YUCAIPA BLVD	Collector	40	976	4,556	51	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
16TH ST	YUCAIPA BLVD	TENNESSEE ST	Collector	26	336	1,019	29	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
6TH ST	WILDWOOD CANYON RD	NEBRASKA LN	Collector	34	553	2,192	28	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
AVE D	16TH ST	15TH ST	Collector	40	1,321	5,164	28	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
AVE D	2ND ST	1ST ST	Collector	37	659	2,845	23	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
AVE D	1ST ST	CALIFORNIA ST	Collector	38	660	2,927	35	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
BELLA VISTA DR	BELLA VISTA CT	GRANT ST	Collector	33	669	2,575	29	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
DUNLAP BLVD	16TH ST	KENTUCKY ST	Collector	42	225	1,103	27	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
PENDLETON RD	FREMONT ST	DATE AVE	Collector	20	3,262	7,610	29	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
PENDLETON RD	DATE AVE	DS@15IN DATE AVE	Collector	24	151	423	32	Selected Yr 1	Surf Recon + Base Rehab / FWM + Strcl Plch + Overlay
OAK GLEN RD	RIV_CO_LIVE OAK CANYON RD	CALIMESA BLVD	Asphalt	42	609	2,982	69	Fall Thru Yr 2	FWM + Thick Overlay (> 2.0 - 3.0)
OAK GLEN RD	RIV_CO_LIVE OAK CANYON RD	CALIMESA BLVD	Asphalt	41	609	2,912	63	Fall Thru Yr 2	FWM + Thick Overlay (> 2.0 - 3.0)
OAK GLEN RD	CALIMESA BLVD	13TH ST	Asphalt	74	940	3,119	52	Fall Thru Yr 3	FWM + Thick Overlay (> 2.0 - 3.0)
OAK GLEN RD	13TH ST	COLORADO ST	Asphalt	74	889	7,678	52	Fall Thru Yr 3	FWM + Thick Overlay (> 2.0 - 3.0)
OAK GLEN RD	COLORADO ST	DS@706E COLORADO ST	Asphalt	61	706	5,022	46	Fall Thru Yr 3	FWM + Thick Overlay (> 2.0 - 3.0)
OAK GLEN RD	DS@706E COLORADO ST	AVENUE E	Asphalt	57	2,200	14,628	48	Fall Thru Yr 3	FWM + Thick Overlay (> 2.0 - 3.0)
Residential Streets									
CUSTER ST	MOUNTAIN VIEW ST	EOP	Residential	26	131	399	28	Selected Yr 1	ACP Full Depth Reconstruction
BELLA VISTA CT	EOP	BELLA VISTA DR	Residential	41	365	1,748	61	Selected Yr 1	EM/FWM + Moderate Overlay (2.0 - 3.0)
HOLLYBROOK LN	HOPE LN	EOP	Residential	24	49	137	13	Selected Yr 1	ACP Full Depth Reconstruction
SIDANIA RD	AVE H	DAMASCUS ST	Residential	26	291	884	42	Selected Yr 1	FWM + Thick Overlay (> 2.0 - 3.0)
Surface Treatment									
AVENUE E (TC)	2ND ST	AVENUE E	Arterial	11	63	81	66	Selected Yr 1	MicroSurface / Chip Seal
AVENUE E (TC)	3RD ST	AVENUE E	Arterial	12	62	86	71	Selected Yr 1	MicroSurface / Chip Seal
AVENUE E (TC)	AVENUE E	3RD ST	Arterial	12	69	97	78	Selected Yr 1	MicroSurface / Chip Seal
YUCAIPA BLVD	16TH ST	15TH ST	Arterial	43	1,398	7,011	83	Selected Yr 1	Surry Seal / Seal Coat
YUCAIPA BLVD	16TH ST	DS@822E 16TH ST	Arterial	36	822	3,454	84	Selected Yr 1	Surry Seal / Seal Coat
YUCAIPA BLVD	DS@822E 16TH ST	15TH ST	Arterial	35	585	2,388	87	Selected Yr 1	Surry Seal / Seal Coat
Residential Streets									
MOUNTAIN VIEW ST	BRYANT ST	CUSTER ST	Residential	34	643	2,551	86	Selected Yr 1	Surry Seal / Seal Coat
MOUNTAIN VIEW ST	CUSTER ST	LINN ST	Residential	25	151	440	81	Selected Yr 1	Surry Seal / Seal Coat
SUNLIGHT DR	BRYANT ST	MONTEREY DR	Residential	34	209	829	72	Selected Yr 1	MicroSurface / Chip Seal

* Segments prioritized based on public comment

**PMP MAP OF PROPOSED
STREETS FOR NEXT FIVE (5)
YEARS**



PROPOSED STREET SEGMENTS FOR
NEXT FIVE (5) YEAR CYCLE

- 2024/2025 PAVEMENT REHABILITATION
- 2024/2025 SURFACE TREATMENT
- YEARS 2 THRU 5

UNIT COST BY TREATMENT TYPE

Table of Overlay and Reconstruction Options with Guidelines for Applications
2024-2025

Rehab Options	Rehab Descriptions	Where Used	Street Conditions	Est. Cost Per/SF
<u>OVERLAY OPTIONS</u>				
Edge Mill & Thin Overlay 1 1/2"	Clean, Repair, CF, Apply Weed Control Edge mill (6' Wide), Install 1 1/2" Overlay	Residential	Extent & Magnitude of cracks is moderate to high.	\$2.09
Full Width Mill and Moderate Overlay 2-3"	Clean, Repair, CF, Apply Weed Control Mill width of roadway, applit 2' to 3" Overlay	Arterials & Collectors-Special Cases Residential	Extent & Magnitude of cracks is moderate to high. Moderate sub-grade failures	\$2.64
Full Width Mill and Thick Overlay >2-3"	Clean, Repair, CF, Apply Weed Control Mill width of roadway, apply >2" to 3"	Arterials & Collectors-Special Cases Residential	Extent & Magnitude of cracks is high. Moderate to high sub-grade failures	\$2.96
<u>RECONSTRUCTION OPTIONS</u>				
Pulverize & Overlay	Pulverize existing pavement (usually when less than 3 1/2") to a maximum depth of 8"-9" if there is an adequate base to mix. Do not pulverize into the existing dirt sub-grade. Grade and compact (no removal of excess material regrade cross slope to accomodate for additional pulverized material, O/L 3 1/2".	Arterials, Collectors & Residential.	Significant failed areas of sub-grade or pavement (30% or more) making O/L not an cost effective approach. (Cost of material removals and to maintain grades is an important factor.)	\$3.17
<u>Abreviation Summary:</u>				
Clean-	Remove loose dirt, debris and vegetation growth (usually in cracks)	FC-	Functional Classification- Arterial (Primary Highways & Secondary Highways), Collectors & Residentials	
Repair-	Remove and Replace areas where pavement or sub-grade has failed.	O/L-	Asphaltic Concrete Overlay (Thickness as shown in chart above.	
CF-	Crack filling of the street surface.	FM-	Full Mill- Milling of the street for the full width	
EM-	Edge Mill- Usually 6' wide along the edge of an existing curb & gutter or berm	Petromat-	Thin layer of fabric used between new and existing pavement to prevent crack reflecting	

Table of Surface Treatment Options with Guidelines for Applications

2024-2025

Rehab Options	Rehab Descriptions	Where Used	Street Conditions	Est. Cost Per/SF
<u>Surface Treatment</u>				
Microsurface	Clean, Striping. Apply approximately 1/2" Micro-Surface paving material. Pavement Patching (Patch) and Crack Filling (CF)	Arterials, Collectors & Residential Streets.	Streets where the extent & magnitude of cracks are moderate to high. Moderate sub-grade failures. May have been previously slurried. Cost of an O/L cannot be justified.	\$0.44
<u>Abbreviation Summary:</u>				
Clean	Remove loose dirt, debris and vegetation growth. apply weed control (usually in cracks)	FC	Functional Classification- Arterial (Primary Highways & Secondary Highways), Collectors & Residentials.	
Repair	Remove and Replace areas where pavement or sub-grade has failed.	O/L	Asphaltic Concrete Overlay (Thickness as shown in chart above).	
CF	Crack filling of the street surface.			