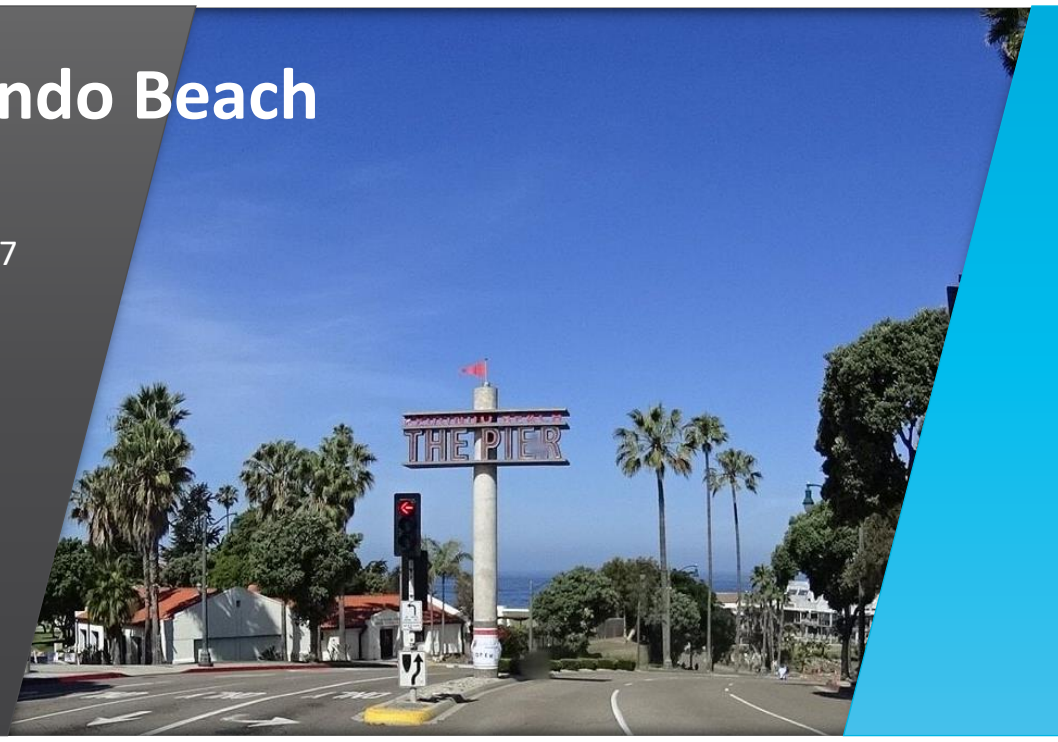
2023 Pavement Management Program Implementation



City of Redondo Beach

Public Works
415 Diamond Street
Redondo Beach, CA 90277

March 2024

NCE
17050 Bushard Street, Suite 200
Fountain Valley, CA 92708

More To Sea℠
redondo
BEACH

Collaboration. Commitment. Confidence.℠

2023 Pavement Management Program Implementation

City of Redondo Beach

March 6, 2024

Prepared for:

City of Redondo Beach
Public Works
531 N Gertruda Ave
Redondo Beach, CA 90277

Prepared by:

Timin Punnackal, P.E. (NV)
Senior Engineer

Luis Alberto Rocher Neri
Staff Engineer

Vivek Jha, P.E. (NJ, MD)
Associate

NCE
17050 Bushard St., Suite 200
Fountain Valley, CA 92708
(714) 848-8897

NCE Project No. 910.07.30

Executive Summary

Nichols Consulting Engineers, Chtd. (NCE) was selected by the City of Redondo Beach (City) to perform an update of its Pavement Management Plan (PMP) using a semi-automated survey. The purpose of the PMP is to help educate policymakers about the current condition of the street network and the impact of various scenarios on future network conditions. This report summarizes the findings from the 2023 PMP update.

The City is responsible for maintaining approximately 152.3 centerline miles of streets, representing a substantial investment of approximately $282 million. The street network includes 43.4 centerline miles of arterial streets, 13.4 miles of collector streets, and 95.5 miles of local streets. Additionally, the City has 7.1 miles of alleyways. In August of 2023, NCE performed a condition survey for the City's street network. Table A below summarizes the network's Pavement Condition Index (PCI) breakdown by functional classification.

Table A. Street Network PCI Breakdown

Functional Class	Centerline Mileage	Percent Area	Weighted Average PCI[1]	Condition
Arterial	43.4	30.2%	69	Good
Collector	13.4	9.8%	68	Good
Local	95.5	60.0%	66	Good
Total	**152.3**	**100.0%**	**67**	**Good**

*The weighted average PCI is calculated by multiplying the area of each street section by the PCI of that section, totaling all sections together, and then dividing by the total area of the network area or functional classification.

The City of Redondo Beach street network's 2023 weighted average (by area) PCI is 67. Overall, 48.4 percent of the City's street network area is in "Very Good" condition, approximately 34.9 percent is in "Good" condition, 16.4 percent is in "Poor" condition, and 0.3 percent is in "Very Poor" condition. The StreetSaver® PMP budget needs analysis[1] indicated that the City will need to spend approximately $76.8 million in the next 5 years to bring the overall network to a condition that can be maintained with ongoing preventive maintenance in the most cost-effective way. However, this is an idealized approach in which most spending occurs in the first year and spending then tapers down to a cost-effective amount.

To assess a more realistic approach, 3 budget scenarios were examined using a yearly inflation factor of 5.0 percent. The budgeted amounts for the 3 scenarios only include the construction cost (i.e., paving and non-paving costs). Other costs such as staff time, design, construction management, and contingencies were not considered. For Scenario 1, NCE created a list of candidate streets based on an initial selection from StreetSaver® which was further adjusted by NCE staff by doing a field visit to confirm the treatment based on the existing surface distress only. For Scenarios 2 and 3, StreetSaver® chose the sections to be treated without any changes from NCE staff.

It should be mentioned that the city currently has upcoming projects that will be finished by 2025. These projects consist of both mill-and-overlay treatments and preventive maintenance. As part of these upcoming

[1] Analysis developed by StreetSaver® to determine the amount of funding (without limitation) necessary to improve and maintain all streets to Category I condition (street's PCI greater than or equal to 70).

projects, the City plans to rehabilitate 2 main arterials, Torrance Boulevard and Manhattan Beach Boulevard with an approximate construction cost of $8.4 M. In addition, a significant investment of $5.4M will be administered in 2025, including the Rehabilitation and preventive maintenance of various residential streets. All the programs are expected to raise the PCI from 67 to 69 by the end of 2026. Please note that the budget amount stated below for each scenario analysis is separate from the cost of the upcoming planned project stated above. The following budget scenarios were evaluated after the budget-allocated projects as part of a 3-year analysis.

Scenario 1: City's anticipated budget ($2.5M per year) for 3 years – The result shows that at the City's anticipated funding level of $7.5 million over 3 years, the network PCI is projected to decrease from 69 to 66 by the end of the analysis period. The cost of deferred maintenance[2] will increase from $54.0 million to $83.2 million by the end of year 3.

Scenario 2: Maintain PCI at 70 ($6.8M per year) for 3 years –The result shows that the City will need to spend a total of $20.4 million over 3 years to maintain the network PCI at 70. Additionally, deferred maintenance will increase from $54.0 million to $60.4 by the end of year 3.

Scenario 3: Increase PCI to 75 ($11.5M per year) for 3 years –The result shows that the City will need to spend a total of $34.5 million over 3 years to increase the network PCI to 75. Additionally, deferred maintenance costs will decrease from $54.0 million to $38.3 million by the end of year 3.

The following table summarizes each scenario, its corresponding 3-year budget, and the PCI and deferred maintenance costs at the end of the analysis period.

Table B. Budget Scenario Analysis Summary

Scenario	Description	Cumulative 3-year Budget ($M)	End of year 3	
			Network PCI	Deferred Maintenance ($M)
1	City's Budget	7.5	66	81.3
2	Maintain PCI at 70	20.4	70	60.4
3	Increase PCI to 75	34.5	75	38.3

In summary, the City of Redondo Beach has a substantial investment of $282 million in the pavement network. Overall, the pavement network is in "Good" condition with a PCI of 67 and is expected to increase to a PCI of 69 after the stated improvements are completed. As shown in Table B above, based on the City's existing budget (Scenario 1) of $7.5 million over 3 years is expected to reduce the overall network PCI from 69 to 66. In Scenario 2, PCI is maintained at 70 over 3 years with an investment of $20.4 million. Under Scenario 3, PCI would increase from 69 to 75 by the end of year 3 with an investment of $34.5 million.

[2] Deferred maintenance is a maintenance and activity that was not performed when it should have been or was scheduled to be performed but was delayed to a future period due to the lack of funding. This calculation includes CICM, design, and contingency costs.

Table of Contents

1 Introduction and Background 1

1.1 Purpose 2

2 Network Summary 3

3 Pavement Condition 4

4 Treatment Optimization 8

5 Maintenance and Rehabilitation Strategies 10

6 Budget Analysis 11

6.1 Budget Needs 11

6.2 Budget Scenarios 11

6.3 Scenario 1: City's Anticipated Budget ($2.5M per year) for 3 years. 13

6.4 Scenario 2: Maintain PCI at 70 ($6.8M per year) for 3 years. 14

6.5 Scenario 3: Increase PCI to 75 ($11.5M per year) for 3 years. 15

6.6 Scenario Comparisons 16

7 Cost Analysis Reconciliation to Previous Report 18

Conclusion and Recommendations 19

7.1 Recommendations 19

List of Figures

Figure 1. Example of Streets with Different PCIs. 5

Figure 2. Street Network Percent Pavement Area by Condition Category. 6

Figure 3. Street Network Percent Pavement Area by Condition Category. 7

Figure 4. Section PRUITTDR-07340 8

Figure 5. Selected Sections for Treatment, StreetSaver® selection 9

Figure 6. Selected Sections for Treatment, manual selection 9

Figure 7. Costs of Maintaining Pavements Over Their Service Lives. 10

Figure 8. PCI vs Deferred Maintenance for Scenario 1 13

Figure 9. PCI vs Deferred Maintenance for Scenario 2 14

Figure 10. PCI vs Deferred Maintenance for Scenario 3 15

Figure 11. Comparison of Annual PCI by Scenario. 16

Figure 12. Comparison of Annual Deferred Maintenance by Scenario. 16

Figure 13. Comparison of Pavement Condition by FY 2028/29 Breakdown by Scenarios. 17

List of Tables

Table 1. Network Summary Statistics by Functional Class 3
Table 2. Pavement Condition Categories 5
Table 3. Pavement Condition Summary - Street Networks.....6
Table 4. Pavement Condition Summary - Alleyways 7
Table 5. Total Number of Streets 9
Table 6. Budget Needs.....11
Table 7. Budget Scenario Analysis Summary.....12
Table 8. Summary of Results from Scenario 1 Analysis.....13
Table 9. Summary of Results from Scenario 2 Analysis.....14
Table 10. Summary of Results from Scenario 3 Analysis.....15

List of Appendices

Appendix A

Section Description Inventory – Average (Weighted by Area) PCI

Appendix B

Maintenance and Rehabilitation (M&R) Decision Tree

Appendix C

Budget Needs

Appendix D

Scenario Results

Appendix E

Scenario 1: Sections Selected for Treatment

Appendix F

GIS Maps

Appendix G

Quality Control Plan (QCP)

1 Introduction and Background

Nichols Consulting Engineers, Chtd. (NCE) was selected by the City of Redondo Beach (City) to update the City's Pavement Management Plan (PMP). To update the City's PMP, NCE performed pavement condition surveys in compliance with ASTM D6433[3]. The surveys did not include non-pavement issues such as traffic, safety and street hazards, geometric issues, shoulders, sidewalks, curb and gutters, drainage issues, or immediate maintenance needs.

After inspection, all survey data was entered into the City's StreetSaver® database, and Pavement Condition Index (PCI) calculations were performed. NCE then reviewed and updated the City's decision tree including maintenance and rehabilitation (M&R) strategies and treatment unit costs. A budget needs analysis was then performed, and 3 budget scenarios were analyzed for the street network.

In general, PMPs are "designed to provide objective information and useful data so that managers can make more consistent, cost effective and defensible decisions related to the preservation of a pavement network."[4] In other words, a PMP is designed to assist cities with answering questions such as:

- What does the City's pavement network include?
- What is the current condition of the pavement network?
- What are the City's current M&R strategies?
- How much funding is required to perform all needed M&R treatments over the next analysis period (typically 3 to 10 years)?
- What effect does the City's existing funding have on the network condition and overall deferred maintenance?
- What effect will other funding levels have on the network condition and deferred maintenance?

[3] ASTM. *ASTM D6433. Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.* (West Conshohocken, PA: ASTM International, 2018), astm.org.
[4] AASHTO *Guidelines for Pavement Management Systems*. (Washington, DC: American Association of State Highway and Transportation Officials, 1990).

1.1 Purpose

The purpose of this report is to assist policy makers in using the results of the PMP. This report analyzes different levels of funding and maximizes the return from expenditures by selecting the most cost-effective repairs.

This report also assists the City with identifying M&R priorities specific to the City's needs, and highlights options for improving the current PCI. These options are developed by conducting "what-if" analyses using StreetSaver® software. By varying the budget amounts available for pavement maintenance and repair, the impact of different funding strategies on the City's streets for the next 6 years were determined.

A comprehensive pavement condition survey was conducted in August 2023, adhering to ASTM D6433[5] protocols for the entire project. This survey provided a holistic assessment of pavement conditions for the City's network. The PMP report offers a comprehensive understanding of the overall infrastructure condition and facilitates effective planning and maintenance strategies for the City.

[5] ASTM. *ASTM D6433*.

2 Network Summary

The City is responsible for maintaining approximately 152.3 centerline miles of pavement, which includes 43.4 centerline miles of arterials, 13.4 centerline miles of collectors, and 95.5 miles of local streets. Additionally, the City has 7.1 miles of alleyways. The network is composed primarily of asphalt concrete pavement and has sections of Portland cement concrete pavement. Table 1 summarizes the street network by functional class.

Table 1. Network Summary Statistics by Functional Class

Functional Class	Centerline Mileage	Percent Area	Weighted Average PCI[1]	Condition
Arterial	43.4	30.2%	69	Good
Collector	13.4	9.8%	68	Good
Local	95.5	60.0%	66	Good
Total	152.3	100.0%	67	Good

Street pavements are one of the City's most valuable assets, and the total street network replacement cost is estimated to be approximately $282 million. This can be viewed as the value of the pavement network and is the amount needed to fund a reconstruction of the entire paved network. It does not include related infrastructure assets such as sidewalks, signals, markings, signs, or storm drains.

3 Pavement Condition

The PCI is a measurement of pavement grade or condition and ranges from 0 to 100. A newly constructed street will have a PCI of 100, while a street in very poor condition will have a PCI of 25 or less. The pavement condition is primarily affected by the climate, traffic loads and volumes, construction materials, and age. The symptoms manifested by the pavement as it ages or fails are determined by the distress types that are present, which for asphalt concrete pavements and Portland cement concrete pavements include:

Asphalt Concrete Pavements:

- Alligator (Fatigue) Cracking
- Bleeding
- Block Cracking
- Bumps & Sags
- Corrugation
- Depression
- Edge Cracking
- Joint Reflection Cracking
- Lane/Shoulder Drop-Off
- Longitudinal/Transverse Cracking
- Patching and Utility Cut Patching
- Polished Aggregate
- Potholes
- Railroad Crossing
- Rutting
- Shoving
- Slippage Cracking
- Swell
- Raveling
- Weathering

Portland Cement Concrete Pavements:

- Blowup/Buckling
- Corner Break
- Divided Slab
- Durability Cracking
- Patching (Large and Small)
- Linear Cracking
- Popouts
- Pumping
- Punchout
- Scaling
- Spalling (Corner and Joint)

The photographs in Figure 1 illustrate the City's asphalt concrete streets and show a range of PCIs.

Figure 1. Example of Streets with Different PCIs.

The definitions of the pavement condition categories and PCI ranges are shown in Table 2. These are the PCI "breakpoints" in StreetSaver®.

Table 2. Pavement Condition Categories

Condition Category	PCI Range	Description
Very Good	70 – 100	Pavements with little or no distress.
Good	50 – 69	Pavements with significant distress that is predominantly load related.
Poor	25 – 49	Pavements with major distress.
Very Poor	0 – 24	Pavements with extensive distress.

The City's overall weighted average PCI for the network in 2023 is 67, which places the overall street network pavement condition in the "Good" category. Figure 2 breaks down the current network PCI by functional classification.

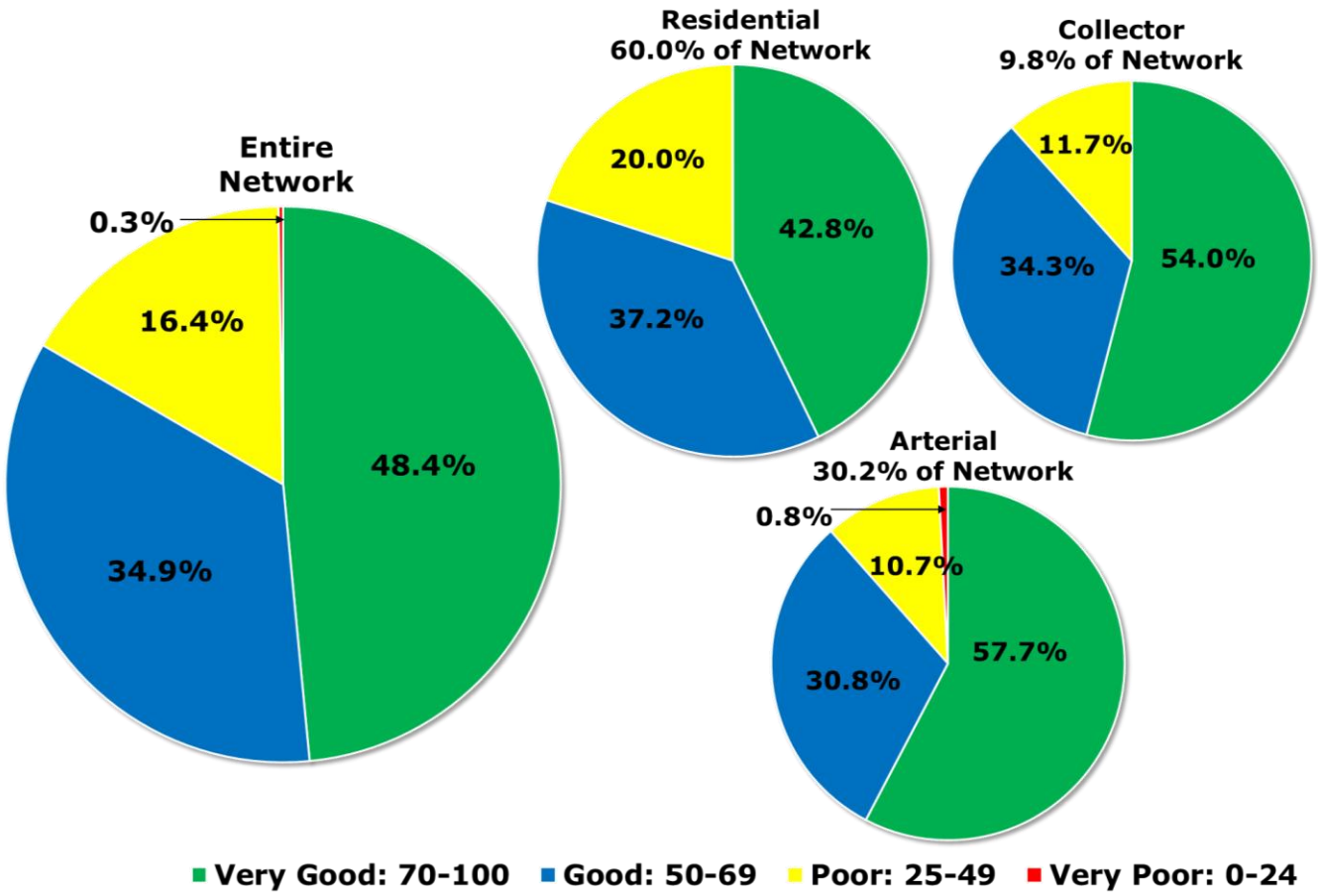


Figure 2. Street Network Percent Pavement Area by Condition Category.

Table 3 shows a pavement condition breakdown for the entire network as well as the arterials, collectors, and local streets by PCI range and condition category. Approximately 48.4 percent (by area) of the street network is in "Very Good" condition, 34.9 percent is in "Good" condition, 16.4 percent is in "Poor" condition, and 0.3 percent is in "Very Poor" condition. Table 4 shows the pavement condition breakdown for alleyways.

Table 3. Pavement Condition Summary - Street Networks

Condition Category	Arterial (%)	Collector (%)	Residential/Local (%)	Entire Network (%)
Very Good	57.7%	54.0%	42.8%	48.4%
Good	30.8%	34.3%	37.2%	34.9%
Poor	10.7%	11.7%	20.0%	16.4%
Very Poor	0.8%	0.0%	0.0%	0.3%

Table 4. Pavement Condition Summary - Alleyways

Condition Category	Alleyways (%)
Very Good	15.5%
Good	34.5%
Poor	47.6%
Very Poor	2.4%

Figure 3 illustrates PCI comparisons between the City and the surrounding agencies using information gathered from the 2022 California Statewide Local Streets and Roads Needs Assessment. The City's PCI of 67 placed the city network in "Good" condition, which positions the city 2 points above the 2022 statewide average of 65.

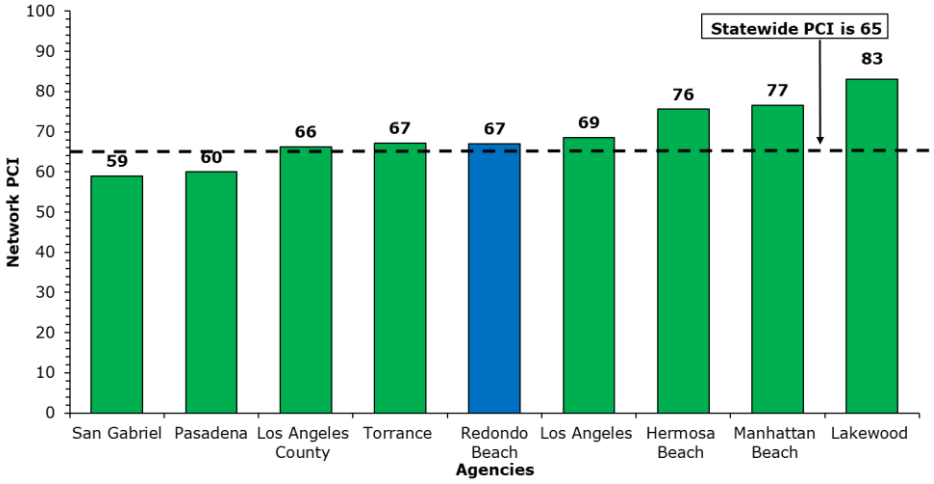


Figure 3. Street Network Percent Pavement Area by Condition Category.

4 Treatment Optimization

Based on the network PCI condition, StreetSaver® will select sections that present the highest Benefit-Cost ratio. The software takes the current PCI and predicts a future condition depending on the analysis period. This allows the software to estimate the required treatment for a desired section in the future. Depending on the established breakpoint values, there are 2 possibilities:

- StreetSaver® assigns the *same* treatment at any given year because the predicted PCI does not deteriorate below the next breakpoint value within the 3-year analysis period. For example, new roads would only need preventive maintenance in the first few years. Thus, regardless of the selected year for the treatment application, StreetSaver® will choose the same treatment.
- StreetSaver® assigns a *different* treatment for a given year because the predicted PCI deteriorates and falls under the next breakpoint value in a later year of the analysis period. For example, some roads would only need preventive maintenance (e.g., slurry seal) if the treatment is applied in the first or second year of the analysis period. However, if the section is not treated until the third year, the PCI may deteriorate enough to trigger the need for rehabilitation (e.g., mill and overlay).

Although StreetSaver® predicts deterioration behavior for most of the sections, the actual pavement characteristics for a particular section might differ from the software's performance model. Thus, engineering judgment is required to assess the treatment feasibility and pavement condition in situations where a specific list of streets (projects) is desired. As an example, Figure 4 illustrates a section where StreetSaver® assigned a rehabilitation treatment (3" Mill and Overlay + 6% Base Repairs). The current PCI in the section is 54 and based on the deterioration curve, it is expected to fall under the breakpoint value of 50 in the next few years, requiring an overlay. By simply considering the PCI value and the predicted deterioration, applying an overlay seems reasonable. However, after NCE physically inspected the section and evaluated the pavement condition, a lighter treatment was considered (Slurry Seal + 4% Base Repairs). As shown in the photo, despite the section presenting some deterioration, it does not seem to have structural issues (e.g., severe alligator cracking) that would require a structural layer within the next few years.

Figure 4. Section PRUITTDR-07340

Based on the current construction cost, the "3" Mill and Overlay + 6% Base Repairs" treatment for Residential streets is $50.25 per square yard (of paved surface area), while the "Slurry Seal + 4% Base Repairs" costs $8.75 per square yard, nearly a sixth of the cost of the more expensive rehabilitation treatment.

Another part where engineering judgment is required is in interpreting the scattered section selections made by StreetSaver®. Due to the non-uniform condition of each street's section (different PCI), it is common that StreetSaver® avoids certain street segments within a year (staggered sections) or assigns different treatments to adjacent sections. The software is designed to choose sections that are the most cost-effective regardless of its constructability. Figure 5 shows sections selected for treatment by StreetSaver®. In this scenario, various sections on multiple streets were selected for treatment and there is no continuity between the sections. This scenario was used as the basis for selection a more detailed street list. Figure 6 shows more continuous section selections with mostly uniform treatments across the segment length.

Figure 5. Selected Sections for Treatment, StreetSaver® selection

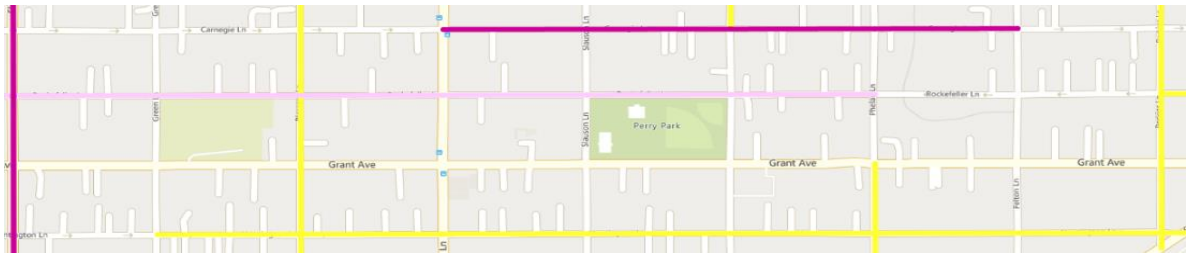


Figure 6. Selected Sections for Treatment, manual selection

In Figure 5, a summary of the treated streets per year is shown. Although the number of streets per year was reduced after NCE manually adjusted the section's selection, it will yield a more constructable maintenance plan. If sections to be treated are too short or are too widely separated, transportation and traffic control costs will likely increase. In contrast, when most sections are continuous or within proximity of each other, mobilization costs are expected to decrease.

Table 5. Total Number of Streets

Approach	Year 1	Year 2	Year 3
StreetSaver® selection	26	30	36
Manual selection	13	24	16

In Summary, StreetSaver® is a powerful network-level analysis tool that can provide a preliminary work plan. It provides a general perspective of the required budget to maintain or increase the network PCI. However, to develop a detailed selection of candidate streets for the City's street maintenance plan, engineering judgment and a site visit were needed to optimize the StreetSaver® streets selection.

5 Maintenance and Rehabilitation Strategies

In general, surface treatments such as crack seals or slurry seals are used when the pavements are in “Good” to “Very Good” condition. This type of treatment is usually considered “preventive maintenance”. When the pavement condition deteriorates to lower levels, overlays and full-depth structure replacements need to be performed. These are considered “rehabilitation” or “reconstruction”. In addition, base repairs are commonly done in preparation for overlay and slurry seal treatments.

Based on a discussion with City staff, a detailed M&R decision tree was prepared and is included in Appendix B. This determined the most effective and realistic treatments for each group of streets by functional class and condition category.

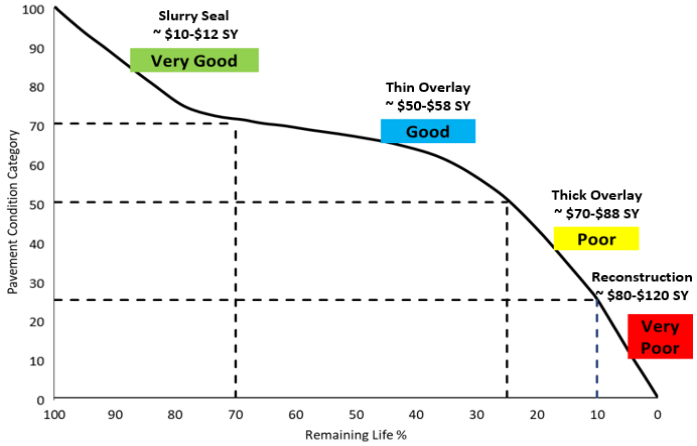


Figure 7. Costs[6] of Maintaining Pavements Over Their Service Lives.

Figure 7 illustrates that pavement maintenance follows the old colloquial saying of "pay now or pay more later". History has shown that it costs much less to maintain streets in good condition than to repair failed streets. By letting pavements deteriorate, streets that once cost ~$12 per square yard to slurry seal may, in a few years, cost as much as ~$105.00 per square yard to reconstruct. The costs shown in the chart above are based on recent bids received by the City. The pavement deterioration curve shown above describes how pavements deteriorate over time. In general, arterials will be expected to have a service life of 25 years, while the service lives of residential streets may exceed 30 years.

Pavements in “Good” condition show some distress requiring more than preventive maintenance. At this point, a well-designed pavement will have reached between 35 and 50 percent of its life, and an overlay will be required to bring its condition back to “Very Good”. A key pavement management repair strategy element is to keep streets in “Very Good” to “Good” condition from deteriorating. This is particularly true for streets in the “Good” range since pavement deterioration will accelerate if left untreated.For pavements in the “Poor” category, approximately 30 percent of service life is left—a thicker grind and overlay (3 to 5 inches) would be required to increase the PCI above 70. Pavements in “Very Poor” condition are near the end of their service lives and often exhibit severe forms of distress, such as potholes, rutting, and extensive cracking. At this stage, reconstruction is typically required. The reconstruction includes new asphalt over replaced aggregate base.

[6] In addition to the contractor’s prices, unit costs are loaded to include staff time, design, construction management, contingencies, and non-asphalt concrete related work.

6 Budget Analysis

Based on the principle that it costs less to maintain streets in good condition than it does to repair those that have failed, cost-effective PMPs employ strategies that eliminate the deferred maintenance and then maintain the network with ongoing preventive maintenance. Such strategies bring the network condition to an optimal PCI that can be maintained over time.

6.1 Budget Needs

The first step in developing a cost-effective strategy is to determine, assuming an unconstrained budget, the total maintenance budget "needs" of the network, in other words the amount of funding required for each street in the network to reach optimal condition based on the policy established in the decision tree. The costs of the treatment(s) over the analysis period were calculated by multiplying the unit cost by the pavement section area at an annual inflation rate of 5.0 percent.

The budget needs are estimated to be approximately $76.8 million over the next 5 years. Of the total budget needs, approximately $5.8M (7.6 percent) is devoted to preventive maintenance, while the rest is allocated for more costly rehabilitation and reconstruction. If the City follows this "ideal" strategy, the average network PCI will increase to 80 by FY 2027/28. Table 6 below shows the impacts of expenditures on the PCI, assuming an unconstrained budget.

Table 6. Budget Needs.

Fiscal Year	Current	24/25	25/26	26/27	27/28	28/29	Total
Total Budget Needs ($M)	NA	58.4	4.7	6.6	3.7	3.4	76.8
Rehabilitation ($M)	NA	55.7	4.2	4.9	3.4	2.8	71.0
Preventive Maintenance ($M)	NA	2.7	0.5	1.7	0.3	0.6	5.8
Treated PCI	67	85	83	82	81	80	NA
Untreated PCI	67	67	65	63	61	59	NA

6.2 Budget Scenarios

Having determined the maintenance needs of the street network, the next step in developing a cost-effective M&R strategy is to generate several alternative budgets and analyze "what-if" scenarios. By examining the impacts of budget "scenarios", the advantages and disadvantages of the 3 funding levels and maintenance strategies can be illustrated.

To assess a more realistic approach, 3 budget scenarios were examined using a yearly inflation factor of 5.0 percent. The budgeted amounts for the 3 scenarios only include the construction cost (i.e., paving and non-paving costs). Other costs such as staff time, design, construction management, and contingencies were not considered. For Scenario 1, NCE created a list of candidate streets based on an initial selection from StreetSaver® which was further adjusted by NCE staff by doing a field visit to confirm the treatment based on the existing surface distress only. For Scenarios 2 and 3, StreetSaver® chose the sections to be treated without any changes from NCE staff.

It should be mentioned that the city currently has upcoming projects that will be finished by 2025. These projects consist of both mill-and-overlay treatments and preventive maintenance. As part of these upcoming projects, the City plans to rehabilitate 2 main arterials, Torrance Boulevard and Manhattan Beach Boulevard with an approximate construction cost of $8.4 M. In addition, a significant investment of $5.4M will be administered in 2025, including the Rehabilitation and preventive maintenance of various residential streets. All the programs are expected to raise the PCI from 67 to 69 by the end of 2026. Please note that the budget amount stated below for each scenario analysis is separate from the cost of the upcoming planned project stated above. The following budget scenarios were evaluated after the budget-allocated projects as part of a 3-year analysis.

Scenario 1: City's anticipated budget ($2.5M per year) for 3 years – The result shows that at the City's anticipated funding level of $7.5 million over 3 years, the network PCI is projected to decrease from 69 to 66 by the end of the analysis period. The cost of deferred maintenance will increase from $54.0 million to $83.2 million by the end of year 3.

Scenario 2: Maintain PCI at 70 ($6.8M per year) for 3 years –The result shows that the City will need to spend a total of $20.4 million over 3 years to maintain the network PCI at 70. Additionally, deferred maintenance will increase from $54.0 million to $61.9 by the end of year 3.

Scenario 3: Increase PCI to 75 ($11.5M per year) for 3 years –The result shows that the City will need to spend a total of $34.5 million over 3 years to increase the network PCI to 75. Additionally, deferred maintenance cost will decrease from $54.0 million to $38.3 million by the end of year 3.

The following table summarizes each scenario with its corresponding 3-year budget and the PCI and deferred maintenance at the end of the analysis period.

Table 7. Budget Scenario Analysis Summary

Scenario	Description	Cumulative 3-year Budget ($M)	End of year 3	
			Network PCI	Deferred Maintenance ($M)
1	City's Budget	7.5	66	81.3
2	Maintain PCI at 70	20.4	70	60.4
3	Increase PCI to 75	34.5	75	38.3

6.3 Scenario 1: City's Anticipated Budget ($2.5M per year) for 3 years.

This scenario mainly targeted the streets from the rehabilitation category (approximately 80% of the budget) and included preventive maintenance on the rest of the network. At the City's anticipated budget of $2.5 million per year on average (construction cost only), the network PCI will decrease from 69 (after the current projects take place) to 66 by the end of year 3. By the end of the analysis period, 44.7 percent will be in "Very Good" condition, 35.9 percent will be in "Good" condition, 17.7 percent will be in "Poor" condition, and 1.7 percent will be in "Very Poor" condition. The deferred maintenance cost will increase from $54.0 million to $81.2 million. Table 8 and Figure 8 show the results of this scenario.

Table 8. Summary of Results from Scenario 1 Analysis

Period	Current	After Current Projects	Year 1	Year 2	Year 3
City's Anticipated Budget ($M)	N/A	N/A	2.5	2.5	2.5
Rehabilitation ($M)	N/A	N/A	2.2	1.7	2.3
Preventive Maintenance ($M)	N/A	N/A	0.3	0.8	0.2
Deferred Maintenance ($M)	58.4	54.0	64.0	72.6	81.2
Network PCI	67	69	68	67	66

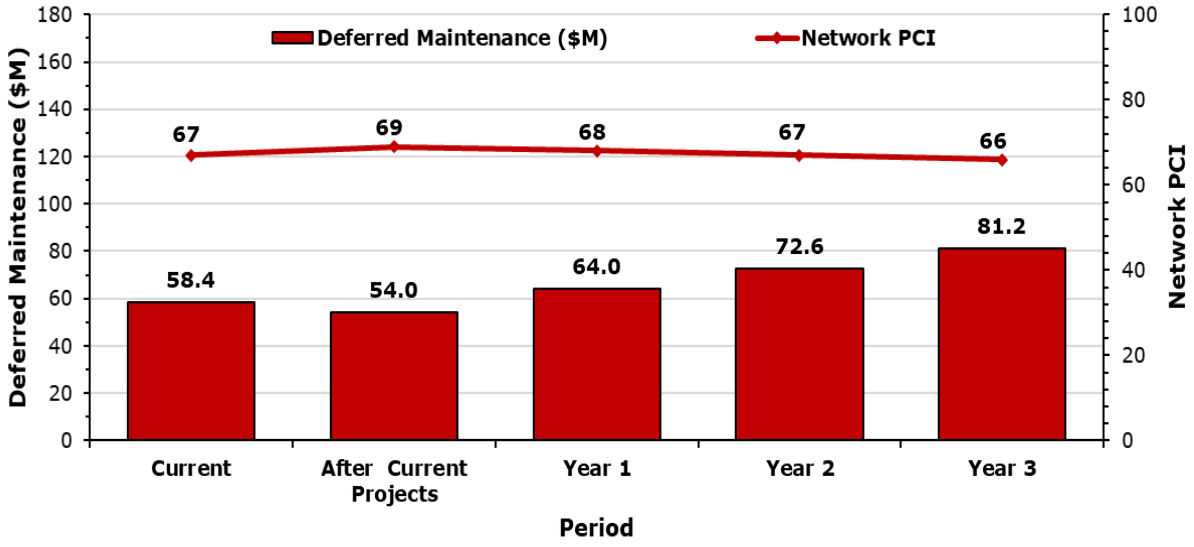


Figure 8. PCI vs Deferred Maintenance for Scenario 1.

6.4 Scenario 2: Maintain PCI at 70 ($6.8M per year) for 3 years.

In this scenario the overall network PCI is maintained at 70. As shown in Table 9 and Figure 9 for Scenario 2, the estimated financial commitment required to accomplish this goal is $20.4 million (construction cost only) over the 3-year analysis period. While the network PCI is maintained at 70, the deferred maintenance at the end of year 3 will grow to $60.4 million ($20.8 million less than in Scenario 1). In this Scenario, 58.4 percent of the network will be in "Very Good" condition, 22.4 percent will be in "Good" condition, 16.7 percent will be in "Poor", and 2.5 percent will be in "Very Poor" condition after 3 years.

Table 9. Summary of Results from Scenario 2 Analysis

Period	Current	After Current Projects	Year 1	Year 2	Year 3
City's Proposed Budget ($M)	N/A	N/A	6.8	6.8	6.8
Rehabilitation ($M)	N/A	N/A	6.1	6.1	6.1
Preventive Maintenance ($M)	N/A	N/A	0.7	0.7	0.7
Deferred Maintenance ($M)	58.4	54.0	$57.4	$59.1	$60.4
Network PCI	67	69	70	70	70

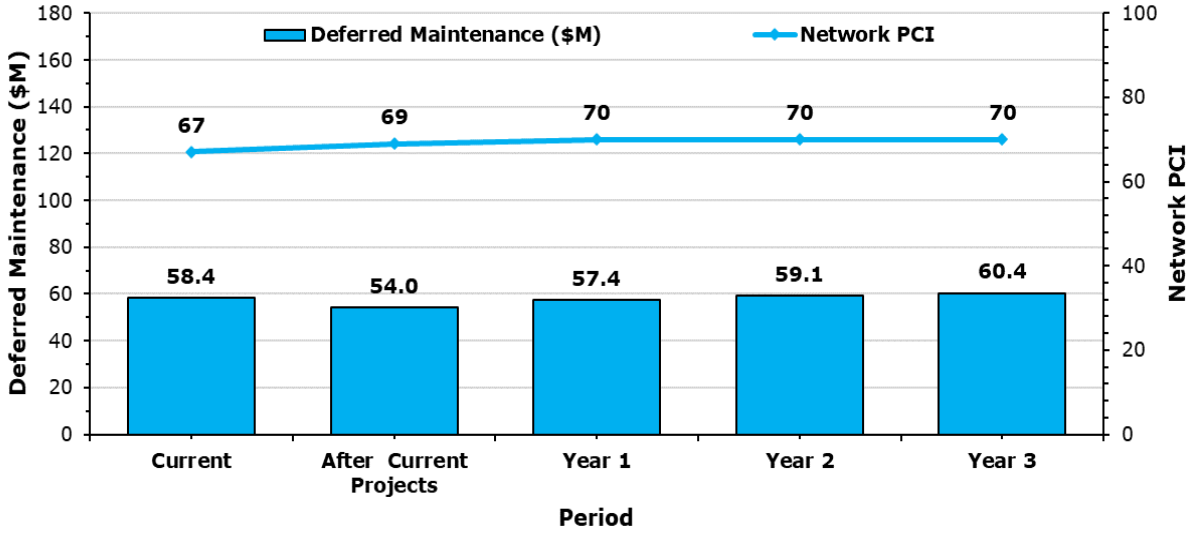


Figure 9. PCI vs Deferred Maintenance for Scenario 2.

6.5 Scenario 3: Increase PCI to 75 ($11.5M per year) for 3 years.

The goal of this scenario is to increase the PCI to 75 by the end of year 3. As shown in Table 10 and Figure 10, the estimated financial commitment required to accomplish this goal is $34.5M (construction cost only) over 3 years. This scenario will result in 70.5 percent of the network being in "Very Good" condition, 18.3 percent being in "Good" condition, 9.4 percent being in "Poor", and 1.8 percent being in "Very Poor" condition. The deferred maintenance cost at the end of year 3 will decrease to $38.3 million ($42.9 million less than Scenario 1).

Table 10. Summary of Results from Scenario 3 Analysis

Period	Current	After Current Projects	Year 1	Year 2	Year 3
City's Proposed Budget ($M)	N/A	N/A	11.5	11.5	11.5
Rehabilitation ($M)	N/A	N/A	10.9	10.9	10.9
Preventive Maintenance ($M)	N/A	N/A	0.6	0.6	0.6
Deferred Maintenance ($M)	58.4	54.0	$50.4	$44.8	$38.3
Network PCI	67	69	71	73	75

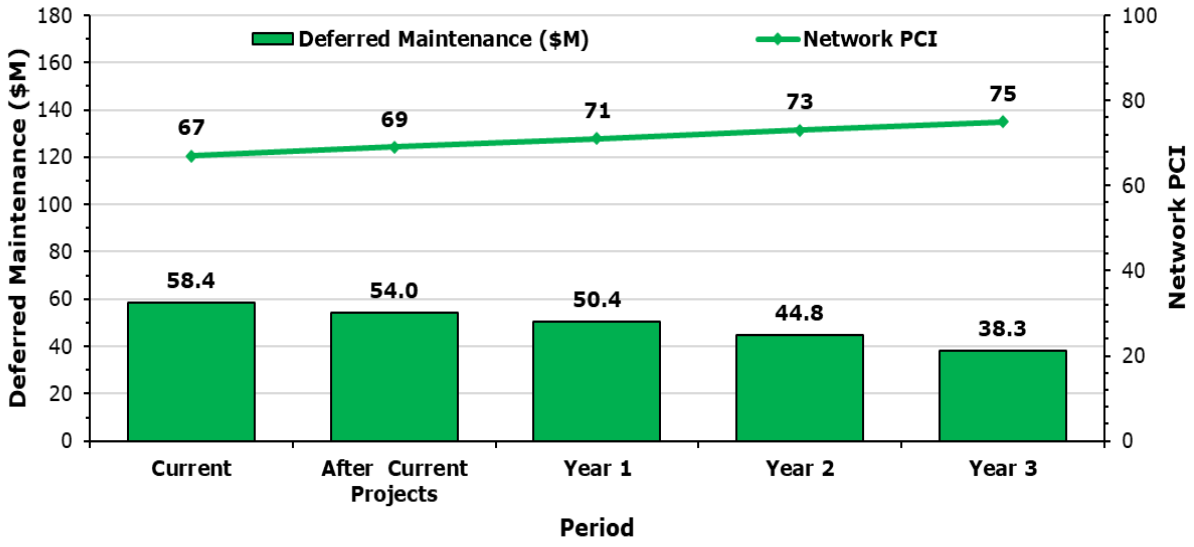


Figure 10. PCI vs Deferred Maintenance for Scenario 3.

6.6 Scenario Comparisons.

Figure 11 compares the annual changes in PCI for each of the scenarios. As described above, the PCI will decrease to 66 in Scenario 1, remain constant at 70 for Scenario 2, and increase to 75 in Scenario 3 by the end of year 3.

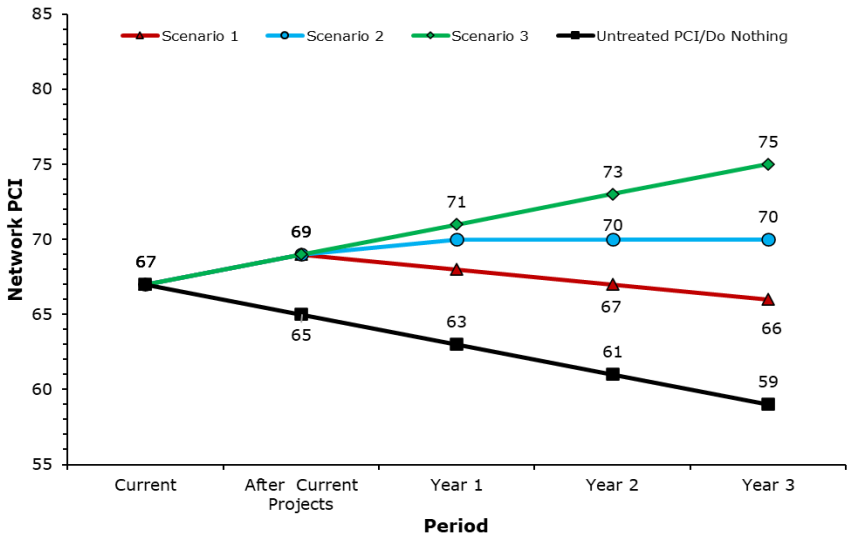


Figure 11. Comparison of Annual PCI by Scenario.

Figure 12 illustrates the changes in deferred maintenance over the 3-year analysis period for each scenario. For Scenario 1 the deferred maintenance will increase from $54.0 million to $81.2 million by the end of year 3. Scenarios 2 and 3 present a deferred maintenance of $60.4 million and 38.3 million, respectively, by the end of year 3.

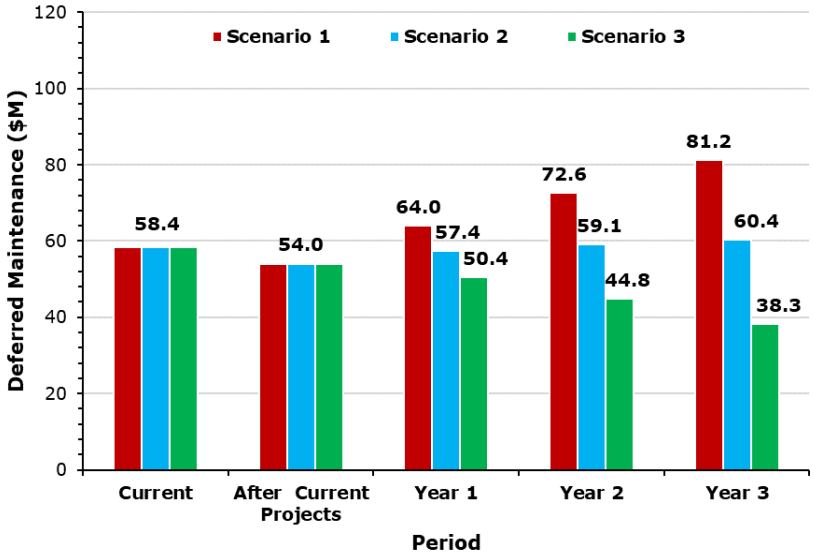


Figure 12. Comparison of Annual Deferred Maintenance by Scenario.

Figure 13 illustrates the percent change in pavement condition for each scenario at the end of year 3. As noted previously, currently, 83.3 percent of the network is in “Very Good” or “Good” condition, and 16.7 percent is in “Poor” or “Very Poor” condition. Under Scenario 1, the portion of the network in “Good” or “Very Good” condition will decrease to 80.6 percent, while the portion of the network in “Poor” or “Very Poor” condition will also increase to 19.4 percent. Under Scenario 2, the portion in “Good” or “Very Good” condition will decrease to 80.4 percent, while the portion in “Poor” or “Very Poor” condition will decrease to 19.6 percent. Under Scenario 3, the portion in “Very Good” or “Good” would be 88.8 percent, leaving only 11.2 percent in “Poor” or “Very Poor” condition.

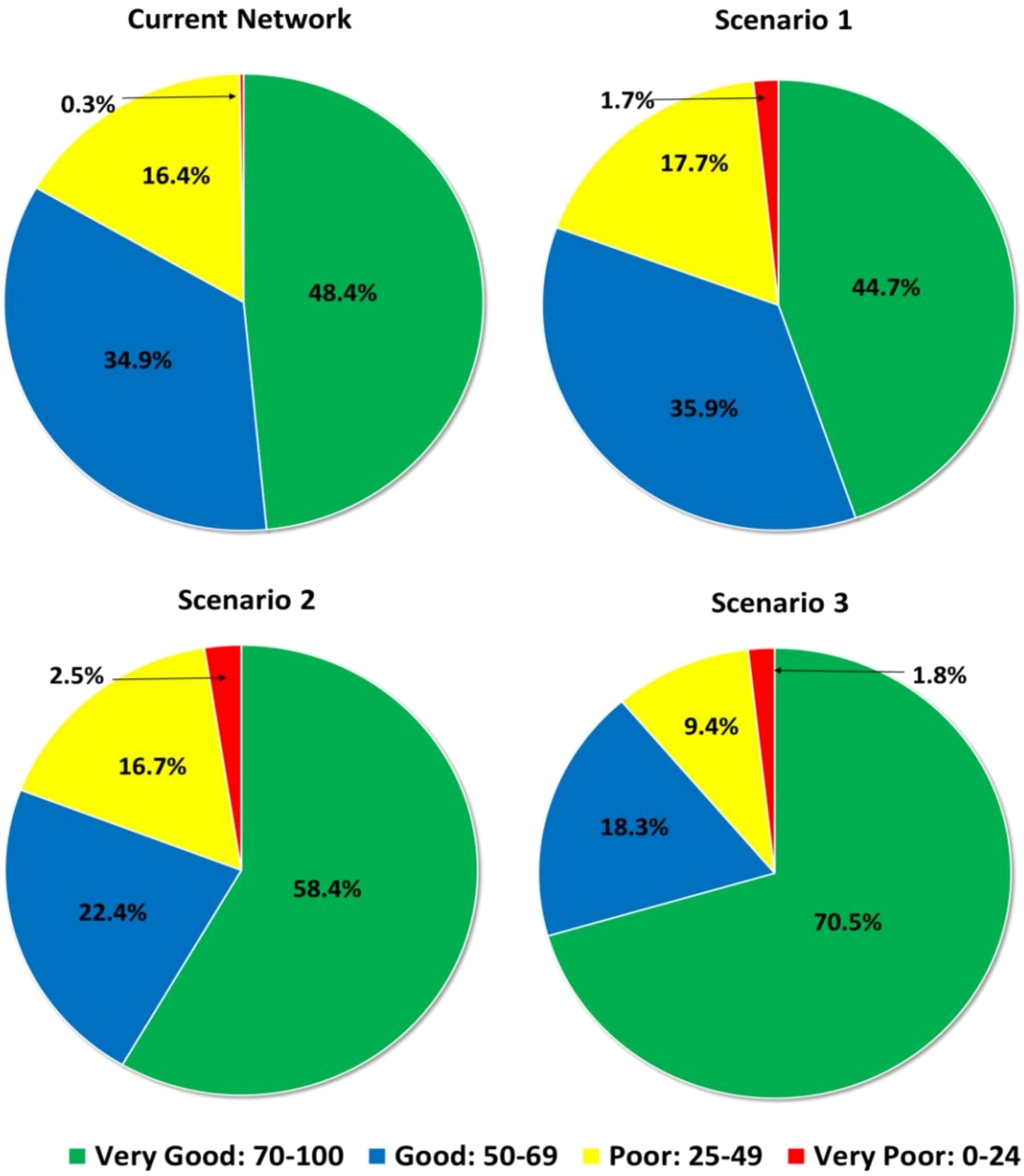


Figure 13. Comparison of Pavement Condition by FY 2028/29 Breakdown by Scenarios.

7 Cost Analysis Reconciliation to Previous Report

There are several reasons that could explain the reduction in PCI at the end of the previous 2021-2023 analysis period. As it is widely known, the appearance of the COVID-19 virus during 2021 disrupted the worldwide economy for several months, leading to the sudden inflation of prices and interest rates. In 2022 the average inflation rate in the United States was 8.00% while it was only 4.70% in 2021 and 1.23% in 2020. Due to this unexpected price increase, the projected funding for the City's rehabilitation and maintenance program could not be performed as expected, increasing the deferred maintenance each year, and significantly impacting the overall network PCI.

In the previous PMP report (2020), NCE considered an inflation rate of only 3% for the 10-year analysis period, resulting in a better network condition than the current situation. As an example, the cost of slurry seal was considered as $3.00/SY in 2020, whereas today, the estimated cost had risen to $5.60/SY. If the 3% inflation rate had stayed, the slurry cost would be approximately $3.30/SY in today's dollars. Other treatments were affected in a similar way. In the Budget Analysis section, a 5.0% inflation rate is considered, 2% higher than the assumed value in 2020. In summary, it was observed that the treatment goals established in the past could not be achieved due to unexpected events that altered treatment cost, decreasing the amount of the network that could be treated, and resulting in a pavement condition less than previously predicted

Conclusion and Recommendations

In summary, the City of Redondo Beach has a substantial investment of $282 million in the pavement network. Overall, the pavement network is in "Good" condition with a PCI of 67 and is expected to increase to a PCI of 69 after the stated improvements are completed. As shown in Table B above, based on the City's existing budget (Scenario 1) of $7.5 million over 3 years is expected to reduce the overall network PCI from 69 to 66. In Scenario 2, PCI is maintained at 70 over 3 years with an investment of $20.4 million. Under Scenario 3, PCI would increase from 69 to 75 by the end of year 3 with an investment of $34.5 million.

7.1 Recommendations

NCE recommends that the City consider the following:

1. **Pavement Budget** - Increase the funding level to improve the network condition, combat high treatment costs from inflation, and reduce the deferred maintenance growth (Scenario 3).
2. **Additional Funding** - Actively pursue additional pavement funding sources in order to address the gap between the City's existing funding and the recommended scenario.
3. **Pavement Maintenance Strategies**
    a. Consider alternative treatments such as full-depth reclamation and cold-in-place or cold central plant recycling, which are alternatives to reconstruction and conventional treatment overlays. These treatments could offer cost savings of approximately 20 to 30 percent compared to traditional treatments.
    b. Continue with a well-funded preventive maintenance program and rehabilitation projects to improve pavement in poor condition. This is necessary to maintain at least the portion of the street network in good condition and avoid increasing the deferred maintenance.
4. **Inspection Strategies** – Monitor future pavement performance and ongoing maintenance needs by updating the required Los Angeles County Metropolitan Transportation Authority inventory of the City's arterial and collector streets on a triennial basis.
5. **M&R Decision Tree** - Review and update the M&R treatment strategies and associated unit costs annually to reflect new construction techniques and costs so that the budget analysis results remain reliable and accurate.