2024 Pavement Management Report

for

City of Upland, CA

Prepared by

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Executive Summary

This is an updated report following the discovery of data formatting that produced erroneous results. Since PAVER is unable to look backward in time the start date used was January 1, 2025. Also, True Area was applied producing greater accuracy but different results.

The nation's roadway system represents an investment of trillions of dollars by local, state, and federal governments. To protect its investment, the City of Upland hired Transmap Corporation to assist in the development of a Network Pavement Management program. This program is designed to assist in the preservation and extending of the useful life of its paved surfaces throughout the region by optimizing the available funds to meet the road network needs.

Upland maintains approximately 191.64 centerline miles of asphalt paved roads, as well as 37.31 miles of paved Alleys and 25 parking lots. This represents an investment of roughly $557.4M, based on the city's replacement (reconstruction) costs, with a "fix-all" cost of $160.4M (See Tables 13 through 15).

Transmap utilizes PAVER (ver. 7.1) to perform road analysis. PAVER, a pavement management system (PMS), is a decision-making tool for the development of cost-effective maintenance and repair alternatives for roads and streets. Developed and maintained by the US Army Corps of Engineers Research and Development Center, it provides a Network-Level, systematic approach to pavement management to ensure optimum return on investment.

PAVER employs a Pavement Condition Index (PCI) condition rating for each segment of roadway (intersection to intersection) in its assessment, on a 0 (Failed) to 100 (Excellent) scale. The inspection criteria and PCI determination are governed by ASTM Standard D6433-11, "Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys" making it an objective and, just as important, repeatable means of assigning a condition rating to the roadways.

On January 31, 2024, a (Boot Camp) meeting was held to begin the process of gathering the necessary information to produce a Pavement Management System (PMS) report. Details regarding costs and budgets were established in preceding discussions and emails.

The City has four (4) district boundaries and four (3) Roadway families, Arterials, Collectors, and Local roads. It also has asphalt Alleys and Parking Lots analyzed separately. The report covers a 5-year plan with a start date of July 1, 2024. A given annual budget of $6.38M is provided and split between road families by area, as well as a $350K Budget for Alleys. There is no given budget for Parking Lots.

The city provided 5 years of maintenance history which was not enough to develop individual Pavement Performance Models for each family so, one was created based on other local data and industry standard and can be seen in Appendix A of this report.

The following budget scenarios were constructed for each family of the City's roadway network:

- **"Fix-All" Cost**
- **Do Nothing Consequences (PCI at 5 years)**
- **Given $6.38M Annual Budget Consequences (budget distributed by area)**
- **Annual Budgets to Maintain Existing PCI's**
- **Annual Budgets to Achieve a PCI equivalent to the existing PCI plus 5 points**
- **Annual Budgets to Achieve a PCI of 70**

1.0 All Asphalt (AC) Pavements

The following are unit prices for (M&R) treatments that were obtained from discussions during the Boot Camp meeting and preceding correspondence. Transmap translated the information and placed it into the appropriate M&R Category ranges shown in the tables below. The column titled "Expected Result" reflects the expected extended life of the pavement as either experienced by the City or provided by the industry. These treatments and costs were applied uniformly throughout the roadway network.

Table 1 - Arterial Asphalt Roads - Treatments, PCI Ranges and Costs

M&R Category	M&R Treatment	Price per Square Yard	Expected Result
Do Nothing (PCI 86 - 100)	Do Nothing	NA	NA
Global (PCI 71 - 85)	Slurry	$5.40	5 – Year Stabilization
Conventional (PCI 41 - 70)	Overlay	$54.00	15-years Reset PCI = 100
Rehab & Reclamation (PCI 0 - 40)	FDR	$85.50	20-years Reset PCI = 100

Table 2 - Collector Asphalt Roads - Treatments, PCI Ranges and Costs

M&R Category	M&R Treatment	Price per Square Yard	Expected Result
Do Nothing (PCI 86 - 100)	Do Nothing	NA	NA
Global (PCI 56 - 85)	Slurry	$4.50	5 -year Stabilization
Conventional (PCI 41 - 55)	Overlay	$36.00	20-years Reset PCI = 100
Rehab & Reclamation (PCI 0 - 40)	FDR	$63.00	25-years Reset PCI = 100

It is important to note that PAVER is designed to optimize the application of the treatments and determine a levelized budget based on treatment costs, the existing conditions, and the deterioration model. Its methodology is not a worst-first approach but instead assigns treatments in a manner that may not be intuitively obvious or operationally convenient, such as grouping roads together for letting.

Table 3 - Local Asphalt Roads - Treatments, PCI Ranges and Costs

M&R Category	M&R Treatment	Price per Square Yard	Expected Result
Do Nothing (PCI 86 - 100)	Do Nothing	NA	NA
Global (PCI 56 - 85)	Slurry	$4.50	5 -year Stabilization
Conventional (PCI 41 - 55)	Overlay	$36.00	20-years Reset PCI = 100
Rehab & Reclamation (PCI 0 - 40)	FDR	$63.00	25-years Reset PCI = 100

Table 4 - Asphalt Alleys - Treatments, PCI Ranges and Costs

M&R Category	M&R Treatment	Price per Square Yard	Expected Result
Do Nothing (PCI 86 - 100)	Do Nothing	NA	NA
Global (PCI 41 - 85)	Slurry	$4.50	5 -year Stabilization
Rehab & Reclamation (PCI 0 - 40)	FDR	$85.50	25-years Reset PCI = 100

Table 5 - Asphalt Parking Lots - Treatments, PCI Ranges and Costs

M&R Category	M&R Treatment	Price per Square Yard	Expected Result
Do Nothing (PCI 86 - 100)	Do Nothing	NA	NA
Global (PCI 56 - 85)	Slurry	$4.50	5 -year Stabilization
Conventional (PCI 41 - 55)	Overlay	$36.00	20-years Reset PCI = 100
Rehab & Reclamation (PCI 0 - 40)	FDR	$63.00	25-years Reset PCI = 100

1.1 Road Characteristics

The table below illustrates the mileage distribution by surface type, number of miles, number of square yards, and the overall weighted average Pavement Condition Index (PCI).

Table 6 - Distribution of All Roads by Pavement Type

Pavement Type	# of Sections	# of CL Miles	Square Yardage	% by # of SY	Weighted Average PCI
Asphalt	2,210	191.64	4,713,566	100%	57
Total	**2,210**	**191.64**	**4,713,566**	**100%**	**57**

Table 7 - Distribution of Asphalt Roads by Family

Functional Class/Paver Designation	# of Sections	# of CL Miles	Square Yardage	% by SY	Weighted Average PCI
Arterials	317	39.8	1,505,619	31.9%	54
Collectors	350	30.17	660,265	14.0%	61
Local Roads	1543	121.67	2,547,682	54.0%	58
Total	**2,210**	**191.64**	**4,713,566**	**100.0%**	**57**

Table 8 - Distribution of Asphalt Roads by District

Functional Class/Paver Designation	District	# of Sections	# of CL Miles	Square Yardage	% by SY	Weighted Average PCI
Arterials	1	79	8.98	322,627	6.8%	61
	2	85	12.02	438,987	9.3%	61
	3	63	10.82	461,848	9.8%	42
	4	90	7.98	282,156	6.0%	56
Collectors	1	110	10.06	210,915	4.5%	61
	2	131	10.53	224,250	4.8%	64
	3	30	4.83	114,632	2.4%	56
	4	79	4.75	110,468	2.3%	58
Local Roads	1	562	39.97	834,595	17.7%	58
	2	545	44.27	953,150	20.2%	62
	3	162	11.77	238,943	5.1%	55
	4	274	25.67	520,993	11.1%	54
Totals		**2210**	**191.65**	**4,713,564**	**100.0%**	**57**

Table 9 - Distribution of Asphalt Alleys by Surface Type

Pavement Type	# of Sections	# of CL Miles	Square Yardage	% by # of SY	Weighted Average PCI
Asphalt	383	37.31	262,644	99.9%	47
Concrete	1	0.03	202	0.1%	91
Total	**384**	**37.34**	**262,846**	**100%**	**47**

Table 10 - Alley Network by District

Pavement Type	District	# of Sections	# of CL Miles	Square Yardage	% by # of Miles	Weighted Average PCI
Asphalt	1	36	5.2	36,609	13.9%	24
	2	79	10.64	74,909	28.5%	57
	3	60	5.26	37,057	14.1%	42
	4	208	16.2	114,068	43.4%	49
Concrete	4	1	0.03	202	0.1%	91
Totals		**384**	**37.33**	**262,845**	**100%**	**47**

Table 11 - Parking Lot Network by Surface Type

Pavement Type	# of Sections	Square Yardage	% by # of Miles	Weighted Average PCI
Asphalt	25	149,031	100.0%	34
Total	**25**	**149,031**	**100%**	**34**

Table 12 - Parking Lot Network by District

Pavement Type	District	# of Sections	Square Yardage	% by # of Miles	Weighted Average PCI
Asphalt	1	5	45,428	30.5%	37
	2	4	10,012	6.7%	23
	3	3	16,952	11.4%	35
	4	13	76,639	51.4%	35
Totals		**25**	**149,031**	**100%**	**34**

2.0 Budget Scenario Details

The following subsections contain various budgeting scenarios for the City's roadway network. The first is a table summarizing the cost if the City was to "fix all" present deficiencies at once. This is followed by various described scenarios tabularizing and graphically illustrating the annual budgets for 5-year periods, as determined by PAVER, and their resulting year-end PCI.

2.1 Fix All Scenarios

Table 13 – Arterial AC Roads – Fix All

M&R Category	Centerline Miles	SY	Price per Square Yard	Totals
Do Nothing (PCI 86 - 100)	5.34	202,857	NA	$0
Global (PCI 71 - 85)	6.83	248,295	$5.40	$1,340,793
Conventional (PCI 41 - 70)	15.38	564,518	$54.00	$30,483,972
Rehab & Reclamation (PCI 0 - 40)	12.25	489,949	$85.50	$41,890,640
Totals	**39.80**	**1,505,619**		**$73,715,405**

Table 14 – Collector AC Roads – Fix All

&R Category	Centerline Miles	SY	Price per Square Yard	Totals
Do Nothing (PCI 86 - 100)	7.24	151,877	NA	$0
Global (PCI 56 - 85)	10.85	236,824	$4.50	$1,065,708
Conventional (PCI 41 - 55)	4.28	99,350	$36.00	$3,576,600
Rehab & Reclamation (PCI 0 - 40)	7.8	172,214	$63.00	$10,849,482
Totals	**30.17**	**660,265**		**$15,491,790**

Table 15 – Local AC Roads – Fix All

M&R Category	Centerline Miles	SY	Price per Square Yard	Totals
Do Nothing (PCI 90 - 100)	12.33	258,016	NA	$0
Global (PCI 70 - 89)	32.08	676,073	$4.50	$3,042,329
Conventional (PCI 50 - 69)	59.76	1,239,678	$36.00	$44,628,408
Full Depth Reclamation (PCI 0 - 29)	17.49	373,915	$63.00	$23,556,645
Totals	**121.66**	**2,547,682**		**$71,227,382**

Total Roadway Fix All Cost - $160,434,405

Table 16 – AC Alleys – Fix All

M&R Category	Centerline Miles	SY	Price per Square Yard	Totals
Do Nothing (PCI 86 - 100)	5.19	36,548	N/A	$0
Global (PCI 56 - 85)	14.15	99,608	$4.50	$448,236
Rehab & Reclamation (PCI 0 - 40)	18.00	126,690	$85.50	$10,831,995
Totals	**37.34**	**262,846**		**$11,280,231**

Table 17 – Parking Lots – Fix All

M&R Category	SY	Price per Square Yard	Totals
Do Nothing (PCI 90 - 100)	9,945	NA	$0
Global (PCI 70 - 89)	8,139	$4.50	$36,626
Conventional (PCI 50 - 69)	50,306	$36.00	$1,811,016
Full Depth Reclamation (PCI 0 - 29)	80,641	$63.00	$5,080,383
Totals	**149,031**		**$6,928,025**

2.2 Do Nothing Scenarios

The following scenarios display the predicted PCI results, over the 5-year planning period if no maintenance actions are taken.

Table 18 - Arterial Asphalt Roads - Do Nothing Consequences

Year Beginning January 2025	Annual Budget (Major)	PCI at Year End	Deferred Maint.
2025	$0	53	$73,200,000
2026	$0	49	$80,100,000
2027	$0	45	$88,100,000
2028	$0	41	$95,600,000
2029	$0	37	$103,400,000

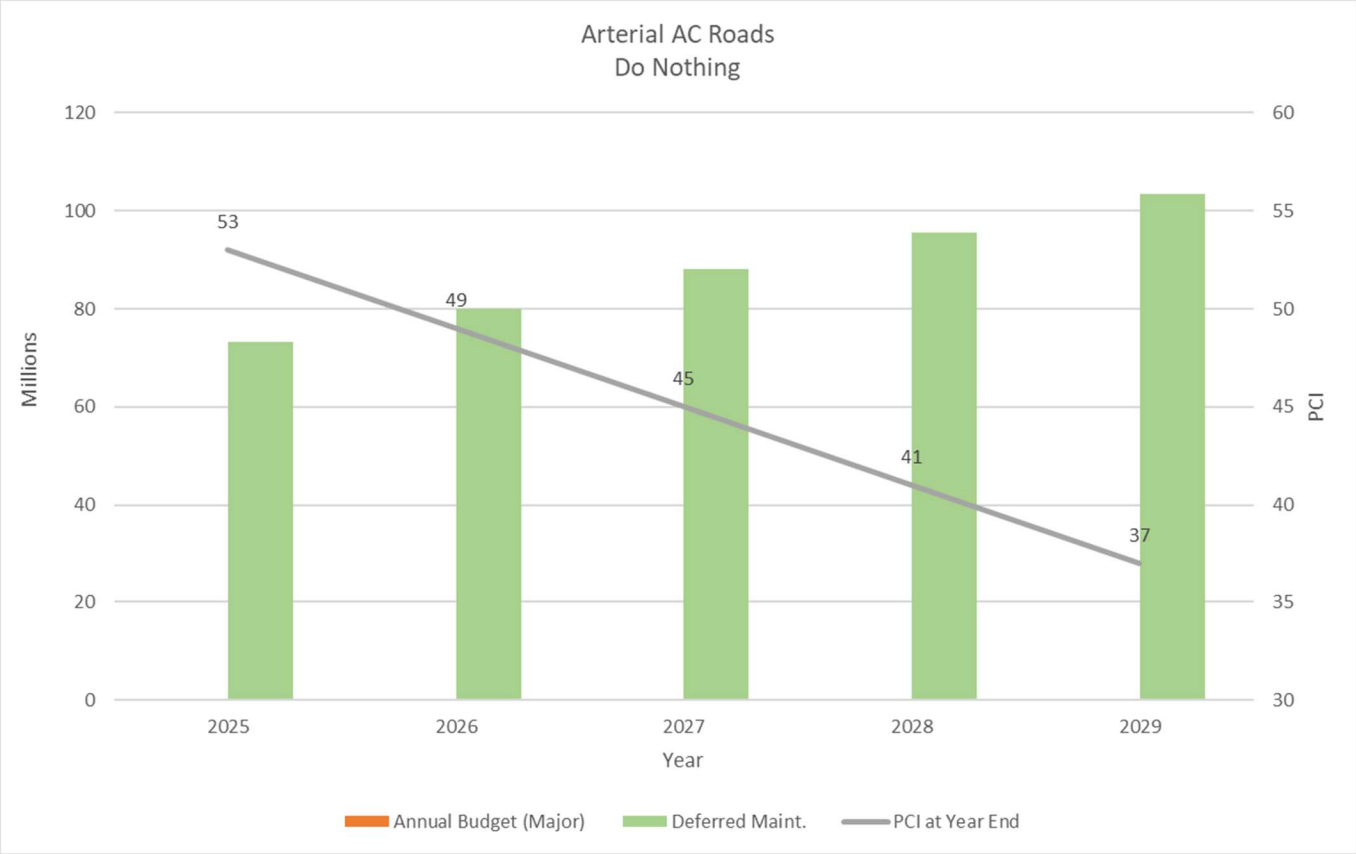


Figure 1. Arterial Asphalt Roads - Do Nothing Consequences

Table 19 - Collector Asphalt Roads - Do Nothing Consequences

Year Beginning January 2025	Annual Budget (Major)	PCI at Year End	Deferred Maint.
2025	$0	60	$20,300,000
2026	$0	56	$22,900,000
2027	$0	52	$24,700,000
2028	$0	48	$26,600,000
2029	$0	44	$29,800,000

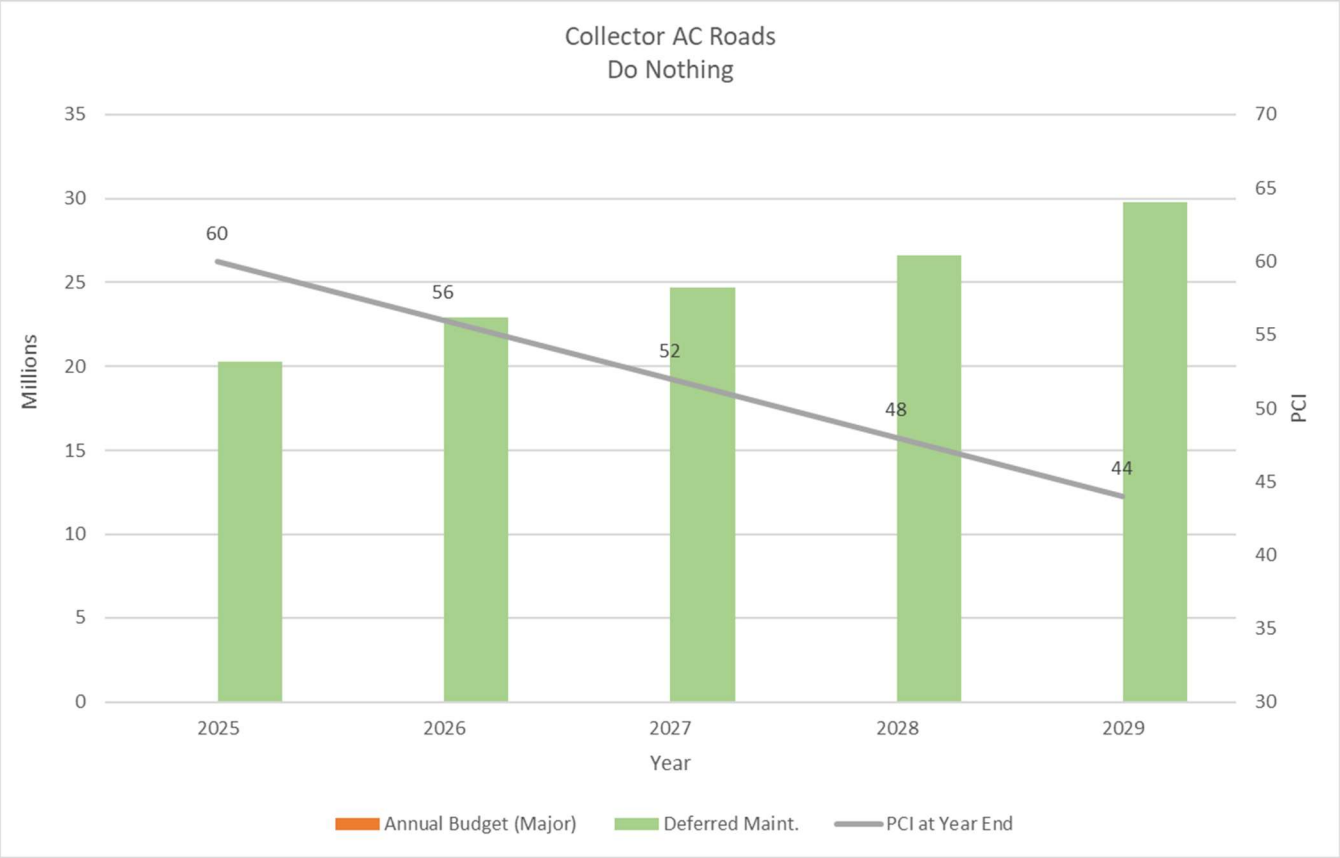


Figure 2. Collector Asphalt Roads - Do Nothing Consequences

Table 20 - Local Asphalt Roads - Do Nothing Consequences

Year Beginning January 2025	Annual Budget (Major)	PCI at Year End	Deferred Maint.
2025	$0	57	$80,800,000
2026	$0	53	$91,200,000
2027	$0	49	$101,000,000
2028	$0	45	$110,600,000
2029	$0	41	$120,600,000

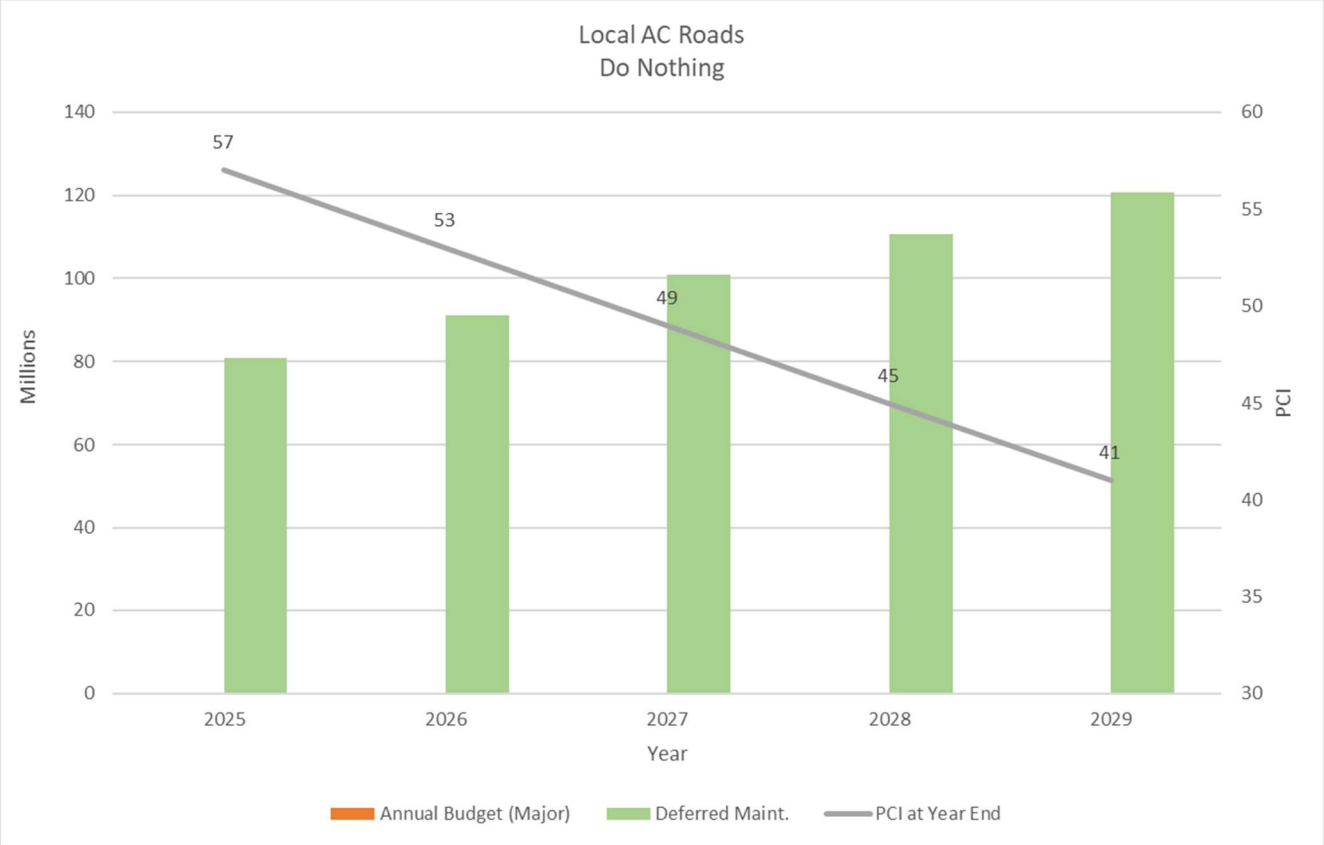


Figure 3. Local Asphalt Roads - Do Nothing Consequences

2029 Asphalt Roadway Network PCI = 40

Table 21 - Asphalt Alleys - Do Nothing Consequences

Year Beginning January 2025	Annual Budget (Major)	PCI at Year End	Deferred Maint.
2025	$0	46	$13,500,000
2026	$0	42	$14,700,000
2027	$0	39	$16,000,000
2028	$0	36	$17,200,000
2029	$0	34	$18,400,000

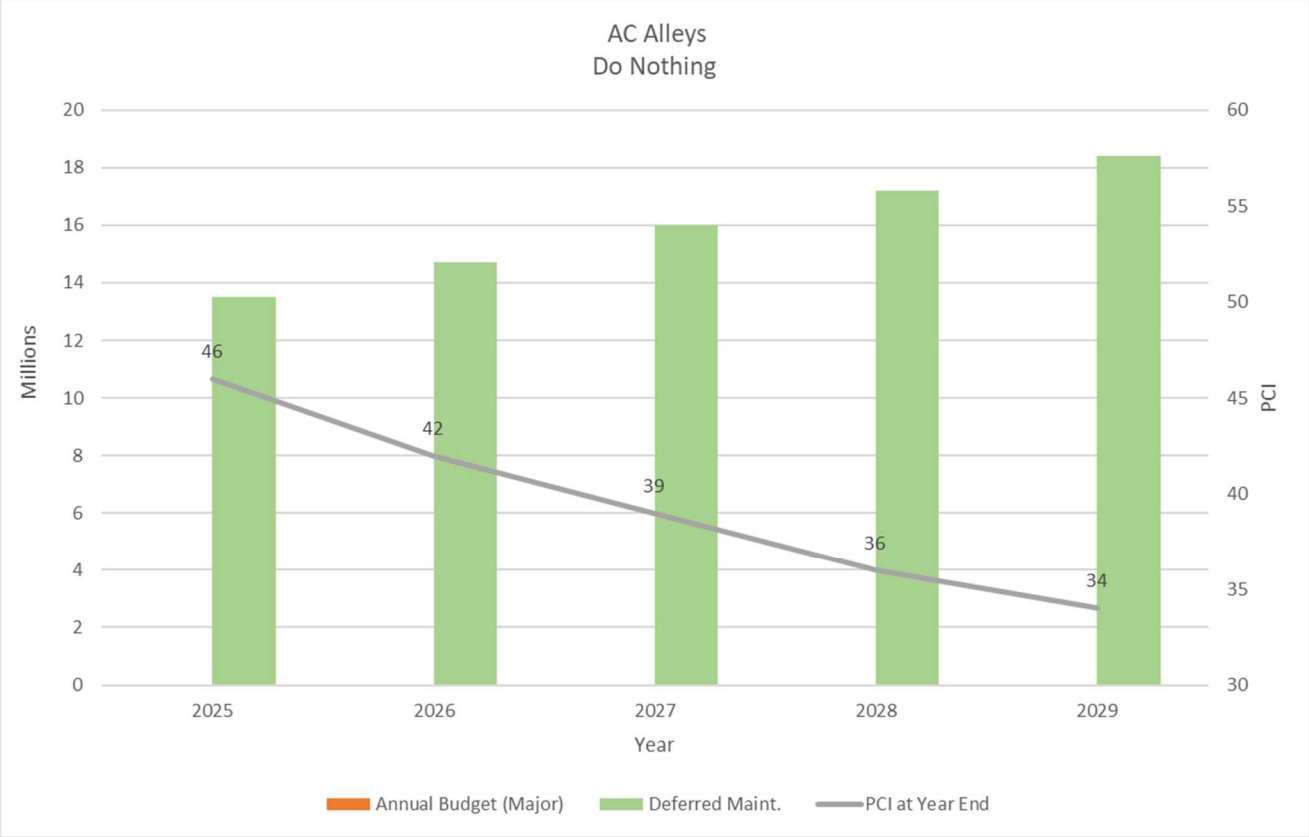


Figure 4. Asphalt Alleys - Do Nothing Consequences

Table 22 - Asphalt Parking Lots - Do Nothing Consequences

Year Beginning January 2025	Annual Budget (Major)	PCI at Year End	Deferred Maint.
2025	$0	33	$8,100,000
2026	$0	28	$8,400,000
2027	$0	23	$8,900,000
2028	$0	18	$9,300,000
2029	$0	13	$9,600,000

Figure 5. Asphalt Parking Lots - Do Nothing Consequences

2.3 Given Annual Budget Consequence Scenarios

The Given budget of $6.38M was divided between each roadway family based on their total SY areas resulting in Arterials - $2.038M, Collectors - $894K, and Local - $3.448M.

Table 23 - Arterial Asphalt Roads – Given $2.038M Annual Budget Consequences

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$788,000	$1,250,000	54	$71,100,000
2026	$216,000	$1,822,000	51	$76,000,000
2027	$58,000	$1,980,000	47	$80,500,000
2028	$228,000	$1,810,000	45	$85,100,000
2029	$49,000	$1,989,000	42	$90,400,000

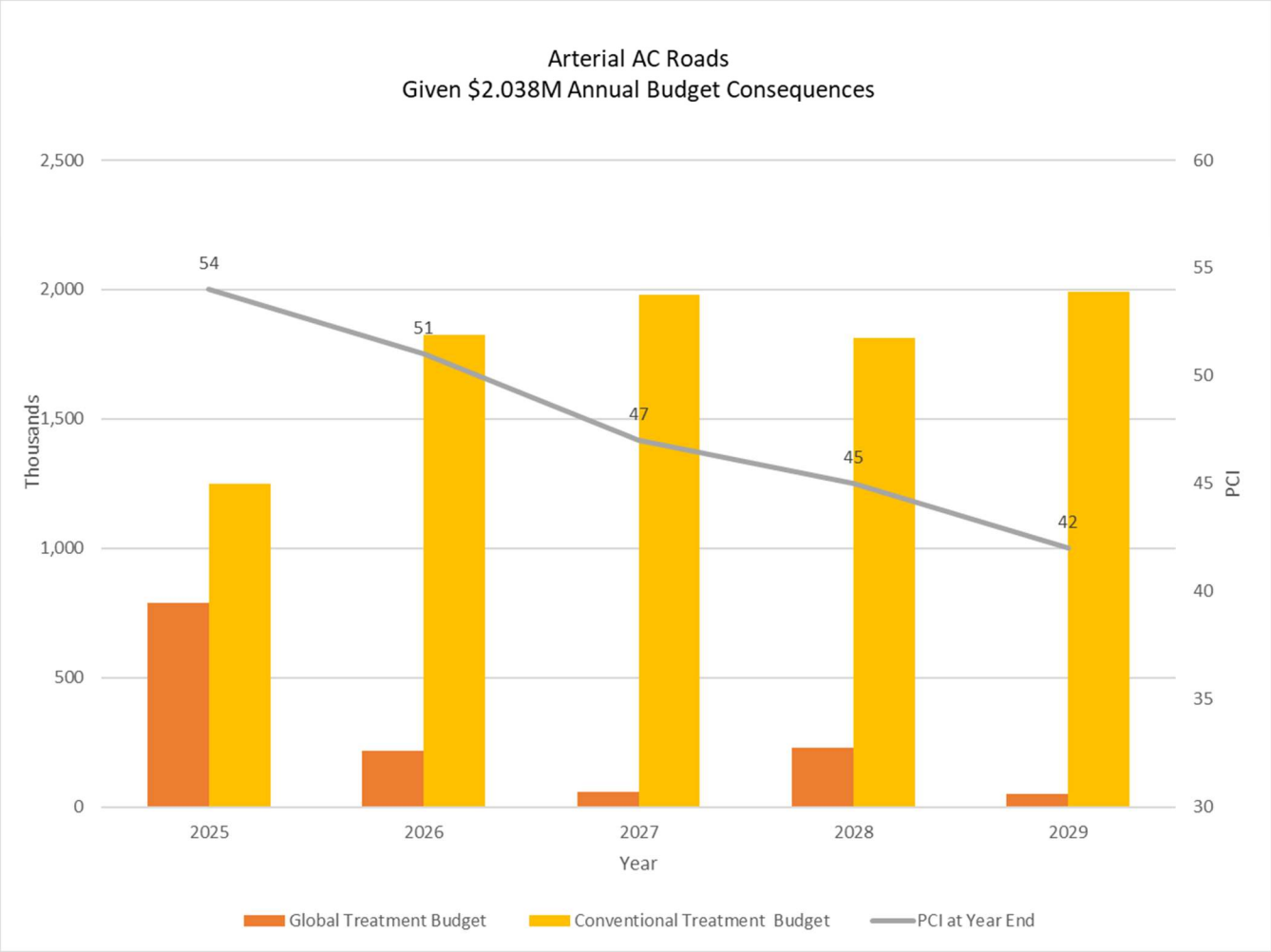


Figure 6. Arterial Asphalt Roads – Given $2.038M Annual Budget Consequences

Table 24 - Collector Asphalt Roads – Given $894K Annual Budget Consequences

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$149,000	$689,000	61	$19,400,000
2026	$38,000	$800,000	58	$20,100,000
2027	$43,000	$795,000	56	$21,800,000
2028	$30,000	$808,000	53	$22,600,000
2029	$33,000	$805,000	51	$24,800,000

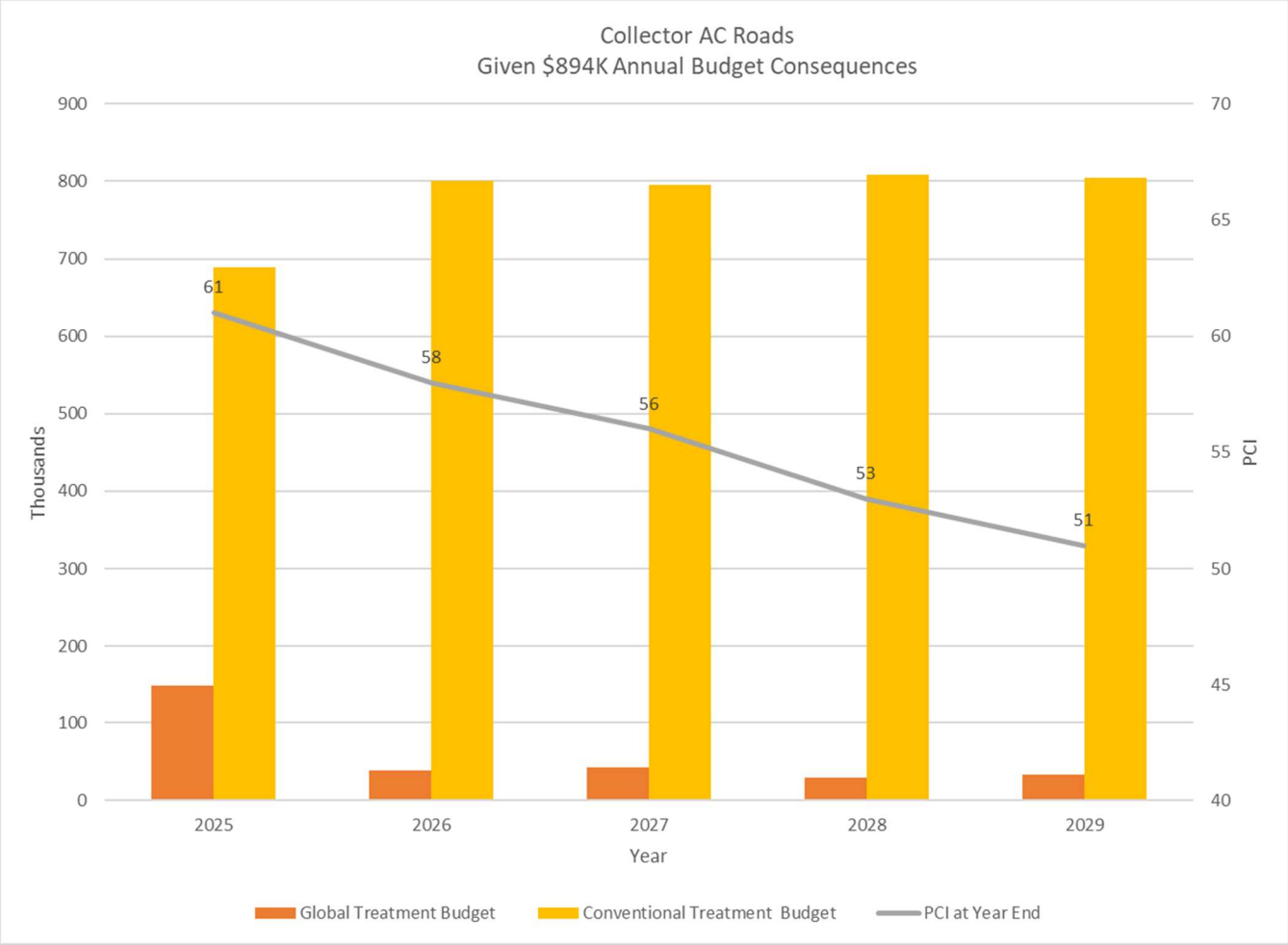


Figure 7. Collector Asphalt Roads – Given $894K Annual Budget Consequences

Table 25 - Local Asphalt Roads – Given $3.448M Annual Budget Consequences

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$1,303,000	$2,145,000	59	$77,400,000
2026	$389,000	$3,059,000	56	$83,800,000
2027	$123,000	$3,325,000	53	$88,500,000
2028	$256,000	$3,192,000	51	$92,900,000
2029	$138,000	$3,310,000	48	$97,600,000

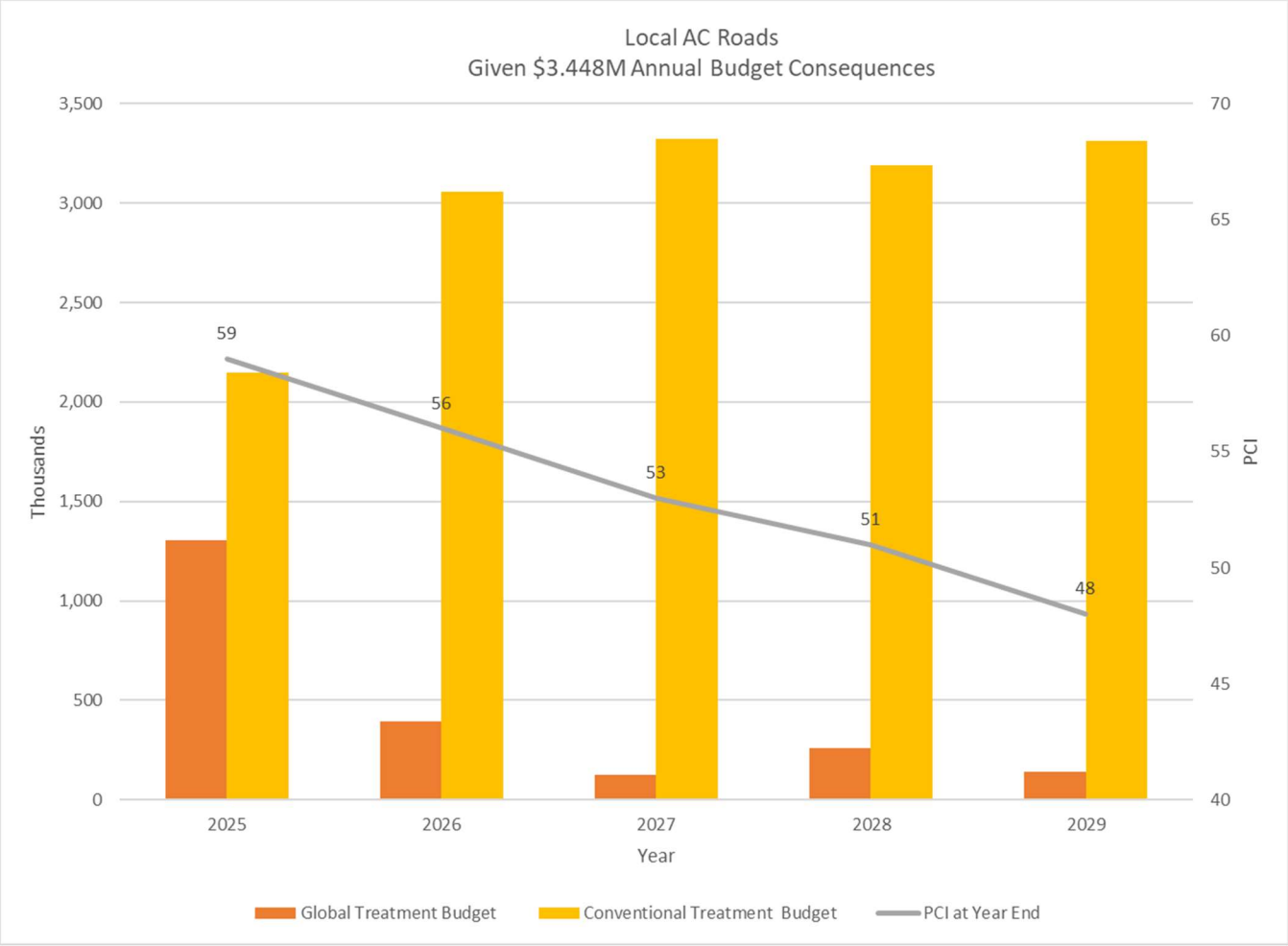


Figure 8. Local Asphalt Roads – Given $3.448M Annual Budget Consequences

2029 Asphalt Roadway Network Total PCI - 47

Table 26 - Asphalt Alleys – Given $350K Annual Budget Consequences

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$95,000	$255,000	48	$13,200,000
2026	$11,000	$339,000	45	$13,600,000
2027	$136,000	$214,000	44	$13,800,000
2028	$22,000	$328,000	42	$14,000,000
2029	$0	$350,000	41	$14,100,000

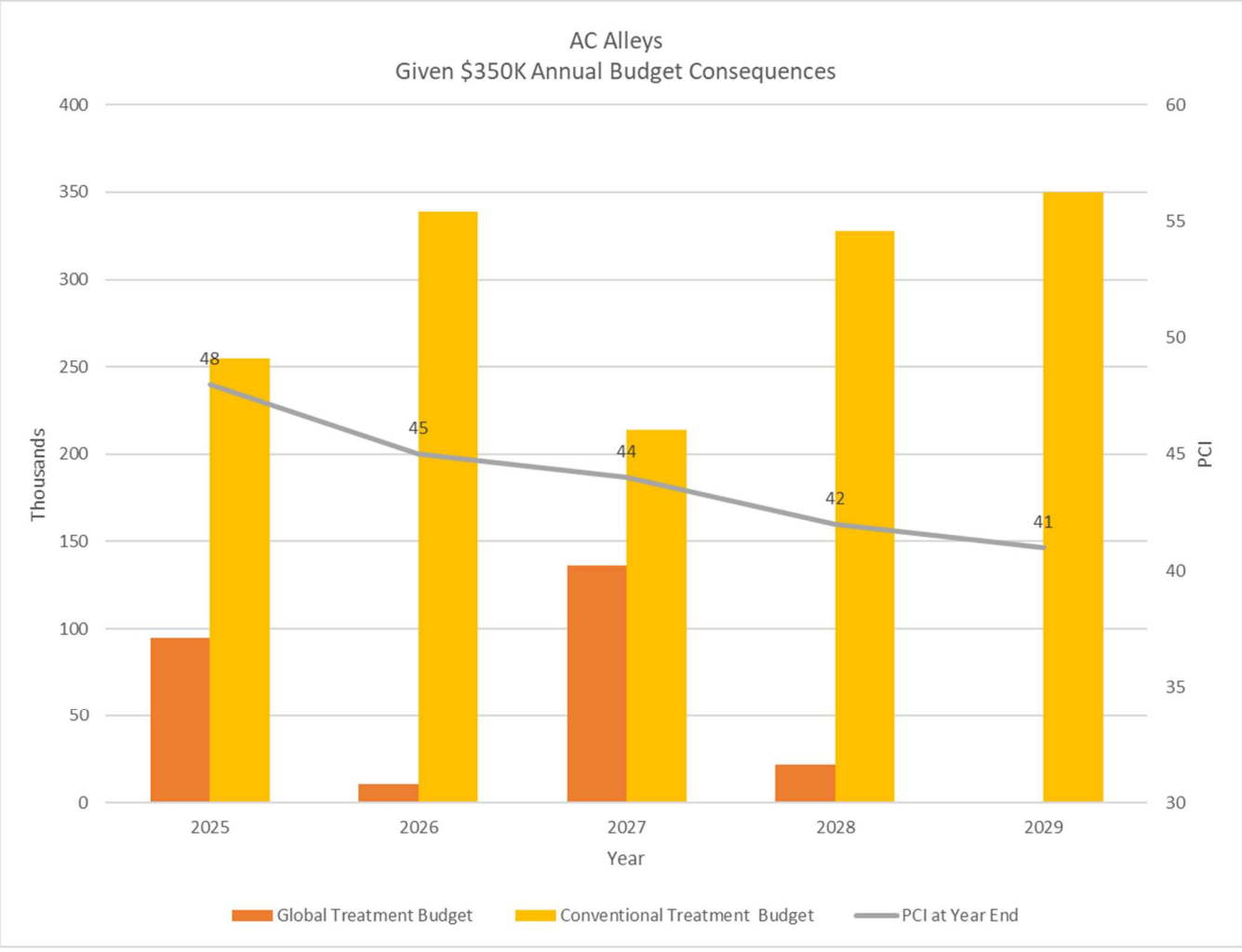


Figure 9. Asphalt Alleys – Given $350K Annual Budget Consequences

2.4 Budgets to Maintain Existing PCI Scenarios

Table 27 - Arterial Asphalt Roads – $6.433M Annual Budget to Maintain PCI of 54

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$788,000	$5,645,000	56	$66,700,000
2026	$216,000	$6,217,000	54	$67,000,000
2027	$58,000	$6,375,000	54	$67,000,000
2028	$228,000	$6,205,000	54	$66,600,000
2029	$49,000	$6,384,000	54	$62,600,000

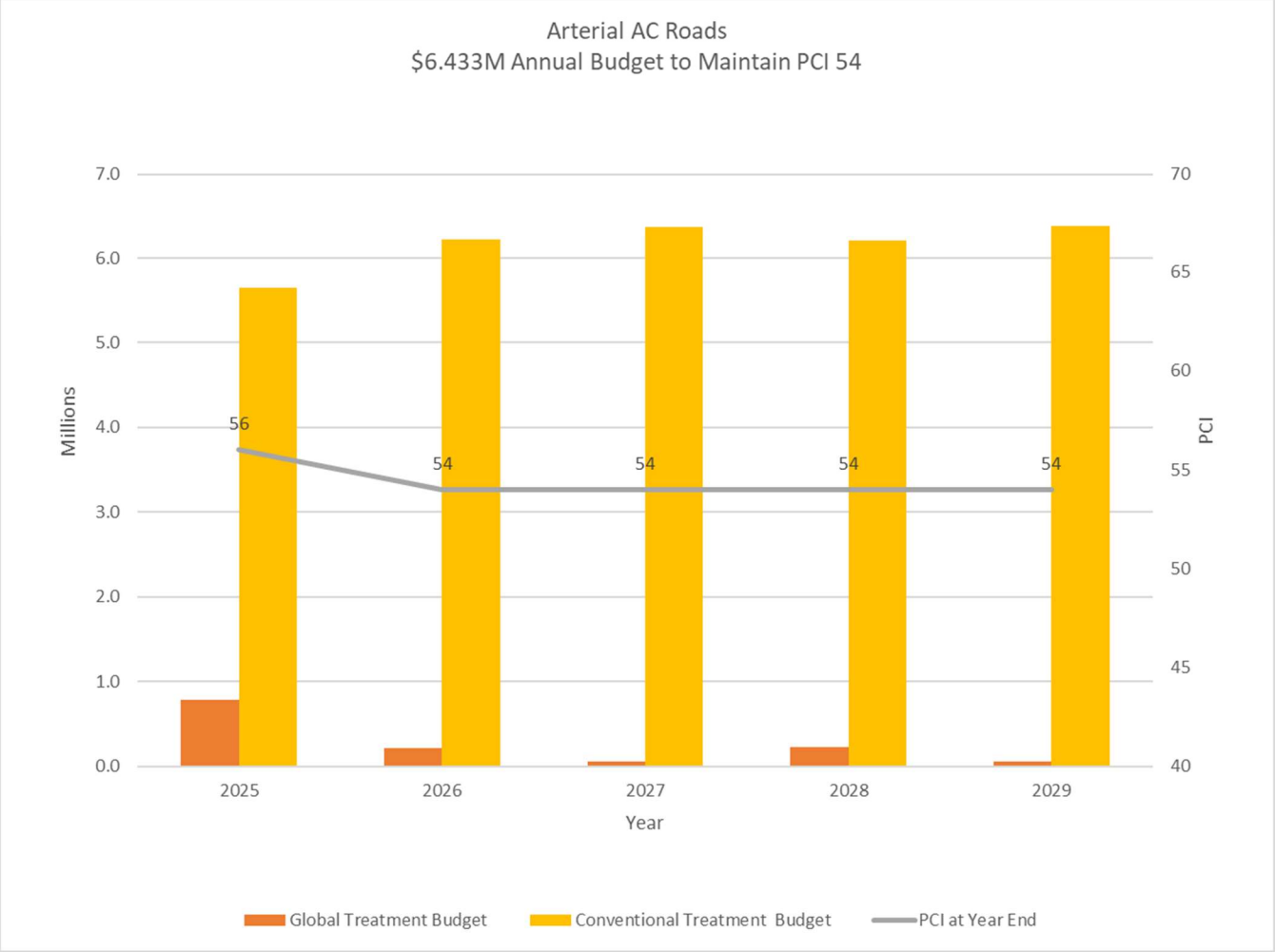


Figure 10. Arterial Asphalt Roads – $6.433M Annual Budget to Maintain PCI of 54

Table 28 - Collector Asphalt Roads – $1.905M Annual Budget to Maintain PCI of 61

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$149,000	$1,826,000	62	$18,400,000
2026	$38,000	$1,931,000	62	$18,900,000
2027	$43,000	$1,915,000	61	$18,700,000
2028	$30,000	$1,946,000	61	$18,400,000
2029	$33,000	$1,943,000	61	$17,500,000

Figure 11. Collector Asphalt Roads – $1.905M Annual Budget to Maintain PCI of 61

Table 29 - Local Asphalt Roads – $7.418M Annual Budget to Maintain PCI of 58

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$1,303,000	$6,115,000	60	$73,400,000
2026	$389,000	$7,029,000	59	$75,700,000
2027	$123,000	$7,295,000	59	$76,200,000
2028	$256,000	$7,162,000	58	$75,700,000
2029	$138,000	$7,280,000	58	$71,800,000

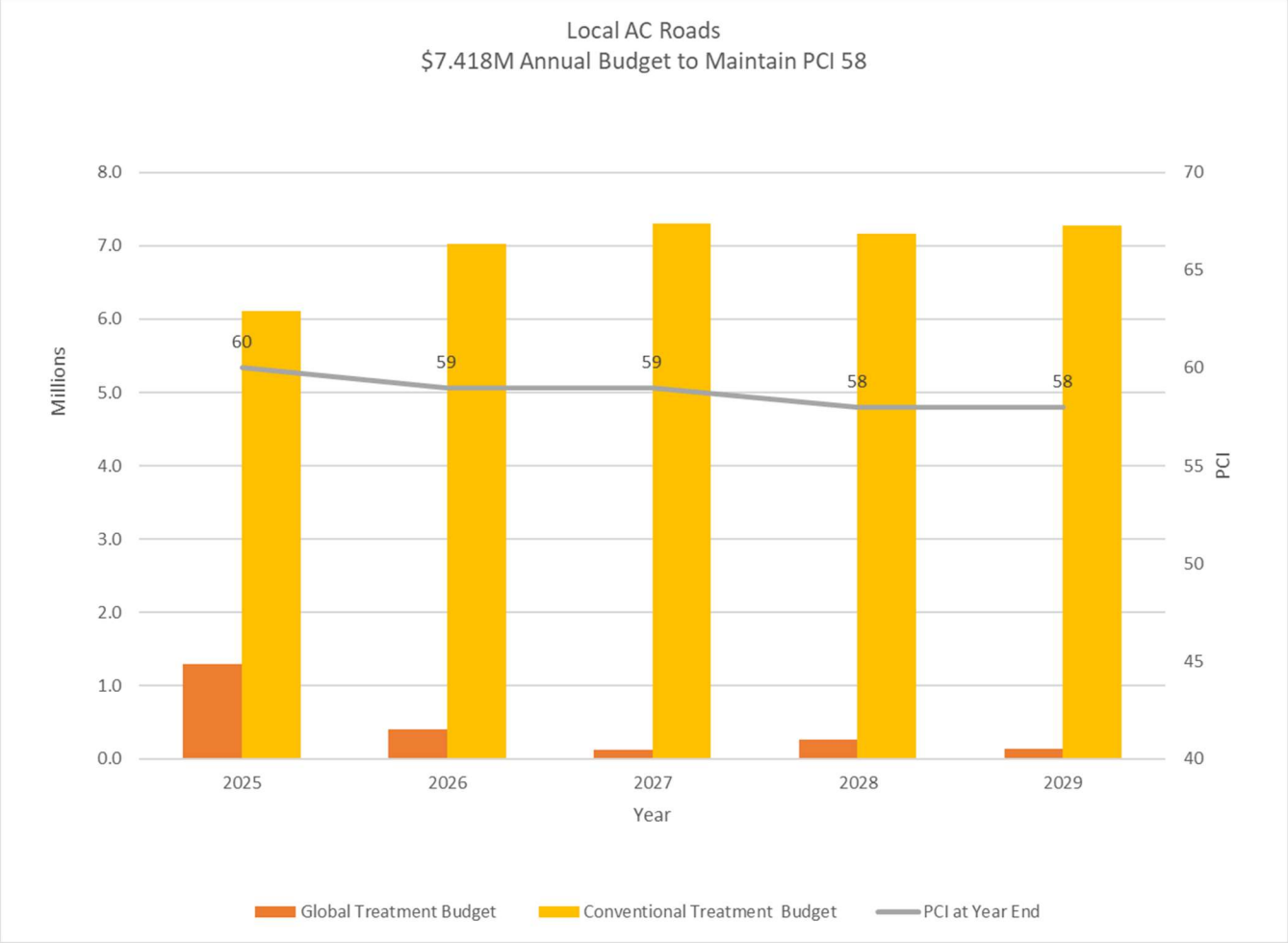


Figure 12. Local Asphalt Roads – $7.418M Annual Budget to Maintain PCI of 58

Total Annual Budget to Maintain Existing PCI (57) - $15.756M

Table 30 - Asphalt Alleys – $699K Annual Budget to Maintain PCI of 47

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$95,000	$604,000	49	$12,800,000
2026	$11,000	$688,000	47	$12,600,000
2027	$136,000	$563,000	46	$12,500,000
2028	$22,000	$677,000	46	$12,200,000
2029	$0	$699,000	47	$11,900,000

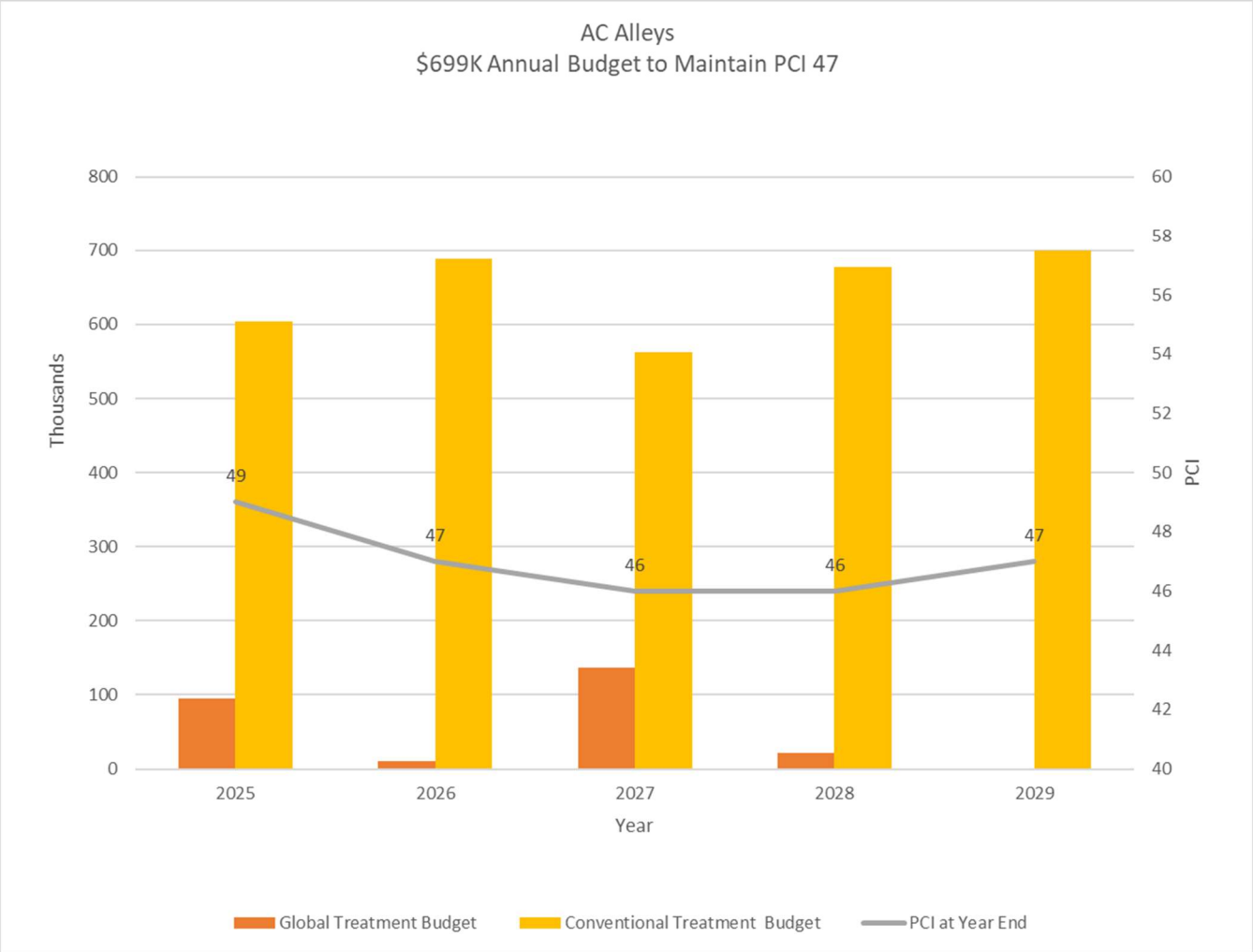


Figure 13. Asphalt Alleys – $699K Annual Budget to Maintain PCI of 47

Table 31 - Asphalt Parking Lots – $475K Annual Budget to Maintain PCI of 34

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$37,000	$438,000	37	$7,600,000
2026	$0	$475,000	35	$7,400,000
2027	$0	$475,000	34	$7,200,000
2028	$9,000	$466,000	34	$6,900,000
2029	$0	$475,000	34	$7,000,000

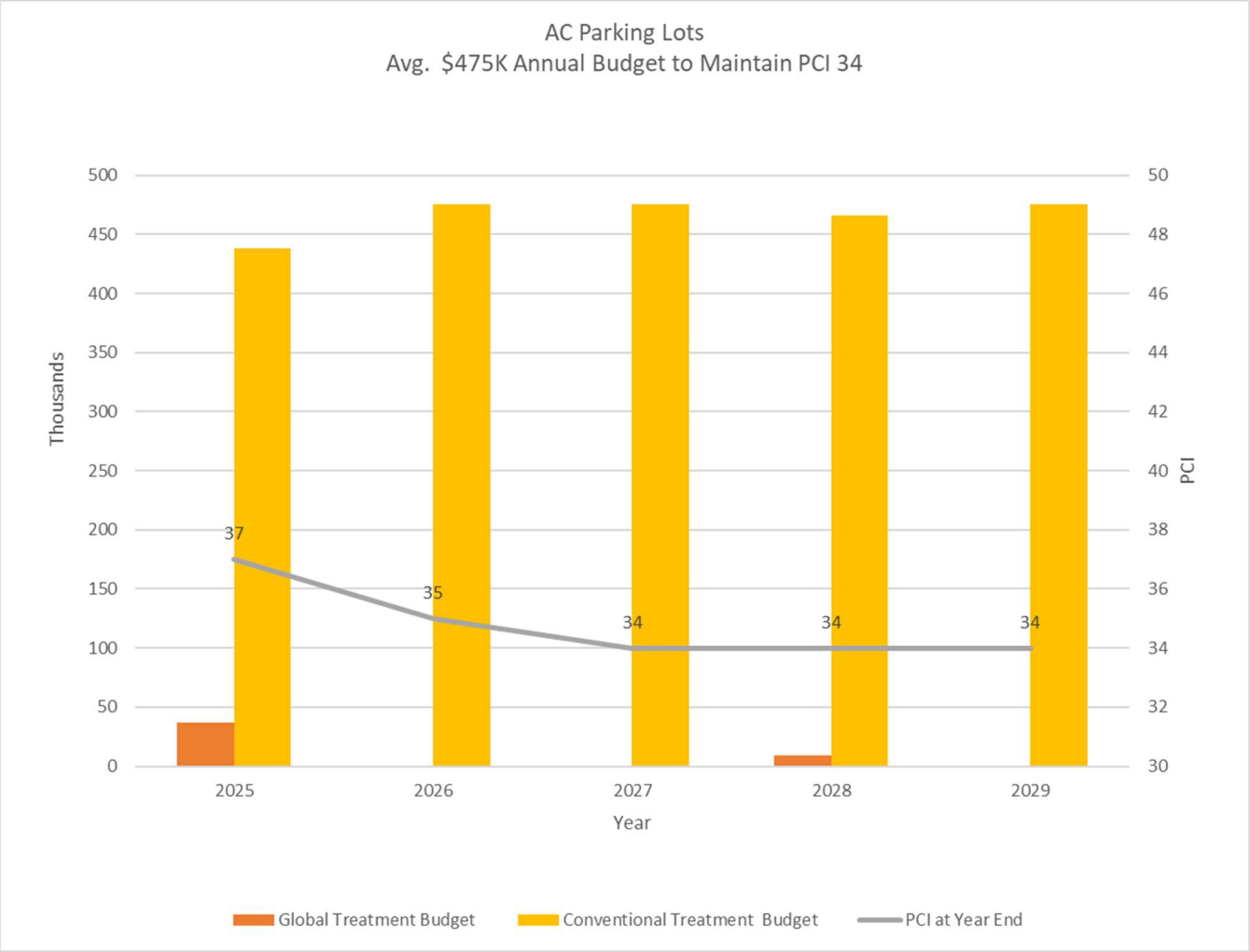


Figure 14. Asphalt Parking Lots – $475K Annual Budget to Maintain PCI of 34

2.5 Budgets to Achieve Existing PCI plus 5 Points Scenarios

Table 32 - Arterial Asphalt Roads – $7.859M Annual Budget to Achieve a PCI of 59

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$788,000	$7,071,000	56	$65,300,000
2026	$216,000	$7,643,000	56	$64,100,000
2027	$58,000	$7,801,000	57	$62,500,000
2028	$228,000	$7,631,000	57	$58,900,000
2029	$49,000	$7,810,000	59	$53,300,000

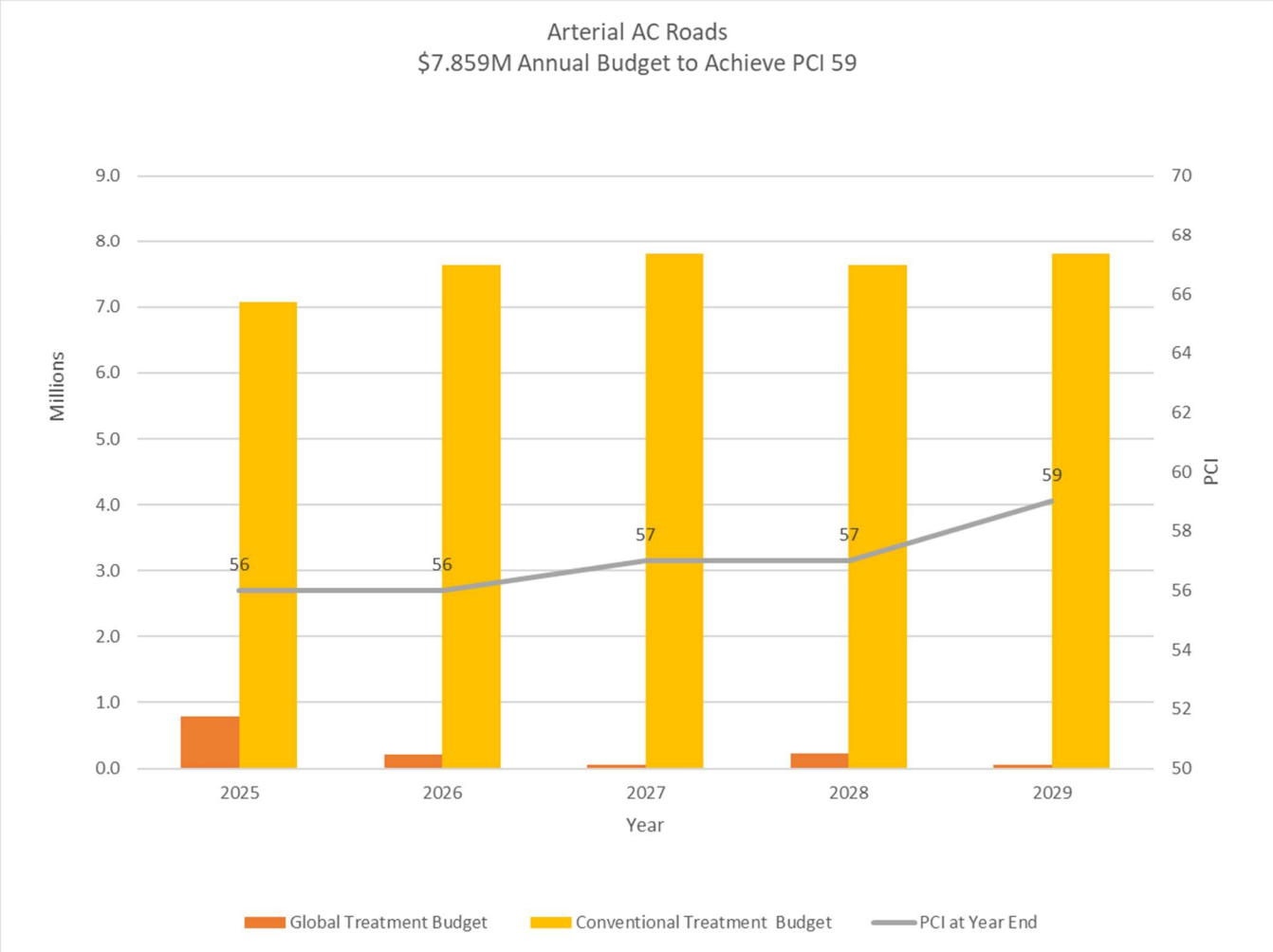


Figure 15. Arterial Asphalt Roads – $7.859M Annual Budget to Achieve a PCI of 59

Table 33 - Collector Asphalt Roads – $2.343M Annual Budget to Achieve a PCI of 66

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
025	$149,000	$2,194,000	63	$17,900,000
026	$38,000	$2,305,000	63	$18,000,000
027	$43,000	$2,300,000	64	$17,300,000
028	$30,000	$2,313,000	66	$16,000,000
029	$33,000	$2,310,000	66	$14,600,000

Figure 16. Collector Asphalt Roads – $2.343M Annual Budget to Achieve a PCI of 66

Table 34 - Local Asphalt Roads – $9.161M Annual Budget to Achieve a PCI of 63

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$1,303,000	$7,858,000	61	$71,700,000
2026	$389,000	$8,772,000	62	$72,200,000
2027	$123,000	$9,038,000	62	$70,800,000
2028	$256,000	$8,905,000	62	$65,100,000
2029	$138,000	$9,023,000	63	$59,100,000

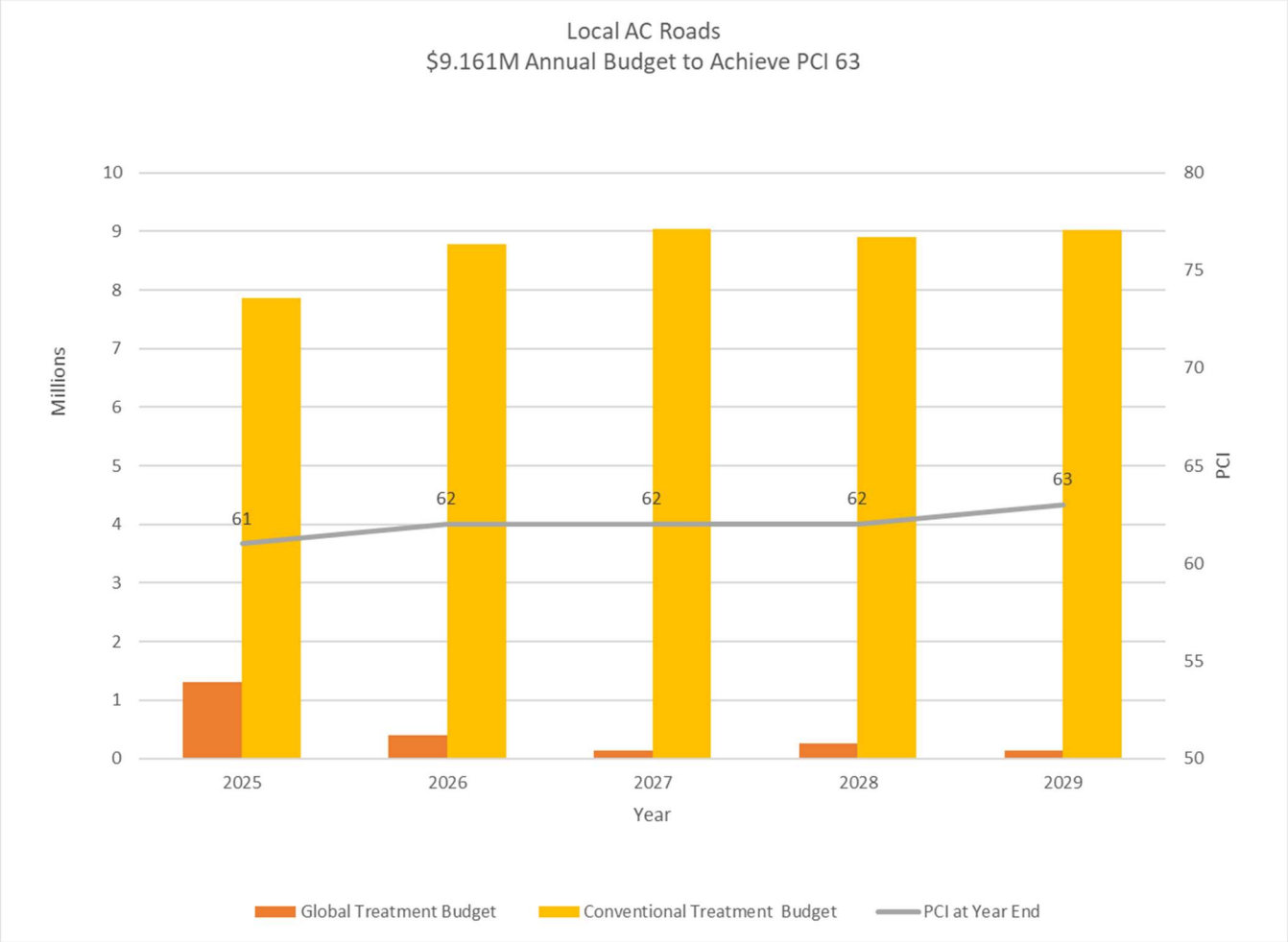


Figure 17. Local Asphalt Roads – $9.161M Annual Budget to Achieve a PCI of 63

Total Annual Budget to Achieve Existing PCI +5 (62) = $19.363M

Table 35 - Asphalt Alleys – $936K Annual Budget to Achieve a PCI of 52

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$95,000	$841,000	49	$12,600,000
2026	$11,000	$925,000	48	$12,100,000
2027	$136,000	$800,000	48	$11,700,000
2028	$22,000	$914,000	49	$11,200,000
2029	$0	$936,000	52	$10,700,000

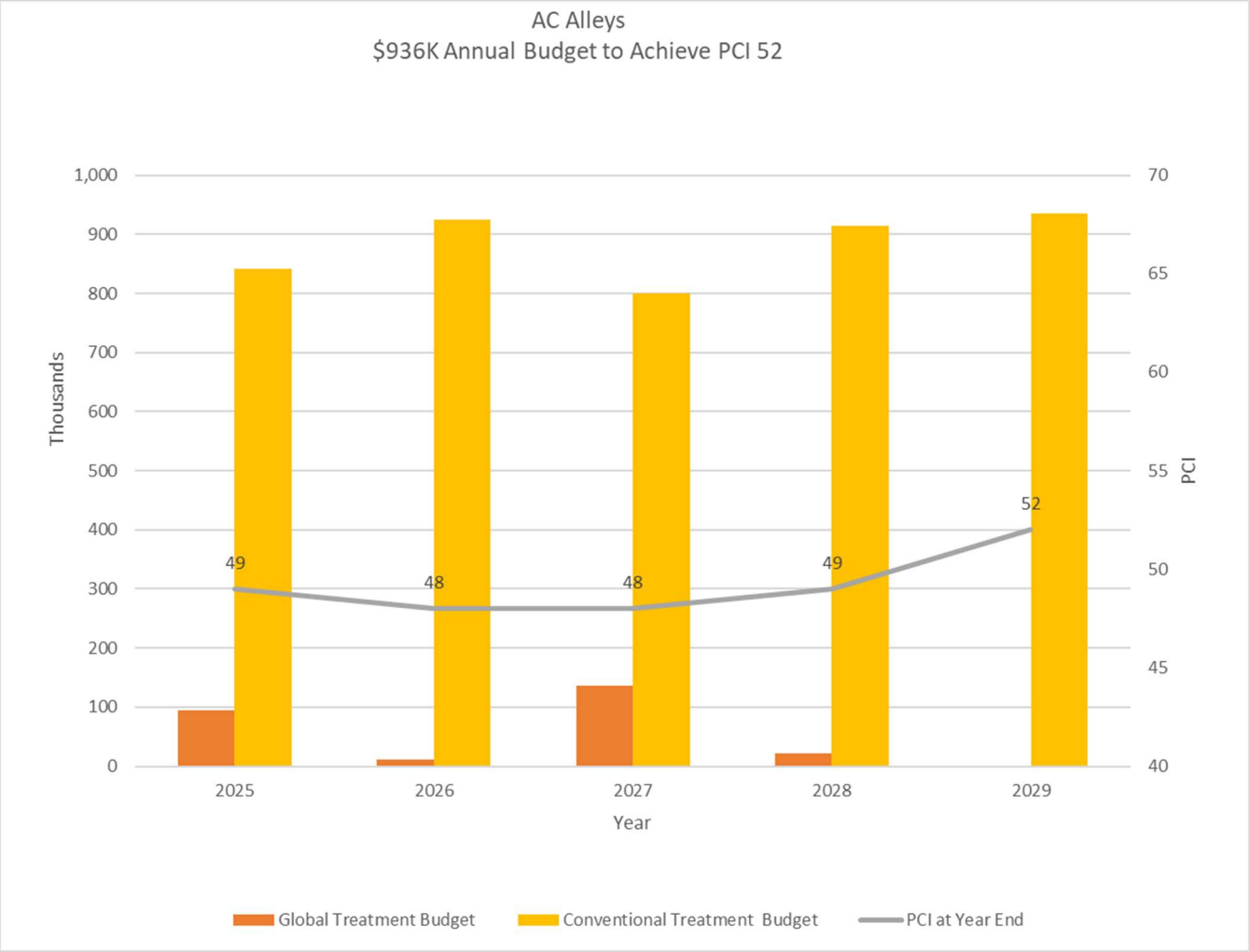


Figure 18. Asphalt Alleys – $936K Annual Budget to Achieve a PCI of 52

Table 36 - Asphalt Parking Lots – 596K Annual Budget to Achieve a PCI of 39

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$37,000	$559,000	37	$7,500,000
2026	$0	$596,000	36	$7,200,000
2027	$0	$596,000	37	$6,800,000
2028	$9,000	$587,000	38	$6,400,000
2029	$0	$596,000	39	$6,100,000

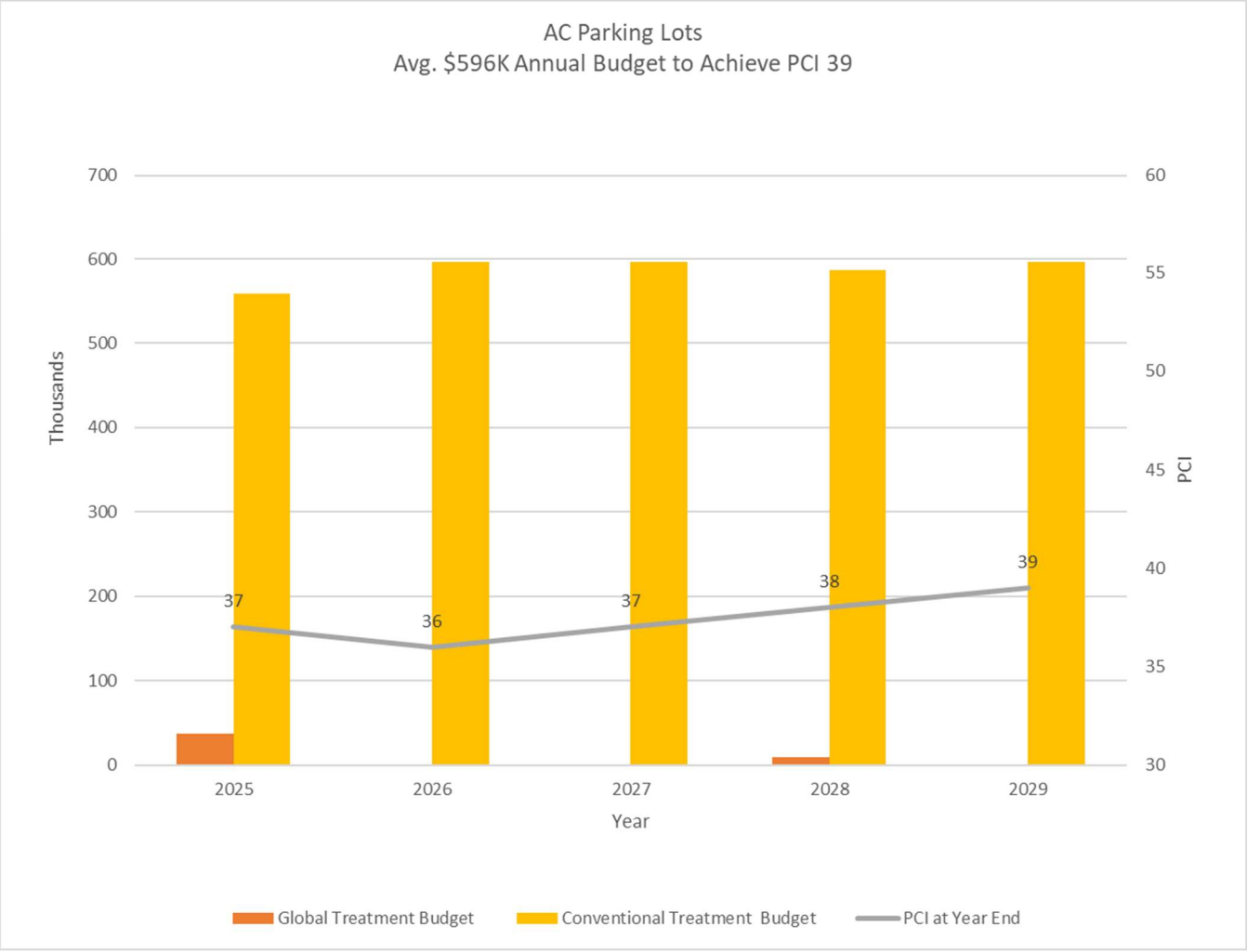


Figure 19. Asphalt Parking Lots – $596K Annual Budget to Achieve a PCI of 39

2.6 Budgets to Achieve a PCI of 70 Scenarios

Table 37 - Arterial Asphalt Roads – $11.144M Annual Budget to Achieve a PCI of 70

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$788,000	$10,356,000	58	$62,000,000
2026	$216,000	$10,928,000	60	$57,500,000
2027	$58,000	$11,086,000	62	$52,400,000
2028	$228,000	$10,916,000	65	$43,600,000
2029	$49,000	$11,095,000	70	$34,200,000

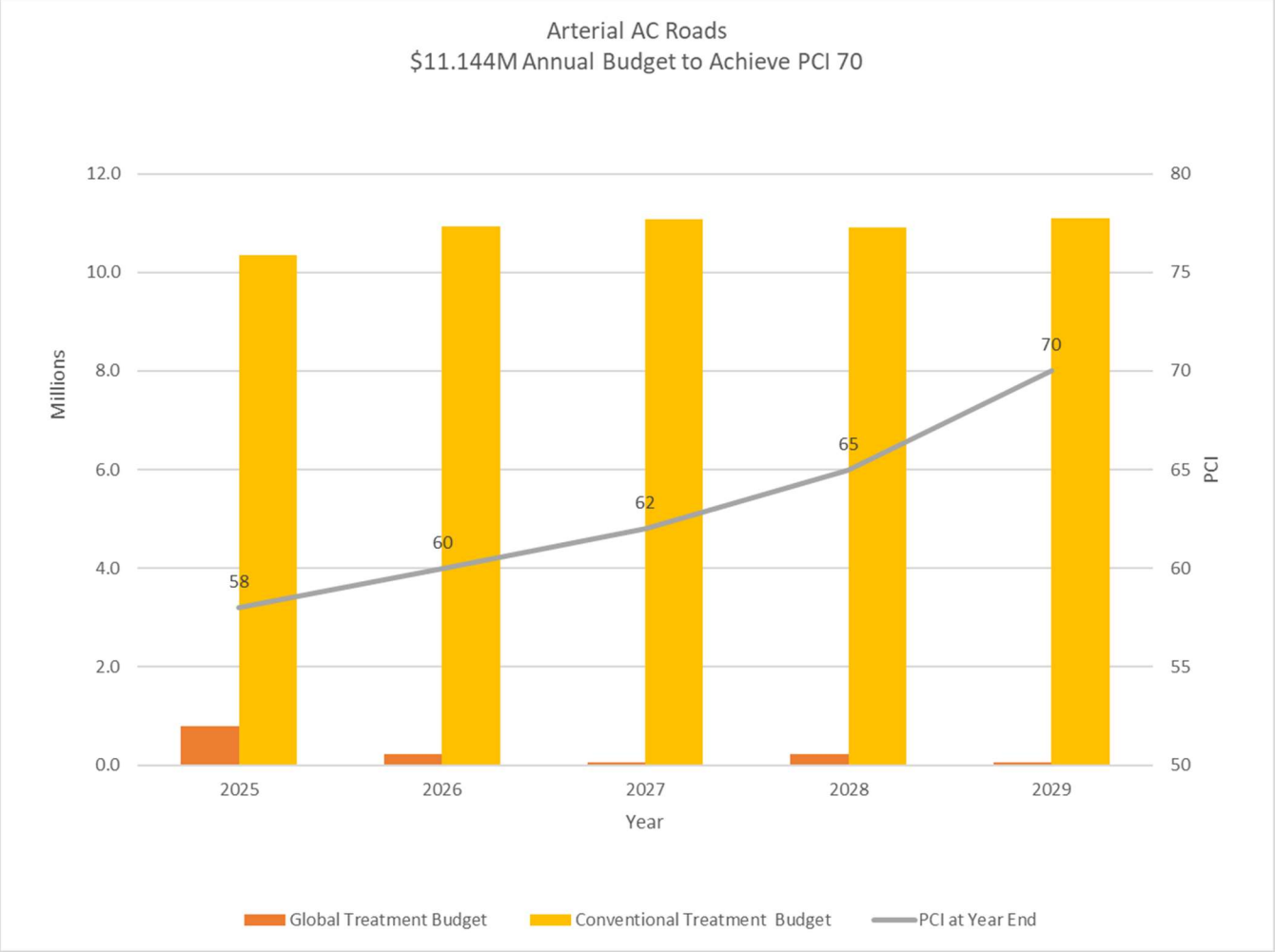


Figure 20. Arterial Asphalt Roads – $11.144M Annual Budget to Achieve a PCI of 70

Table 38 - Collector Asphalt Roads – $2.775M Annual Budget to Achieve a PCI of 70

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$149,000	$2,626,000	64	$17,500,000
2026	$38,000	$2,737,000	65	$17,200,000
2027	$43,000	$2,732,000	66	$16,000,000
2028	$30,000	$2,745,000	67	$14,100,000
2029	$33,000	$2,742,000	70	$12,300,000

Figure 21. Collector Asphalt Roads – $2.775M Annual Budget to Achieve a PCI of 70

Table 39 - Local Asphalt Roads – $12.311M Annual Budget to Achieve a PCI of 70

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$1,303,000	$11,008,000	62	$68,500,000
2026	$389,000	$11,922,000	64	$65,800,000
2027	$123,000	$12,188,000	65	$61,100,000
2028	$256,000	$12,055,000	67	$51,700,000
2029	$138,000	$12,173,000	70	$42,200,000

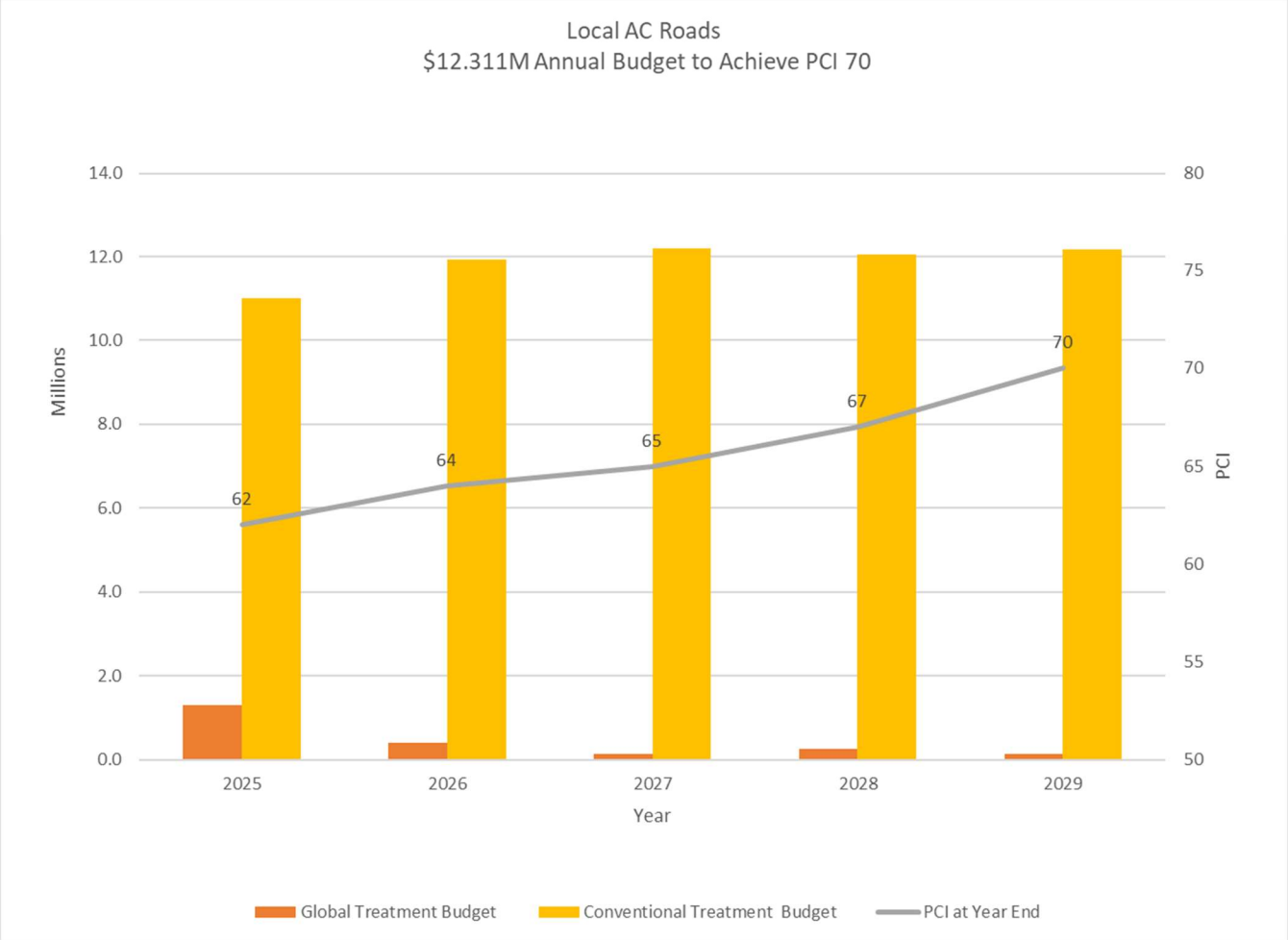


Figure 22. Local Asphalt Roads – $12.311M Annual Budget to Achieve a PCI of 70

Total Annual Budget to Achieve Network PCI of 70 - $26.23M

Table 40 - Asphalt Alleys – $1.846M Annual Budget to Achieve a PCI of 70

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$95,000	$1,751,000	51	$11,700,000
2026	$11,000	$1,835,000	53	$10,200,000
2027	$136,000	$1,710,000	58	$8,900,000
2028	$22,000	$1,824,000	64	$7,400,000
2029	$0	$1,846,000	70	$5,800,000

Figure 23. Asphalt Alleys – $1.846M Annual Budget to Achieve a PCI of 70

Table 41 - Asphalt Parking Lots – $1.724M Annual Budget to Achieve a PCI of 70

Year Beginning January 2025	Global Treatment Budget	Conventional Treatment Budget	PCI at Year End	Deferred Maint.
2025	$37,000	$1,687,000	46	$6,400,000
2026	$0	$1,724,000	55	$4,800,000
2027	$0	$1,724,000	67	$3,200,000
2028	$9,000	$1,715,000	77	$2,000,000
2029	$0	$1,724,000	75	$2,500,000

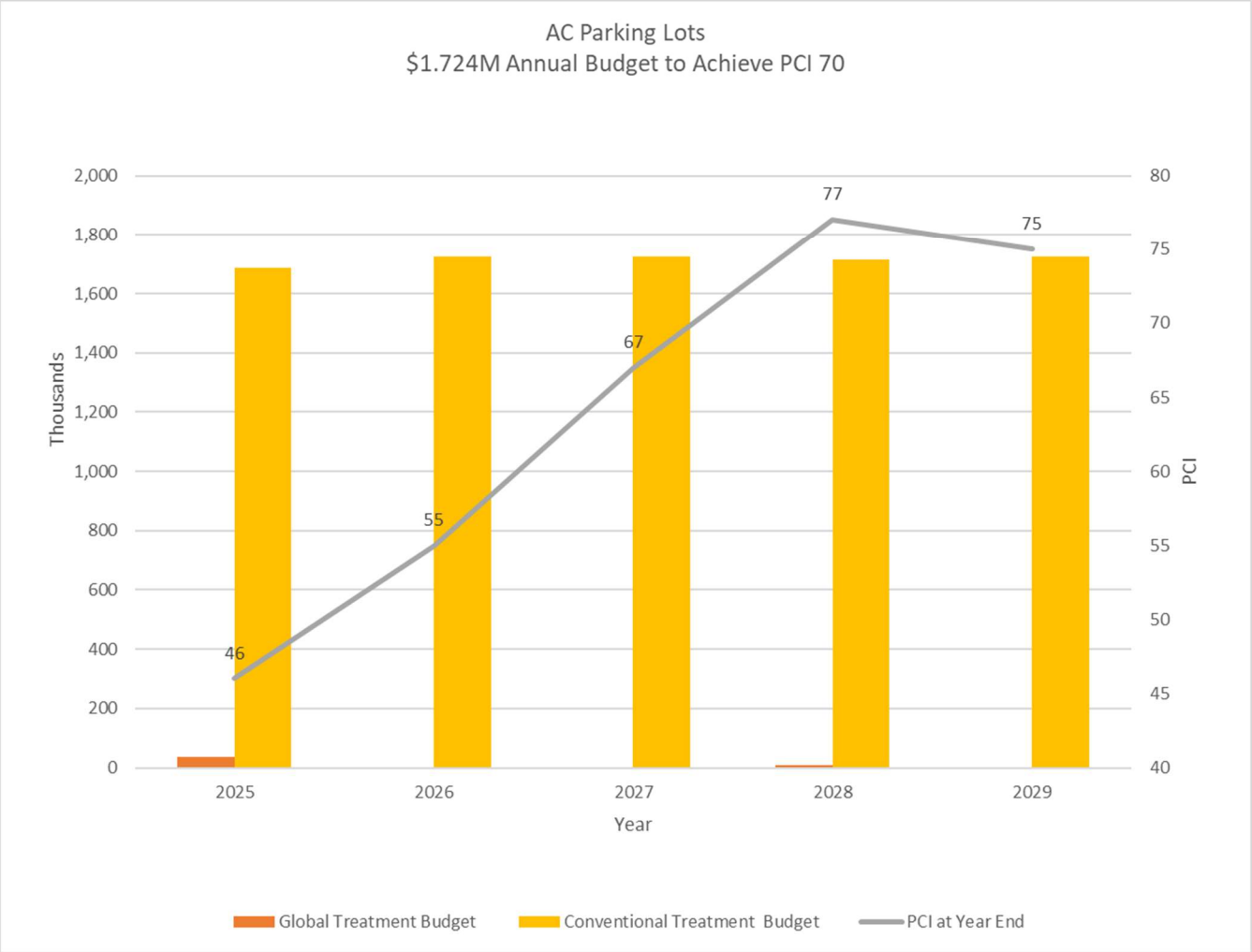


Figure 24. Asphalt Parking Lots – $1.724M Annual Budget to Achieve a PCI of 70

2.7 Scenario Summaries

Table 42 - Arterial Asphalt Roads - Scenarios Summary

Year Beginning January 2025	Do Nothing	Given $2.038M Budget	$6.433M to Maintain PCI 54	$7.859M to Achieve 59	$11.144M to Achieve PCI 70
2025	53	54	56	56	58
2026	49	51	54	56	60
2027	45	47	54	57	62
2028	41	45	54	57	65
2029	37	42	54	59	70

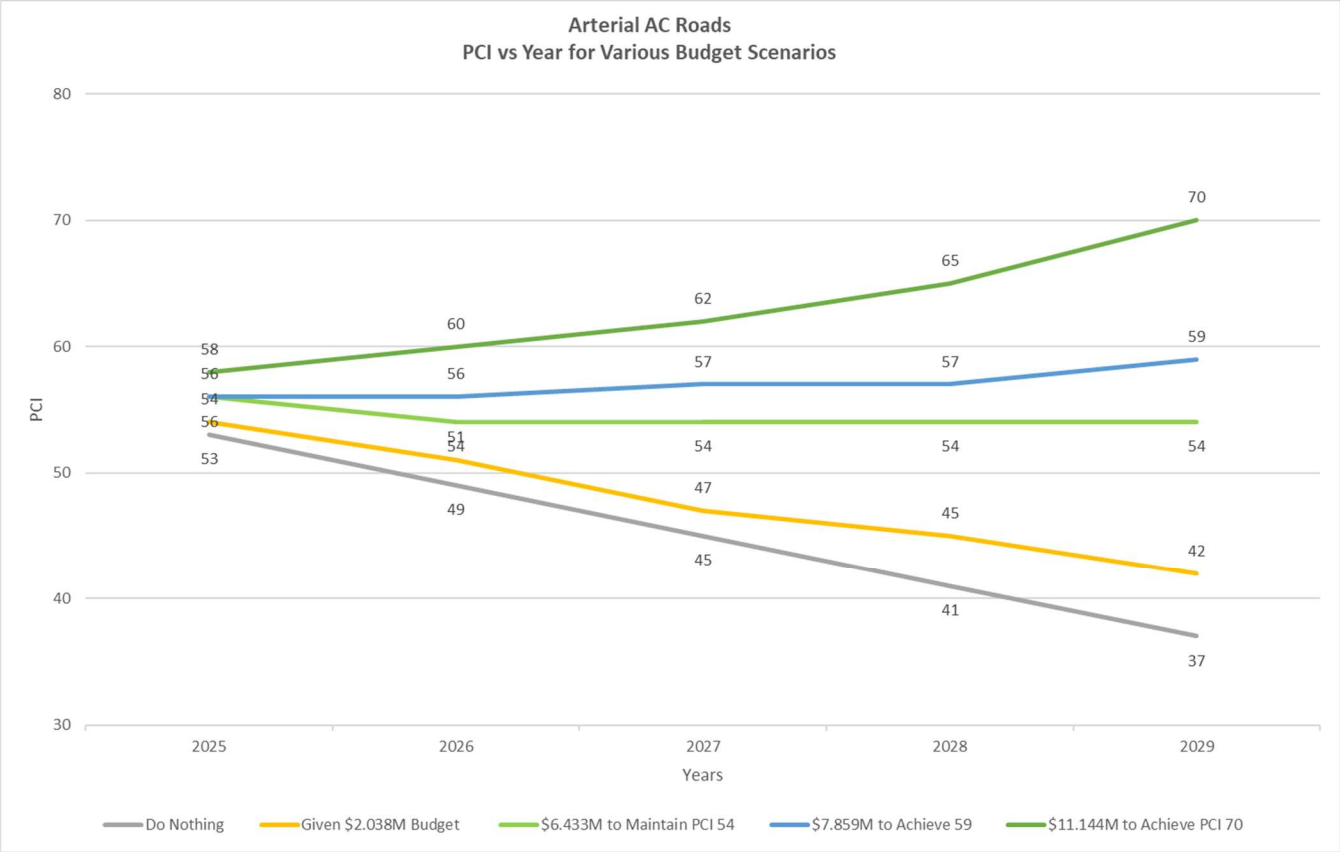


Figure 25. Arterial Asphalt Roads - Scenarios Summary

Table 43 - Collector Asphalt Roads - Scenarios Summary

Year Beginning January 2025	Do Nothing	Given $894K Budget	$1.905M to Maintain PCI 61	$2.343M to Achieve 66	$2.775M to Achieve PCI 70
2025	60	61	62	63	64
2026	56	58	62	63	65
2027	52	56	61	64	66
2028	48	53	61	66	67
2029	44	51	61	66	70

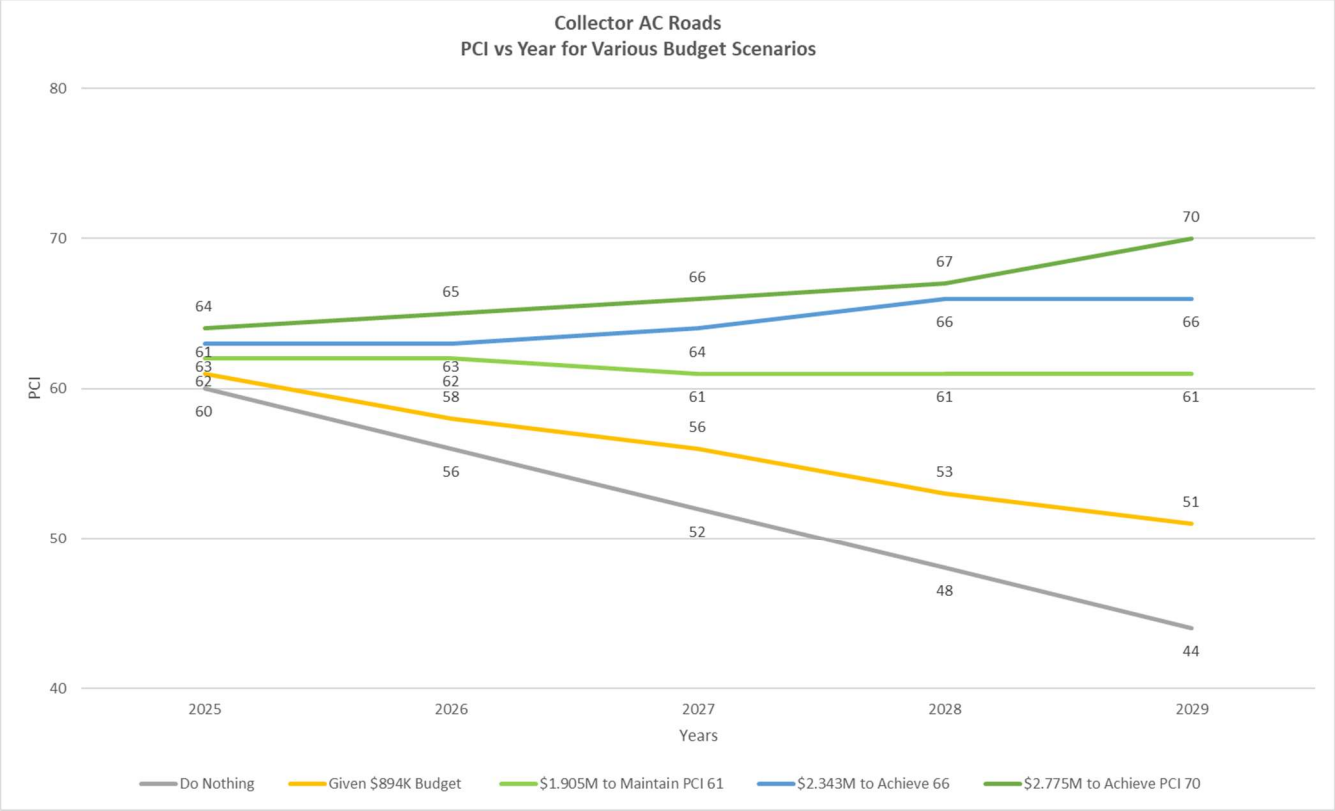


Figure 26. Collector Asphalt Roads - Scenarios Summary

Table 44 - Local Asphalt Roads - Scenarios Summary

Year Beginning January 2025	Do Nothing	Given $3.448M Budget	$7.418M to Maintain PCI 58	$9.161M to Achieve 63	$12.311M to Achieve PCI 70
2025	57	59	60	61	62
2026	53	56	59	62	64
2027	49	53	59	62	65
2028	45	51	58	62	67
2029	41	48	58	63	70

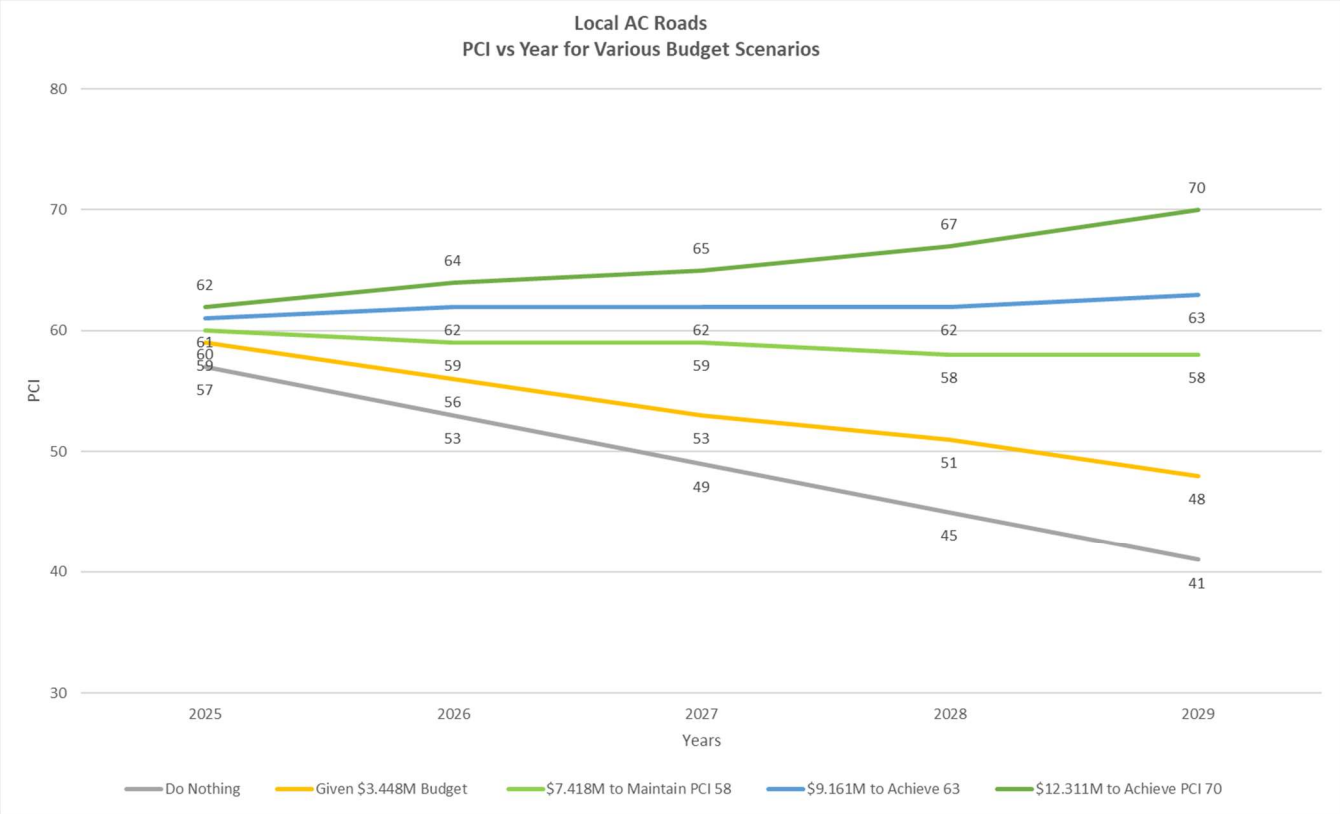


Figure 27. Local Asphalt Roads - Scenarios Summary

Table 45 - Asphalt Alleys - Scenarios Summary

Year Beginning January 2025	Do Nothing	Given $350K Budget	$699K to Maintain PCI 47	$936K to Achieve 52	$1.846M to Achieve PCI 70
2025	46	48	49	49	51
2026	42	45	47	48	53
2027	39	44	46	48	58
2028	36	42	46	49	64
2029	34	41	47	52	70

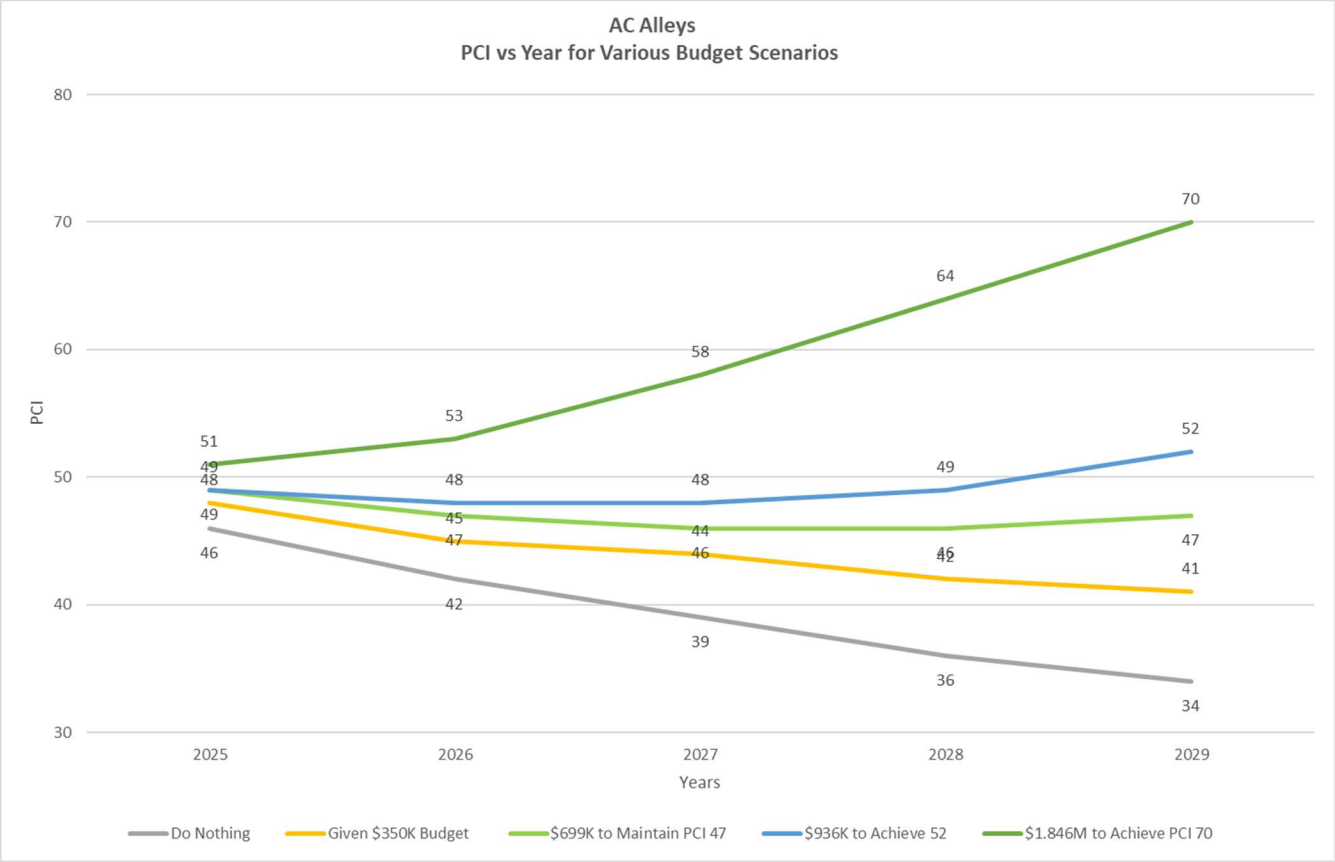


Figure 28. Asphalt Alleys - Scenarios Summary

Table 46 - Asphalt Parking Lots - Scenarios Summary

Year Beginning January 2025	Do Nothing	Avg. $475K to Maintain PCI 34	Avg. $596K to Achieve 39	Avg $1.724M to Achieve PCI 70
2025	33	37	37	50
2026	28	35	36	58
2027	23	34	37	70
2028	18	34	38	78
2029	13	34	39	75

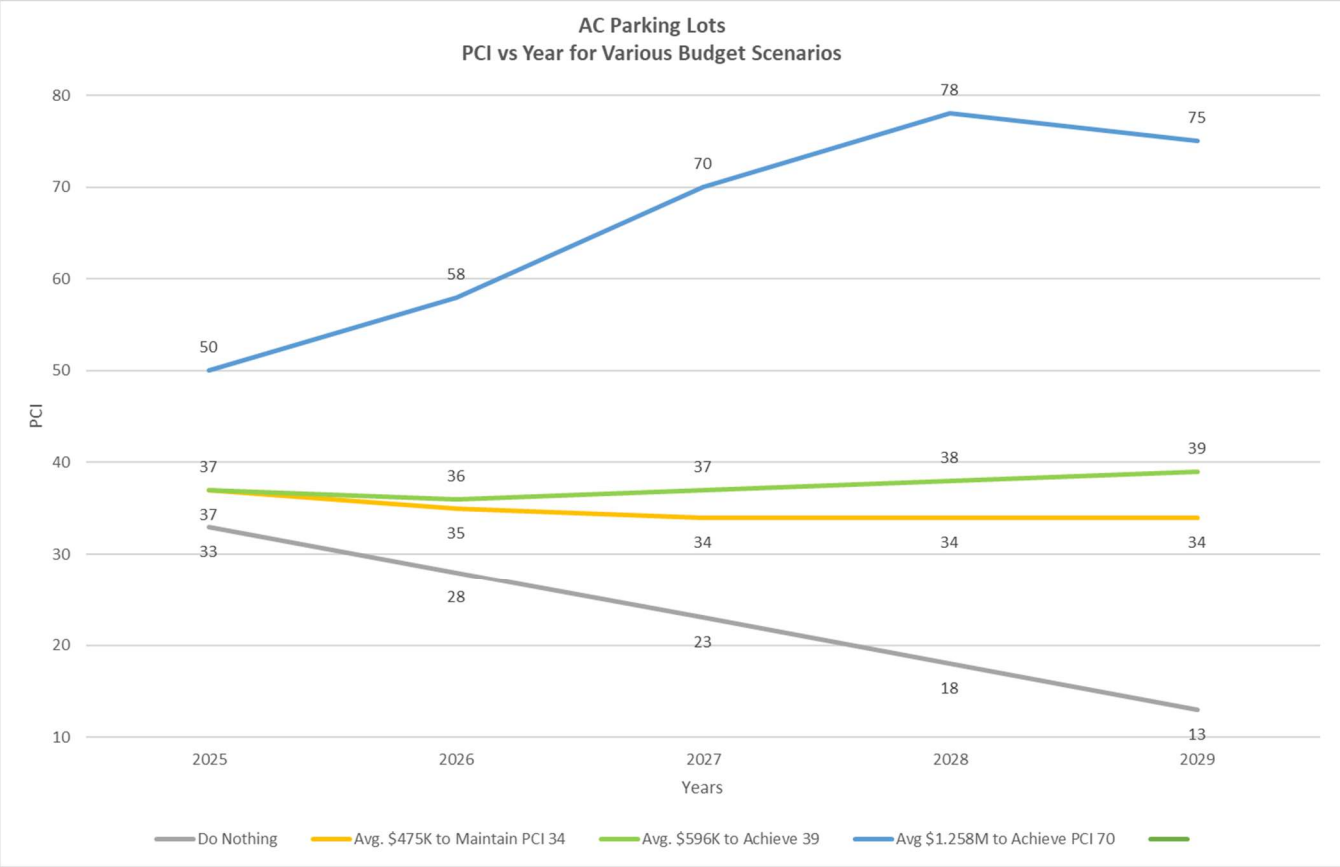


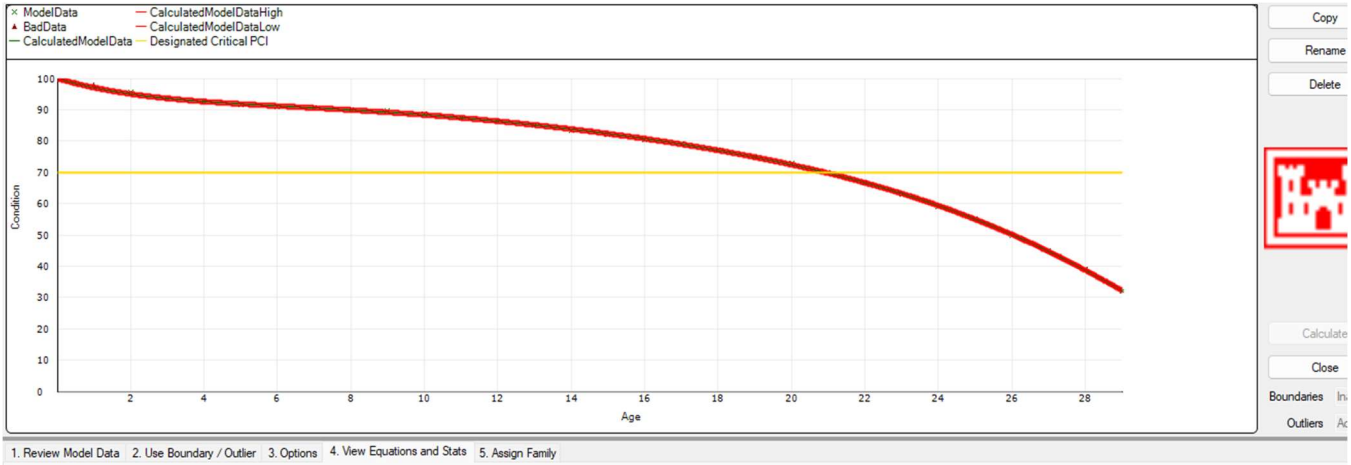
Figure 29. Asphalt Parking Lots - Scenarios Summary

Appendix A - Asphalt Pavement Performance Curve

The predictive modeling (family modeling) process groups pavements of similar construction that are subjected to similar traffic loads, weather, and other factors that affect pavement life. The historical data on pavement condition can be used to build a model which can predict the future performance of a group of pavements with similar attributes. In PAVER, this model of a pavement's life is referred to as a "family."

The performance curve plays a key role in the development of network-level budget analysis. If the deterioration rate of the curve is too steep, the required budget to repair these pavements will increase. If the deterioration rate of the curve is too flat, the required budget to repair these pavements will be too small. Both situations are erroneous, but when analyzing over a brief period, like 5 years, the change at any point over that period needs only be close initially. Constructing models that can accurately predict the performance of any road is an iterative process that is refined from the results of multiple condition surveys. Historical maintenance data are useful but can be initially misleading because they will contain many outliers particularly if the data are not being collected specifically for this purpose.

Figure A-1 below shows the results from the asphalt performance model developed for the City for Arterial/Collector and Local roads.



1 * (100 - 3.48679971694946 X^1 + 0.61124587059021 X^2 - 0.0618810392916203 X^3 + 0.00311908428557217 X^4 - 8.01940186647698E-05 X^5 + 7.85595318575361E-07 X^6) PCI Pts

Figure A.1. All Roads - Pavement Performance Curve as translated by PAVER and its polynomial.

Appendix B - Pavement Condition Index (PCI) Formula

Step 1: In a Network Level PMS, a survey of a limited number of sample units per section is sufficient. A sample area is defined as an area of 2,500 square feet plus or minus 1,000. A section is viewed as the smallest management unit when considering the application and selection of maintenance and repair (M&R) treatments.

$$PCI_s = PCI_r = \frac{\sum_{i=1}^{R} PCI_{ri} \times A_{ri}}{\sum_{i=1}^{R} A_{ri}}$$

Where

PCI_s = PCI of a pavement section

PCI_r = area weighted average PCI of random (or representative) sample units

PCI_{ri} = PCI of random sample unit number i

A_{ri} = area of the random sample unit *i*

R = total number of inspected random sample units

Step 2: If additional sample units are inspected, they can be used to enhance the section PCI as follows:

$$PCI_a = \frac{\sum_{i=1}^{A} (PCI_{ai} \times A_{ai})}{\sum_{i=1}^{A} A_{ai}}$$

$$PCI_s = \frac{PCI_r(A_s - \sum_{i=1}^{A} A_{ai}) + PCI_a \times \sum_{i=1}^{A} A_{ai}}{A_s}$$

PCI_a = area weighted average PCI of additional sample units

PCI_{ai} = PCI of additional sample unit number *i*

A_{ai} = area of additional sample unit *i*

A_s = total section area

Step 3: Using customer-defined constraints, such as the desired level of service, available rehabilitation technologies, or budgets, paving plans are developed in the Pavement Management System.

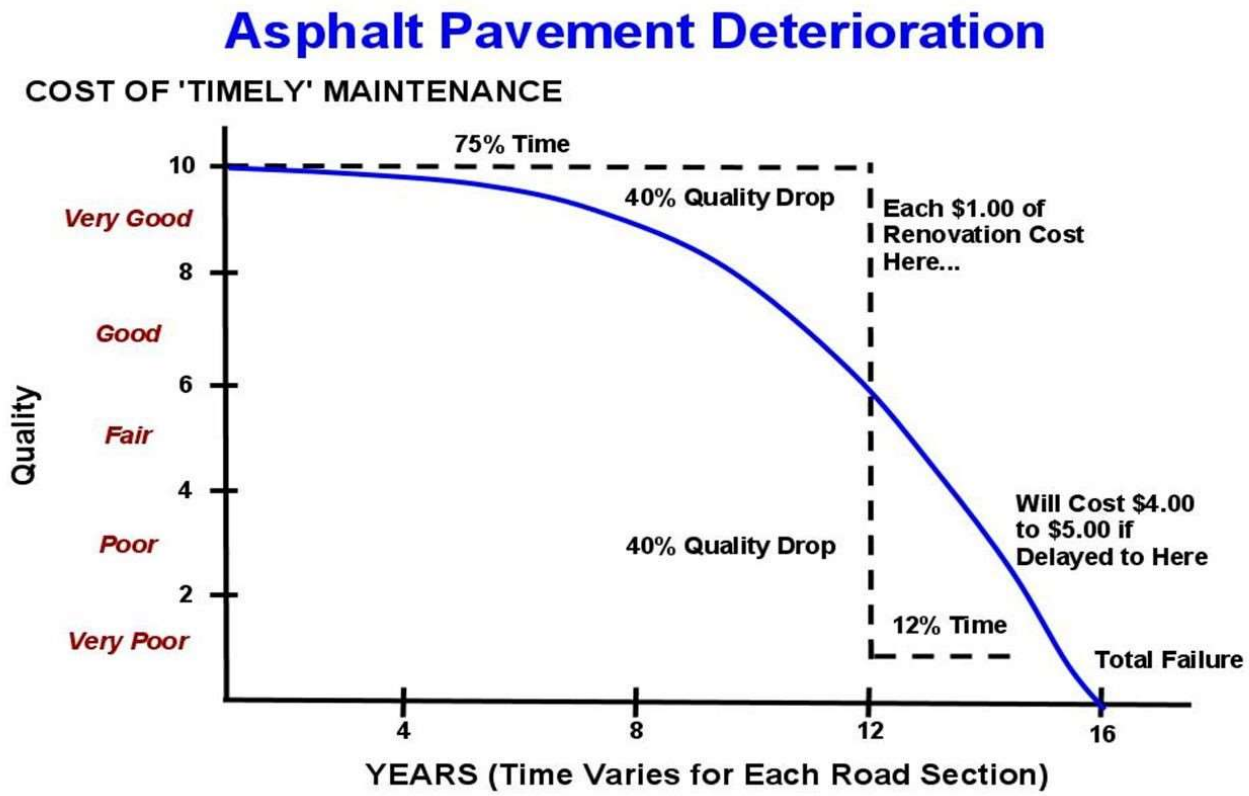
Appendix C - Principles of Pavement Management

Given the persistent shortage of funding for maintaining street systems, the most efficient means of maximizing the return on investment for road maintenance is to implement a Pavement Management System.

Pavement management is a systematic approach to maximizing the life of a pavement network while optimizing the use of constrained funding encompassing planning, budgeting, funding, designing, constructing, monitoring, evaluating, maintaining, rehabilitating and reconstructing a pavement network.

A Pavement Management System assists in finding and implementing the best Maintenance & Rehabilitation (M&R) strategies. Intuitively, we know that repairing streets when they are still in fair condition costs less over their lifetime than waiting to fix roads that have fallen into poor condition and extensive research over the years has proven this to be true. A proactive approach of routine pavement management means less money wasted on roadway reconstruction and a potential savings of millions of dollars.

This process is illustrated below. It details how timely intervention can delay the inevitable total reconstruction for as long as practical. If repairs are delayed until a road is rated in "Fair" condition or worse, the cost of rehabilitation becomes 4 to 5 times more expensive than for those roads in "Good" condition. This means without preventative pavement maintenance; the cost of rehabilitation will be prohibitively expensive.



A Pavement Management System also provides a way to store an accurate inventory of all roadways, enriched with links to easements, as-built records, and historical documentation. The breadth and depth of information they hold, including digital images of roadways, baseline pavement condition data, and reviews of deterioration over time, are invaluable resources for measuring and tracking the effectiveness of Maintenance and Rehabilitation strategies.

Successful pavement management system programs let agency decision-makers develop reliable performance models for the roadway, which can be used to generate sound policies and long-term rehabilitation strategies, budgets, and timetables.

Another compelling reason for implementing a Pavement Management System is the Governmental Accounting Standards Board (GASB) Statement 34. This regulation requires agencies that collect taxes to manage a long-term, fixed infrastructure asset to either:

- **Option #1** - Implement financial accounting controls to effectively depreciate and plan for the replacement of fixed assets.
- **Option #2** - Implement an asset management system that provides a mechanism to gauge and budget for the long-term rehabilitation and/or maintenance of assets.

This study completed on the roadway network can be used as the basis for achieving GASB 34** compliance, either as the foundation for the inventory and valuation of the network (Option #1) or as the foundation of an asset management system (Option #2).

**Although it is not required to meet GASB 34 standards, it is recommended to follow the industry's best practices regarding monitoring their infrastructure.

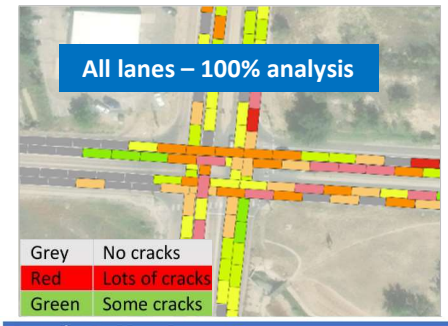
The Pavement Management Process

The figure below depicts the three unique, but equally important, steps that comprise the Pavement Management Process.

System Configuration

Field Data Collection

Analysis and Reporting



Reporting Dashboard	
PMS Report Date	December 2021
Number of Miles in Network	907.23 C/L Miles
Network Value	$1.41B
Cost to Fix Everything	$130.84M
Average Network PCI	Principle/Arterial (AB) - 75 Collector/Local (CE) – 69
Work Planning Horizon	5-Years
Roadway Families	Principle/Arterial (AB) & Collector/Local (CE)
Do-Nothing Budget Scenario	PCI= 59 & 54 after 5-Years
Current $17M Annual Budget (AB-$3.363M & CE-$13.637M)	PCI 70 and 72 after 5-Years
Annual Budget to Maintain AB PCI = 75 and CE PCI 69	AB - $5.101M & CE - $10.836M
Annual Budget to Achieve Network PCI of 80	AB - $6.073M & CE - $17.338M

1. System Configuration

System configuration involves identifying all roadways of the project network and assigning them a unique identifier. Each section has attributes such as physical characteristics (length, width, etc.), pavement type, and road classification. As part of system configuration, the network is linked to a GIS map. This map is loaded into our web-based mapping system.

2. Field Data Collection

After system configuration is completed, every roadway and all lanes in the system are surveyed and its condition is assessed using the following criteria:

Surface Distress

We use a Laser Crack Measurement System (LCMS4m) 3D pavement imaging technology. Pavement surface distresses, including alligator cracking, block cracking, rutting, raveling, reflective cracking, loss of section, bleeding, edge distress, and patched areas, as well as right of way (ROW) imagery will be collected on a segment-by-segment basis, with each distress captured by type, extent, and severity.

Table 1, with respect to the pavement type (AC=Asphalt Pavement and PCC=Portland Cement Concrete).

Description of Surface Distresses Recorded by Transmap

Pavement Distresses for Asphalt Pavement

Alligator Cracking	**Patching and Utility Cut Patching**
Block Cracking	**Potholes**
Bleeding	**Rutting**
Edge Cracking	**Weathering**
Transverse and Longitudinal Cracking	**Raveling**
	Bumps and Sags, Corrugations and Depressions

Pavement Distresses for Concrete Pavement

Divided Slabs	**Pop Outs**
Linear Cracking	**Pumping**
Corner Breaks	**Scaling or Map Cracking**
Durability ("D") Cracking	**Shrinkage Cracking**
Faulting	**Corner or Joint Spalling**
Joint Seal Damage	**Small or Large Patching**

Detailed descriptions of pavement distress and severity can be found in ASTM D6433-11.

Severity

Once distress has been identified, its severity (Low, Moderate, High) is attached to the appropriate record and its count, e.g., the number of potholes, square footage (area covered by cracking), or linear feet (length of a specific crack) are added as well.

In a Network Level PMS, a survey of a limited number of sample units per section is sufficient. A sample area is defined as an area of 2,500 square feet plus or minus 1,000. A section is viewed as

the smallest management unit when considering the application and selection of maintenance and repair (M&R) treatments. All field survey data collected in samples are summarized on a section-by-section basis. Each section constitutes a unit of data to populate the Pavement Management System.

Other data collected during field surveys include the pavement width, the pavement type, GPS coordinates, and digital images.

3. Analysis and Reporting

The results of a Pavement Management System analysis provide a quantitative performance score called Pavement Condition Index (PCI).

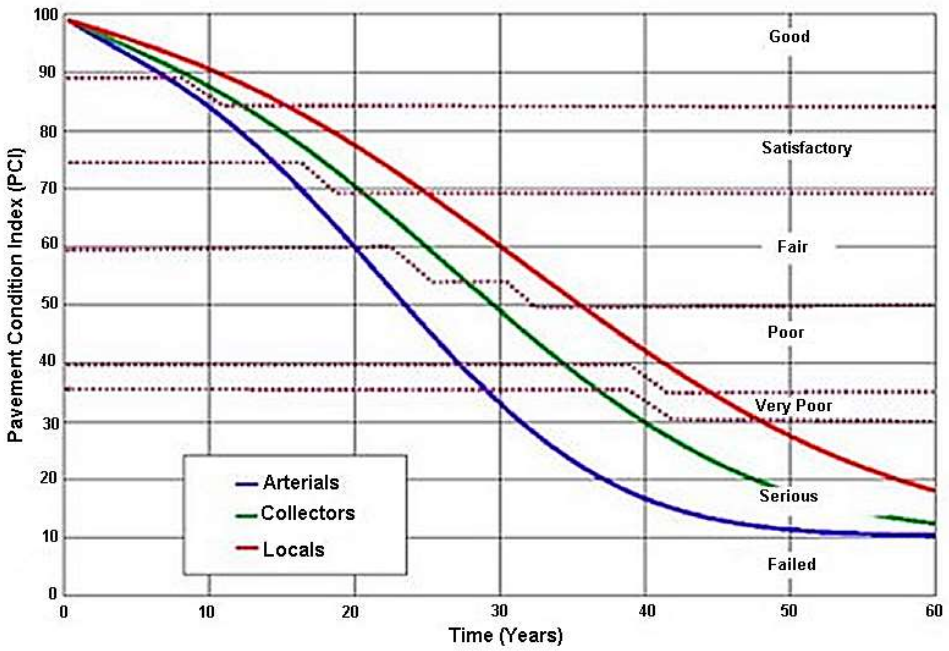
Pavement Condition Index (PCI) is an engineering terminology representing the surface condition of the pavement on a scale of 0 to 100. For example:

- PCI of 100 is a pavement in perfect condition.
- PCI of 0 is a pavement that is destroyed.

The PCI is a distress-based condition index, i.e., specific distresses in the pavement are identified and tallied, and the type, severity, and extent of each distress are used to calculate a single number representing the pavement condition. The higher numbers reflect better pavement. The formula used to calculate the PCIs is in **Appendix B**.

All condition ratings of the field surveys are captured at sample areas and combined to calculate one value, which represents the PCI of a pavement section using the area weighted average.

Understanding the Pavement Condition Index



Understanding the Pavement Condition Index Score

The following illustration shows how the Pavement Condition Index (PCI) deteriorates over time for three different types of roadways. It also compares the PCIs to commonly used descriptive terms (Good, Satisfactory, Fair, Poor, Very Poor, Serious, Failed). The divisions between the descriptive terms are not fixed but are meant to indicate common perceptions of roadway conditions.

An industry-standard defines the different PCI condition levels with respect to the remaining life of a pavement and typical rehabilitation options recommended.

Industry Standard for PCI Condition Levels

PCI Range	Work Type	Rehabilitation Options
86-100 Good	**Rejuvenation**	**Little or no maintenance E.g., Crack Seal, Reclimite, fog seal**
71-85 Satisfactory	**Global**	**Routine Maintenance, e.g., Seals such as slurry seal**
56-70 Fair	**Critical**	**Non-structural overlay, cape seal**
41-55 Poor	**Conventional**	**Structural Overlay Overlay or Mill & overlay**
26-40 Very Poor	**Conventional**	**Structural Overlay Overlay or Mill & overlay**
11-25 Serious	**Reconstruction**	**Reconstruction, rebuild, full depth reclamation**
0-10 Failed	**Reconstruction**	**Reconstruction, rebuild, full depth reclamation**

Maintenance and Rehabilitation Planning

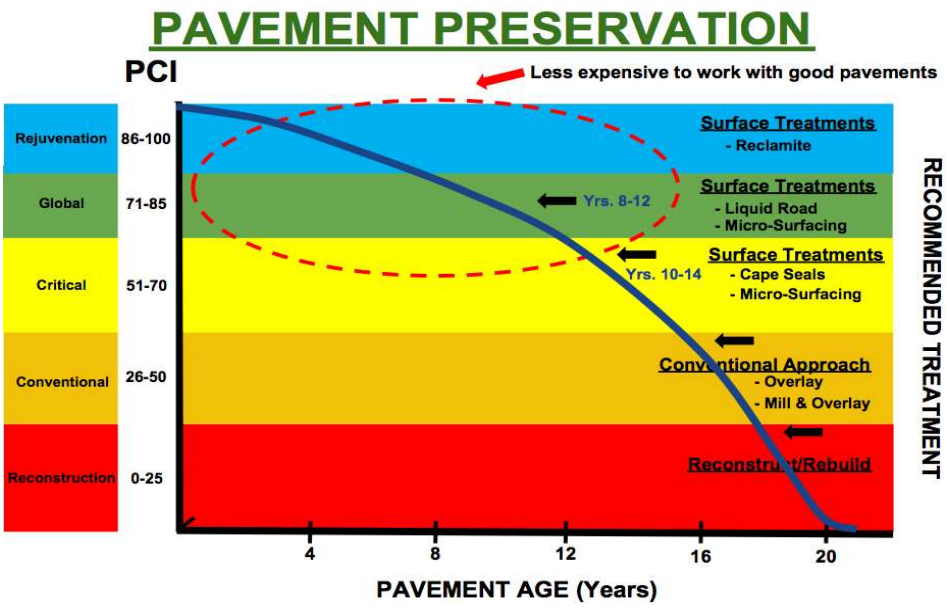
Key Analysis Inputs

All Pavement Management Systems require user input to establish budget estimates and pavement Maintenance & Rehabilitation (M&R) plans. During the Boot Camp, decisions were made that affected the pavement rehabilitation program in a variety of ways. The key inputs are:

- The M&R pavement preservation categories
- The M&R pavement treatment type
- The PCI ranges are assigned to the M&R categories.
- The Critical PCI
- Unit cost for each pavement treatment type
- Expected life of the treatment type
- Agency budget and length of the planning period
- Budget required to achieve a target PCI at the end of the planning period.
- Desired deferred maintenance at the end of the planning period

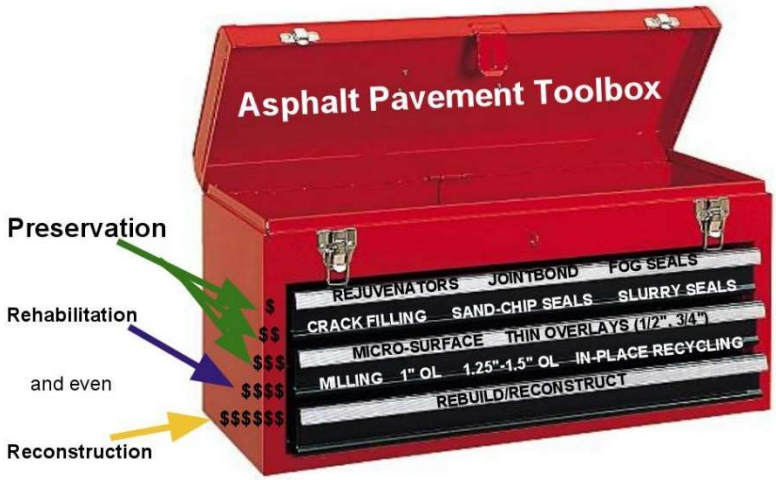
Pavement Preservation

The figure below represents the American Public Works Association (APWA) industry-standard pavement preservation curve.



Pavement Preservation

The figure below represents APWA's Pavement Toolbox. This toolbox looks at preservation treatments and how they are cost-effective to use as opposed to spending all funding on worst-first maintenance (rehabilitation/reconstruction).



Preservation Treatments

This hierarchical strategy ensures that roadways slated for reconstruction remain in the reconstruction pipeline even if there is a funding shortfall. Available funds are used to preserve those streets that can be treated with slurries and overlays. No real equity is lost when those roads become unacceptable for use since they were already scheduled for reconstruction.