PUBLIC WORKS DEPARTMENT MEMORANDUM
#01-2020

DATE: January 13, 2020

TO: Honorable Mayor Meredith Leighty and City Council Members

THROUGH: Heather Geyer, City Manager

FROM: Kent Kisselman, PE – Director of Public Works

SUBJECT: 2019 Pavement Condition Assessment

PURPOSE
Present information obtained from the 2019 Pavement Condition Assessment to include current total street network conditions and recommendations for future roadway asset management.

BACKGROUND
The City of Northglenn is responsible for the pavement condition assessment of its roadway network every three years and to maintain an average pavement condition index (PCI) rating of 70 or better throughout its entire roadway network pursuant to Resolution No. 06-92, Series 2006. The City is responsible for approximately 106 center line miles of roadway. The roadway network is classified into arterial, collector, and local roadways. The percent breakdown can be found in Attachment 1 – Functional Classification Distribution by Area.

The City has adopted the PCI as a measure of pavement condition for asset management purposes. The PCI was first developed by the Army Corp of Engineers and then further standardized by the American Society for Testing and Materials (ASTM International). ASTM D6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Survey describes a method for the determination of road and parking lot pavement conditions through visual surveys using the PCI method of quantifying pavement condition.

In 2016, the City contracted with IMS Infrastructure Maintenance Services, LLC to complete the survey and provide recommendations for roadway asset management. In order to keep a consistent rating, the City contracted IMS again in 2019. IMS Infrastructure completes field inspections through the use of laser technology. The laser technology is used to accurately identify distresses within the pavement area based on the ASTM Standard. For local roadways the assessment is completed over the main driving surface. For arterial and collectors the data is collected over the main travel lane. This provides an unbiased, consistent and accurate measure of the roadway pavement condition.

IMS Infrastructure completed its field survey and data analysis, see Attachment 2 – Final Report. Highlights from the final report are discussed below:

The City of Northglenn average PCI is a 60 with a backlog of 6.9% for collectors and locals, and 62 with a backlog of 9.8% for arterials. The City's average PCI falls within the "Good" ranking. Backlog is defined as the percentage of streets at or below a PCI of 40 (poor and very poor).

a. The majority of the streets within the city fall within the fair and marginal category. The breakdown in PCI based on percentage is shown in Attachment 3 – As Surveyed Pavement Condition Rating Using Descriptive Terms.

b. A backlog below 15% is recommended to be maintained as those streets that fall below this threshold will require very expensive treatments to repair.

With the information available the next step is to find ways to select and prioritize roadway projects. To achieve this goal staff is working on the implementation of a pavement management program. Streetlogix is a highly customizable, web-based asset management software that enables municipalities to optimize their road budget within a GIS environment. The system provides information on the state of their infrastructure and makes maintenance and repair recommendations, including prioritizing roadway and sidewalk projects.

STAFF RECOMMENDATION

A. Staff recommends a one-time increase to the residential street program of $2,200,000 in 2020.
B. In addition to the one-time need above. Staff recommends that the annual budget be increased for the residential street program from the current $800,000/year to $1,250,000/year (an increase of $450,000 annually) in order to achieve an average PCI of 64 from 2021-2024.
C. Staff recommends implementation of the proposed 5 year Arterials Rehabilitation Plan shown on page 3 of this memo.
D. Amend current Council policy of a PCI rating of 70 to use the PCI Good condition range of 60 to 70 moving forward.

BUDGET/TIME IMPLICATIONS

The current and future PCI average of the roadway network is directly correlated to the City budget allocation within the Residential Street Program. Currently, the program is funded from the Adams County Transportation Tax (ADCOT) accounted for in the Capital Projects Fund. Below is a table showing funding per year projecting PCI after 5 years of maintenance and rehabilitation strategies implemented with current and proposed budget.

Current Residential Street Program Budget

Year	Budget	Projected PCI*
2020	$800,000	61
2021	$800,000	61
2022	$800,000	60
2023	$800,000	60
2024	$800,000	59

Proposed Residential Street Program Budget

Year	Budget	Projected PCI*
2020	$3,000,000	64
2021	$1,250,000	64
2022	$1,250,000	64
2023	$1,250,000	64
2024	$1,250,000	64

Due to the size of arterial rehabilitation projects, staff proposes these projects be handled as individual capital improvement projects and the creation of a 5 year Arterials Rehabilitation Plan.

Proposed 5 Year Arterials Rehabilitation Plan Budget

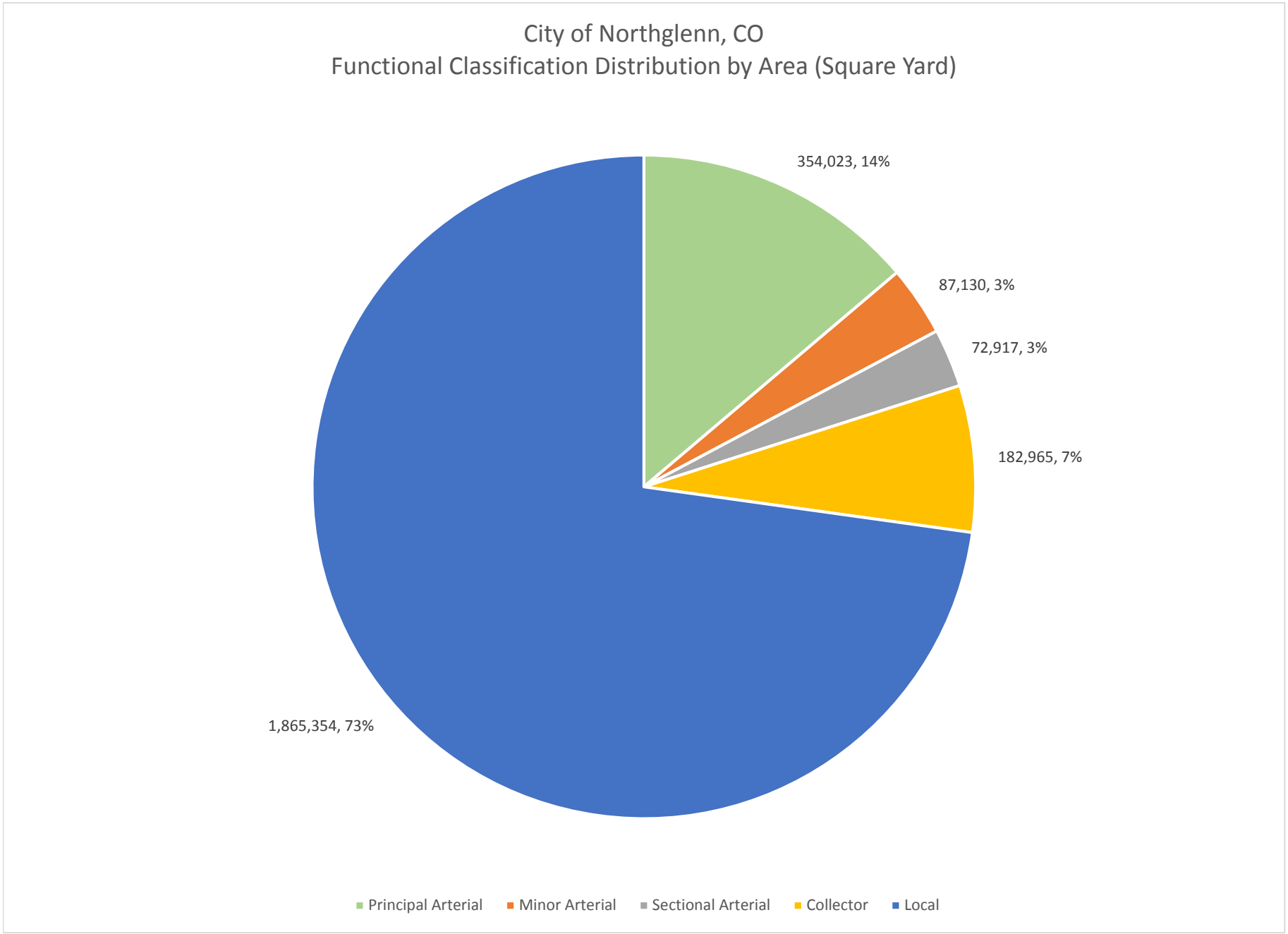
Year	Budget*	Street	From	To	PCI	Treatment
2020	$1,500,000	104th Ave	Zuni St	Huron St	47	Full Width Mill (FWM) & Overlay
2021	$1,500,000	Huron St	97th Ave	104th Ave	36	FWM & Overlay
2022	$1,200,000	Washington St	112th Ave	120th Ave	45	FWM & Overlay
2023	$1,700,000	104th Ave	Huron St	Washington St	44	FWM & Overlay
2024	$1,100,000	Washington St	104th Ave	112th Ave	62	FWM & Overlay

*Based on 2019 paving bids

Funding is available for the proposed residential street program and arterial plans by using one-time reserves from either the Capital Projects Fund or General Fund ($2,200,000 in 2020) and using ADCOT and the 4.000 Mills Property Tax restricted for road rehabilitation project. The program budgets will be evaluated through the annual budget process.

STAFF REFERENCE
If Council members have any comments or questions they may contact Kent Kisselman, Director of Public Works, at 303.450.4005 or kkisselman@northglenn.org.

ATTACHMENTS
1. Functional Classification Distribution by Area
2. Final Report
3. As Surveyed Pavement Condition Rating Using Descriptive Terms
4. Presentation


City of Northglenn, CO
Functional Classification Distribution by Area (Square Yard)
354,023, 14%
87,130, 3%
72,917, 3%
182,965, 7%
1,865,354, 73%
Principal Arterial
Minor Arterial
Sectional Arterial
Collector
Local

Northglenn, CO

Pavement Management Analysis Report

October 2019

City of Northglenn, CO
Attn.: Daniel Martinez, Civil Engineer II
11701 Community Center Drive
Northglenn, CO 80233-8061

IMS Infrastructure Management Services

IMS Infrastructure Management Services
1820 West Drake Drive, Suite 104, Tempe, AZ 85283
Phone: (480) 839-4347, Fax: (480) 839-4348
www.imsanalysis.com

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APPENDED REPORTS **Following Page 42**

APPENDED MAPS **Located on Thumb Drive**

Abbreviation or Acronym	Definition
$k	Dollars in thousands ($,000)
$M	Dollars in millions
%SP	Percent Spreadability - component of deflection analysis
AC	Asphalt Concrete - asphalt streets, flexible pavements, also known as ACP
ACP	Asphalt Concrete Pavement - asphalt streets, flexible pavements, also known as AC
ART	Arterial roadway functional classification
ASTM	American Society of Testing Methods
Avg	Average
BCI	Base Curvature Index - component of deflection analysis
Brk	Break
CAL	Coarse Aggregate Loss
CDV	Corrected Deduct Value - part of the ASTM D6433 PCI calculation
COL	Collector roadway functional classification
Crk	Crack
DeflCON	Deflection Condition - structural load analysis based on traffic loading and deflection
DMD	Dynamic Maximum Deflection - temperature corrected deflection
Dvdd Slab	Divided Slab
DynaCON	Dynamic Condition - structural layer analysis
ft or FT	Foot
ft2 or FT2	Square foot
FunCL	Functional Classification
FWD	Falling weight deflectometer
GCI	Gravel Condition Index
GFP	Good - Fair - Poor
GIS	Geographic Information System
GISID	GIS segment identification number
H&V	Horizontal and Vertical
IRI	International Roughness Index
Jt	Joint
L&T	Longitudinal and Transverse
LAD	Load associated distress
LOC	Local roadway functional classification - same as RES
LOG	Lip of Gutter
m	Metre or meter
M	Moderate
m2	square metre or square meter
MART	Major arterial roadway functional classification
Max	Maximum
MaxDV	Maximum Deduct Value
MCOL	Major collector roadway functional classification
mi or Mi	Mile
Min	Minimum
MnART	Minor arterial roadway functional classification
MnCOL	Minor collector roadway functional classification
MOD	Moderate
NLAD	Non-load associated distress
OCI	Overall condition index, also known as PCI
Olay	Overlay
PART	Primary arterial roadway functional classification
Pavetype	Pavement Type
PCC	Portland Cement Concrete - concrete streets
PCI	Pavement Condition Index - generic term for OCI
R&R	Remove and replace
RART	Rural arterial roadway functional classification
PWF	Priority Weighting Factor
Recon	Reconstruction
Rehab	Rehabilitation
RES	Local roadway functional classification - same as LOC
RI or RCI	Roughness Index
S	Strong
SART	Secondary arterial roadway functional classification
SCI	Surface Curvature Index - componenent of deflection analysis
SDI	Surface Distress Index
SI	Structural Index
STA	Station or chainage
Surf Trtmt	Surface Treatment
TDV	Total Deduct Value
W	Weak

1.0 EXECUTIVE SUMMARY & RECOMMENDATIONS

PROJECT SUMMARY

In 2019 IMS Infrastructure Management Services, LLC (IMS) was contracted by the City of Northglenn to conduct a pavement condition assessment and analysis update on approximately 95 centerline miles of City maintained asphalt and concrete roadways that are considered Local / Collector. There is an additional 13 miles of roadway that is considered Arterial.

IMS mobilized their Laser Road Surface Tester (RST) to conduct an objective assessment using industry standard pavement distress protocols such as those found in ASTM D6433-11. At that time, the City's Local / Collector network average Pavement Condition Index was found to be a 60 and the City's backlog (roads below a PCI of 40) was at 5.5%. Additionally, the City's Arterial roadway network had an average PCI of 63 and backlog of 10%.

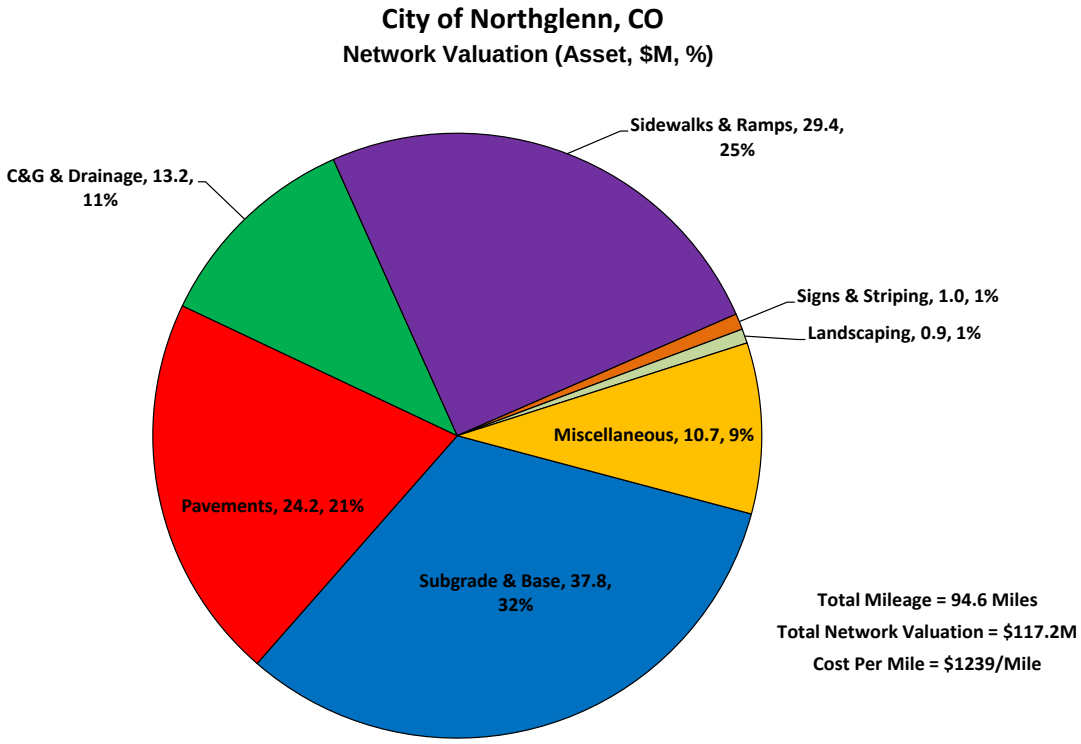


Figure 1a- Replacement Value of Roadway Network (Collector / Local)

As seen in **Figure 1a**, Northglenn has just over 95 centerline miles of roadway, encompassing over 2M square yards of pavement surfacing, which is predominantly asphalt. At an average replacement cost for a typical roadway just over $1.2M per mile, not including the value of the land, the City has over $117.2M invested in its paved roadway network.

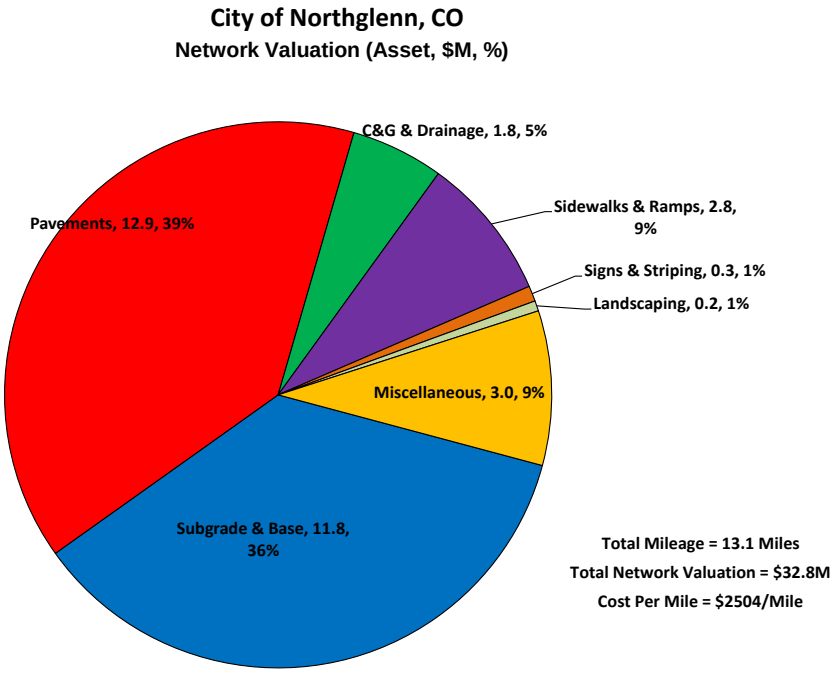


Figure 1b- Replacement Value of Roadway Network (Arterial)

As seen in **Figure 1b**, Northglenn has just over 13 centerline miles of roadway, encompassing over 514K square yards of pavement surfacing, which is predominantly asphalt. At an average replacement cost for a typical roadway just over $2.5M per mile, not including the value of the land, the City has over $32.8M invested in its paved roadway network.

SUMMARY METRICS OF HEALTH (LOCAL /COLLECTOR)

Pavement Condition Index (PCI) – The PCI score is a ranking assessment on the overall health of a pavement segment on a scale of 0 to 100. The network average PCI is a good global indicator of a network's overall health. *(Explained in section 4)*

Percent of Excellent Roads – Roads with a condition category of Excellent are those that score between a PCI of 85 to 100.

Backlog –Backlog is the Very Poor and Poor roads (between a PCI of 0 and 40) that represent a portion of the network in need of extensive rehabilitation such as full and partial reconstruction. Using sound pavement management and finance principles, a very healthy network will have a backlog of 10% or less.

Northglenn's Local / Collector's met two of three of the metrics for evaluating the quality of its roadway network.

- ✓ Northglenn's network average pavement condition score is within the national average currently seen by IMS of 60 to 65, with the City's average scoring a 60.
- The number of streets rated Excellent is below the minimum recommended target of 15% at 6.9%
- ✓ The backlog amount is below the average value of 12% at 5.5%.

Northglenn's Arterial network met three out of three of the metrics for evaluating the quality of its roadway network.

- ✓ Northglenn's network average pavement condition score is within the national average currently seen by IMS of 60 to 65, with the City's average scoring a 63.
- ✓ The number of streets rated Excellent is above the minimum recommended target of 15% at 16.5%
- ✓ The backlog amount is below the average value of 12% at 9.8%.

BUDGET SCENARIOS

The current annual budget for Northglenn Local / Collector network is $750K per year dedicated to pavement preservation and rehabilitation. This will inflate the backlog to 24% while reducing the average PCI to a 55 over 5 years. Please note this number is an annual budget average across all 5 years of the analysis horizon.

The Recommended budget for Arterial and Collector roads is $3.68M per year and will elevate the network average PCI to a 70 while maintaining a backlog of 10%. This is a "Backlog Control Budget"

Northglenn does not have a set budget for Arterials but spends an average of $1M per year. This budget will increase the average PCI of Arterial roadways to 71 while also increasing the backlog to 17%.

The recommended budget of $1.25M for arterial roadways will arrest the growth of backlog at 8% while increasing the average PCI to 76.

EXECUTIVE SUMMARY CONCLUSION

The Northglenn network has divided their pavement analysis into two sections, as seen above. An average PCI of 59 and a backlog of 5.5%, can be seen along the Local / Collector network, while the Arterial network has an average PCI of 62 with a backlog of 9.8%. With the City's existing budget, the network conditions within the Arterial network will continue to improve into the 70s PCI range, but the backlog will also sharply increase to 17%.

Within the Collector / Local network the City's existing budget of $750K will result in unhealthy deterioration of the level of service within the community. This will ultimately result in a PCI of 55 and a backlog of 24% within this network. Pavement managers should be aware that a large percentage of local/collector roads currently exist in the "Marginal" 40-50 PCI range. This represents a large collection of streets that will soon fall into the "backlog" category and require costly rehabilitation efforts to restore to full service. These streets should be monitored closely over the next 5 years.

2.0 PRINCIPLES OF PAVEMENT MANAGEMENT

2.1 PAVEMENT PRESERVATION

Preservation of existing roads and street systems has become a major activity for all levels of government. Because municipalities must consistently optimize the spending of their budgets, funds that have been designated for pavement must be used as effectively as possible. The best method to obtain the maximum value of available funds is through the use of a pavement management system.

Pavement management is the process of planning, budgeting, designing, evaluating, and rehabilitating a pavement network to provide maximum benefit with available funds.

A pavement management system is a set of tools or methods that assist decision makers in finding optimal strategies for providing and maintaining pavements in a serviceable condition over a given time period. The intent is to identify the optimum level of long-term funding to sustain the network at a predetermined level of service while incorporating local conditions and constraints.

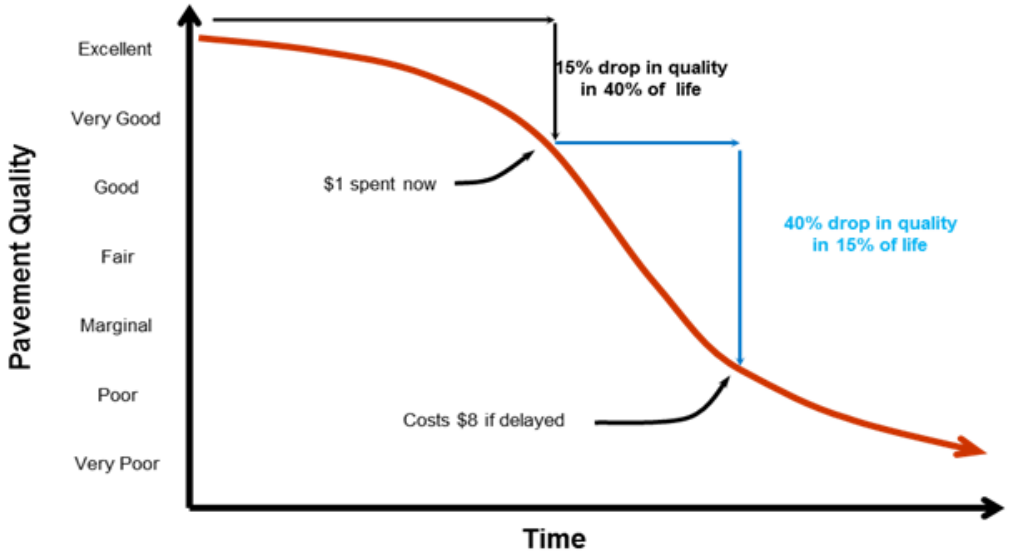


Figure 2 – Pavement Deterioration and Life Cycle Costs

As shown as **Figure 2**, the streets that are repaired while in good condition will cost less over their lifetime than those left to deteriorate to a poor condition. Without an adequate routine pavement maintenance program, streets require more frequent reconstruction, thereby costing millions of extra dollars.

The key to a successful pavement management program is to develop a reasonably accurate performance model of the roadway, and then identify the optimal timing and rehabilitation strategy. The resultant benefit of this exercise is realized by the long term cost savings and increase in pavement quality over time. As illustrated in **Figure 2,** pavements typically deteriorate rapidly once they hit a specific threshold. A $1 investment after 40% lifespan is much more effective than deferring maintenance until heavier overlays or possibly reconstruction are required just a few years later.

Once implemented, an effective pavement information management system can assist agencies in developing long-term rehabilitation programs and budgets. The key is to develop policies and practices that delay the inevitable total reconstruction for as long as practical yet still remain within the target zone for cost effective rehabilitation. That is, as each roadway approaches the steepest part of its deterioration curve, apply a remedy that extends the pavement life, at a minimum cost, thereby avoiding costly heavy overlays and reconstruction. **Figure 3** illustrates the concept of extending pavement life through the application of timely rehabilitations.

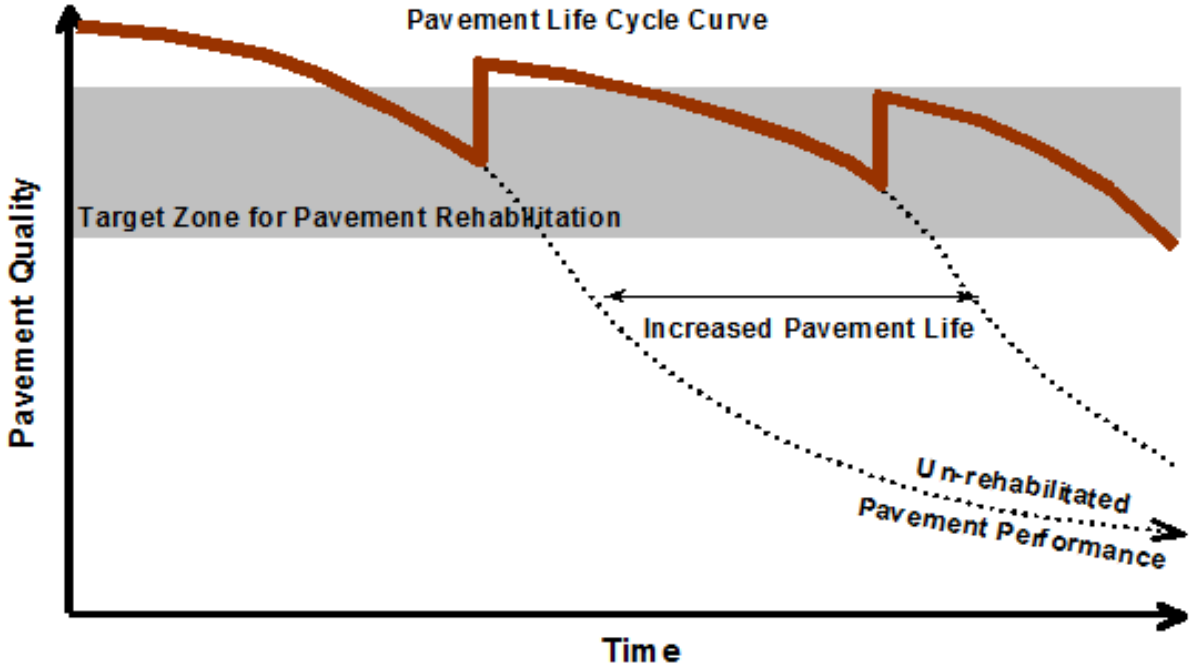


Figure 3 – Pavement Life Cycle Curve

Ideally, the lower limit of the target zone shown in **Figure 3** would have a minimum PCI value in the 60 to 70 range to keep as many streets as possible requiring a thin overlay or less. The upper limit would tend to fall close to the higher end of the Very Good category – that is a pavement condition score approaching 85. Other functions of a pavement management system include assessing the effectiveness of maintenance activities, new technologies, and storing historical data and images.

For Northglenn, a prioritization methodology based on pavement condition, pavement materials, functional class, and strength rating was used to analyze the network condition and develop the proposed 5 year rehabilitation plan.

The analysis methodologies and data collection technologies were based on *ASTM D6433 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys* (hereinafter ASTM D6433) for assessment of pavement surface condition and the International Roughness Index (IRI) for quantification of pavement roughness on all City streets. These measurements of pavement quality are combined to form an overall 0 to 100 Pavement Condition Index (PCI), with 100 being the best.

2.2 ECONOMIC IMPACTS OF MAINTENANCE & REHABILITATION

The role of the street network as a factor in the City's well-being cannot be overstated. In the simplest of terms, roadways form the economic backbone of a community. They provide the means for goods to be exchanged, commerce to flourish, and commercial enterprises to generate revenue. As such, they are an investment to be maintained.

The overall condition of an agency's infrastructure and transportation network is a key indicator of economic prosperity. Roadway networks, in general, are one of the most important and dynamic sectors in the global economy. They have a strong influence on not only the economic well-being of a community, but a strong impact on quality of life. Well-maintained road networks experience multiple socioeconomic benefits through greater labor market opportunities and decreasing income gap.

As a crucial link between producers and their markets, quality road networks ensure straightforward access to goods and drive global and local economies. Likewise, higher network quality has a strong correlation to improvements in household consumption and income. Roads also act as a key element to social cohesion by acting as a median for integration of bordering regions. This social integration promotes a decreased gap in income along with diversity and a greater sense of community that can play a large role in decreasing rates of poverty.

Conversely, deterioration of roads can have adverse effects on a community and may bring about important and unanticipated welfare effects that the governments should be aware of when cutting transportation budgets. Poor road conditions increase fuel and tire consumption while shortening intervals between vehicle repair and maintenance. In turn, these roads result in delayed or more expensive deliveries for businesses and consumers. Economic effects of poor road networks, such as time consuming and costly rehabilitation, can be reduced if a proactive maintenance approach is successfully implemented. To accomplish this, a pavement assessment and analysis should be completed every few years in an effort update the budget models and rehabilitation plans. As shown below, the IMS Laser Road Surface Tester (featured in **Figure 4**) was mobilized to Northglenn to conduct an objective survey.

Figure 4 – Laser Road Surface Tester (RST)

3.0 THE PAVEMENT MANAGEMENT PROCESS

3.1 FUNCTIONAL CLASS REVIEW

As part of the scope of this assignment, the functional classification designations currently used in the Northglenn pavement management program were adopted for their use in the pavement analysis.

Although there is no uniform standard for classifying pavement into functional classes, The Federal Highway Administration (FHWA), American Public Works Association (APWA) and Institute of Transportation Engineers (ITE) offer some broad guidelines on how to assign classifications that were followed in this study.

The City's functional classification definitions used in the assessment are as follows:

1. **Principal Arterial (PART)** – all cross City corridors consisting of 2 to 4 or more lanes, generally spaced at 1 mile intervals with daily traffic counts generally exceeding 20,000 vehicles per day. Major cross City corridors with a landscaped median were also assigned to Principal Arterials.
2. **Section Line Arterial (SART) –** All cross City arterials located along the major section lines.
3. **Minor Arterial (MnART)** – Continuous and discontinuous cross city and inter-district corridors that are 2 to 4 lanes across and generally have a centerline stripe or a designated bus route. The ADT generally falls in the 10,000 to 20,000 vehicle per day range. They are typically spaced on the ½ or ¼ mile section line and on occasion, may have a short non-landscaped median.
4. **Collector (COL)** – Continuous and discontinuous cross City and inter-district corridors that are 2 to 4 lanes across and generally have a centerline stripe or a designated bus route. The ADT generally falls in the 1,000 to 10,000 vehicle per day range. They are typically spaced on the ½ or ¼ mile section line and on occasion, may have a short non-landscaped median. Major collectors are also assigned to streets segments leading to, or adjacent to, a major traffic generator site such as a regional shopping complex. Collectors form the entrance to communities and may have a decorative landscaped median of short duration.
5. **Local (LOC)** – These are the majority of the street segments consisting of all residential roads not defined above or as industrial/commercial.

The paved roadway network consists of 5 functional classes, covering approximately 110 miles of pavement. The average pavement condition index (PCI) of the roadway network is a 60.5 and the network's primary pavement type is asphalt. The following table and **Figure 5** summarize the functional classification splits within the system.

Local/Collector

City of Northglenn, CO
Network Summary by Functional Class

	Pavetype	Network	Collector	Local
Segment (Block) Count	All Streets	994	37	957
	Asphalt	990	35	955
	Concrete	4	2	2
Network Length (ft):	All Streets	499,633	28,808	470,825
	Asphalt	495,864	26,206	469,658
	Concrete	3,769	2,602	1,167
Network Length (mi):	All Streets	94.6	5.5	89.2
	Asphalt	93.9	5.0	89.0
	Concrete	0.7	0.5	0.2
Average Width (ft):	All Streets	36.9	57.2	35.7
	Asphalt	36.7	56.4	35.7
	Concrete	56.8	65.1	38.2
Network Area (yd2):	All Streets	2,048,319	182,965	1,865,354
	Asphalt	2,024,540	164,139	1,860,401
	Concrete	23,779	18,826	4,953
Current Pavement Condition	All Streets	59	50	60
Index (CPCI)	Asphalt	59	47	60
8/1/19	Concrete	74	72	81
Pavement Condition Index	All Streets	60	50	61
(Surveyed PCI)	Asphalt	60	48	61
	Concrete	74	72	81
Current Backlog (%)	All Streets	7		
Current Network Index	All Streets	55		
Surface Distress Index (SDI)	All Streets	56	42	58
8/1/19	Asphalt	56	39	58
	Concrete	79	76	90
Roughness Index (RI)	All Streets	65	65	65
8/1/19	Asphalt	65	65	65
	Concrete	65	65	64

City of Northglenn, CO
Network Summary by Functional Class

	Pavetype	Network	Principal Arterial	Minor Arterial	Section Line Arterial
Segment (Block) Count	All Streets	94	56	25	13
	Asphalt	83	45	25	13
	Concrete	11	11	0	0
Network Length (ft):	All Streets	69,172	42,963	15,670	10,539
	Asphalt	59,620	33,411	15,670	10,539
	Concrete	9,552	9,552	0	0
Network Length (mi):	All Streets	13.1	8.1	3.0	2.0
	Asphalt	11.3	6.3	3.0	2.0
	Concrete	1.8	1.8	0.0	0.0
Average Width (ft):	All Streets	66.9	74.2	50.0	62.3
	Asphalt	67.4	77.1	50.0	62.3
	Concrete	63.7	63.7	0.0	0.0
Network Area (yd2):	All Streets	514,070	354,023	87,130	72,917
	Asphalt	446,449	286,402	87,130	72,917
	Concrete	67,621	67,621	0	0
Current Pavement Condition	All Streets	62	63	70	48
Index (CPCI)	Asphalt	59	59	70	48
8/1/19	Concrete	82	82	0	0
Pavement Condition Index	All Streets	63	63	71	49
(Surveyed PCI)	Asphalt	60	59	71	49
	Concrete	82	82	0	0
Current Backlog (%)	All Streets	10	Percentage of Network with a PCI < 4		
Current Network Index	All Streets	56	Minimum Acceptable Network Index		
Surface Distress Index (SDI)	All Streets	57	58	68	37
8/1/19	Asphalt	53	52	68	37
	Concrete	82	82	0	0
Roughness Index (RI)	All Streets	73	73	74	71
8/1/19	Asphalt	72	72	74	71
	Concrete	81	81	0	0

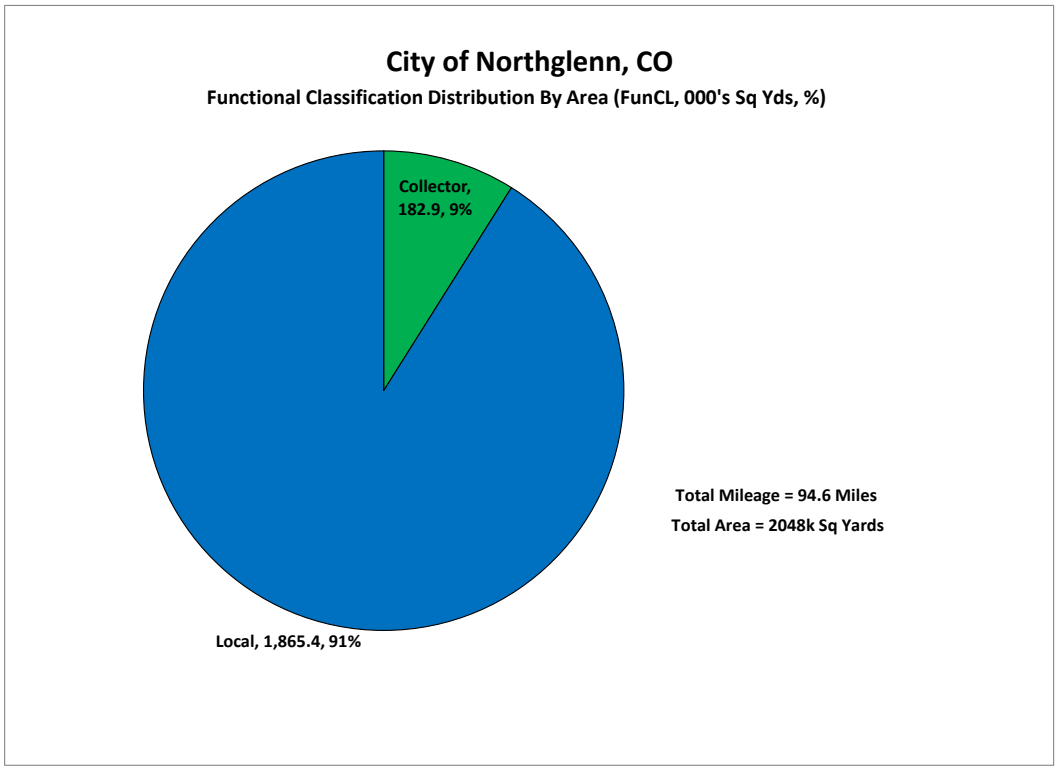


Figure 5a – Functional Class Distribution by Milage

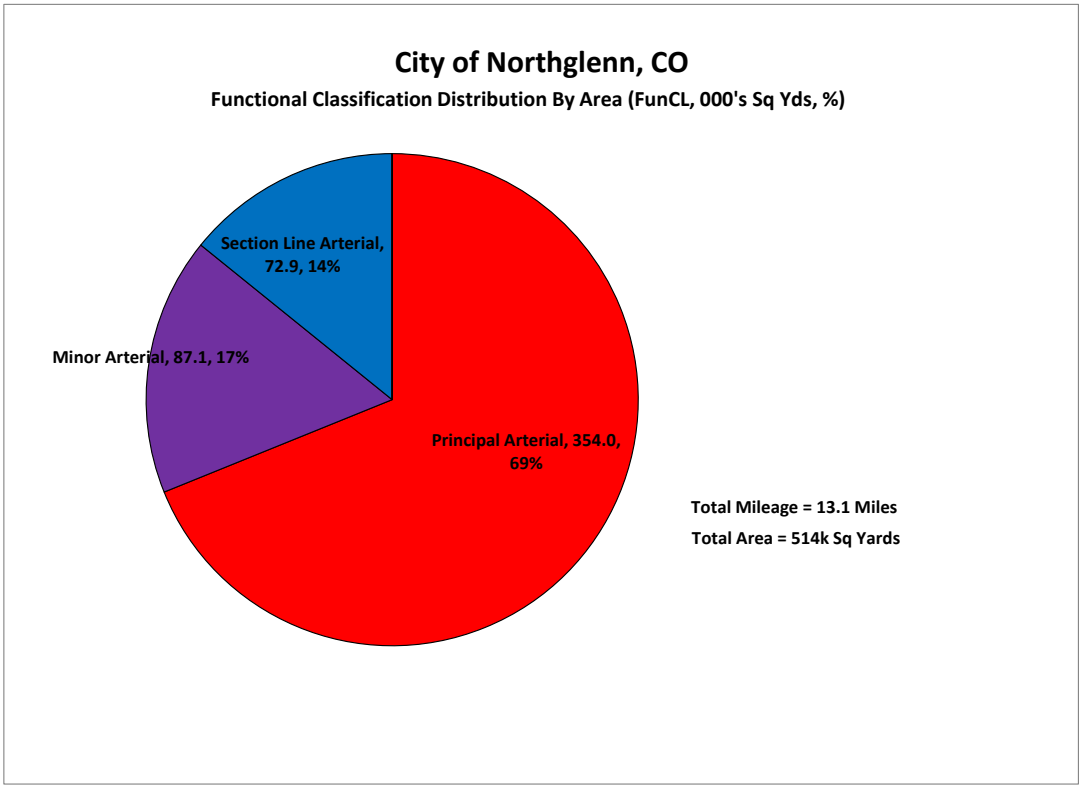


Figure 5b – Functional Class Distribution by Milage

The following figure (**Figure 6**) highlights the functional classifications used for the Northglenn roadway network. An electronic version of this map is appended to this report.

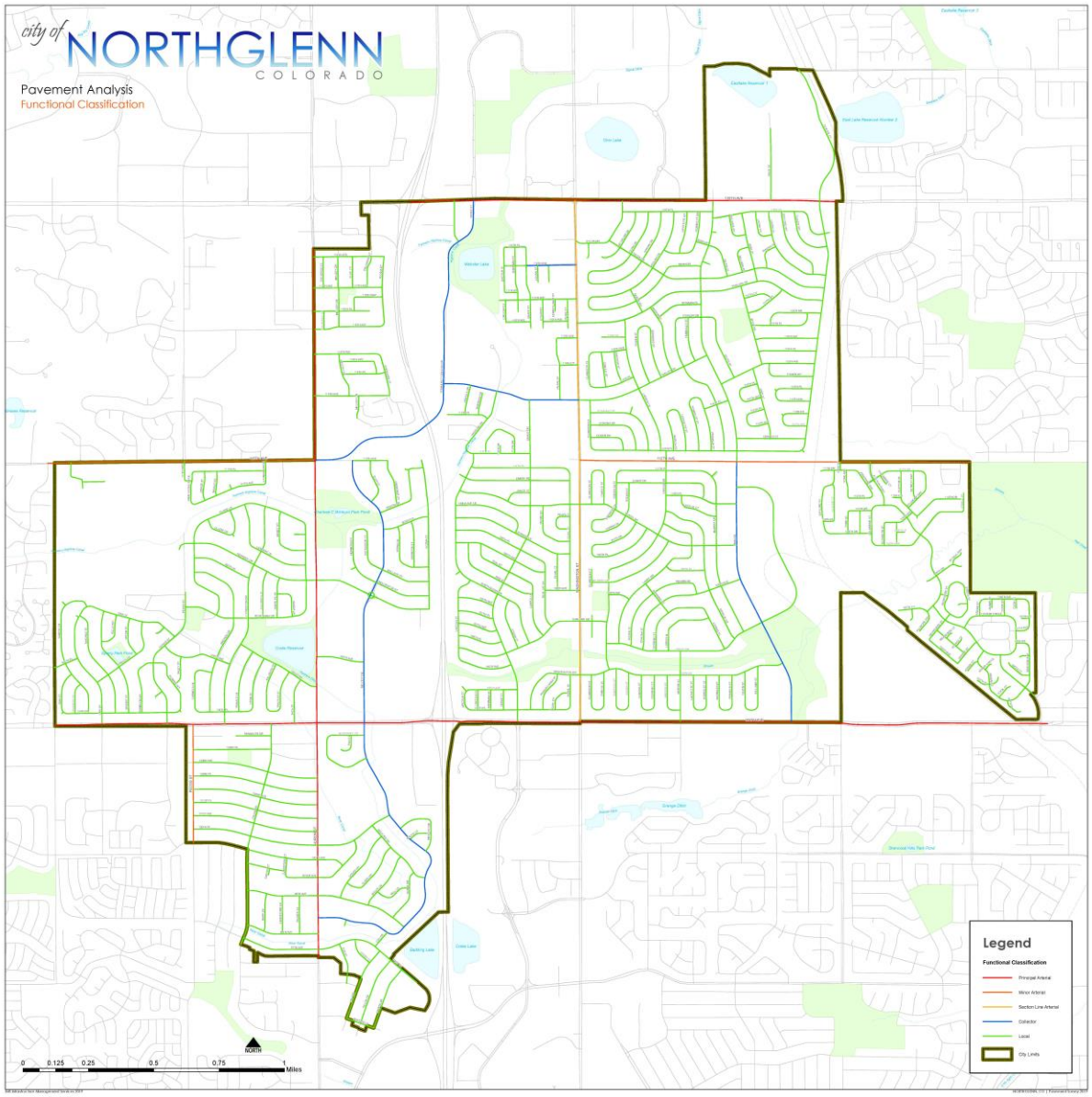


Figure 6 – Northglenn Functional Classification Designation

3.2 ASSEMBLY OF DATA INTO PROJECTS

Northglenn's Geographic Information System (GIS) was used as the basis for segmenting the roadway network on a block-by-block basis. Each segment was assigned a unique identifier referred to as a GISID, establishing a one-to-one relationship between the GIS and the street inventory. The segments form the basic building block of the pavement management system and are where all attribute and condition data are stored.

The centerline segments were aggregated together within the pavement management system to form logical projects that the analysis and rehabilitation program are developed against.

- Arterial projects run from major intersection to major intersection up to 1 mile in length.
- Similar to arterials, collector streets within a neighborhood were aggregated together to form a single project where practical.
- Local streets along a homogenous route were aggregated together along with adjacent side streets to form a small neighborhood based approach.

Segments were joined only when the pavement condition and functional classification were homogeneous in nature such that when joined they have a relatively uniform condition that may be rehabilitated using a single strategy.

The following figure (**Figure 7**) highlights the projects, used for the analysis. An electronic version of this map is appended to this report.

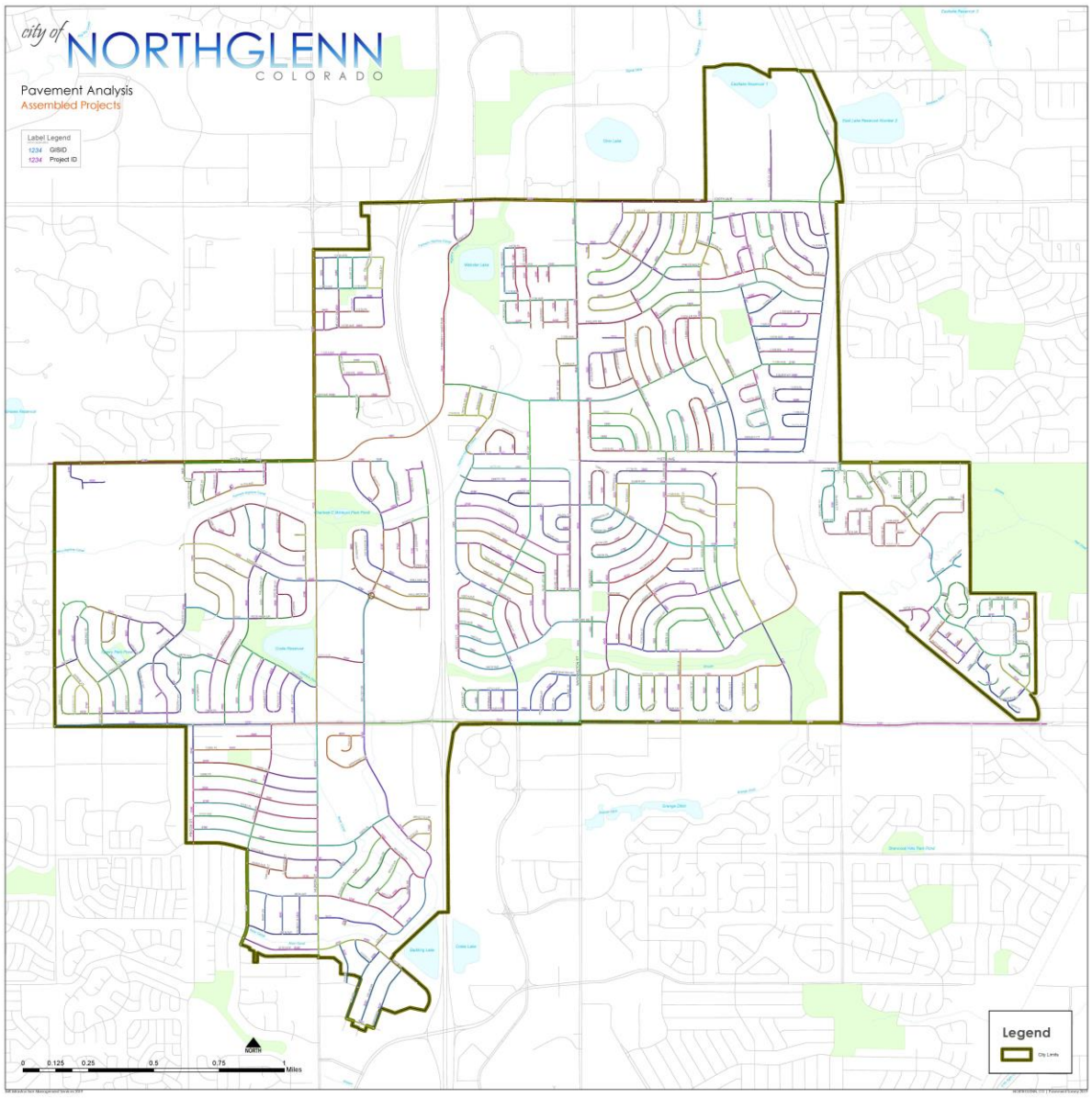


Figure 7 – Northglenn Assembled Projects

3.3 FIELD SURVEY METHODOLOGY

Following a set of predefined assessment protocols matching the pavement management software (ASTM D6433), a specialized piece of survey equipment – referred to as a Laser Road Surface Tester (Laser RST, pictured on page 5) – is used to collect observations on the condition of the pavement surface, as well as collect high definition digital imagery and spatial coordinate information. The Laser RST surveys each local street from end to end in a single pass, while all other roadway classifications are completed in two passes.

Key pavement condition data elements collected by the Laser RST include:

Surface Distress Index – The Laser RST collects surface distress observations based on the extent and severity of distresses encountered along the length of the roadway following ASTM D6433 protocols for asphalt and concrete pavements. The surface distress condition (cracking, potholes, raveling, and the like) is considered by the traveling public to be the most important aspect in assessing the overall pavement condition.

Presented on a 0 to 100 scale, the Surface Distress Index (SDI) is an aggregation of the observed pavement defects. Within the SDI, not all distresses are weighted equally. Certain load associated distresses (caused by traffic loading), such as rutting or alligator cracking on asphalt streets, or divided slab on concrete streets, have a much higher impact on the surface distress index than non-load associated distresses such as raveling or patching. Even at low extents and moderate severity – less than 10% of the total area – load associated distresses can drop the SDI considerably. ASTM D6433 also has algorithms within it to correct for multiple or overlapping distresses within a segment.

For this project, extent and severity observations were collected, processed, and loaded into the pavement management software. Within the software, the following distresses, listed in order from greatest to lowest impact, are presented as a 0 to 10 rating for review and reporting:

- Alligator Cracking – Alligator cracking is quantified by the severity of the failure and number of square feet. Even at low extents, this can have a large impact on the condition score as this distress represents a failure of the underlying base materials.
- Wheel Path Rutting – Starting at a minimum depth of ¼ inch, wheel path ruts are quantified by their depth and the number of square feet encountered. Like alligator cracking, low densities of rutting can have a large impact on the final condition score.
- Longitudinal, Transverse, Block (Map), and Edge Cracks – These are quantified by their length and width. Longitudinal cracks that intertwine are the start of alligator cracking.
- Patching – Patching is quantified by the extent and quality of patches. When the majority of a roadway surface is covered by a patch, such as a large utility replacement, the rating of the patch is minimized. All potholes are rated as patches.
- Distortions – All uneven pavement surfaces, such as depressions, bumps, sags, swells, heaves, and corrugations, are included as distortions and are quantified by the severity and extent of the affected area.
- Raveling – Raveling is the loss of fine aggregate materials on the pavement surface and is measured by the severity and number of square feet affected.

- Bleeding – Bleeding is the presence of free asphalt on the roadway surface caused by too much asphalt in the pavement or insufficient voids in the matrix. The result is a pavement surface with low skid resistance and is measured by the amount and severity of the area.
- Similar distresses were collected for concrete streets including divided slab, corner breaks, joint spalling, faulting, polished aggregate, and scaling.

Roughness Index – Roughness is recorded following the industry standard "International Roughness Index" (IRI), a measure of the change in elevation over a distance expressed as a slope and reported in millimeters/meter. The IRI value is converted to a 0 to 100 score and reported as the Roughness Index (RI) as follows:

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

ln(IRI) is the natural logarithm of IRI.

In common terms, a newer street would generally have a Roughness Index above 85, while one due for an overlay would be in the range 40 to 70. Failed streets typically have roughness values below 40.

Structural Index – The network of streets was not tested for structural adequacy, instead, the relationship between the final pavement condition score and amount of load associated distresses was analyzed and each pavement section assigned a Weak, Moderate or Strong strength rating. The assigned structural index (30, 60 or 80 for weak, moderate and strong respectively) was not used in determining the overall pavement condition score, but simply to classify the pavement strength and aid in selecting appropriate rehabilitation strategies.

Pavement Condition Index (PCI) – Following our field surveys, the condition data is assembled to create a single score representing the overall condition of the pavement. The Pavement Condition Index (PCI) is calculated as follows:

PCI = 33% Roughness Index + 67% Surface Distress Index

Development of the pavement management plan and budgets were completed using Northglenn - specific rehabilitation strategies, unit rates, priorities, and pavement performance curves. The process was iterative in its attempt to obtain the greatest efficiency and cost benefit.

4.0 NORTHGLENN SURVEY PAVEMENT CONDITION

4.1 UNDERSTANDING THE PAVEMENT CONDITION INDEX

The following compares the Pavement Condition Index (PCI) to commonly used descriptive terms. Divisions between the terms are not fixed, but are meant to reflect common perceptions of condition.

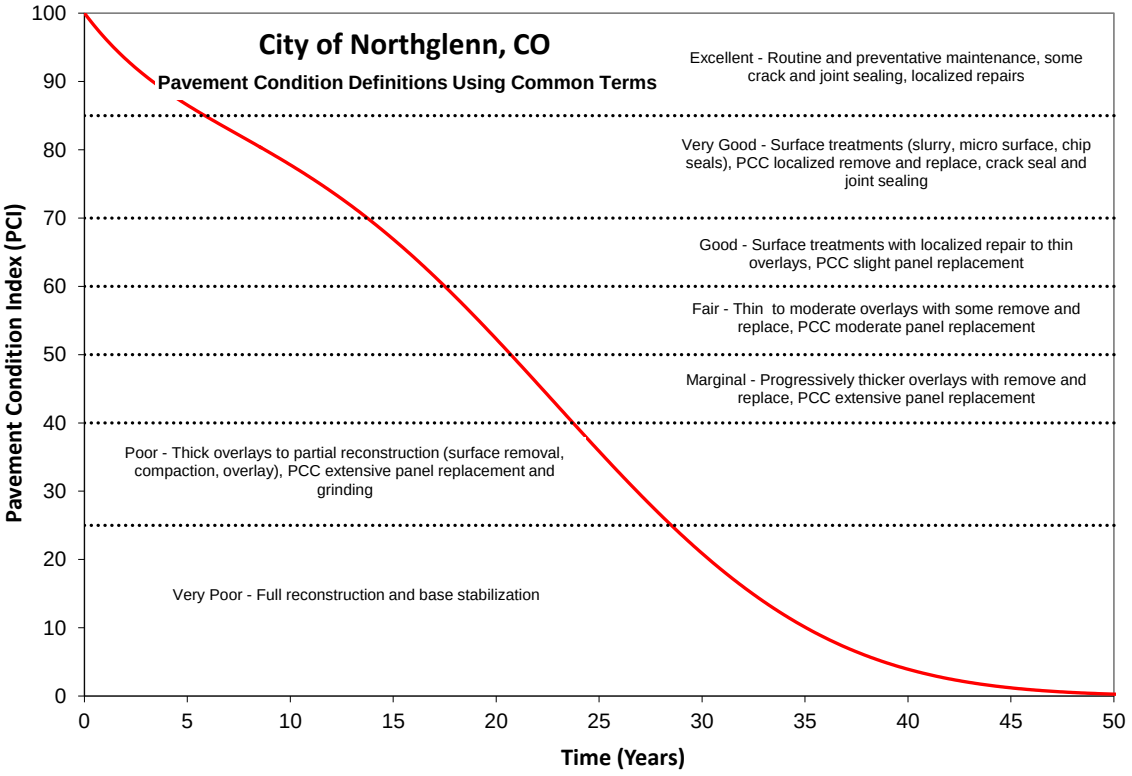


Figure 1 – Understanding the Pavement Condition Index (PCI) Score

The following table details a general description for each of these condition levels with respect to remaining life and typical rehabilitation actions:

PCI Range	Description	Relative Remaining Life	Definition
85 – 100	Excellent	15 to 25 Years	Like new condition – little to no maintenance required when new; routine maintenance such as crack and joint sealing.
70 – 85	Very Good	12 to 20 Years	Routine maintenance such as patching and crack sealing with surface treatments such as seal coats or slurries.
60 – 70	Good	10 to 15 Years	Heavier surface treatments, chip seals and thin overlays. Localized panel replacements for concrete.
40 – 60	Marginal to Fair	7 to 12 Years	Heavy surface-based inlays or overlays with localized repairs. Moderate to extensive panel replacements.
25 – 40	Poor	5 to 10 Years	Sections will require very thick overlays, surface replacement, base reconstruction, and possible subgrade stabilization.
0 – 25	Very Poor	0 to 5 Years	High percentage of full reconstruction.

The images presented below provide a sampling of the Northglenn streets that fall into the various condition categories with a discussion of potential rehabilitation strategies.

Very Poor (PCI = 0 to 25) – Complete Reconstruction (Not a Northglenn street)

Northglenn has no streets that fall within the Very Poor category - the above image is for illustrative purposes only.

Celedonia Street from Front Street to Main Street (GISID 1485, PCI = 23) – Rated as Very Poor, this street displays spreading base failure as evidenced by the severe alligator cracking and patching. It is also worth noting that the patching along the left hand side of the street has severely deteriorated as evident by the amount of weeds growing between the seams. A mill and overlay on this street would not be suitable as the base has failed and would not meet an extended service life of at least 15 years. This street requires a full reconstruction and should be carefully monitored.

Deferral of reconstruction of streets rated as Very Poor will not cause a substantial decrease in pavement quality as the streets have passed the opportunity for overlay-based strategies. Due to the high cost of reconstruction, Very Poor streets are often deferred until full funding is available in favor of completing more streets that can be rehabilitated at lower costs, resulting in a greater net benefit to the City. This strategy however must be sensitive to citizen complaints forcing the street to be selected earlier. 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

Huron Street from West 103rd Avenue to 104th Avenue (GISID 11489, PCI = 31) – Rated as Poor, this segment still has some remaining life before it becomes a critical reconstruction need. As evident in the imagery, some of the cracks have been sealed or patched, however the patches are now beginning to deteriorate. On this street, the base is showing signs of failure in areas exhibiting alligator/fatigue cracking. The severely cracked areas are isolated and do not persist throughout the entire segment length. These areas should be dug out and structurally patche. If left untreated, within a short period of time, a full reconstruction would be required.

On arterial roadways, Poor streets often require partial to full reconstruction – that is removal of the pavement surface and base down to the subgrade and rebuilding from there. On local roadways, they 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.

In general, the service life of Poor streets is such that if deferred for too long, it would require a more costly reconstruction. Streets rated as Poor are typically selected first for rehabilitation as they provide the greatest cost/benefit to the City – that is the greatest increase in life per rehabilitation dollar spent.

Marginal (PCI = 40 to 50) – Progressively Thicker Overlays

104th Avenue from Melody Drive to 104th I-25 (GISID 3621, PCI = 43) – Marginal streets have distresses that tend to be localized and moderate in nature – that is they do not extend the full length of the segment and can be readily dug out and repaired. On this street segment the failed area does not quite extend the full length or width of the roadway and is still serviceable. Placing an overlay on this street without repairing the base would not achieve a full 15 year life as the failure would continue to occur over time. Structural patching of the failed areas along localized rehabs would permit a full width grind and inlay on this street segment and return it to full service. The curb lines are straight and drainage is functioning well.

Similar to streets rated as Very Poor, Marginal streets that display high amounts of load associated distresses are selected as a priority for rehabilitation as they provide the greatest cost/benefit to the City. If left untreated, Marginal streets with high amounts of load associated distresses would 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

104th Avenue from Irma Drive to Brendon Way (GISID 8350, PCI = 58) – Rated in the Fair category, these streets require thin to moderate overlays for asphalt when they enter their need year (generally within 2-3 points of the lower PCI in the defined range). Several distresses are present, but tend to be more localized and moderate in severity, and non-load related (primarily longitudinal and transverse cracking and raveling). On this segment of road, most of the cracked areas have been sealed.

Asphalt streets rated as Fair tend to receive a lower priority when developing a rehabilitation program. The reason for this is the cost to complete an overlay now would be on the order of $14.00 to $17.00/yd2. If deferred, the rehabilitation cost would only increase by about $3 to $5/yd2, again depending on the functional classification, in about 5 to 10 years. This delay represents a 20% difference over the time stated. Thus, the cost of deferral is low when compared to deferring a thick overlay to a reconstruction with a two to threefold increase in cost.

Good (PCI = 60 to 70) – Surface Treatments to Thin Overlays

112th Avenue from Raritan Street to West 111th Way (GISID 3639, PCI = 69) – Rated as Good with the primary cause of deterioration the transverse and longitudinal cracking, as well as patching. It also displays small amounts of load associated distresses that can easily be removed to restore the visual appearance of the roadway. The existing cracks should be sealed and the pavement surface restored, with a heavier surface treatment such as microsurfacing or double slurry to fully waterproof the pavement and cover the crack sealant. The occasional dig out and replacement may be required to correct localized deficiencies. Alternatively, depending on the extent of the distressed areas, base strength and drainage, a thin overlay may be applied.

Asphalt streets rated as Good are ideal candidates for thinner surface-based rehabilitations and local repairs. Depending on the amount of localized failures, a thin edge mill and overlay, or possibly a surface treatment, would be a suitable rehabilitation strategy for streets rated as Good. Streets that fall in the high 60 - low 70 PCI range provide the greatest opportunity for extending pavement life at the lowest possible cost, thus applying the principles of the perpetual life cycle approach to pavement maintenance. The adjacent photo is a great example of a street segment (not a Northglenn Road) that displayed low load associated distresses and thus, high structural characteristics, and once the distressed areas were replaced, a slurry seal was applied. The patching accounted for less than 5 to 10% of the total area and resulted in a good looking, watertight final surface at a much lower cost than an overlay with less disruption to the neighborhood and curb line. The patches were paver laid and roller compacted.

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

Huron Street from West 116th Place to West 117th Avenue (GISID 3712, PCI = 82) – Rated as Very Good, this road displays minor amounts of transverse cracking. The surface is non-weathered, and the base is still strong. This street is an example of a candidate for preventative maintenance and light weight surface treatments to extend the life of a roadway.

Asphalt streets rated as Very Good generally need lightweight surface-based treatments such as surface seals, slurries, chip seals or microsurfacing. Routine maintenance such as crack sealing and localized repairs often precede surface treatments. The concept is to keep the cracks as waterproof as possible through crack sealing and the application of a surface treatment. By keeping water out of the base layers, the pavement life is extended without the need for thicker rehabilitations such as overlays or reconstruction. Surface treatments also tend to increase surface friction and visual appearance of the pavement surface but do not add structure or increase smoothness.

Surface treatments may include:

- *Double or single application of slurry seals (slurries are a sand and asphalt cement mix).*
- *Microsurfacing – asphalt cement and up to 3/8 sand aggregate.*
- *Chip seals and cape seals (Chip seal followed by a slurry).*

Additional cost benefits of early intervention include:

- *Less use of non-renewable resources through thinner rehabilitation strategies.*
- *Less intrusive rehabilitation and easier to maintain access during construction.*
- *Easier to maintain existing drainage patterns.*

Excellent (PCI = 85 to 100)

104th Avenue from Fox Run Parkway to East 104th Avenue (GISID 8975, PCI = 97) – Rated as Excellent, displaying little to no surface distresses. The ride is smooth and the surface is non-weathered and the base is strong. In a couple of years, this street segment would be an ideal candidate for routine maintenance activities such as crack sealant rehabilitation.

In terms of pavement management efficiency, a program based on worst-first, that is starting at the lowest rated street and working up towards the highest, does not achieve optimal expenditure of money. Generally, under this scenario, agencies can not sufficiently fund pavement rehabilitation and lose ground despite injecting large amounts of capital into the network.

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

4.2 EVALUATING THE PAVEMENT QUALITY AND BACKLOG

The concept of the Pavement Condition Index (PCI) score, backlog percentage and number of streets rated as Excellent must be fully understood in order to understand and develop an effective pavement management program. These three metrics should fall into certain ranges in order to measure the quality and long term viability of a network.

The PCI score indicates the overall pavement condition and represents the amount of equity in the system; it is the value most commonly considered when gauging the overall quality of a roadway network. It may also be used to define a desired level of service: that is, an agency may wish to develop a pavement management program such that in five years the overall network score meets a set minimum value. Obviously, the higher the PCI score the better off the overall network condition is. Agencies with an average PCI score above 80 (when considering surface distress, roughness and possibly strength) are rare and found only in a few select communities. Less than 1 in 20 communities surveyed by IMS have that high of a condition average. Averages between 65 and 80 are indicative of either newer networks, or ones that have an ongoing pavement rehabilitation program and tend to be fully funded. Scores between 60 and 65 are common and represent a reasonable average providing a satisfactory balance between levels of service and funding, and when taken with the other two metrics may represent a well-managed and funded network. A minimum score of 60 means that overall the network falls at the lower end of the range where light weight surface treatments and thin overlays are the standard rehabilitation practice. Below a 60 means an agency has to rely on more costly rehabilitations and reconstructions to address condition issues.

At the upper end of the condition scale, a minimum of 15% of the network should be rated as Excellent. Generally, at or above 15%, means that a noticeable percentage of the roadway network is in like new condition, requiring only routine maintenance. While higher percentages of streets rated as Excellent are certainly desirable, the annual cost to maintain rates at higher multiples is often cost prohibitive. Below 15% means the agency is struggling to effectively rehabilitate their network on an annual basis. The 15% marker represents a cost effective balance between annual investment and satisfactory level of service.

Backlog roadways are those that have dropped sufficiently in quality to the point where surface based rehabilitation efforts would no longer prove to be cost effective. These roadways are rated Poor or Very Poor and will require either partial or total reconstruction. Backlog is expressed as the percentage of roads requiring reconstruction as compared to the network totals.

It is the backlog, however, that defines the amount of legacy work an agency is facing and is willing to accept in the future. It is the combination of the three metrics that presents the true picture of the condition of a roadway network, and conversely defines improvement goals.

Generally, a backlog of 10% to 15% of the overall network is considered manageable from a funding point of view with 12% being a realistic target. Fifteen percent (15%) is used as a control limit to indicate the maximum amount of backlog that can be readily managed. Backlog rates below 10%, again are certainly desirable, but financially unachievable for a large percentage of agencies. Backlogs approaching 20% or more tend to become unmanageable, unless aggressively checked through larger rehabilitation programs, and will grow at an alarming rate. At 20% a tipping point has been met and the backlog tends to increase faster than an agency's ability to reconstruct their streets.

4.3 NORTHGLENN NETWORK CONDITION DISTRIBUTION

Figure 9 presented below shows the distribution of pavement condition for the roadway network in Northglenn. The average PCI for the network Local/Collector is 59. While direct comparisons to other agencies are difficult due to variances in ratings systems, Northglenn is slightly below average when compared to other agencies recently surveyed by IMS, which typically fall in the 60 to 65 range.

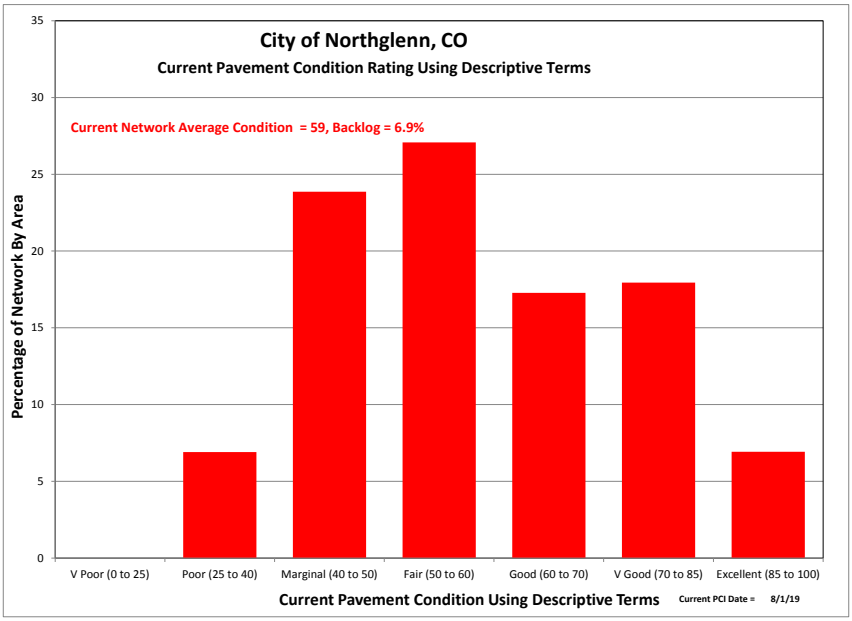


Figure 9a – Roadway Network Present Status (Local/Collector)

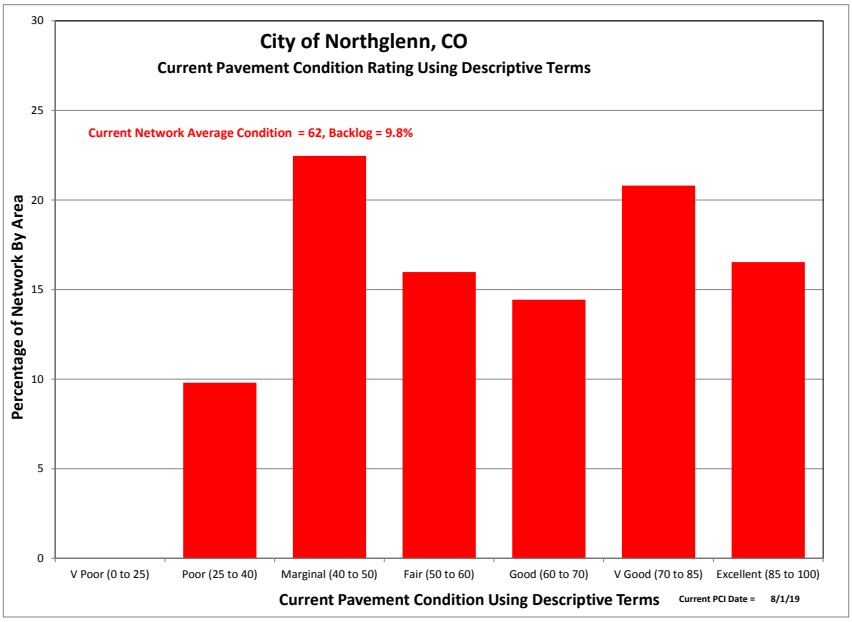


Figure 9b – Roadway Network Present Status (Arterials)

The following graph **(Figure 10)** plots the same pavement condition information of the Local/Collector network, but instead of using the actual Pavement Condition Index (PCI) value, descriptive terms are used to classify the roadways.

- Seven percent (6.9%) of the network can be considered in Excellent condition and require only routine maintenance. The target value for Excellent streets should be 15%, so the Northglenn network just barely fails to meet this condition.
- Eighteen percent (17.9%) of the network falls into the Very Good classification. These are roads that benefit most from preventative maintenance techniques such as microsurfacing, slurry seals and localized panel repairs.
- Seventeen percent (17.3%) of the streets are rated as Good and are candidates for lighter surface-based rehabilitations such as thin overlays or slight panel replacements.
- Fifty-one percent (51%) of network can be considered Fair to Marginal condition representing candidates for progressively thicker overlay-based rehabilitation or panel replacements. If left untreated, they will decline rapidly into reconstruction candidates.
- The remaining Seven percent (6.9%) of the network is rated as Poor or Very Poor, meaning these roadways have failed or are past their optimal due point for overlay or surface-based rehabilitation and may require progressively heavier or thicker forms of rehabilitation (such as extensive panel replacement, surface reconstruction or deep patch and paving) or total reconstruction.

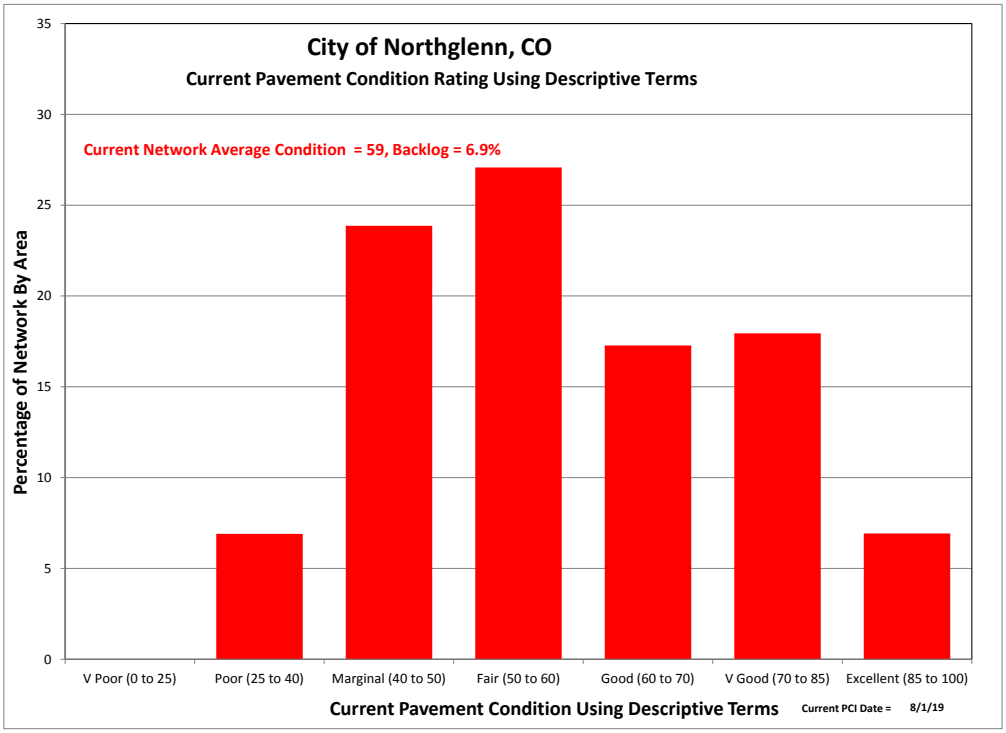


Figure 10 – Roadway Network Present Status Using Descriptive Terms

Figures 11 and 12 present the surveyed condition of the streets using PCI and Good-Fair-Poor descriptive terms, respectively. Electronic versions of these maps are appended to this report.

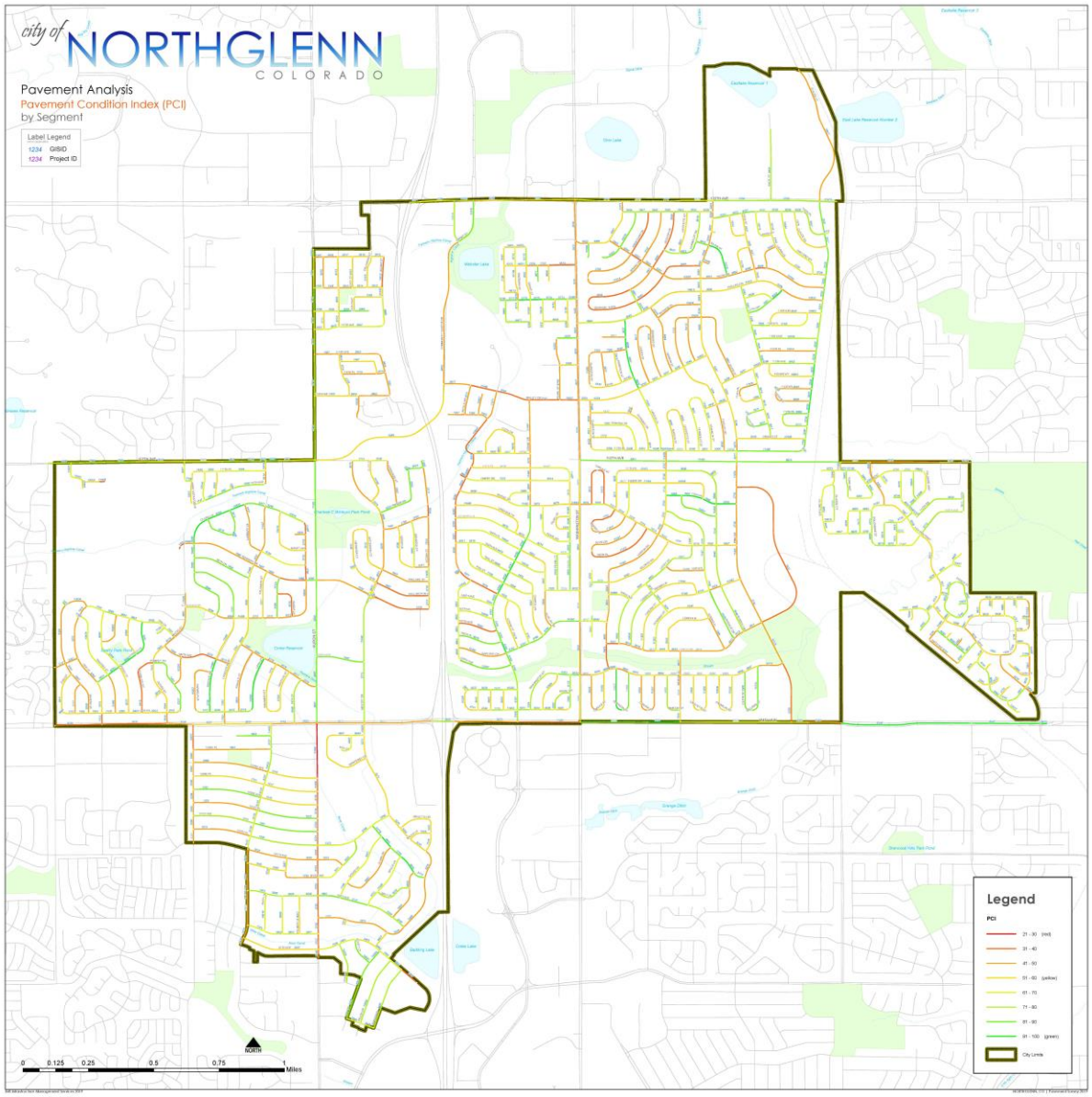


Figure 11 – Northglenn by Segment Using Pavement Condition Index (PCI)

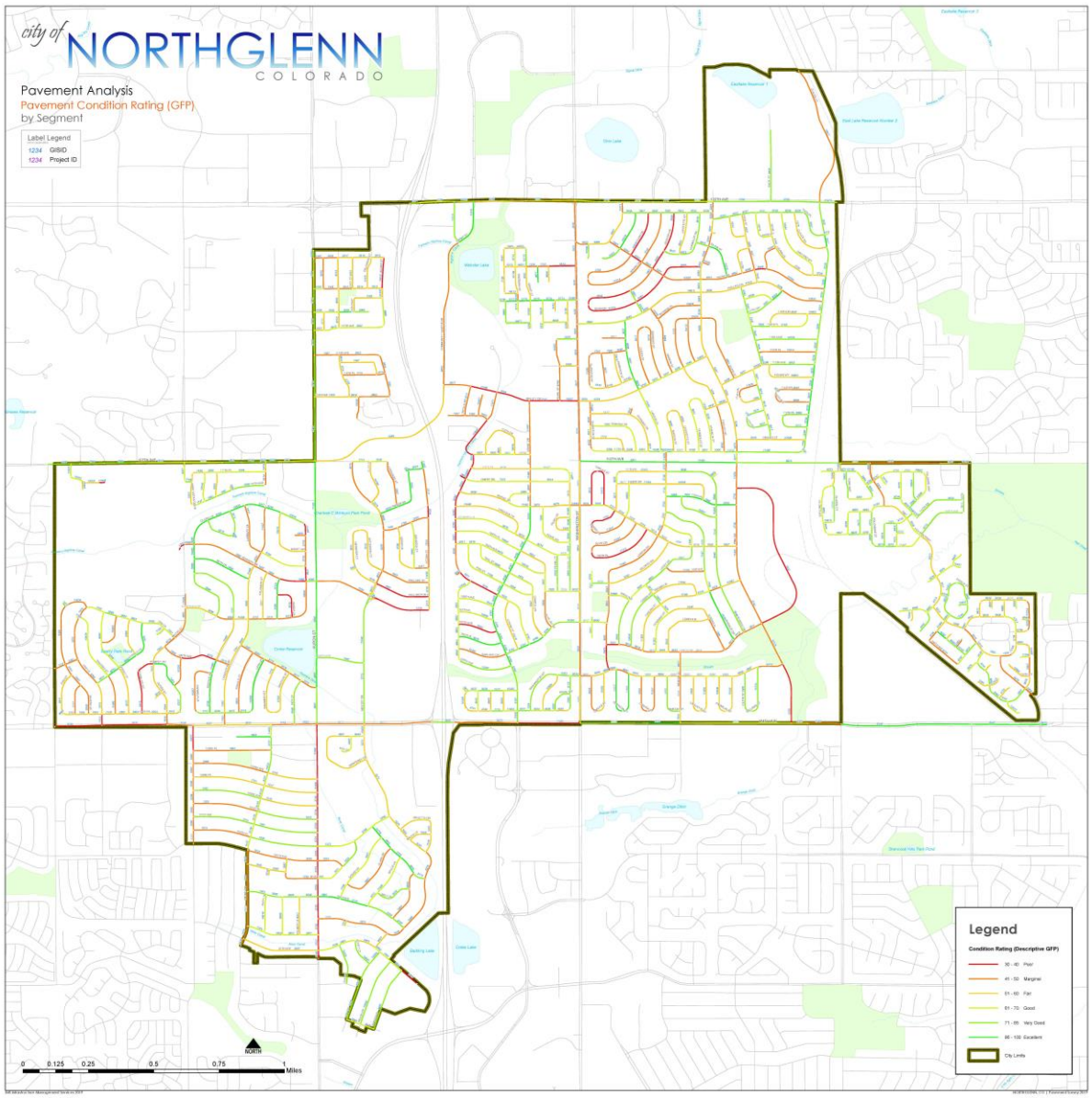


Figure 12 – Northglenn Pavement Condition by Segment Using Descriptive Terms

4.4 STRUCTURAL AND LOAD ASSOCIATED DISTRESS ANALYSIS

Structural testing and analysis was not performed for the City of Northglenn. Instead, analysis of the cause of pavement failure for these street segments was completed by examining the types of distresses that have caused the PCI score to drop.

Surface distresses may be categorized into two classifications – load associated distresses (LADD) and non-load associated distresses (NLAD). Load associated distresses are those that are directly related to traffic loading and structural capacity. Non-load associated distresses are those that result from materials or environmental issues including shrinkage (transverse) cracking, bleeding and raveling. Generally, load associated distresses affect the overall condition score more than non-load associated distresses – as is the case in Northglenn. For asphalt streets, roadways were classified as Weak, Moderate, or Strong.

The purpose of the structural analysis is twofold:

- The structural analysis provides input into which performance curve each segment is to use – performance curves are used to predict pavement deterioration over time.
- Structural analysis assists in rehabilitation selection by constraining inadequate pavement sections from receiving too light of a rehabilitation and conversely, identifying segments suitable for lighter weight treatment.

Figure 14 plots the relationship of the load associated distresses (shown in red) against pavement condition. As can be seen from the plot, at higher PCI scores, most pavements fall into the moderate strength classification as the distresses have not yet begun to manifest themselves into severe failures. As the PCI score drops, the load associated distresses typically affect the PCI score to a higher degree with more segments being classified as weak. Conversely, segments that have a declining PCI score and low LADD, are classified as strong as they display few load associated failures. High PCI score (above 60) rehab selections should focus on pavement preservation activities such as surface treatments or thin overlays, possibly with some localized pavement repairs and crack sealing.

The sum of the Load-Associated Distress deducts (LADD) is also used to qualify the appropriate rehabilitation strategy selection in addition to the overall pavement condition score. For example, a street that has a good PCI score (that is between 60 and 70) and is displaying relatively low load associated distress deducts would be a suitable candidate for a surface treatment in place of a thin overlay in that the PCI score is more influenced by materials issues such as transverse cracking or raveling.

Overall, the low amounts of streets exhibiting weak performance can generally be attributed to poor subgrade conditions, insufficient pavement thickness and increased traffic loading – in particular heavy, side-loading garbage and recycling trucks (an unintended consequence of green initiatives) along with school buses and delivery vehicles. The average weight of these vehicles coupled with tire pressure and configuration today compared to those from a few decades ago has increased drastically.

- The upper black diagonal line identifies segments that have a high ratio of load associated distresses compared to their PCI score. These segments are classified as weak.
- The lower black diagonal line identifies segments that have a low ratio of load associated distresses compared to their PCI score and are classified as strong.
- Segments that fall between the two lines are assigned a moderate pavement strength.

The sum of the Load-Associated Distress deducts (LADD) is also used to qualify the appropriate rehabilitation strategy selection in addition to the overall pavement condition score.

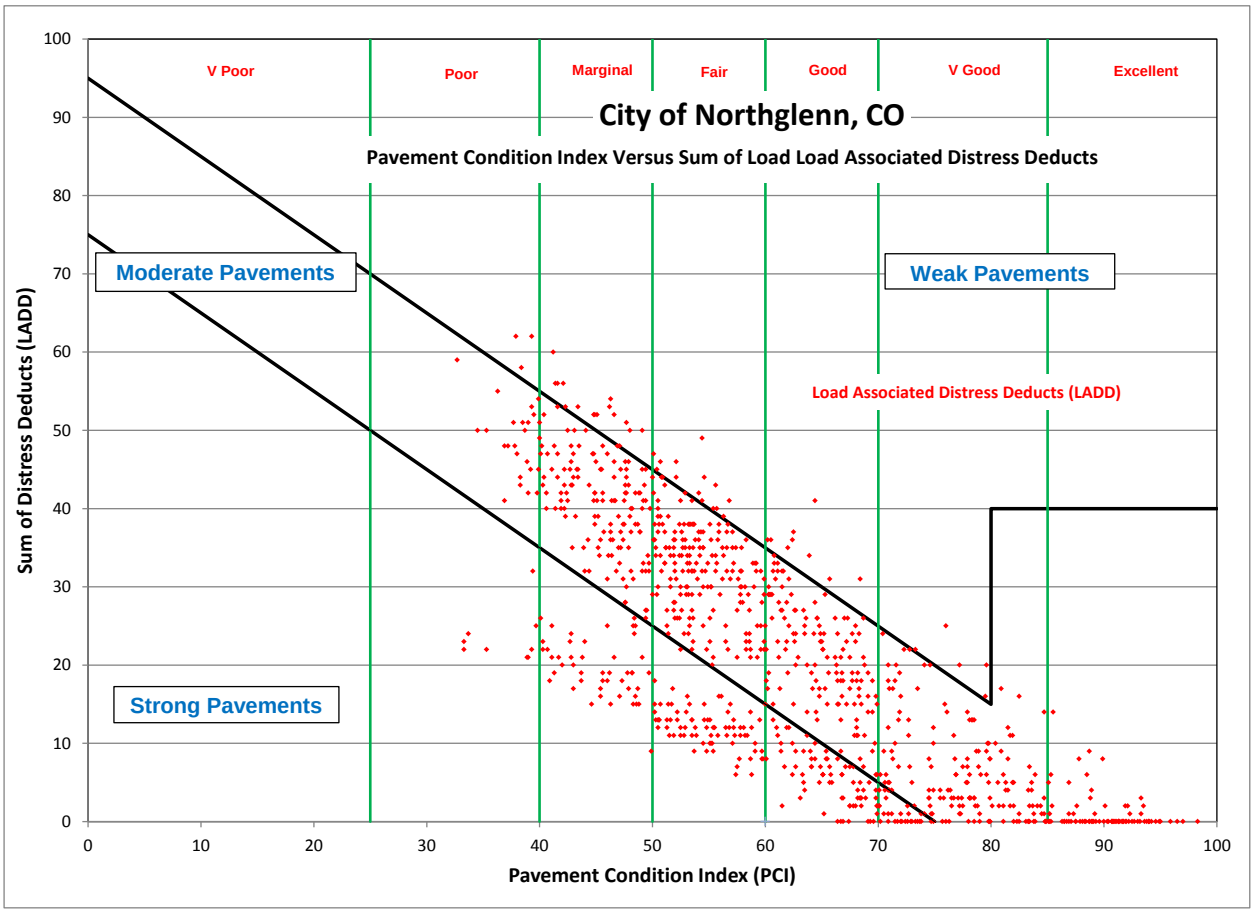


Figure 14 – Pavement Condition Index versus Sum of Distress Deducts

5.0 REHABILITATION PLAN AND BUDGET DEVELOPMENT

5.1 KEY ANALYSIS SET POINTS AND PAVEMENT PERFORMANCE CURVES

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

Some of the highlights include:

- The pavement performance curves that are used to predict future pavement condition. Asphalt streets are classified as weak, moderate, or strong, and then assigned the appropriate pavement performance curve based on their functional classification to use in the analysis. The concept of load associated distresses does not apply to concrete streets.
- The shape of performance curves reflect the concept of deferred maintenance and salvage life. Instead of dropping to an absolute PCI value of 0 after 40 years of service, the curves are designed to become asymptotic to the age axis and have a whole life of approximately 50 to 60 years depending on pavement type. This indicates the notion that once a street deteriorates past a specific threshold – about a PCI of 20, age becomes less important in rehab selection.
- Priority ranking analysis uses prioritization for rehabilitation candidate selection. It is designed to capture as many segments in their need year based on the incremental cost of deferral. The higher the functional classification of a street, the higher priority a segment is given.

Rehabilitation Strategies and Unit Rates

The rehab strategies and unit rates used in the pavement analysis can be found on the following page. Some important parameters include:

- **Rehab Code and Activity** – The assigned identifier and name to each rehabilitation strategy. The term "RR" refers to "Remove and Replace", otherwise known as Structural Patching. When this term is present, additional funds have been assigned to the strategy to allow for an increased amount of preparation work and patching. The relative terms of thin, moderate and thick are used to describe the overlay thickness. This is to facilitate consistency in the naming convention, but does not imply the same material thickness has to be used for each functional classification.

  The recommended rehab activities for any given PCI range may vary due to pavement strength and functional classification. For example, an arterial between a PCI of 50 to 60 may receive a thin to moderate overlay, while a local access road may only receive a chip seal or thin overlay.

- **Unit Rates** – The rehab costs are presented on a per square yard basis for each pavement type, functional class, and rehabilitation activity combination. The rates were developed using typical national averages for similar activities and adjusted for Northglenn's location and unique conditions. An additional burden to all costs was also added to cover City overheads, design and engineering and inspection. Costs for peripheral concrete rehab (valley gutters, inlets, approaches, etc.) have not been included in the analysis.

The unit rates are reflected in the network value, final budgets, and average cost/mile for doing work in Northglenn.

City of Northglenn, CO
Rehabilitation Strategies and Unit Rates

			Rehab Group 1			Rehab Group 2			Rehab Group 3									
Pavetype	Rehab Code	Rehab Activity	Min PCI	Critical PCI (Need Year)	Max PCI	Min PCI	Critical PCI (Need Year)	Max PCI	Min PCI	Critical PCI (Need Year)	Max PCI	Base Unit Rate ($/yd2)	Collector Unit Rate ($/yd2)	Local Unit Rate ($/yd2)	Construction Activities Burden Included in Unit Rates (%)	Agency Overheads Included in Unit Rates (%)	Reset PCI	Steady State Life Cycle (Yrs)	CBA Rehab Priority (Info Only)
All	5	Routine Maintenance	85	100	100	80	82	100	80	82	100	0.00	0.00	0.00	0	0		1	
Asphalt	10	Slurry Seal / Seal Coat	80	82	85	70	73	80	70	73	80	3.70	3.70	3.70	10	15	85	3	15
Asphalt	20	MicroSurface / Chip Seal	70	73	80				60	63	70	4.90	4.90	4.90	10	15	88	14	7
Asphalt	23	MicroSurface / Chip Seal + Strctrl Ptch	70	73	80								5.70	5.70	10	15	88	14	8
Asphalt	26	MicroSurface / Chip Seal + Strctrl Ptch	70	73	80	60	63	70	50	54	60		6.40	6.40	10	15	88	14	6
Asphalt	30	Edge Mill + Thin Overlay (1.5 - 2.0)	60	63	70				50	54	60	16.50	16.50	16.50	10	15	92	24	13
Asphalt	33	Edge Mill + Thin Overlay (1.5 - 2.0) + Strctrl Ptch	60	63	70	50	54	60	50	54	60		18.25	18.25	10	15	92	24	14
Asphalt	36	Edge Mill + Thin Overlay (1.5 - 2.0) + Strctrl Ptch	50	54	60	50	54	60	40	44	50		20.00	20.00	10	15	92	24	5
Asphalt	40	EM/FWM + Moderate Overlay (2.0 - 3.0)	50	54	60	50	54	60	40	44	50	18.50	18.50	18.50	10	15	94	30	10
Asphalt	43	EM/FWM + Moderate Overlay (2.0 - 3.0) + Strctrl Ptch	50	54	60	40	44	50	40	44	50		20.25	20.25	10	15	94	30	4
Asphalt	46	EM/FWM + Moderate Overlay (2.0 - 3.0) + Strctrl Ptch	40	44	50	40	44	50	25	30	40		22.00	22.00	10	15	94	30	11
Asphalt	50	FWM + Thick Overlay (> 2.0 - 3.0)	40	44	50							22.00	22.00	22.00	10	15	96	37	9
Asphalt	53	FWM + Thick Overlay (> 2.0 - 3.0) + Strctrl Ptch	40	44	50	25	30	40					24.00	24.00	10	15	96	37	12
Asphalt	56	FWM + Thick Overlay (> 2.0 - 3.0) + Strctrl Ptch	25	30	40								26.00	26.00	10	15	96	37	1
Asphalt	60	Surf Recon + Base Rehab / FWM + Strctrl Ptch + Olay	25	30	40	25	30	40	0	15	25	47.50	47.50	47.50	10	15	98	45	2
Asphalt	70	ACP Full Depth Reconstruction	0	15	25	0	15	25	0	15	25	69.00	69.00	69.00	10	15	100	56	3
Concrete	510	PCC Jnt Rehab & Crk Seal	80	82	100	80	82	100	80	82	100	0.56	0.55	0.55	10	15	83	2	11
Concrete	520	PCC Localized Rehab	70	73	80	70	73	80	70	73	80	3.47	3.50	3.50	10	15	85	16	10
Concrete	523	PCC Localized Rehab + Grind	70	73	80	70	73	80	70	73	80		3.50	3.50	10	15	85	16	3
Concrete	530	PCC Slight Pnl Rplcmnt (<10%)	60	63	70	60	63	70	60	63	70	14.84	14.75	14.75	10	15	88	31	8
Concrete	533	PCC Slight Pnl Rplcmnt (<10%) + Grind	60	63	70	60	63	70	60	63	70		14.75	14.75	10	15	88	31	8
Concrete	540	PCC Moderate Pnl Rplcmnt (< 20%)	50	54	60	50	54	60	50	54	60	28.00	28.00	28.00	10	15	90	41	6
Concrete	543	PCC Moderate Pnl Rplcmnt (< 20%) + Grind	50	54	60	50	54	60	50	54	60		28.00	28.00	10	15	90	41	6
Concrete	550	PCC Extensive Pnl Rplcmnt (<33%)	40	44	50	40	44	50	40	44	50	40.88	41.00	41.00	10	15	94	54	4
Concrete	553	PCC Extensive Pnl Rplcmnt (<33%) + Grind	40	44	50	40	44	50	40	44	50		41.00	41.00	10	15	94	54	4
Concrete	560	PCC Partial Reconstruction	25	30	40	25	30	40	25	30	40	81.76	82.00	82.00	10	15	96	66	1
Concrete	570	PCC Full Depth Reconstruction	0	15	25	0	15	25	0	15	25	124.32	124.00	124.00	10	15	100	84	2

**Unit rates vary slightly between functional classes*

City of Northglenn, CO
Rehabilitation Strategies and Unit Rates

			Rehab Group 1			Rehab Group 2			Rehab Group 3										
Pavetype	Rehab Code	Rehab Activity	Min PCI	Critical PCI (Need Year)	Max PCI	Min PCI	Critical PCI (Need Year)	Max PCI	Min PCI	Critical PCI (Need Year)	Max PCI	Base Unit Rate ($/yd2)	Principal Arterial Unit Rate ($/yd2)	Minor Arterial Unit Rate ($/yd2)	Section Line Arterial Unit Rate ($/yd2)	Construction Activities Burden Included in Unit Rates (%)	Agency Overheads Included in Unit Rates (%)	Reset PCI	Steady State Life Cycle (Yrs)	CBA Rehab Priority (Info Only)
All	5	Routine Maintenance	85	100	100	80	82	100	80	82	100	0.00	0.00	0.00	0.00	0	0		1	
Asphalt	10	Slurry Seal / Seal Coat	80	82	85	70	73	80	70	73	80	3.70	4.10	4.00	3.90	10	15	85	2	15
Asphalt	20	MicroSurface / Chip Seal	70	73	80				60	63	70	4.90	5.40	5.30	5.10	10	15	88	10	7
Asphalt	23	MicroSurface / Chip Seal + Strctrl Ptch	70	73	80								6.20	6.10	5.90	10	15	88	10	8
Asphalt	26	MicroSurface / Chip Seal + Strctrl Ptch	70	73	80	60	63	70	50	54	60		7.00	6.90	6.70	10	15	88	10	6
Asphalt	30	Edge Mill + Thin Overlay (1.5 - 2.0)	60	63	70				50	54	60	16.50	18.25	17.75	17.25	10	15	92	18	12
Asphalt	33	Edge Mill + Thin Overlay (1.5 - 2.0) + Strctrl Ptch	60	63	70	50	54	60	50	54	60		20.00	19.50	19.25	10	15	92	18	14
Asphalt	36	Edge Mill + Thin Overlay (1.5 - 2.0) + Strctrl Ptch	50	54	60	50	54	60	40	44	50		22.00	21.50	21.00	10	15	92	18	5
Asphalt	40	EM/FWM + Moderate Overlay (2.0 - 3.0)	50	54	60	50	54	60	40	44	50	18.50	21.25	20.50	20.00	10	15	94	23	9
Asphalt	43	EM/FWM + Moderate Overlay (2.0 - 3.0) + Strctrl Ptch	50	54	60	40	44	50	40	44	50		23.25	22.50	21.75	10	15	94	23	4
Asphalt	46	EM/FWM + Moderate Overlay (2.0 - 3.0) + Strctrl Ptch	40	44	50	40	44	50	25	30	40		25.50	24.50	23.75	10	15	94	23	11
Asphalt	50	FWM + Thick Overlay (> 2.0 - 3.0)	40	44	50							22.00	26.50	25.50	24.25	10	15	96	28	10
Asphalt	53	FWM + Thick Overlay (> 2.0 - 3.0) + Strctrl Ptch	40	44	50	25	30	40					29.00	27.75	26.50	10	15	96	28	13
Asphalt	56	FWM + Thick Overlay (> 2.0 - 3.0) + Strctrl Ptch	25	30	40								31.50	30.00	28.75	10	15	96	28	1
Asphalt	60	Surf Recon + Base Rehab / FWM + Strctrl Ptch + Olay	25	30	40	25	30	40	0	15	25	47.50	57.50	55.00	52.50	10	15	98	34	2
Asphalt	70	ACP Full Depth Reconstruction	0	15	25	0	15	25	0	15	25	69.00	76.00	74.00	72.50	10	15	100	42	3
Concrete	510	PCC Jnt Rehab & Crk Seal	80	82	100	80	82	100	80	82	100	0.56	0.60	0.60	0.60	10	15	83	2	11
Concrete	520	PCC Localized Rehab	70	73	80	70	73	80	70	73	80	3.47	4.00	3.90	3.70	10	15	85	16	10
Concrete	523	PCC Localized Rehab + Grind	70	73	80	70	73	80	70	73	80		4.00	3.90	3.70	10	15	85	16	3
Concrete	530	PCC Slight Pnl Rplcmnt (<10%)	60	63	70	60	63	70	60	63	70	14.84	18.00	17.25	16.25	10	15	88	31	8
Concrete	533	PCC Slight Pnl Rplcmnt (<10%) + Grind	60	63	70	60	63	70	60	63	70		18.00	17.25	16.25	10	15	88	31	8
Concrete	540	PCC Moderate Pnl Rplcmnt (< 20%)	50	54	60	50	54	60	50	54	60	28.00	35.50	33.50	31.50	10	15	90	41	6
Concrete	543	PCC Moderate Pnl Rplcmnt (< 20%) + Grind	50	54	60	50	54	60	50	54	60		35.50	33.50	31.50	10	15	90	41	6
Concrete	550	PCC Extensive Pnl Rplcmnt (<33%)	40	44	50	40	44	50	40	44	50	40.88	54.50	51.00	47.50	10	15	94	54	4
Concrete	553	PCC Extensive Pnl Rplcmnt (<33%) + Grind	40	44	50	40	44	50	40	44	50		54.50	51.00	47.50	10	15	94	54	4
Concrete	560	PCC Partial Reconstruction	25	30	40	25	30	40	25	30	40	81.76	104.00	98.00	92.50	10	15	96	66	1
Concrete	570	PCC Full Depth Reconstruction	0	15	25	0	15	25	0	15	25	124.32	165.00	154.00	144.00	10	15	100	84	2

Min PCI, Critical PCI, and Max PCI – These define the Pavement Condition Index (PCI) range applicable to the rehab selection. The Critical PCI defines when a segment is in its need year and is deemed to be critical, otherwise if deferred, the street declines in PCI past the point which the rehabilitation is no longer appropriate. Generally the Critical PCI falls 2 to 4 points higher than the minimum PCI applicable for each rehab activity.

Selection and Prioritization of Rehab Candidates

The City's pavement management program incorporates a series of user defined values to prioritize and select the street segments for rehabilitation. The rehab selection order is not worst first, but rather designed to capture as many segments in their need year based on the incremental cost of rehab deferral. A Street is considered to be in its need year when it has reached its maximum service life and any further deferral would require a heavier and more costly rehabilitation. The rehab program has been designed to maximize the increased service life for each rehabilitation dollar spent on a segment.

Other factors included in the prioritization process focus on:

- **Need Year** – streets are only selected when they have expended their service life and are optimal for rehab selection.
- **Functional Classification** – generally priority is given to higher functional classifications as they provide greater benefits to a larger group of users
- **Pavement Strength** – weaker streets are prioritized higher than stronger ones as they deteriorate faster.
- **Area** – a very slight increase in priority is given to larger projects over smaller ones.

The net result is a program that favors thick overlays, followed by partial reconstruction projects then full reconstruction projects (more for safety reasons than cost-benefit). These are then followed by surface treatments and lastly by moderate to thin overlays.

The programmed deterioration curves illustrated in **Figure 16** are designed to integrate the pavement condition distribution performance curves for the network, with the applied rehabilitation strategies and their expected life cycle. Different color performance curves are meant to represent the full suite of curves assigned to segments based upon their functional class, pavement type, and strength.

It is important to recognize that even though all streets fall into specific rating categories and their respective rehabilitation strategies, it is not until a street falls to within a few points of the lower end of the range that it will become a critical need selected for rehabilitation.

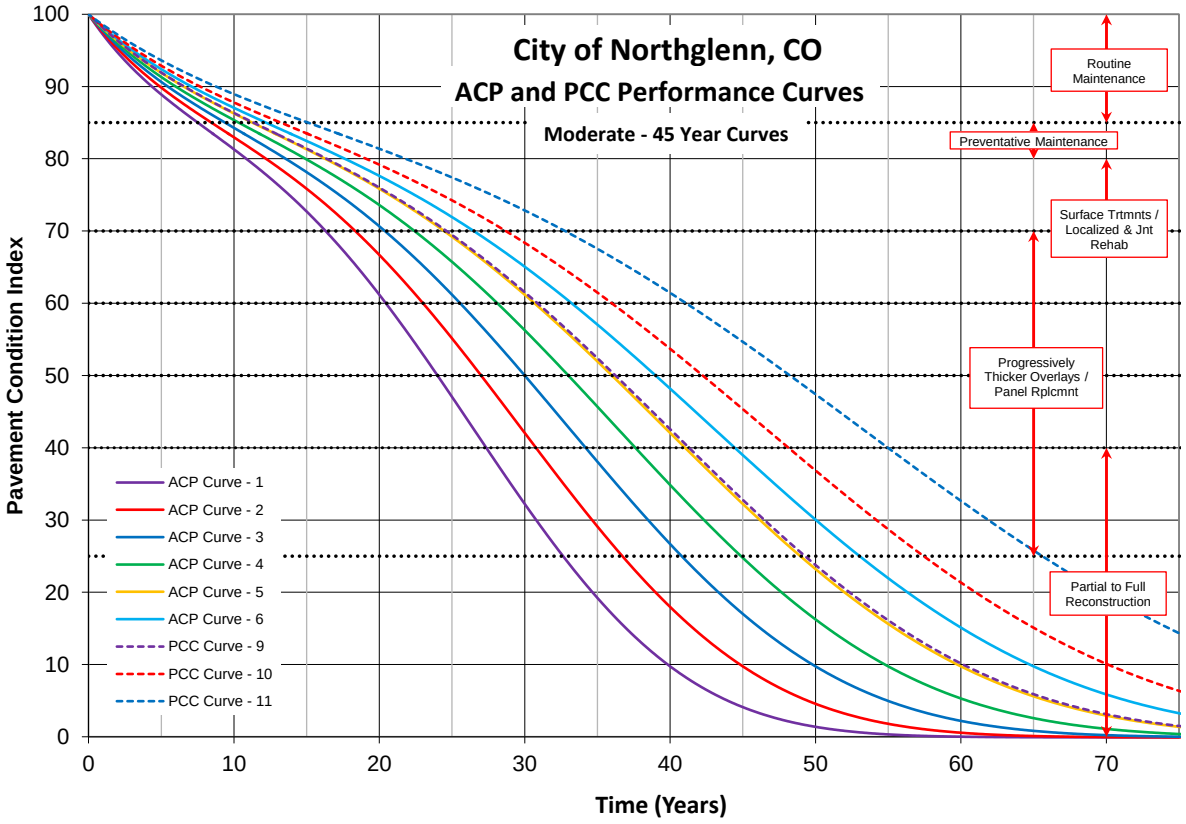


Figure 16 - Performance Curves

5.2 NETWORK BUDGET ANALYSIS MODELS

An analysis containing a total of 10 profile budget runs plus a Do Nothing options was prepared for Northglenn.

The analysis results for Collectors and Locals are summarized below:

- **Do Nothing** (illustrated in Figure 20) – This option identifies the effect of spending no capital for 5 years. After 5 years, this scenario results in a network average PCI drop from a 59 to a 51 and a dramatic increase in backlog to 30%.
- **Client Budget** (Green Line) – this represents the City's current annual budget of $750K annually dedicated to pavement preservation and rehabilitation. This level of funding will result in a network average PCI score of 55 and a backlog increase to 24%.
- **Steady State PCI** – this is simply the funds required to maintain the current network average PCI at a 59. The annual budget required to do so is on the order of $1.63M annually, however backlog (Very Poor & Poor roadways) continues to climb to 17%.
- **Backlog Control Budget** – A budget designed to arrest the growth of backlog to 10%. This budget is also the IMS recommended budget.

The results of the analysis are summarized in **Figure 17** below. The X-axis highlights the annual budget, while the Y-axis plots the 5 Year Post Rehab Network Average PCI value. The diagonal blue line is the results of the pavement analysis (the Northglenn model profile).

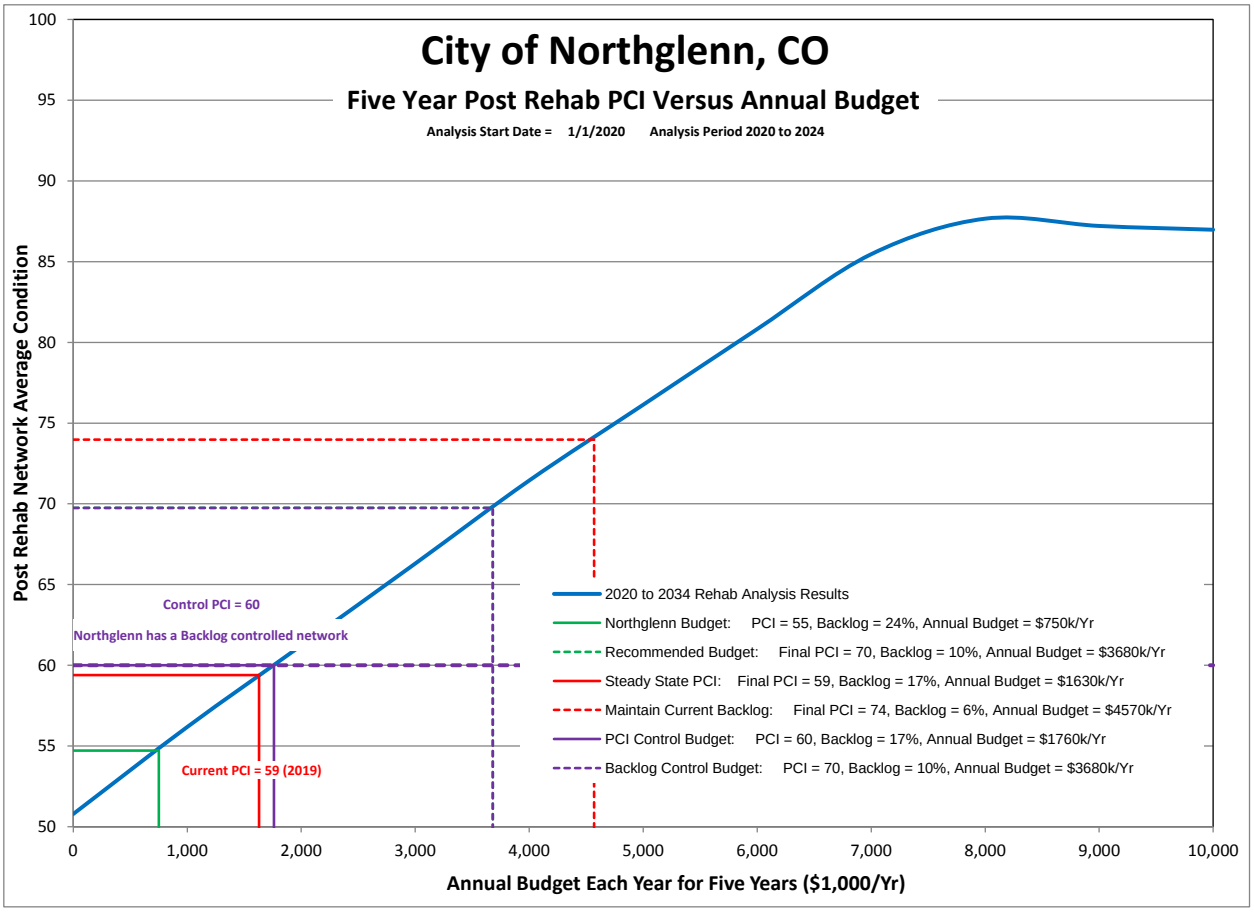


Figure 17 – 5 Year Post Rehab Network PCI Analysis Results

Figure 18 presents the resultant network backlog against annual budget. Similar to Figure 17, but instead of plotting the average PCI score, the blue diagonal line represents the total backlog after 5 years.

The lower the backlog the better, with a maximum of 12% recommended

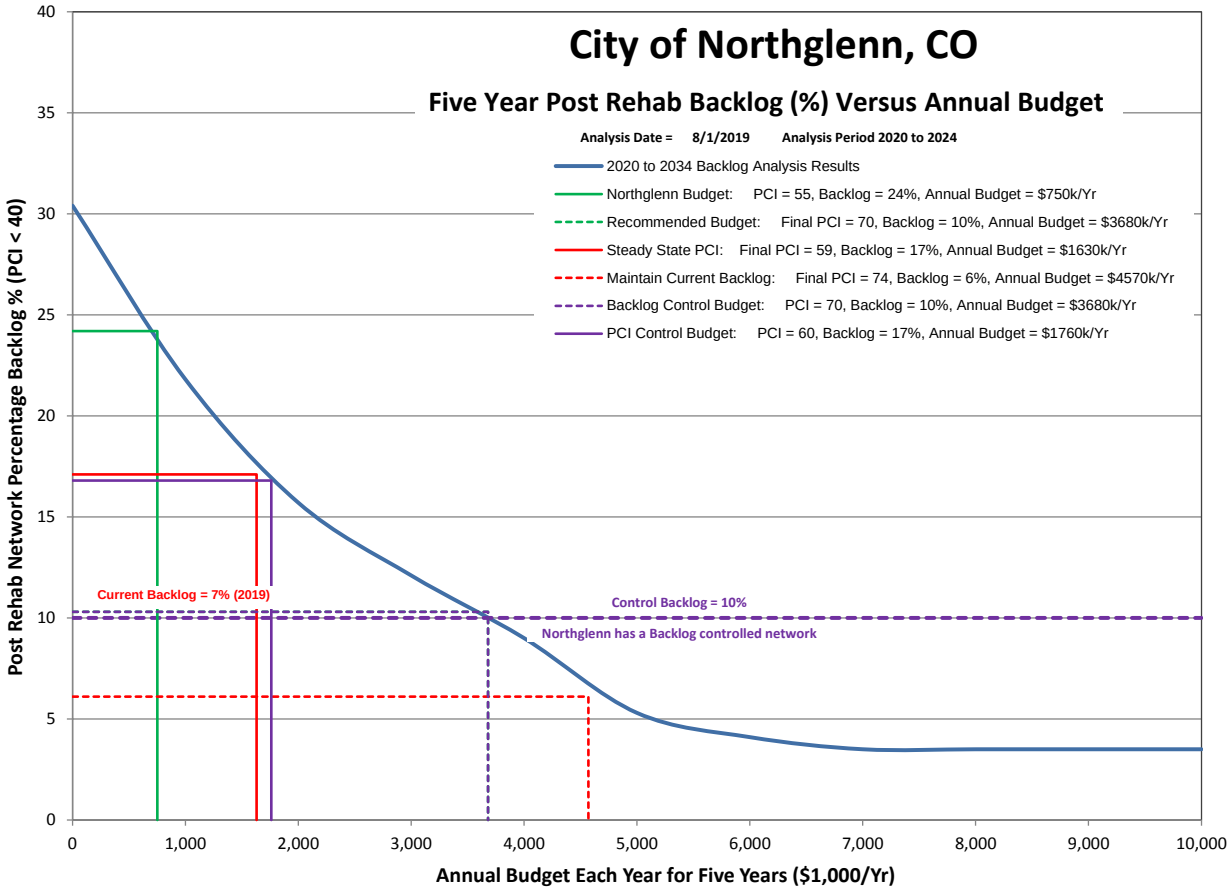


Figure 18 – 5 Year Post Rehab Network Backlog Results

Figure 19 presents the analysis results on an annual basis. This shows that if the budget falls below $1.63M/year (Steady State Budget), over time the overall condition of the roads will deteriorate as backlog continues to grow.

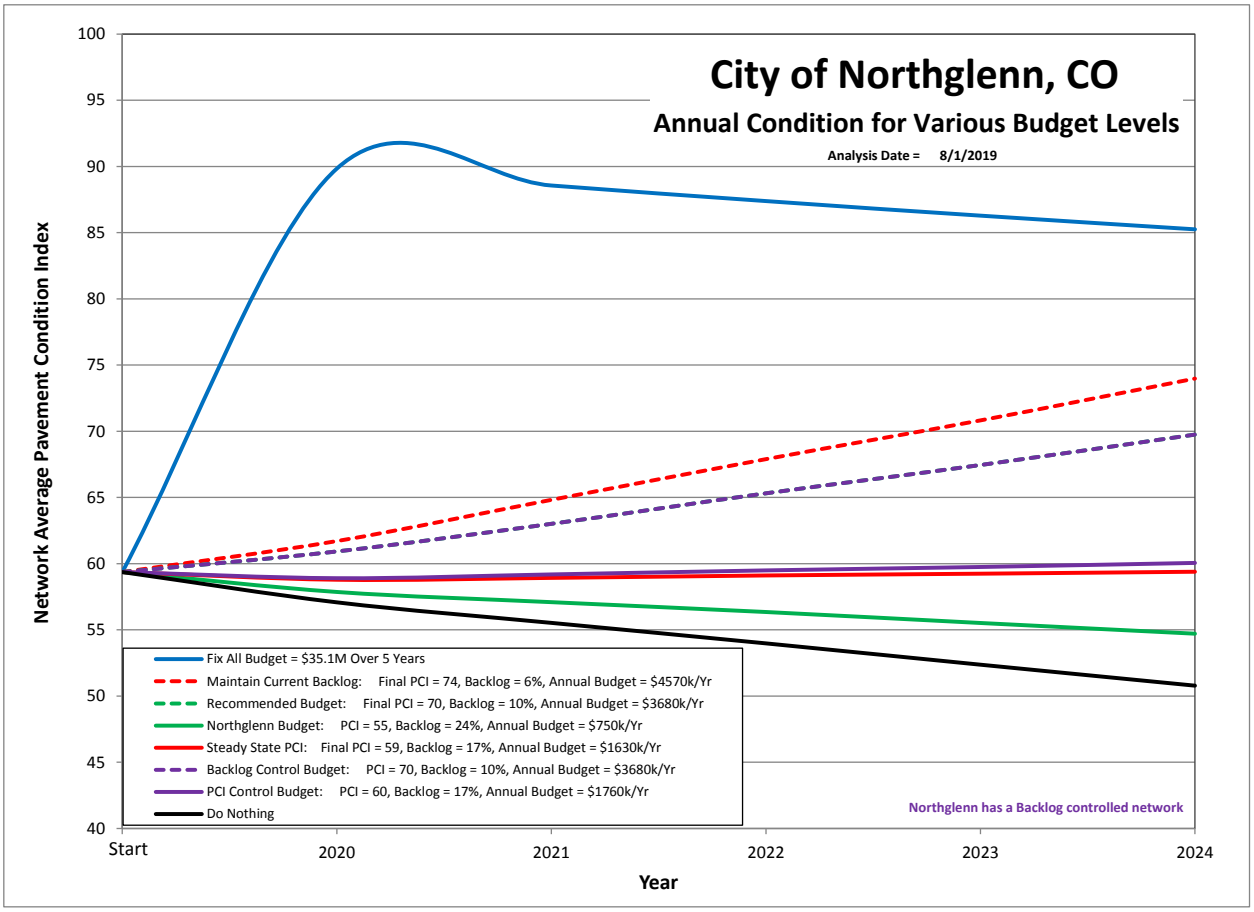


Figure 19– 5 Year Annual PCI

5.3 POST REHABILITATION CONDITION

The following figure (**Figure 20**) compares the current network condition distribution (red) against what the 5-year post rehabilitation distribution would be at with a budget of $750K/year (blue). As can be seen in the plot, the Northglenn budget will reduce the overall network's PCI average and increase the amount of roads in the backlog category.

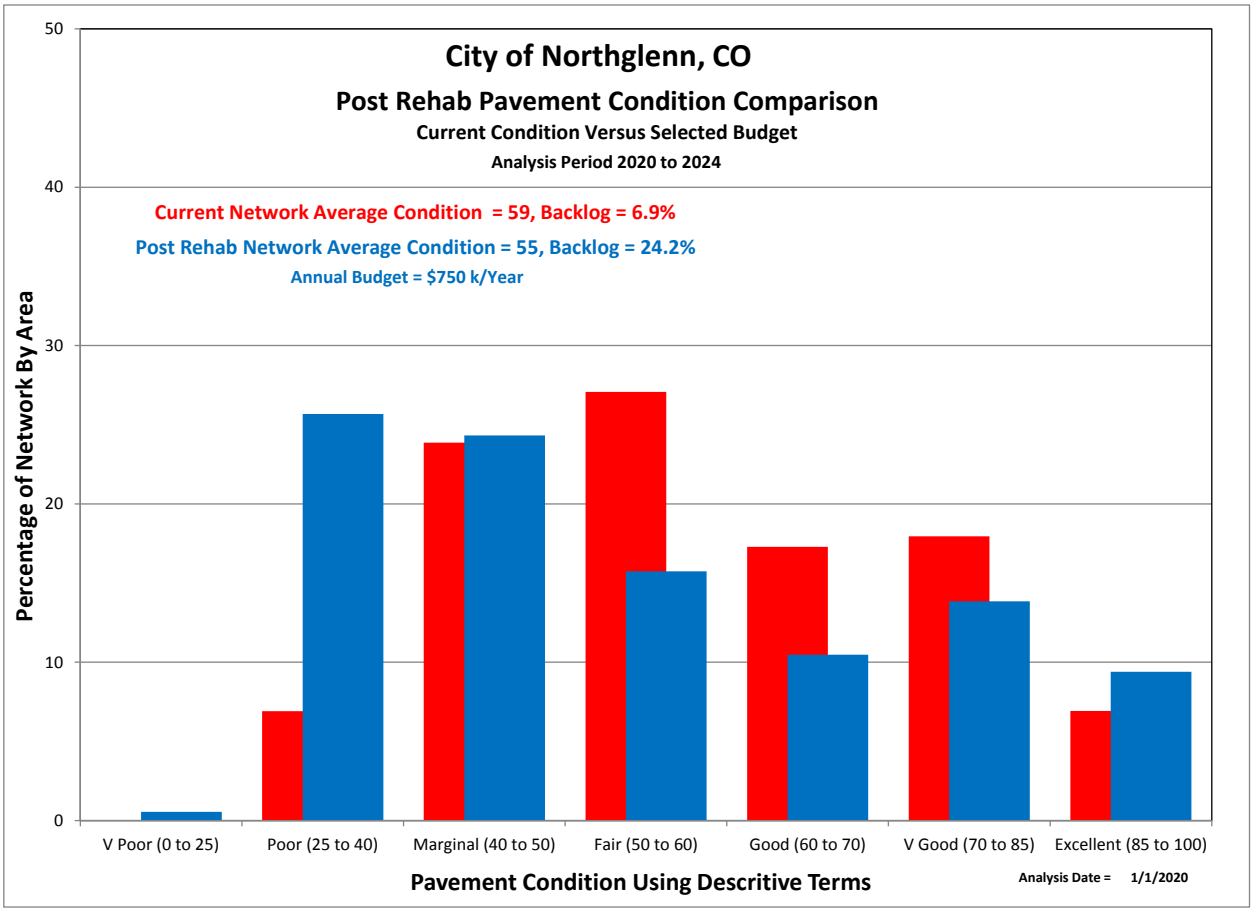


Figure 20 – Five-Year Post Rehabilitation Condition Distribution

Three metrics are used to evaluate the quality of a roadway network, they are:

Average Condition – should be between 60 and 65 at a minimum
Percentage of Backlog – target 12%, should be less than 15%, must be less than 20%
Percentage of Streets Rated as Excellent – should be greater than 15%

Figures 21 and 22 present the current Northglenn recommended budget network rehabilitation plan by year and activity. Electronic versions of these maps are appended to this report.

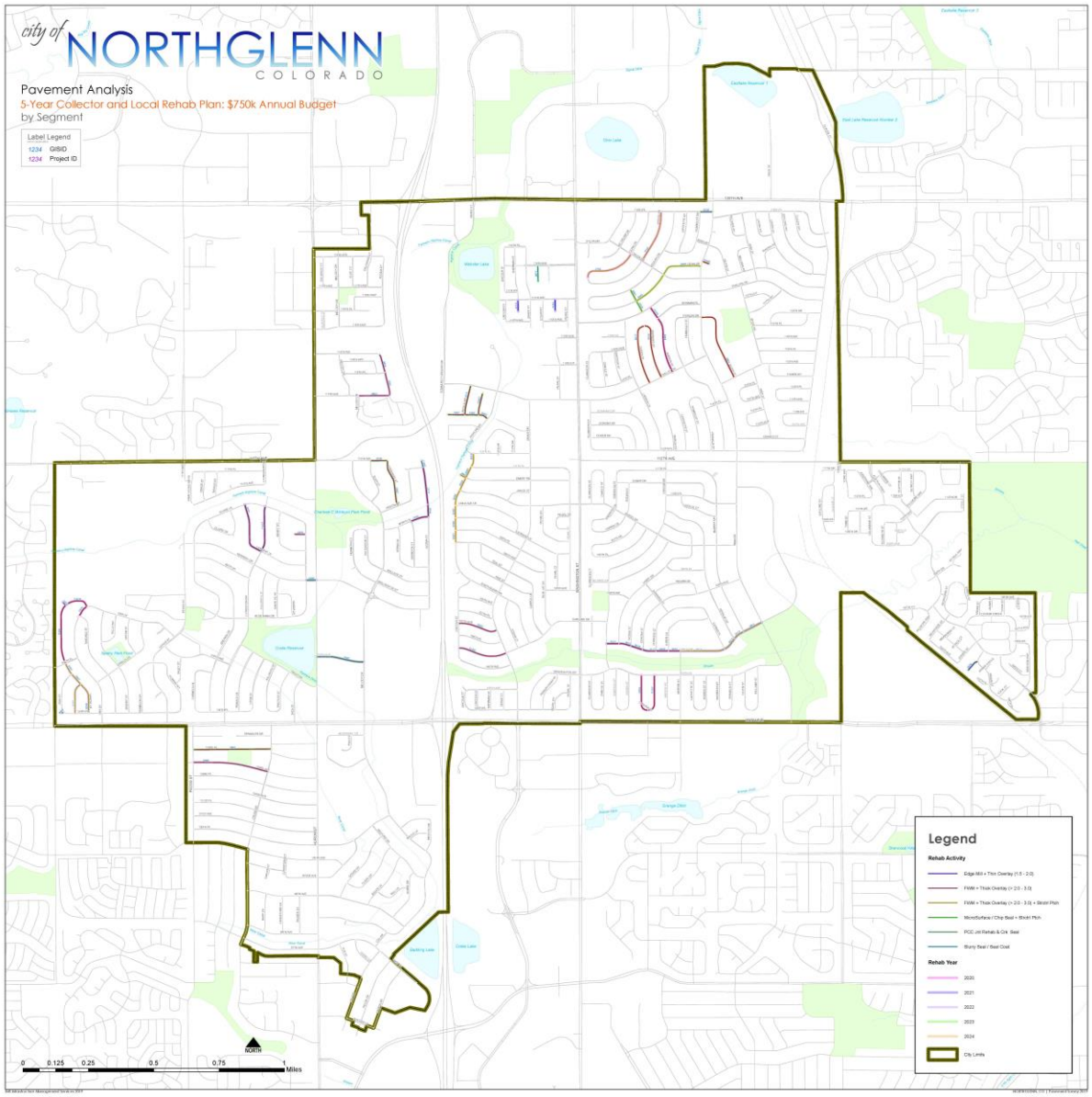


Figure 21 – $750K/Year Rehabilitation Plan by Segment – Collector/Local

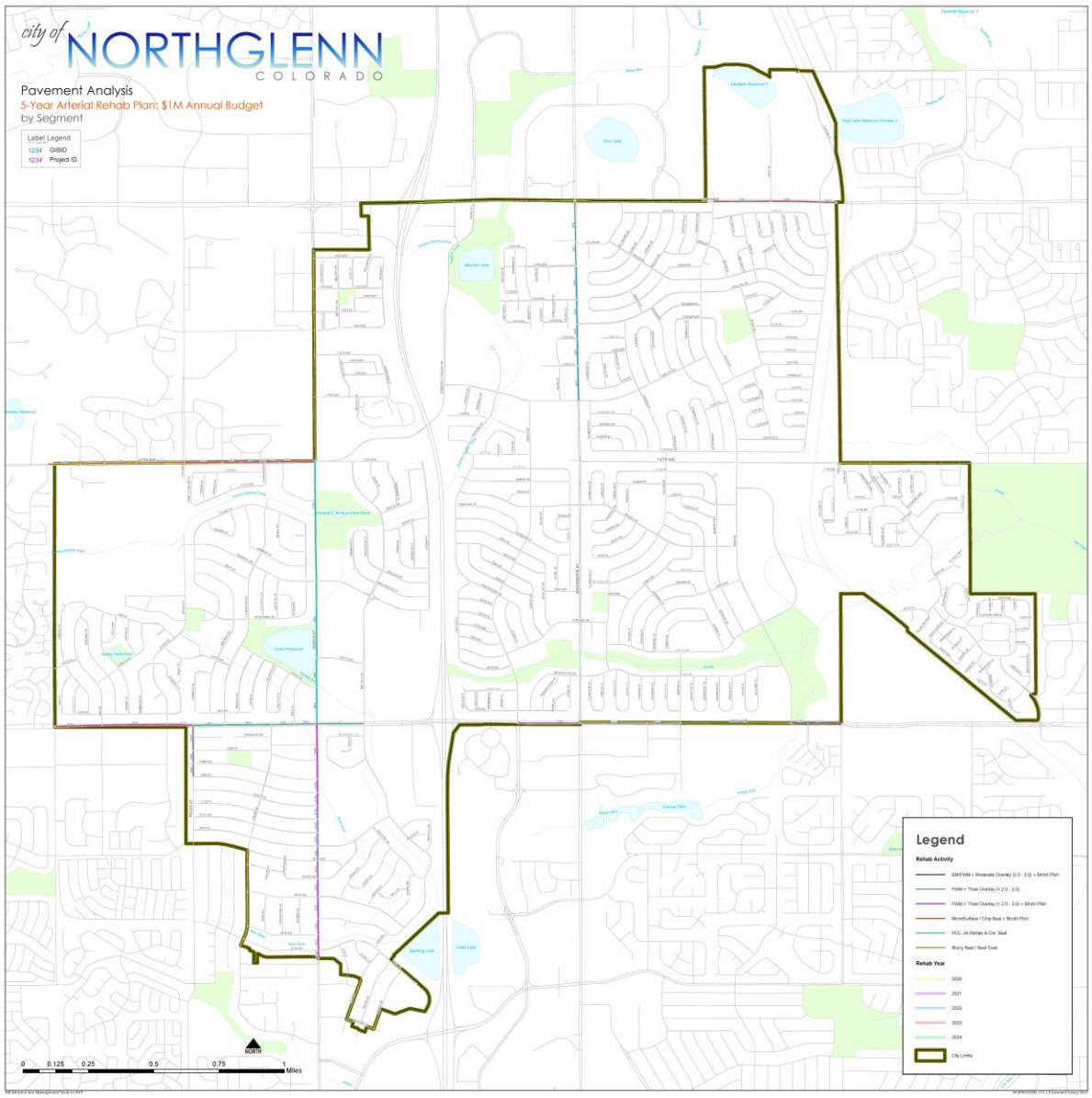


Figure 22 – $1M/Year Rehabilitation Plan by Segment – Arterial

5.5 True Cost of Underfunding of a Roadway Network (Locals/ Collectors)

Funding of roadway rehabilitation is an exercise in identifying the balance between available funding and the desired level of service that is right for each agency. There are no hard rules for what is the definitive level of funding as this is a decision for local elected officials, based on their priorities and practices.

However, the true costs of over and underfunding must be presented in order to provide decision makers with all the information available to base the decisions upon. Northglenn has a considerable investment in their paved roadway network with a combined replacement value (just for the streets, not right of way) exceeding $117M. Spreading this cost over a 50 to 100 year period (the expected ultimate life of a roadway) means that an annual investment on the order of $1.63M per year would be required – not including the cost of maintenance, deterioration ,repair curbing, drainage, tree roots, sidewalks or ADA ramps.

Government Accounting Standards Board Statement 34 requires that agencies who collect taxes (local, business, property or gas taxes) for the purpose of maintaining long term infrastructure assets (such as roads) be good stewards of those assets by either accounting for them financially on the City's balance sheet, or implement a methodology to manage and fund them to a locally defined level of service.

The condition of a roadway network may be equated to equity in a depreciating asset. Regular payments to that asset must be made in order to maintain the equity at a constant level. Should those payments fall short, the equity must eventually be replaced through a large influx of capital in order to make the investment whole again. Roadway networks are no different. Long term underfunding of rehabilitation and maintenance is the direct equivalent of removing equity from an asset – eventually it must be repaid through total reconstruction. The following table compares the real cost of the various budgets against the Do Nothing and Steady State options.

City of Northglenn, CO
Equity Removal Summary

Starting PCI:	59		
Five Year Post Rehab Fix All PCI:	85		
Fix All PCI Increase:	26		
Five Year Fix All Total Cost ($):	35,091,000		
Cost Per PCI Point (Total Cost / PCI Increase, $/pt)	1,356,000		
Equity Removal Based On PCI Restoration			**For PCI Controlled Agencies**
Model:	**Do Nothing**	**$1000k Annual**	**Steady State**
Annual Budget ($k/Year):	0	1000	1630
Starting PCI	59	59	59
Final PCI	51	56	59
PCI Drop:	9	3	0
Cost to Replace Equity (PCI Drop X $/Pt, $):	11,636,000	4,325,000	0
5 Year Budget Expenditure ($):	0	5,000,000	8,150,000
Total 5 Year Cost ($):	11,636,000	9,325,000	8,150,000
Cost Over Steady State Budget ($):	3,486,000	1,175,000	0
Additional Annual Cost Over Steady State ($/year):	**697,200**	**235,000**	**0**

5.6 NETWORK RECOMMENDATIONS AND COMMENTS

The following recommendations are presented to Northglenn as an output from the pavement analysis, and must be read in conjunction with the attached reports.

1. Northglenn should adopt a policy statement to maintain PCI at or above a 70 while keeping backlog below 10%.

   An annual budget of $750K for Collectors and Locals (dedicated to pavement rehabilitation) will achieve a network average PCI of 55 and backlog will be increased to 24%.

   An annual budget of $3.68M for Collectors and Locals will achieve a network average PCI of 70 with the backlog halting at 10%

   An annual budget of $1M for Arterials will achieve a network average PCI of 71 with a backlog growth to 17%

   An annual budget of $1.25M for Arterials will achieve a network average PCI of 76 with a backlog reduction to 8%

2. The full suite of proposed rehabilitation strategies and unit rates should be reviewed annually as these can have considerable effects on the final program.

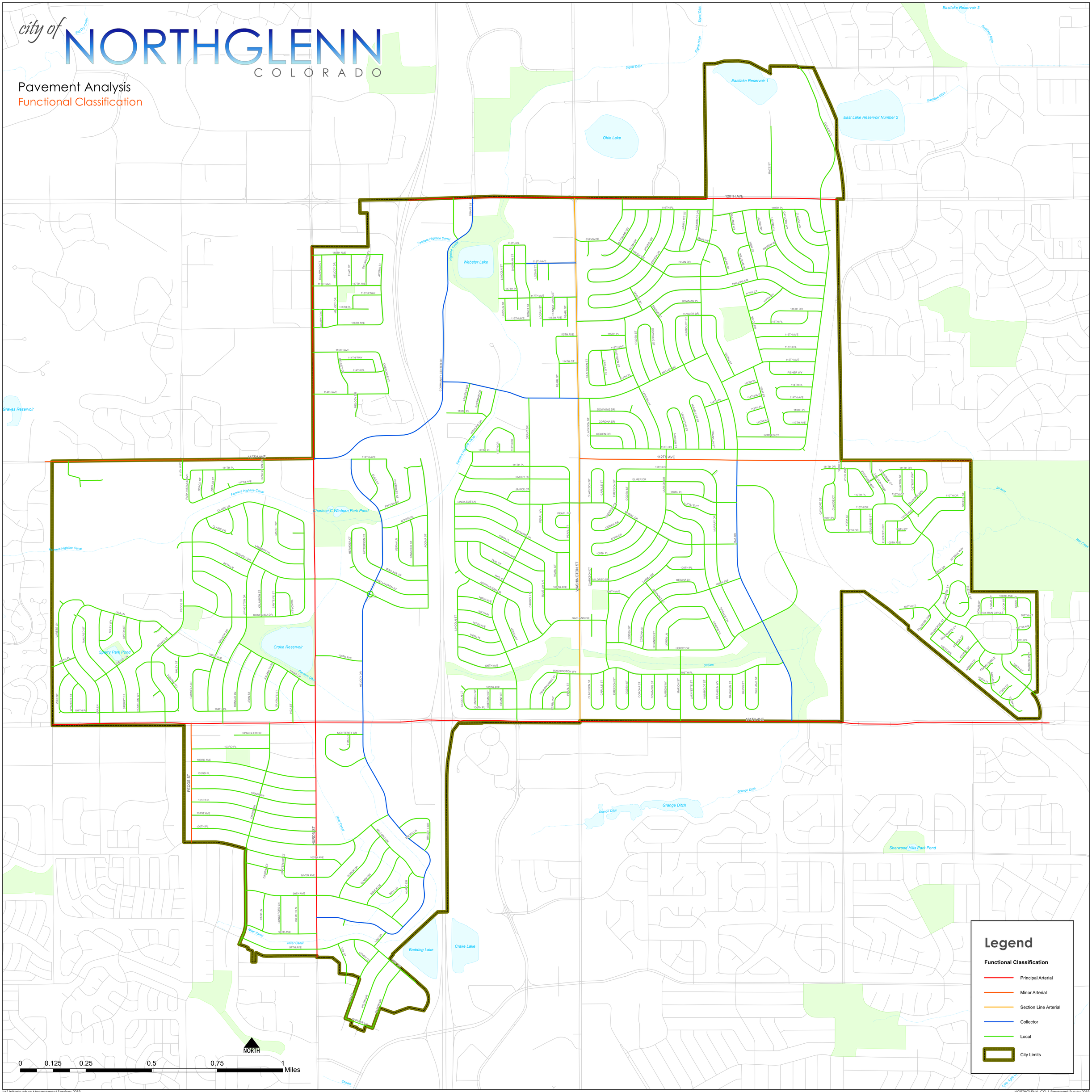
3. No allowance has been made for network growth. As the City expands or increases the amount of paved roads, increased budgets will be required.

4. No allowance has been made for routine maintenance activities such as asphalt crack sealing, pothole filling, sweeping, striping or patching within the budget runs and analysis. These costs are assumed to be outside the pavement management costs.

5. The City should resurvey their streets every few years to update the condition data and rehabilitation program.

city of NORTHGLENN
COLORADO

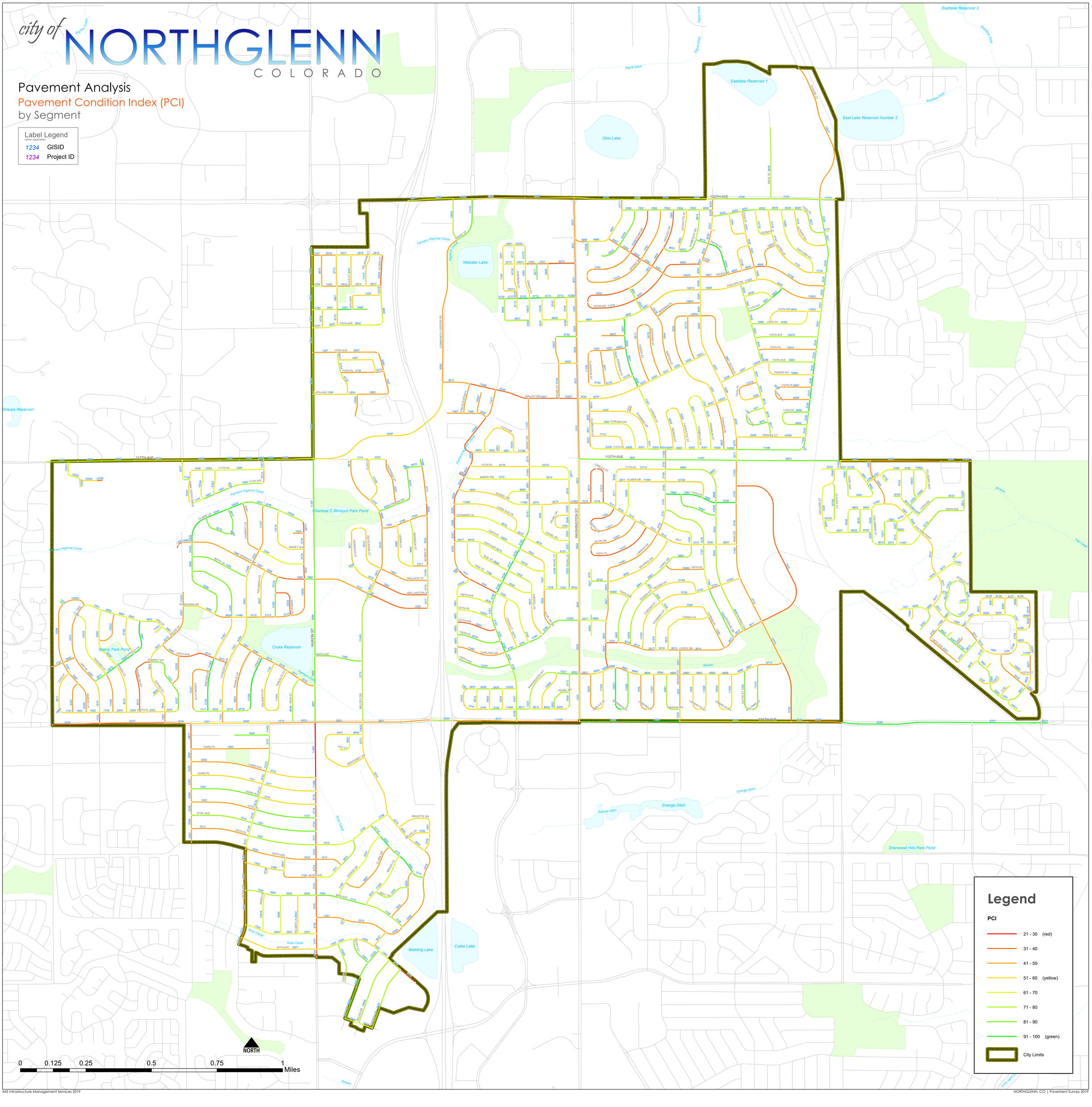
Pavement Analysis
Functional Classification



city of NORTHGLENN
COLORADO

Pavement Analysis
Pavement Condition Index (PCI)
by Segment

Label Legend
(when applicable)
1234 GISID
1234 Project ID



Legend

PCI

- 21 - 30 (red)
- 31 - 40
- 41 - 50
- 51 - 60 (yellow)
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100 (green)
- City Limits

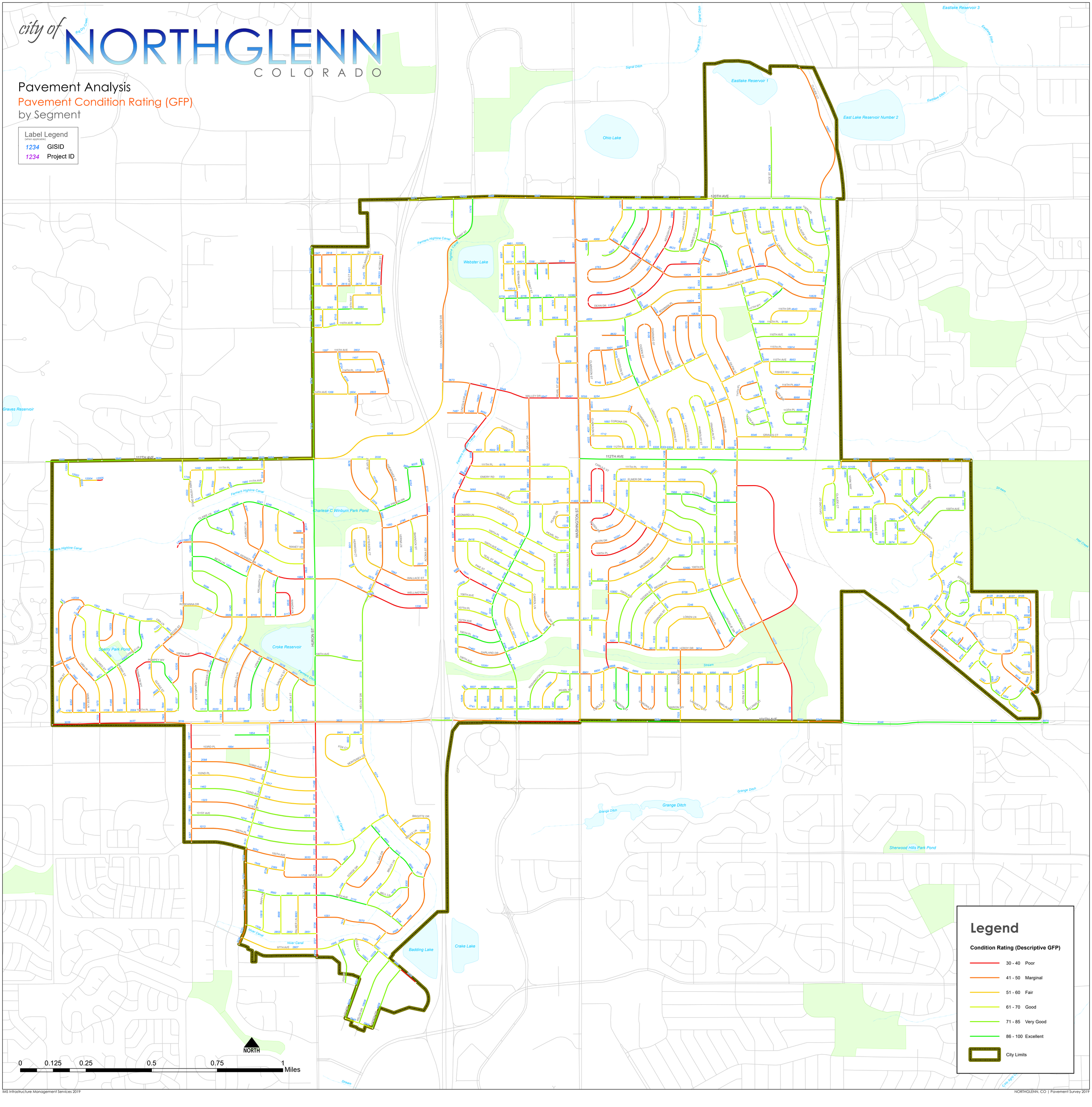
city of NORTHGLENN
COLORADO

Pavement Analysis

Pavement Condition Rating (GFP)

by Segment

Label Legend
(when applicable)
1234 GISID
1234 Project ID



Legend

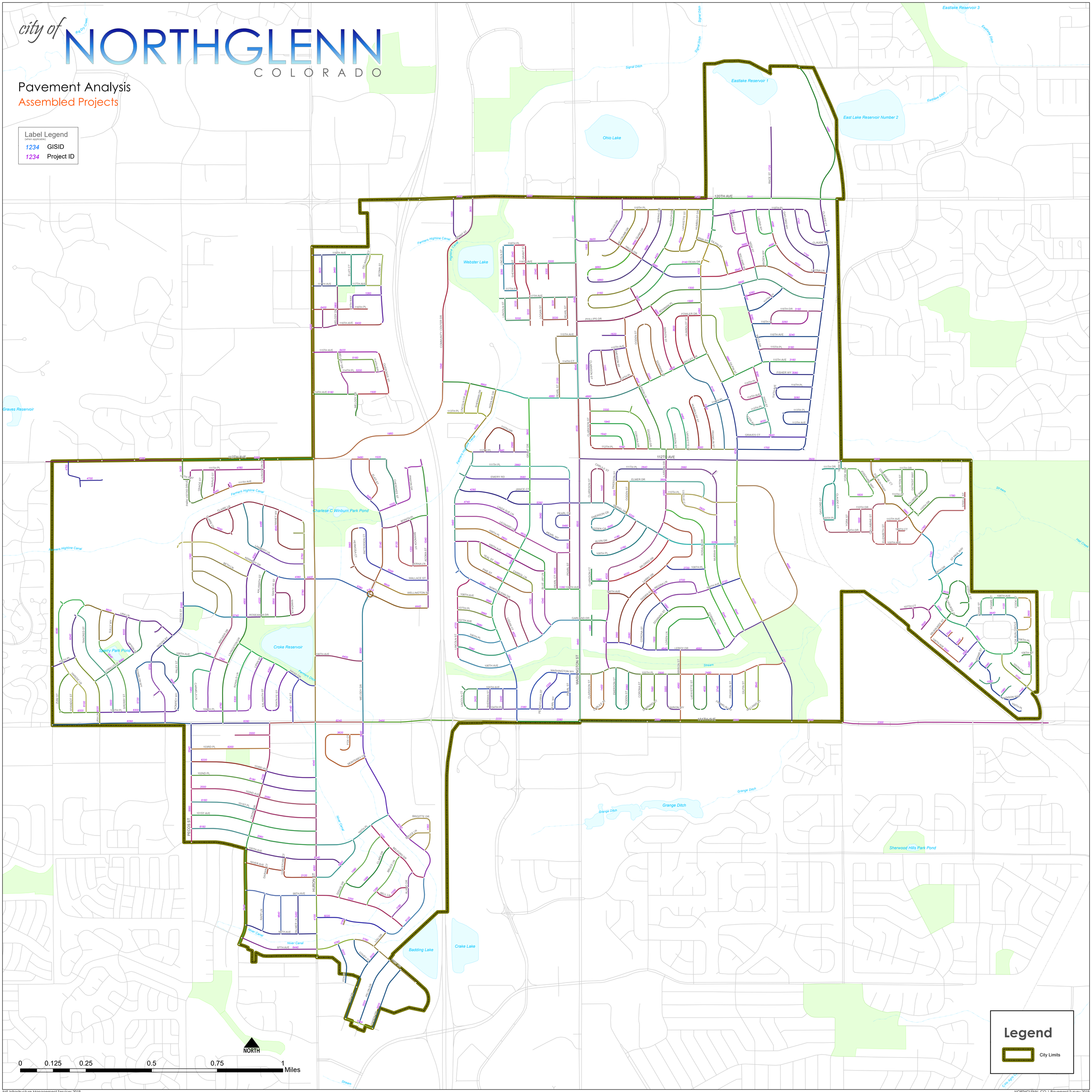
Condition Rating (Descriptive GFP)

- 30 - 40 Poor
- 41 - 50 Marginal
- 51 - 60 Fair
- 61 - 70 Good
- 71 - 85 Very Good
- 86 - 100 Excellent
- City Limits

city of NORTHGLENN
COLORADO

Pavement Analysis
Assembled Projects

Label Legend
(when applicable)
1234 GISID
1234 Project ID



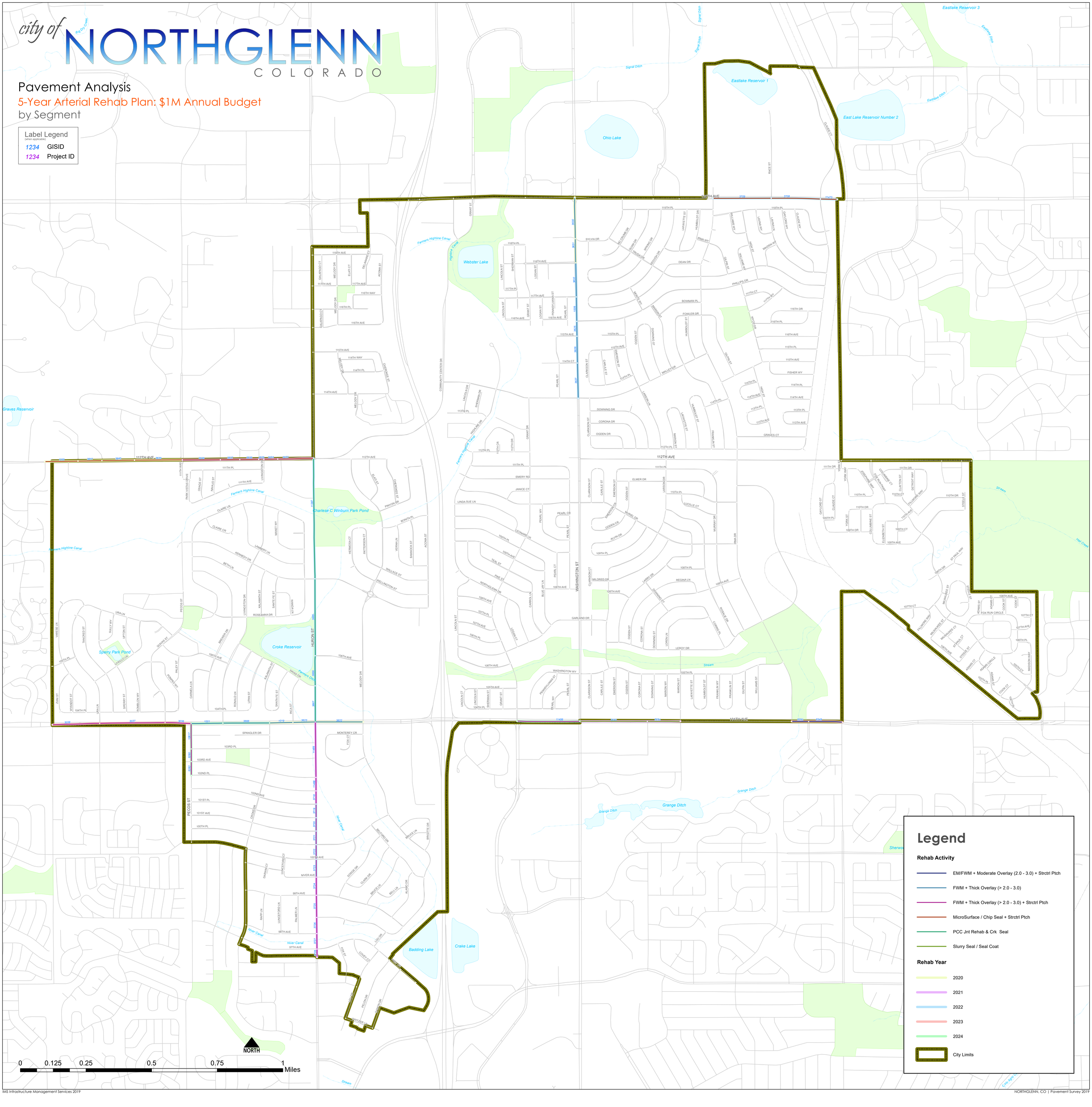
city of NORTHGLENN COLORADO

Pavement Analysis

5-Year Arterial Rehab Plan: $1M Annual Budget

by Segment

Label Legend
(when applicable)
1234 GISID
1234 Project ID



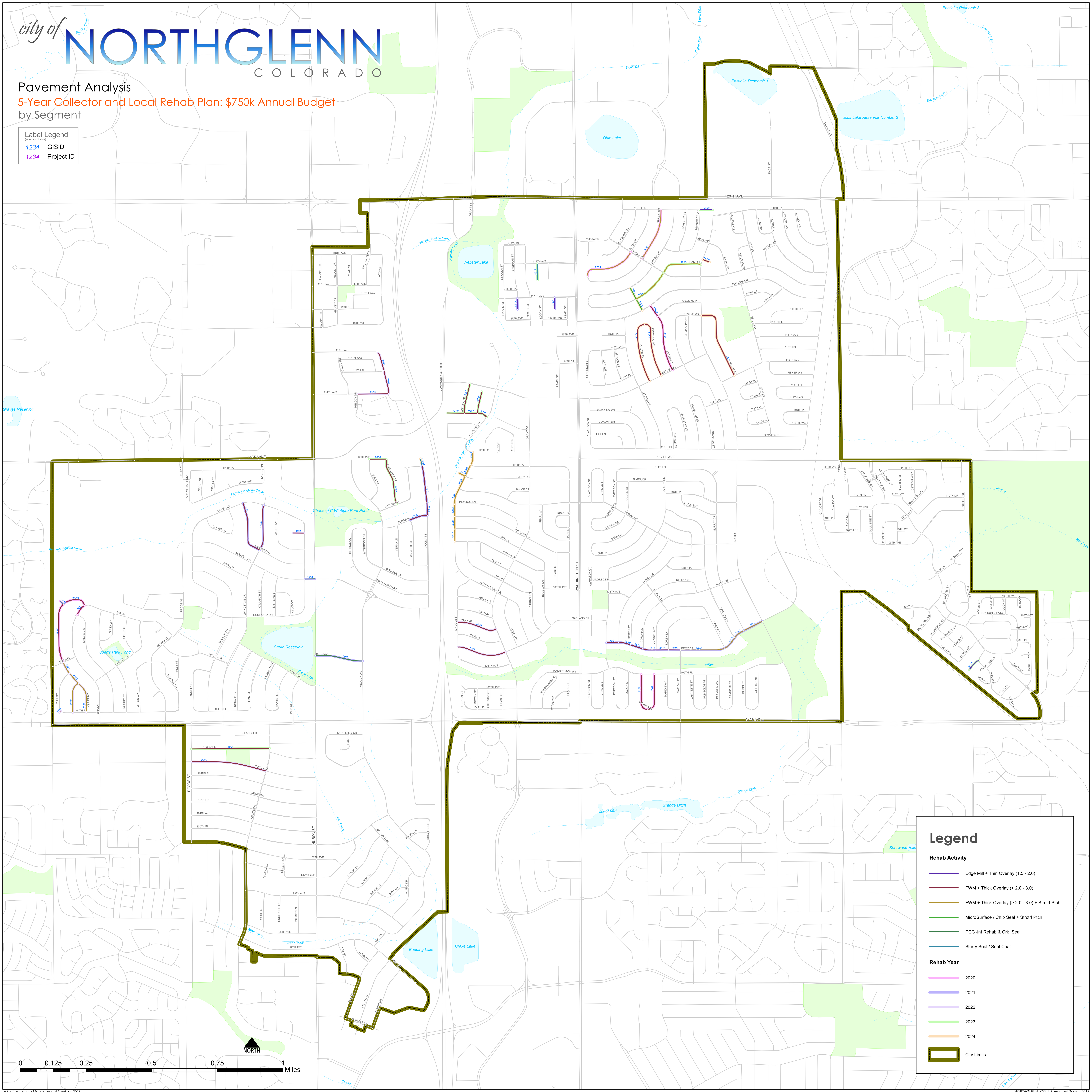
Legend

Rehab Activity

- EM/FWM + Moderate Overlay (2.0 - 3.0) + Strctrl Ptch
- FWM + Thick Overlay (> 2.0 - 3.0)
- FWM + Thick Overlay (> 2.0 - 3.0) + Strctrl Ptch
- MicroSurface / Chip Seal + Strctrl Ptch
- PCC Jnt Rehab & Crk Seal
- Slurry Seal / Seal Coat

Rehab Year

- 2020
- 2021
- 2022
- 2023
- 2024
- City Limits



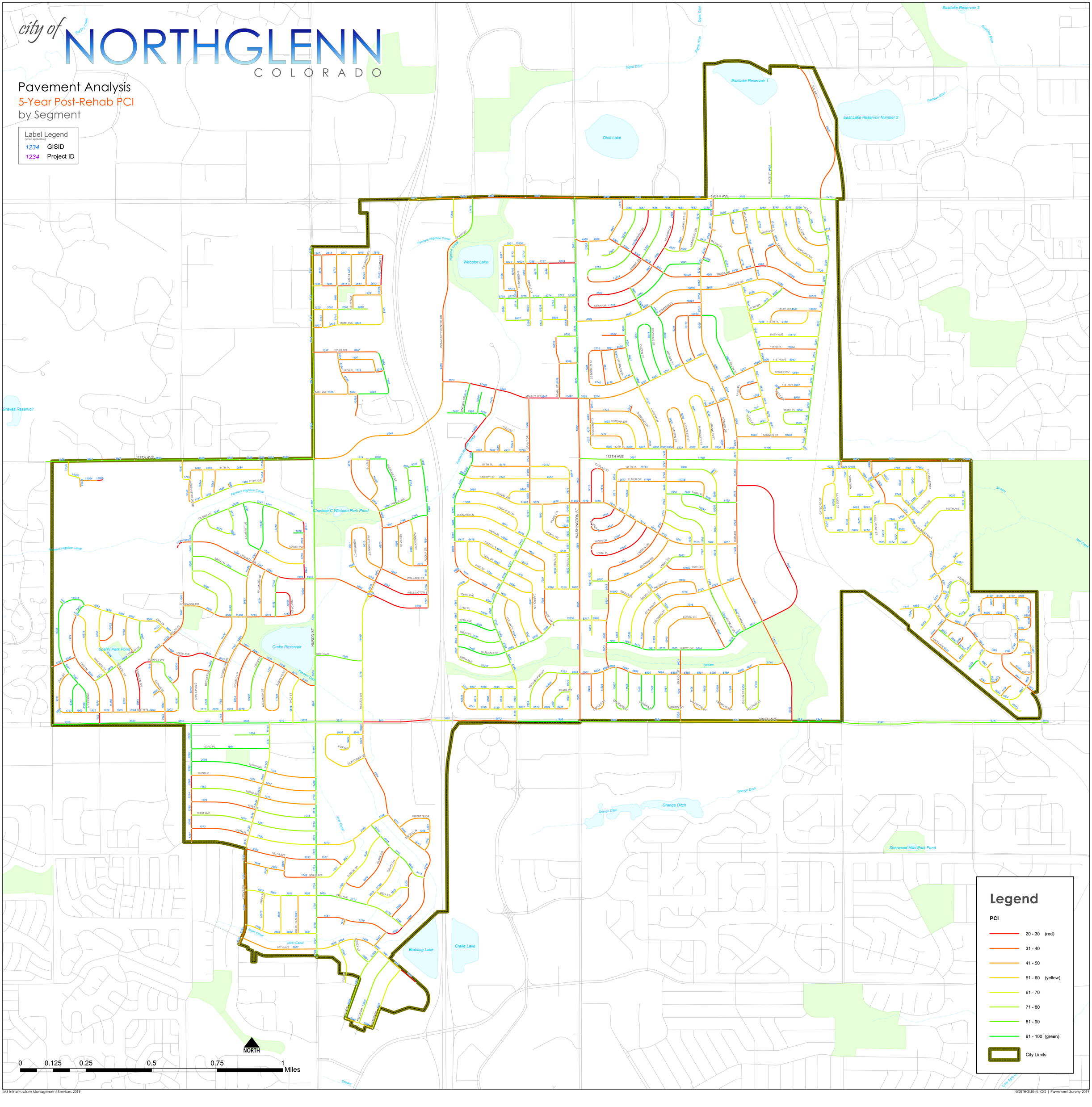
IMS Infrastructure Management Services 2019

NORTHGLENN, CO | Pavement Survey 2019

city of NORTHGLENN
COLORADO

Pavement Analysis
5-Year Post-Rehab PCI
by Segment

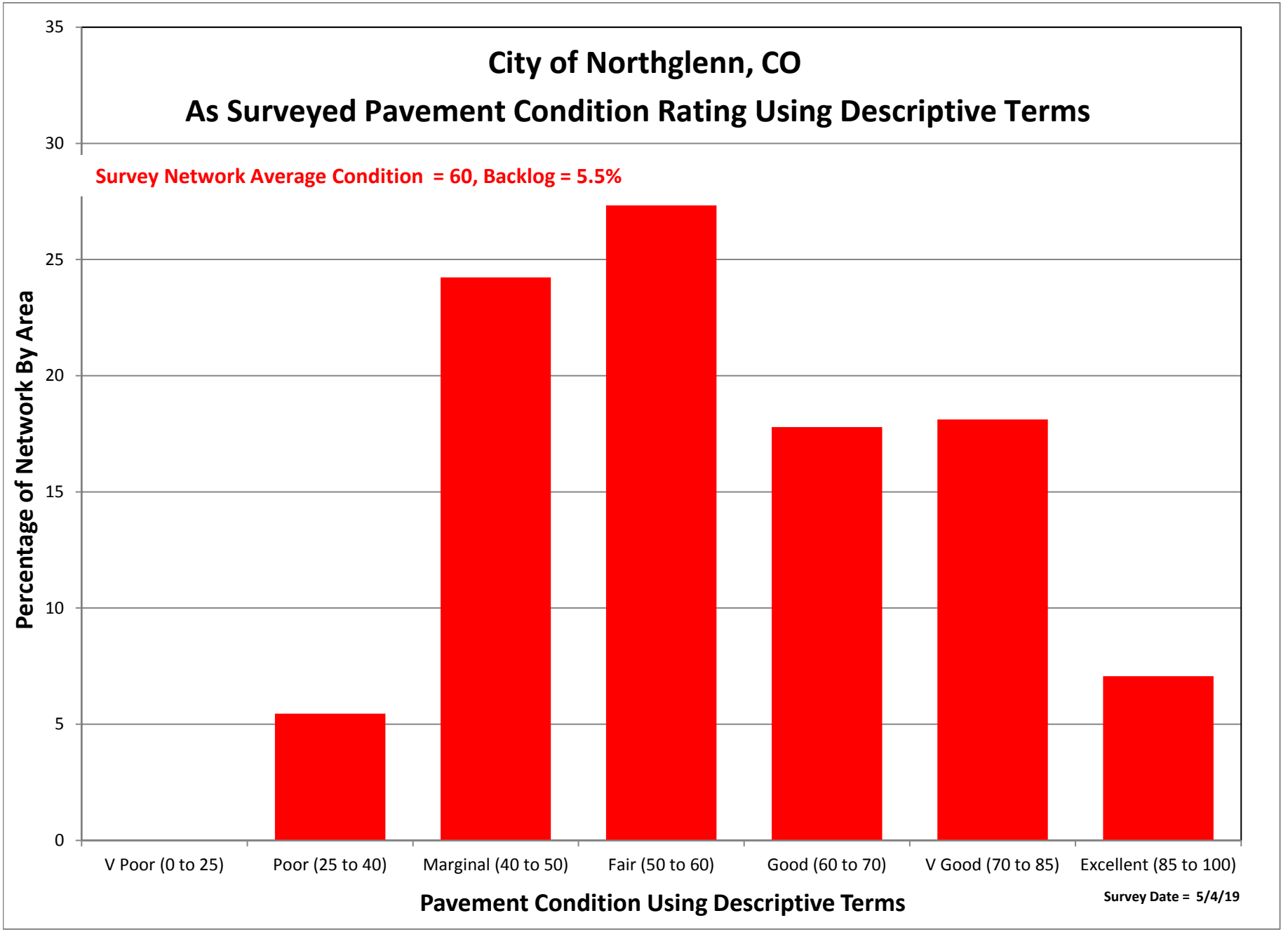
Label Legend
(when applicable)
1234 GISID
1234 Project ID



Legend

PCI

- 20 - 30 (red)
- 31 - 40
- 41 - 50
- 51 - 60 (yellow)
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100 (green)
- City Limits


City of Northglenn, CO
As Surveyed Pavement Condition Rating Using Descriptive Terms
Survey Network Average Condition = 60, Backlog = 5.5%
Percentage of Network By Area
35
30
25
20
15
10
5
0
V Poor (0 to 25)
Poor (25 to 40)
Marginal (40 to 50)
Fair (50 to 60)
Good (60 to 70)
V Good (70 to 85)
Excellent (85 to 100)
Pavement Condition Using Descriptive Terms
Survey Date = 5/4/19

CITY OF Northglenn

2019 Pavement Condition Index (PCI)

Background

- The City is responsible to maintain an average PCI of 70 (Resolution No. 06-92, Series 2006).
- PCI methodology adopted by the City – ASTM D6433.
- PCI is conducted every 3 years ($45k).
- IMS Infrastructure completed 2016 and 2019 PCI using laser technology.
- 2016 PCI ranking was 59.
- Next PCI scheduled for 2022.

2019 PCI Results

- The City's road network is divided in two groups.
  - Collectors and Locals
  - Arterials

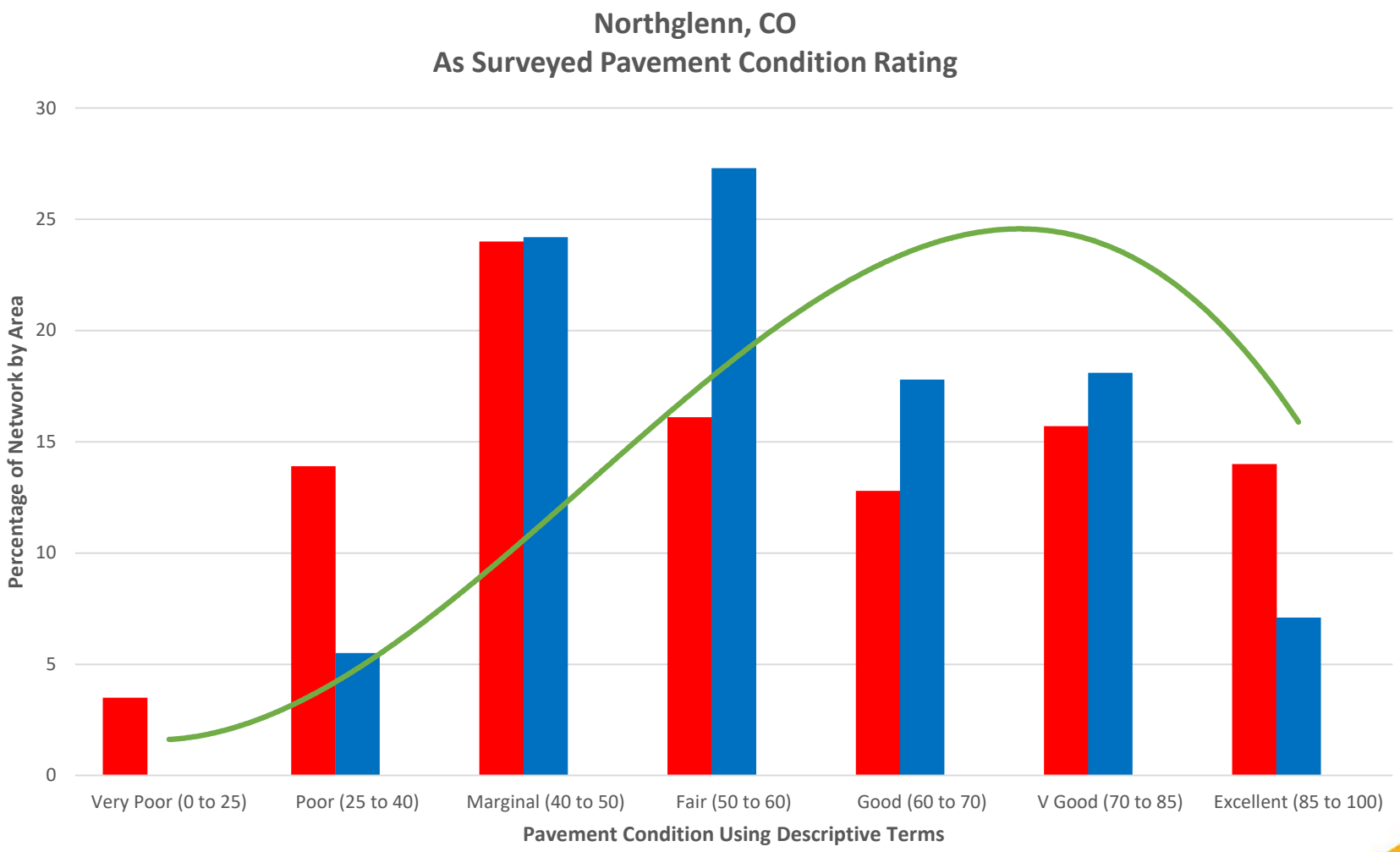
Northglenn Network	PCI (Average 60 to 65)	Percent of Excellent (min. 15%)	Backlog (less than 10%)
Collectors and Locals	60	7%	5.5
Arterials	63	17%	9.5

- Backlog is defined as the percentage of streets with a PCI of 40 or less.
- Percent of Excellent under 15% indicates agency may be struggling to properly fund road network maintenance.
- Generally a very healthy agency will have less than 10% backlog. If backlog reaches 20%, work could become extremely costly.

Condition Rating

Condition	Range	Miles Collectors and Locals (94.6 Total)	Miles Arterials (13.1 Total)	Recommended Treatment
Excellent	85 to 100	6.7	2.4	Crack Sealing
Very Good	70 to 85	17.5	2.7	MicroSurface / Chip Seal
Good	60 to 70	17	1.6	Edge Mill + Thin Overlay or Chip Seal
Fair	50 to 60	25.7	2.2	Edge Mill + Thin Overlay (1.5 -2.0 in)
Marginal	40 to 50	21.5	2.7	Full Width Mill (FWM) + Thick Overlay + Minimal or No Patching
Poor	25 to 40	6.2	1.5	FWM + Thick Overlay (2.0 – 3.0 in) + Possibly Extensive Patching
Very Poor	0 to 25	0	0	Reconstruction

2016 PCI vs. 2019 PCI



Rehab Plan and Investment Impact

- Collectors and Locals (Residential Street Program)
  - Staff proposes the following rehabilitation plan to work towards achieving a 65 PCI rating over the next 5 years.

Year	Budget	Additional Appropriation	Miles	Projected PCI*
2020	$800,000	$2,200,000	7.7	64
2021	$1,250,000**		2.8	64
2022	$1,250,000**		2.6	64
2023	$1,250,000**		2.7	64
2024	$1,250,000**		2.8	64

*Results based on the City's 2019 paving bids, not on IMS estimates

** Future Appropriation

Rehab Plan and Investment Impact

- Arterials
  - Staff proposes the following rehabilitation plan for Arterials.
  - The City is matching $3.8 Million for the 120th Avenue Improvements.

Year	Budget*	Street	From	To	PCI	Treatment
2020	$1,500,000	104th Ave	Zuni St	Huron St	47	FWM + Overlay
2020	$600,000	Huron St	104th Ave	99th Ave		Waterline Replacement
2020	$200,000	Huron St				Stormwater Improvements
2021	$700,000	Huron St	97th Ave	104th Ave	36	FWM + Overlay
2022	$1,200,000	Washington St	112th Ave	120th Ave	45	FWM + Overlay
2023	$1,500,000	104th Ave	Huron St	Washington St	44	FWM + Overlay
2024	$1,100,000	Washington St	104th Ave	112th Ave	62	FWM + Overlay

* Budget numbers based on the City's 2019 paving bids, not on IMS estimates

New Pavement Management Program

Streetlogix is a highly customizable, web-based asset management software that enables municipalities to optimize their road budget within a GIS environment.

- Provides state of infrastructure.
- Makes maintenance and repair recommendations.
- Prioritizes roadway projects.

Pavement Management Program

- Software

https://login.streetlogix.com/

- Story Board

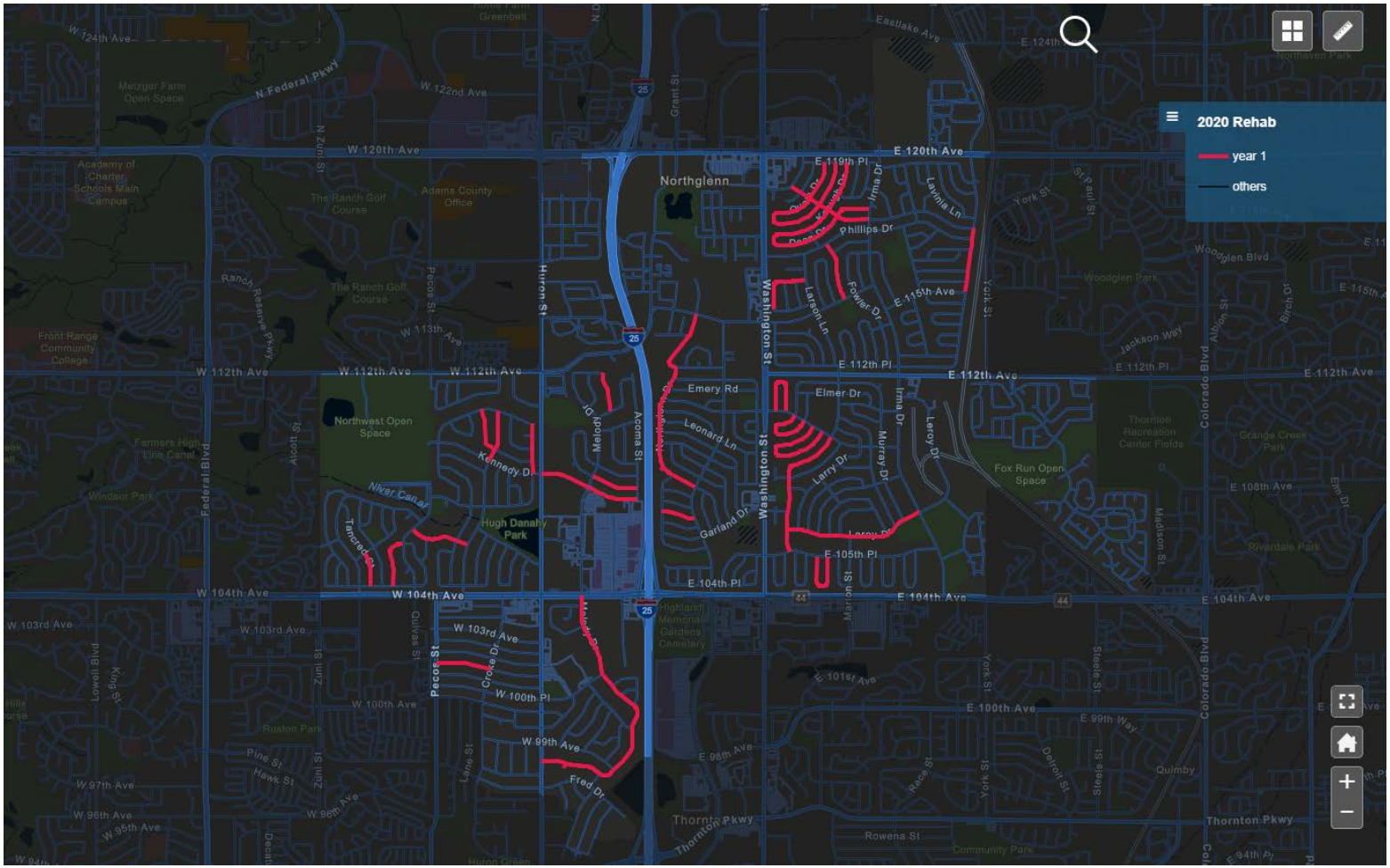
http://t.ly/xNXz5

2020 Rehabilitation Plan

FWM + Thick Overlay			
STREET	FROM	TO	PCI
ALVIN DR	E 109TH PL	MURIEL DR	47
CARLILE ST	MURIEL DR	CLARKSON ST	41
CHEROKEE ST	PINYON DR	112TH AVE	42
CLARKSON ST	E 114TH PL	E 115TH AVE	44
CLARKSON ST	MURIEL DR	CARLILE ST	40
CLAUDE CT	E 115T AVE	TRUDA DR	81
CORONA ST	DOWNING ST	E 105TH PL	43
DEAN DR	KEOUGH DR	IRMA DR	34
DOWNING ST	CORONA ST	E 105TH PL	42
E 107TH AVE	LINCOLN ST	GRANT DR	39
E 109TH PL	ALVIN DR	MURIEL DR	40
E 115TH AVE	CLARKSON ST	LARSON LN	43
EMERSON CR	OGDEN CR	MURIEL DR	37
HIGHLINE DR	E 112TH PL	MALLEY DR	40
KENNEDY DR	HURON ST	ACOMA ST	47
KEOUGH DR	DEAN DR	E 119TH PL	40
LAMBERT LN	LIVINGSTON DR	CLAIRE LN	42

FWM + Thick Overlay			
STREET	FROM	TO	PCI
LARSON DR	E 105TH PL	MURIEL DR	41
LEROY DR	LARSON DR	IRMA DR	40
LIVINGSTON DR	KENNEDY DR	CLAIRE LN	45
MARION ST	PHILLIPS DR	MALLEY DR	42
MELODY DR	HURON ST	104TH AVE	54
NORTHGLEN N DR	E 112TH PL	GRANT DR	39
OGDEN CR	EMERSON CR	MURIEL DR	44
QUAM DR	SPRING DR	E 119TH PL	38
ROMBLON WY	W 104TH PL	QUIVAS ST	39
ROSEANNA DR	KENNEDY DR	CLAIRE LN	38
SPRING DR	QUAM DR	E 119TH PL	42
TANCRED ST	W 104TH PL	UTRILLO LN	45
TRUDA DR	SYLVIA DR	IRMA DR	42
W 101ST PL	PECOS ST	CROKE DR	45
W 106TH AVE	QUIVAS ST	LIVINGSTON DR	41
WELLINGTO N ST	MELODY DR	ACOMA ST	40

2020 Rehabilitation Plan



Cost Analysis

Collector and Local		
Year	Budget	Projected PCI*
2020	$3,000,000	64
2021	$1,250,000	64
2022	$1,250,000	64
2023	$1,250,000	64
2024	$1,250,000	64

Collector, Local and Arterial		
Year	Budget	Projected PCI*
2020	$9,600,000*	64
2021	$1,950,000	64
2022	$2,450,000	65
2023	$2,750,000	66
2024	$2,350,000	66

*Includes 120th Avenue Improvements Match

Current Policy (PCI = 70) Collector and Local		
Year	Budget	Projected PCI*
2020	$5,000,000	67
2021	$1,750,000	68
2022	$1,750,000	68
2023	$1,750,000	69
2024	$1,750,000	70

Current Policy (PCI = 70) Collector and Local		
Year	Budget	Projected PCI*
2020	$7,500,000	70
2021	$1,250,000	70
2022	$1,250,000	70
2023	$1,250,000	70
2024	$1,250,000	70

Staff Recommendations

- Staff recommends a one-time budget increase to $3,000,000 in 2020 to raise the PCI to an estimated 64 ranking for local and collector.
- Staff recommends that the annual budget be increased for the residential street program from the current $800,000/year to $1,250,000/year in order to maintain an average PCI of 64 in 5 years.
- Staff recommends implementation of the Arterials Rehabilitation Plan.
- Staff recommends realigning the PCI policy to a range of Good (PCI 60 to 70).