CITY OF DUNWOODY, GA

2013 Pavement Management Report

January, 2014

Prepared By
David E. Butler P.E.

IMS Infrastructure Management Services
1775 Winnetka Circle, Rolling Meadows, IL 60008
Phone: (847) 506-1500, Fax: (847) 255-2938
www.ims-rst.com

TABLE OF CONTENTS

List of Acronyms and Abbreviations

Abbreviation or Acronym	Definition
$M	Dollars in millions
ACP	Asphalt Concrete Pavement - asphalt streets
ART	Arterial roadway functional classification
ASTM	American Society of Testing Methods
Brk	Break
CAL	Coarse Aggregate Loss
CDV	Corrected Deduct Value
COL	Collector roadway functional classification
Crk	Crack
DeflCON	Deflection Condition - structural load analysis
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
m2	sqaure metre
M	Moderate
MaxDV	Maximum Deduct Value
mi or Mi	Mile
MnART	Minor arterial roadway functional classification
MOD	Moderate
NLAD	Non-load associated distress
OCI	Overall condition index, also known as PCI
Olay	Overlay
PCC	Portland Cement Concrete - concrete streets
PCI	Pavement Condition Index - generic term for OCI
R&R	Remove and replace
Recon	Reconstruction
Rehab	Rehabilitation
RES	Local roadway functional classification - same as LOC
RI or RCI	Roughness Index
S	Strong
SDI	Surface Distress Index
SI	Structural Index
STA	Station or chainage
Surf Trtmt	Surface Treatment
TDV	Total Deduct Value
W	Weak

1.0 PROJECT DESCRIPTION

1.1 PRINCIPLES OF PAVEMENT MANAGEMENT

Nationwide, billions of dollars have been invested in roadway networks by municipal, state and federal governments. Locally, the City of Dunwoody has in excess of 2,444,000 square yards and 145 miles of paved roads. Preservation of existing road and street systems has become a major activity for all levels of government. There is a shortage of funds to maintain street systems at the state and local government levels. Funds that have been designated for pavements must therefore be used as effectively as possible. One proven method to obtain maximum value of available funds is through the use of a pavement management program. The PavePRO pavement management system was used for the analysis for the City of Dunwoody. Pavement management is the process of planning, budgeting, funding, designing, constructing, monitoring, evaluating, maintaining, and rehabilitating the pavement network to provide maximum benefits for available funds. A pavement management system is a set of tools or methods that assists decision makers in finding optimum strategies for providing and maintaining pavements in a serviceable condition over a given time period.

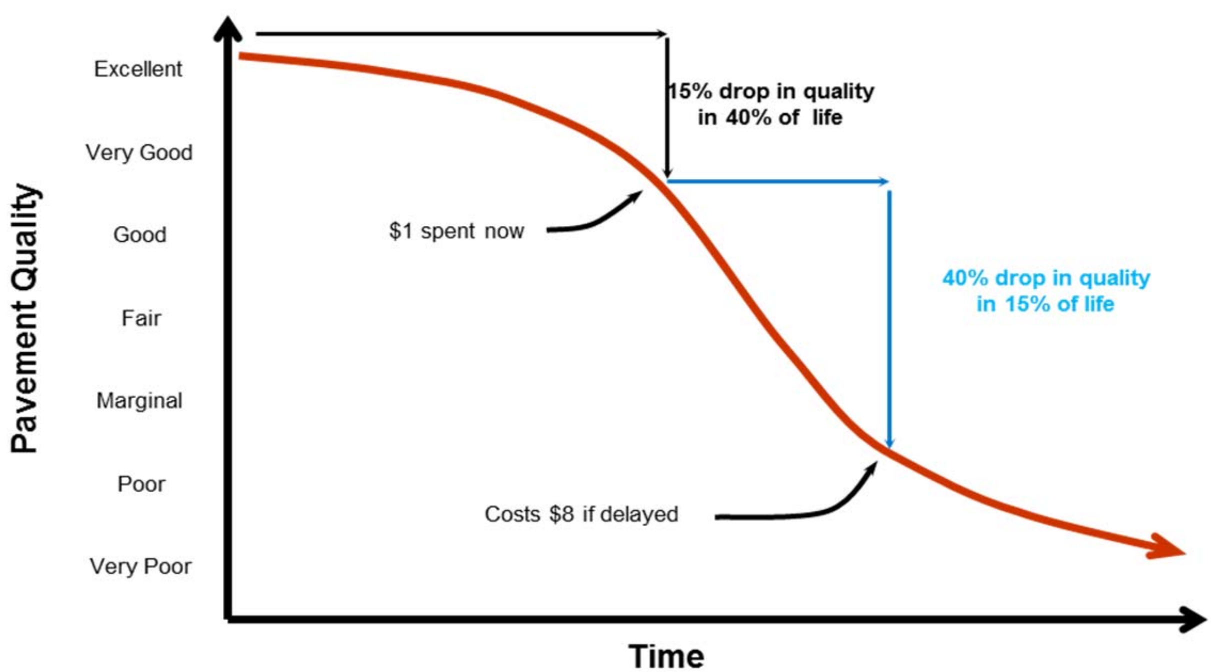

Figure 1 – Pavement Deterioration and Life Cycle Costs

As shown in Figure 1, streets that are repaired when they are in a good condition will cost less over their lifetime than streets that are allowed to deteriorate to a poor condition. Without an adequate routine pavement repair program, streets require more frequent reconstruction, thereby costing millions of extra dollars.

Over time pavement quality drops, until the pavement condition becomes unacceptable. The condition of each street is dependent on many factors – foremost of which are the strength or the roadway structure and traffic loading. 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 1, 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 reconstruction is required just a few years later.

Once implemented, an effective pavement management system can assist agencies in developing long-term rehabilitation programs and budgets. The key is to develop policies and practices that follow the pavement life cycle curve to 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 steep part of its deterioration curve, apply a remedy that extends the pavement life - at a minimum cost, thereby avoiding costly reconstruction. Thus, the goal of a pavement management system is to identify the optimal level of funding, timing, and renewal strategy agencies should adopt to keep their roadway network at a satisfactory level of service. Figure 2 illustrates the concept of extending pavement life through the application of timely rehabilitation activities.

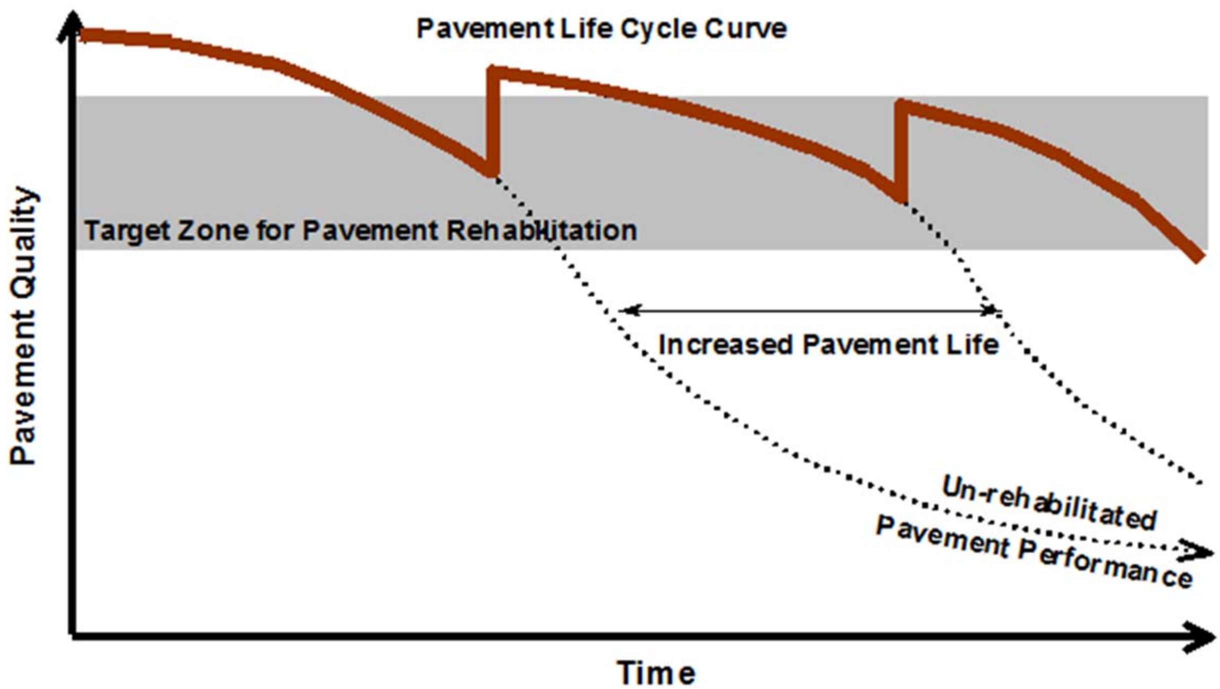

Figure 3 – Pavement Life Cycle Curve

Other functions of a pavement management system include:

- Provide a means to store an accurate inventory of all streets owned and or managed by the agency. An up to date inventory is a crucial foundation to a pavement management information system.
- Provide a means to store roadway and construction history including the year of rehabilitation, pre-rehab pavement condition, costs and activities.
- Assess the effectiveness of maintenance and rehabilitation strategies and new technologies.
- Provide a means to store digital images to provide a visual record of each roadway and its characteristics.

- Act as a central registry of the roadway network that can then be distributed to other utilities to provide a linkage between all right of way assets.

1.2 THE PURPOSE OF PAVEMENT MANAGEMENT

Agencies implement pavement management systems for a variety of reasons:

- The agency desires to use analytical tools and technologies to more effectively manage their assets. This need often comes to the forefront due to rapidly increased costs and rapidly deteriorating pavements.
- In some cases a pavement management system is required in order to qualify for various types of funding.
- The Governmental Accounting Standards Board (GASB) Statement 34 now requires agencies that collect taxes for the purpose of managing a long-term, fixed infrastructure assets to either:
  - Option #1 *(Standard Method)* - Implement financial-accounting controls to effectively depreciate and plan for replacement of fixed assets, or,
  - Option #2 *(Modified Method)* - Implement an asset management system that provides a mechanism to gauge and budget for the long-term rehabilitation/maintenance of an asset.

The study completed on the City's roadway network may be used as the basis for achieving their GASB 34 compliance. In the case of Option #1, this study may be used as the basis for the inventory and valuation of the roadway network. For Option #2, once implemented the study recommendations may form the core of the GASB 34 compliance.

1.3 THE PAVEMENT MANAGEMENT PROCESS

The actual pavement management process involves three unique, but important steps, and is presented graphically in Figure 4. Each activity builds on the previous, until the end result is a prioritized paving and rehabilitation program.

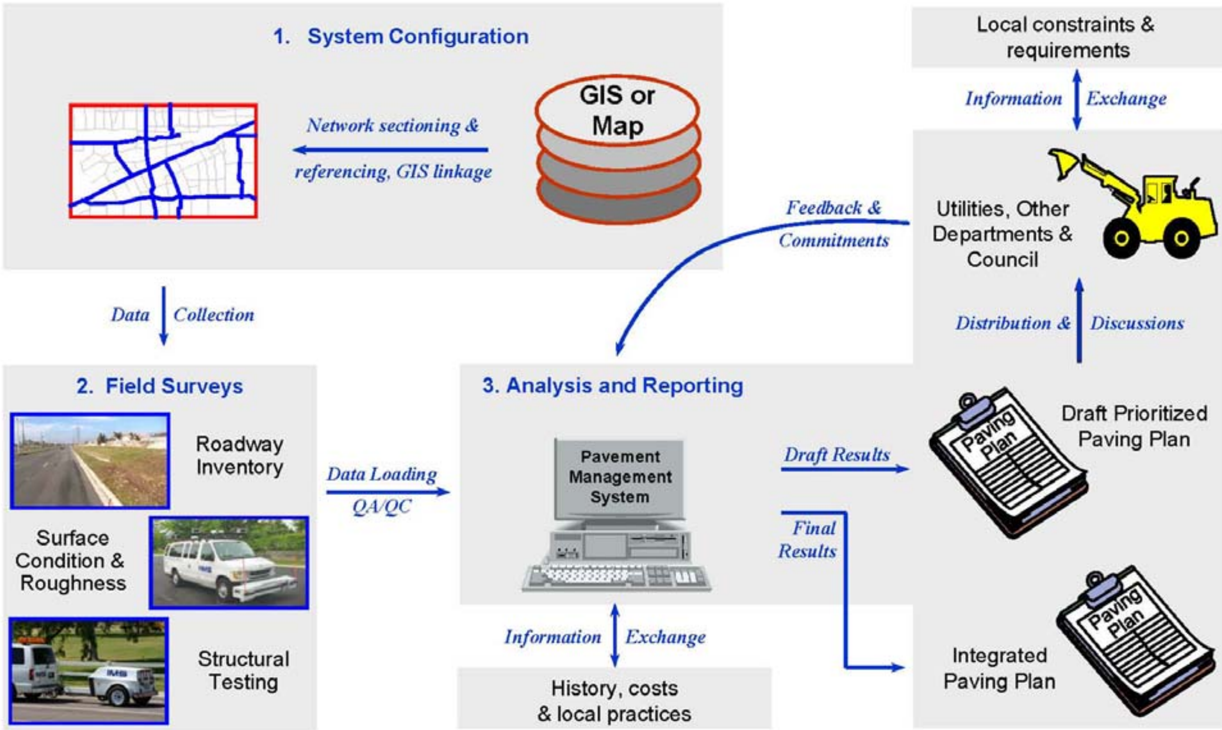

Figure 4 - The Pavement Management Process

The three steps are as follows;

1. **System Configuration** – this step involves identifying all roadways in the City's network, assigning them a unique identifier, listing their physical characteristics (length, width etc,) and demographic attributes (pavement type, traffic, climatic condition), and linking the network to a Geographic Information System (GIS).

2. **Field Surveys** – following a set of pre-defined assessment protocols, each roadway in the network is surveyed in order to develop a pavement condition rating or score. The following evaluation criteria are being used for the paved roadway network:

   - Roughness – a qualitative score is used to quantify the smoothness of a roadway. Roughness is measured following the industry standard "International Roughness Index" (IRI). It is an open-ended score that measures the vehicular response to traveled surface roughness and reports the value as inches/mile.
   - Rutting – measurement of wheel path rut depths by severity and length. Rut depth is a concern for two reasons – if there is insufficient cross slope, they can hold water and thus cause vehicle control problems. They also identify areas of loss of base structural strength.

- Crack Condition – used to qualify and quantify the level of cracking displayed by the road. Crack Condition consists of transverse cracking, longitudinal cracking, block cracking, and edge cracking along with other distresses. It is considered to be an important distress group in assessing the overall structural and surface condition.

All data is being collected and summarized on a block-by-block basis. Confirmation of pavement type, assessment of drainage and shoulder conditions, GPS coordinates, and digital images are also being collected as part of the field surveys.

3. **Analysis & Reporting** – Data analysis establishes the pavement condition scores. It will be completed in four separate processes as follows:

Step 1 – the results of the surface condition field surveys are being processed for loading into the pavement management software. The software uses a Cracking Condition Score, Rutting Condition Score, and a Roughness Condition Score. The Cracking Condition Score originates from the severity & extent data collected for pavement cracking and is based on a 10 to 100 scale. The Rutting Condition Score originates from the severity & extent data collected for the pavement rutting and is also based on a 10 to 100 scale. The Roughness Condition Score is an index based on the IRI value collected for the pavement and is based on a 10 to 100 scale.

Step 2 – The Cracking Condition Score, Rutting Condition Score, and Roughness Condition Score are combined to generate the Surface Condition Score using 60% of the Cracking Condition Score, 25% of the Rutting Condition Score, and 15% Roughness Condition Score.

Step 3 – In some cases, results obtained from the structural pavement assessment using either a falling weight deflectometer or a dynaflect are linked to each pavement section. The structural analysis is dependent on the traffic loading that each pavement supports, thus necessitating traffic counts percentages, including heavy trucks, for each roadway. Structural testing was not part of the 2013 testing.

Step 4 – In order to generate the Pavement Condition Index, external factors such as drainage, shoulder condition, and climate are subtracted from the Surface Condition Score. These external factors remove a maximum of fifteen points from the Surface Condition Score.

The analysis is then completed using a either a level of service based or approach in which the user specifies a target condition average and the software identifies the required budget, or a budget based approach in which fixed annual budgets are input and the software selects the streets to be rehabilitated.

Options for prioritization of candidates can be based on worst first or can include additional factors such as functional class or traffic.

1.4 PAVEMENT SURFACE CONDITION SURVEY

Acquiring and processing input information is the foundation of pavement management. The City of Dunwoody pavement performance data was collected using a Road Surface Tester to obtain continuous surface condition, rutting, roughness, GPS and digital image data on each of the segments of this project.

Pavement distresses that were included in the survey for asphalt roadways are as follows:

Distress	Description
Roughness	International Roughness Index based score – an assessment of the riding comfort of the roadway converted to a 0 to 100 score. Roughness makes up 1/3 of the overall condition score.
Transverse Profile	Measurement of the average of rut depths along with 2 critical thresholds.
Transverse Cracking	Measurement of transverse cracks quantified by 5 width and 2 depth categories.
Longitudinal Cracking	Measurement of extent and severity of longitudinally oriented cracks.
Alligator Cracking	Measurement of extent and severity of load associated fatigue cracking.
Block Cracking	Measurement of the presence of non-load associated block/map cracking.
Edge Cracking	An assessment of the cracks along the roadway edge.
Miscellaneous Distresses	An assessment of the any other distress not identified above such as distortion, bleeding, delamination, scaling, unfilled potholes etc.

1.5 UNDERSTANDING THE PAVEMENT CONDITION SCORE

The following illustration compares Pavement Condition Index to commonly used descriptive terms. The divisions between the descriptive terms are not fixed and may vary between functional class and pavement type. They are meant to reflect common perceptions of roadway condition.

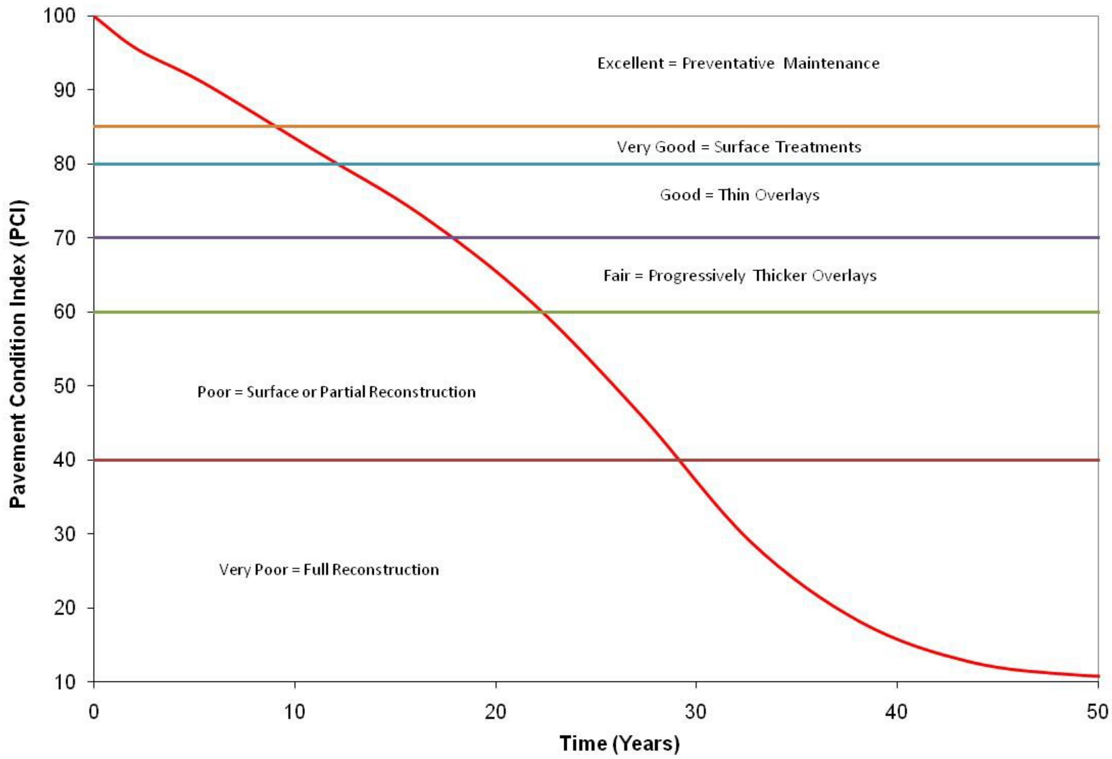

Figure 4 – Understanding the Pavement Condition Index Score

The general idea of what these condition levels mean with respect to remaining life and typical rehabilitation actions is included in the following table:

PCI Range	Description	Relative Remaining Life	Definition
85 – 100	Excellent	15 to 25 Years	Like new condition – little to no maintenance required when new; or routine maintenance such as crack and joint sealing.
80 – 85	Very Good	12 to 20 Years	Routine maintenance such as patching, crack sealing with possible surface treatments - chip seals, seal coats, slurries or micro-surfacing.
70 – 80	Good	10 to 15 Years	Heavier surface treatments and thin overlays. Localized panel replacements.
60 – 70	Fair	7 to 12 Years	Progressively thicker overlays with localized repairs. Moderate to extensive panel replacements.
40 – 60	Poor	5 to 10 Years	Sections will require very thick overlays or surface replacement, base reconstruction and possible subgrade stabilization.
10 – 40	Very Poor	0 to 5 Years	High percentage of full reconstruction.

2.0 PAVED NETWORK CONDITION AND FINDINGS

2.1 ROADWAY SECTIONS INVESTIGATED

The intent of this study was to develop a network level management program for the paved roadway system of Dunwoody. At the time of the survey, the network consisted of 147 centerline miles of roadway, broken down into 4 functional classes. Roadways are only asphalt pavement (AC).

	Total Network	Arterial	Collector	Minor Collector	Local
Length (ft):	2,454,148	473,854	293,153	132,771	1,554,370
Length (Mi):	145.4	20.1	8.7	13.1	103.5
Number of Block Sections:	1,551	300	206	85	961
Area (yd^2):	2,454,148	473,854	293,153	132,771	1,554,370
Percentage of Network:		19.3	11.9	5.4	63.3

The following plot summarizes the total network by area split between functional classifications.

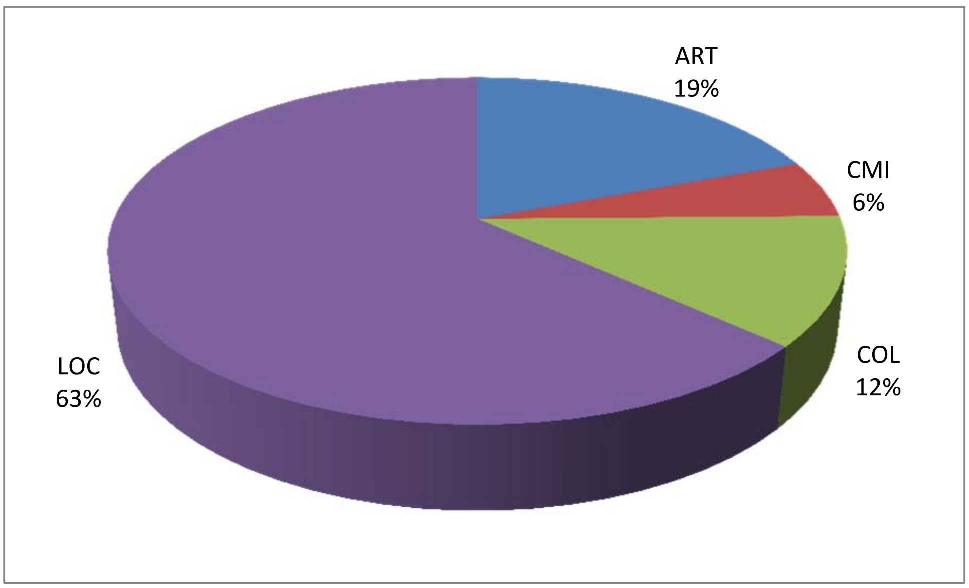

Figure 5 – Network Split by Functional Classification by Pavement Area

2.2 NETWORK PRESENT CONDITION

The street network owned or managed by the City of Dunwoody consists of approximately 147 centerline miles of pavement. At the time of testing, the average condition of the paved network was 66 with streets ranging from a low of 33 to a high of 97.

Figure 6, presented below shows distribution of pavement condition for the roadway network in the City of Dunwoody on a 10 to 100 scale, 10 being worst and 100 being best condition. The roadway network displays atypical pavement condition characteristics when compared to other agencies of similar size and environment. Typically a more uniform bell shape curve – centered on streets in the 60 to 80 range is encountered. In this case there are many street centered around the 40 to 70 range with an additional large group in the 100 to 85 range. This may represent the recent work done on many of major streets but, still shows many streets that are still in need of repair.

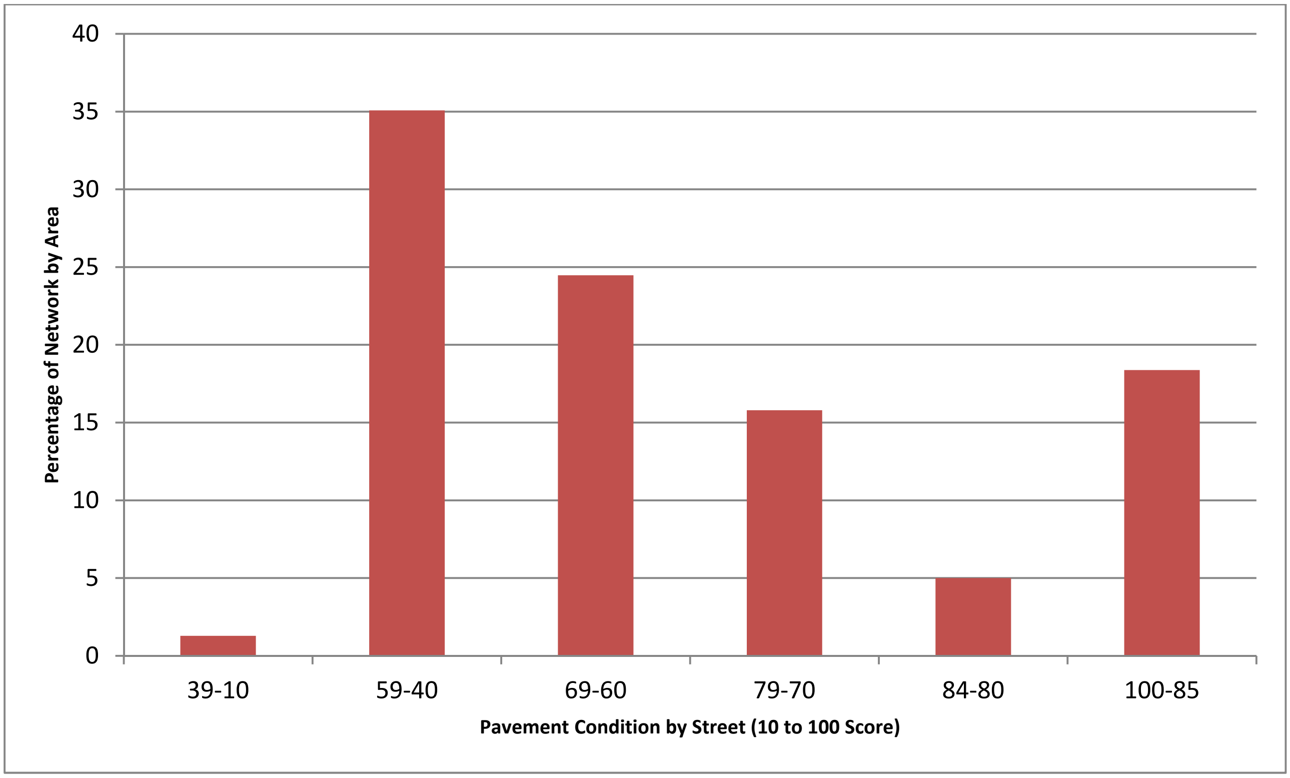

Figure 6 – Paved Network Present Status

The following graph (figure 7) plots the same pavement condition information, but instead of using the actual pavement condition index value, descriptive terms are used to classify the roadways. From the chart, 18% of the network can be considered in excellent condition with a PCI score greater than 85. These are the like new roads and only require routine maintenance such as minor patching and some crack sealing. On a typical network, 10% to 15% of the roads are generally rated as excellent. Furthermore, 5% of the City of Dunwoody network falls into the very good classification. These are roads that benefit the most from preventative maintenance techniques such as micro- surfacing, slurry seals and localized repairs. If left untreated these roadways will drop in quality to become overlay candidates.

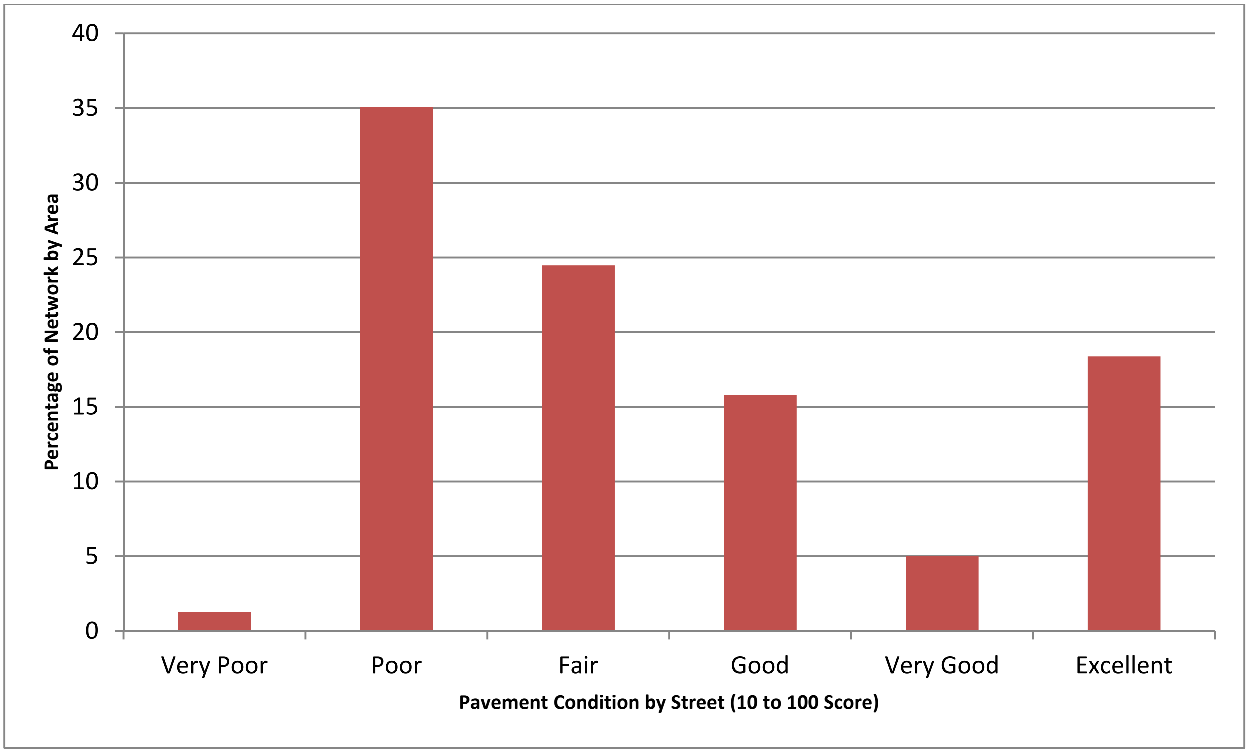

Figure 7 – Network Pavement Condition by Descriptive Classification

40% of the network can be considered in “good” or “fair” condition, representing candidates for progressively thicker overlay based rehabilitation.

These pavements are beginning to deteriorate at an accelerated rate. Some of them can be saved by resurfacing in the near future. Delay would increase the cost of repair significantly for these pavements. In that sense, they are the 'optimal' pavements for repair. If left untreated, they will decline rapidly into reconstruction candidates.

The remaining 36% percent of the network is rated as “poor” or “very poor”, meaning these roadways have failed or are past their optimal due point for overlay based rehabilitation and may require progressively heavier or thicker forms of rehabilitation (such as surface reconstruction) or total reconstruction. Roadways falling progressively into the poor and unacceptable categories (PCI less than 60), should be considered the City’s “backlog” of immediate work to do. These are the roadways that require rehabilitation efforts, in thicker depths, or reconstruction.

2.3 PRESENT CONDITION BY FUNCTIONAL CLASS

The following plot presents the present condition broken down in major roadways (arterials and non-residential collectors) and minor roadways (residential streets and residential collectors).

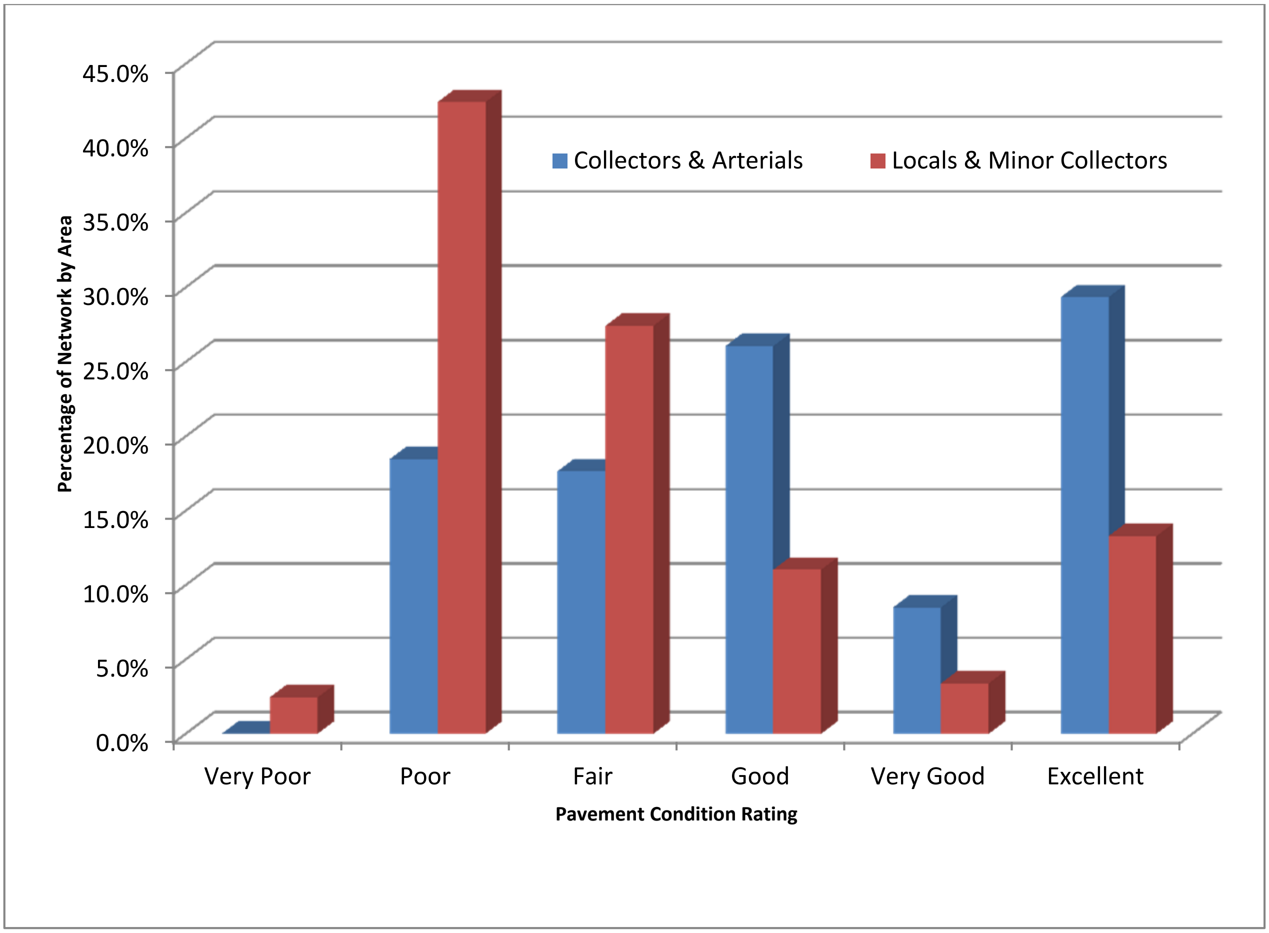

Figure 8 - Network Pavement Condition by Functional Class

As can been seen from the plot, both the major and minor networks display different condition characteristics, with the major network in better condition with fewer poor roads.

2.4 RECONSTRUCTION BACKLOG

Backlog roadways are those that have dropped in quality such that surface based rehabilitation efforts would no longer prove to be cost efficient and require either partial or total reconstruction. Backlog is expressed as the percentage of roads requiring reconstruction as compared to the network totals.

> ***The concept of pavement condition index (PCI) score and backlog must be fully understood in order to develop an effective pavement management program. The PCI score indicates the overall pavement condition and represents the amount of equity in the system and 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 5 years the overall network score meets a set minimum value. It is the backlog however, that defines the amount of work an agency is facing and is willing to accept in the future. Further, it is the combination of the two that presents the true picture of the condition of a roadway network, and conversely defines improvement goals.***

Generally a backlog of 10% to 20% of the overall network is considered manageable from a funding point of view – a target value of less than 15% would be considered ideal. A backlog below 10%, while certainly desirable from a service perspective, may represent a non-optimal expenditure of funds if rehabilitation dollars are limited. Backlogs approaching 20% and above tend to become unmanageable unless aggressively checked through larger rehabilitation programs.

With the City of Dunwoody's current reconstruction backlog at 36%, the City's objectives need to focus on developing an effective overlay and backlog reduction program to minimize the number of roadways that will deteriorate into reconstruction candidates and at the same time reduce the backlog to a manageable level.

3.0 REHABILITATION PLAN AND BUDGET DEVELOPMENT

3.1 PAVEMENT MANAGEMENT METHODS

All pavement management systems require user inputs in order to establish real world budgets and rehabilitation plans. The keys among these inputs are:

- Whether to be a budget driven or level of service driven agency.
- Whether to focus on doing a worst first or prioritized based rehabilitation plan.
- Length of design period – either 5 or 10 years
- Desired level of service at the end of the design period.
- Desired backlog at the end of the design period.

There are many ways to manage a given pavement network. The pavement management program used for the City of Dunwoody has two general methods that can be run with different parameters to achieve a variety of scenarios. The first method, called "Level Analysis", allows the user to select a desired level of service to maintain while the program reports the associated annual budget. In this method the average condition of the network is brought to a selected level by rehabilitating streets from low condition to high condition. However, the streets are not usually done in a worst first order. Instead, the cost benefit of each strategy is considered so that an optimum strategy at an optimum time can be performed. The second method, called "Budget Analysis", allows the user to select a fixed budget for each year while the program reports the associated level of service. In this method the streets are selected optimally while staying within the budget constraints. In some cases the optimum strategy or the timing of rehabilitation for a particular street will be altered to fit within a particular budget. Each of the above inputs affects the final budget and rehabilitation program in a variety of manners.

3.2 REHABILITATION UNIT RATES

The base costs and assumptions used to develop the rehabilitation unit rates are as follows:

- No allowances for City overhead, landscaping, signage, or signal improvements.
- 15% allowance for traffic control, engineering and inspections and contingencies.
- Minimum overlay thickness = 1.5", maximum overlay thickness = 3.5". Milling will be selected on-site and either be edge or full width.
- No allowance for ADA compliance or sidewalk improvements.
- $0.25/yd2 allowance for striping and pavement markings.
- Restrict local roads to surface based rehabilitation – "Deep Patch and Pave".

Rehabilitation	Arterials ($/yd2)	Collectors ($/yd2)	Minor Collectors ($/yd2)	Residential ($/yd2)
Surface Treatments (slurries/microsurfacing)	3.25	3.00	2.75	2.75
1.0" Mill and 1.5" AC Overlay	12.75	12.25	11.75	11.75
1.5" Mill and 2.0" AC Overlay	13.25	12.75	12.25	12.25
2.0" Mill and 2.5" AC Overlay	13.75	13.25	12.75	12.75
2.5" Mill and 3.0" AC Overlay	14.25	13.75		
3.0" Mill and 3.5" AC Overlay	14.75			
Deep Patch and Pave		16.75	15.75	15.75
Full Reconstruction	50.75	45.00		

3.3 DO NOTHING, FIX ALL AND BUDGET ANALYSIS COMPARISON

The following plot presents the "Fix All" and "Do Nothing" options against the present condition.

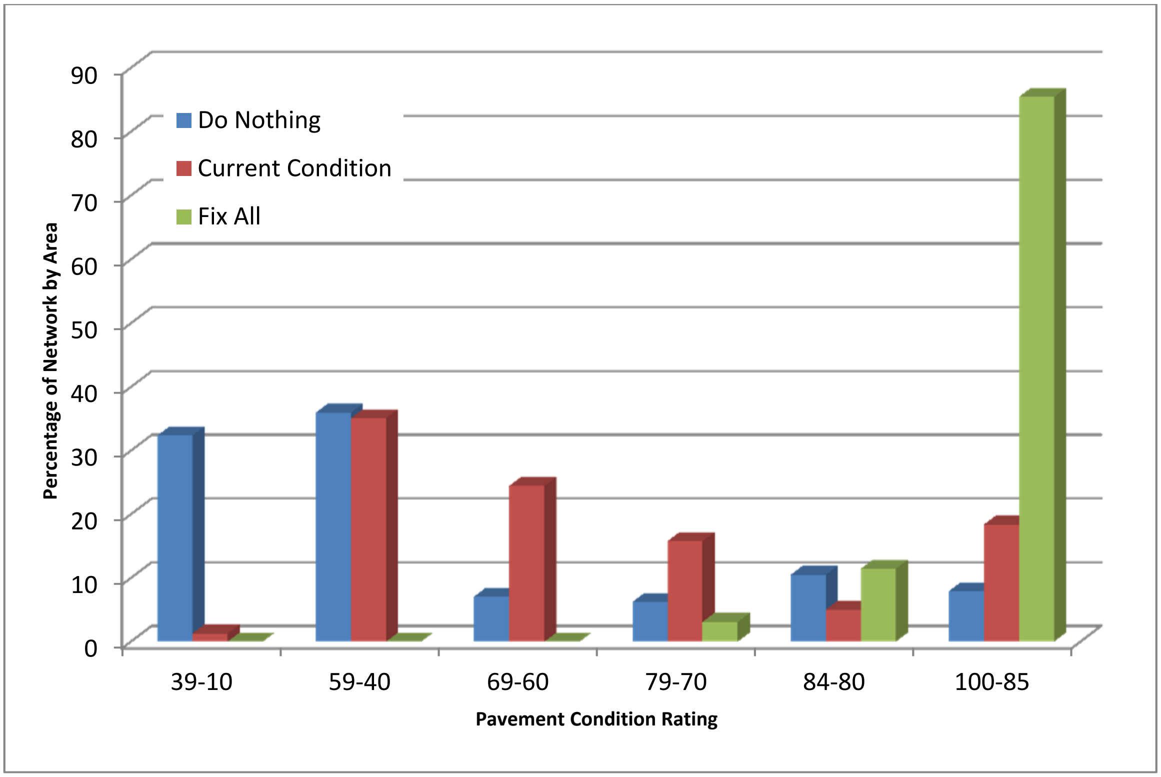

Figure 9 – Do Nothing and Fix All Options Compared Against Current Condition

The cost to theoretically rehabilitate all roadways in the City of Dunwoody, to a like new condition is approximately $33.8M and results in a network PCI score of 84 with no backlog (new pavement is considered to be between 85 and 95). This assumes unlimited funding is available and all roadways are rehabilitated in their optimal year. Obviously this is an unreasonable expectation for level of service and funding, however it does identify an upper limit of potential expenditure.

It is projected that if no rehabilitation or maintenance is done, the network PCI will drop from its current level of 66 to 53 within 5 years and increase the backlog to 68%.

The net gain in network average condition for the Fix All option is 22 points (88 – 66 = 22). Dividing this gain into the Fix All total of $33.8M yields approximately $1.5M per point gained. Thus the Do Nothing option can be estimated to remove over $19M in equity from the system {(66-53)*1.5 = 19.5}, while the cost to maintain the network at a 66 is only $11.5M.

3.4 BUDGET ANALYSIS

A total of 10 budget scenarios were assessed for Dunwoody. The starting PCI is for 2014 and the Final PCI is 2018. The results of the 10 programs are plotted in figure 10 and presented in the following table.

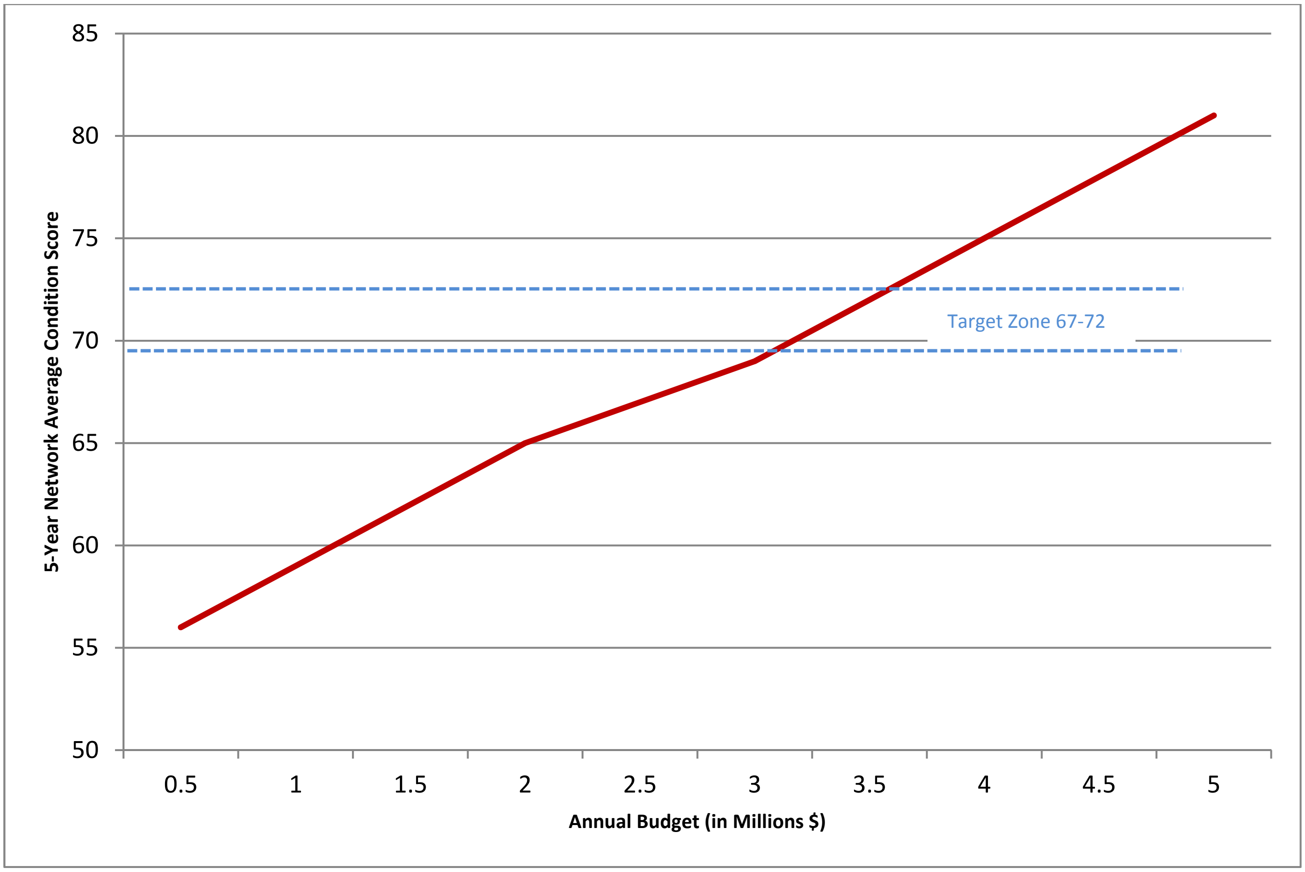

Figure 10 – Annual Budget Versus 5 Year Network Average Pavement Condition Index

Budget Scenario	Starting PCI	Annual $	Final PCI	PCI Change	Final Backlog
Do Nothing	66	0	53	-13	68
$2.1 Million	66	2.1	65	-1	47
$2.5 Million	66	2.5	67	1	44
Fix All	66	6.8	88	22	0

Annual budgets of $ 2.1million and $2.5 million dedicated to roadway rehabilitation were run. The results of these budget runs are included in the appendix of this report.

3.5 NETWORK RECOMMENDATIONS AND COMMENTS

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

1. The as-measured pavement condition score at year end 2013, as well as the current network average score for the city is 66. The backlog is 36%.
2. Dunwoody has made significant improvements since the 2009 testing. There is significant work still to be done. The City should adopt a policy identifying the desired level of service and acceptable amount of backlog. We suggest a PCI target above 70, with a backlog of no more than 15%.
3. The City should review the recommended program to aggregate stretches of road that have differing years of rehabilitation but are in close geographic proximity to each other.
4. Any streets that are to be rehabilitated due to widening or underground utility repairs should be added to the scenarios as "Must Do" streets.
5. The City should continue a proactive approach to pavement management, focusing on early intervention and maintaining their existing investments in pavements. This would allow the City to maintain the quality of their system with little increase in backlog – in order to achieve this with limited funding, some reconstruction candidates may get postponed in favor of multiple overlay projects.
6. The full suite of proposed rehabilitation strategies should be reviewed prior to finalization of these budgets as they can have a large effect on the analysis. This analysis focused on the primary activities of slurry seals, overlays and reconstruction. The City may wish to expand the overlay strategies to include progressively thicker overlays based on decreasing PCI scores.
7. GASB 34 compliance may be achieved by adopting the recommendations and budget contain herein.
8. The City should consider developing an ongoing program to maintain the pavement and right of way asset management system such that it can continue to be used to effectively manage the City's roadway assets. Maintenance of the asset management system should consist of:
    - Updating the pavement condition information either every 3 years, or completing 1/3 of the network annually. This will allow the City to update their roadway inventory, GIS data and pavement condition data on a routine basis.
    - An estimated budget of $125 to $150/mile (inclusive of surface distress data collection and processing, and data loading) may be used to cover the annual surveys.

The analyses and recommendations presented in this report are based upon the data obtained from the Client and other information discussed in this report. This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted pavement engineering practices. No warranty, expressed or implied, is provided. In the event that any information furnished to us, as outlined in this report, is inaccurate or changes, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the pavement engineer.