



Harris & Associates

**Program Managers
Construction Managers
Civil Engineers**

July 08, 2005

Ms. Sharon Good
City Engineer
City of Clearlake
14050 Olympic Drive
Clearlake, CA 95422

Subject: Final Report - Pavement Management Program .

Dear Ms. Brundage:

As part of the development of the Pavement Management Program for the City of Clearlake, Harris & Associates hereby submits the Final Pavement Management Report.

The information contained in this report presents the findings from a pavement condition survey of the City's street network. The City is also provided with the information that was used to develop the recommended improvement program. The report covers the following categories:

- Executive Summary of 2005 PMP Update
- Pavement Condition Index for all streets
- Budget Analysis and Recommended Work Program based on various budgets

It has been a pleasure working with the City on this project. Please contact me at (925) 827-4900 ext. 219 with any questions you may have in the future regarding Pavement Management or any other services Harris & Associates could provide.

Sincerely,

Harris & Associates

Vijay Pulijal
Project Engineer
(For Josh Watkins)

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EXECUTIVE SUMMARY

In February 2005, Harris & Associates updated the Pavement Management Program (PMP) for the City of Clearlake. The PMP provides a management tool to inventory street pavement, assess pavement condition, record historical maintenance, forecast budget needs, and view impacts of funding on City-wide pavement condition over time. Pavement condition evaluations were performed on all the City's streets by Harris inspectors.

The PMP is also a software-based tool for analyzing pavement conditions and recommending rehabilitation strategies based on funding levels. The software focuses on providing cost effective recommendations that enhance the overall system Pavement Condition Index (PCI). In general, asphalt pavement deteriorates over time by both traffic loading and weathering. The MTC software recommends that 24% of the budget be put to preventable maintenance treatments such as seal cracks or chip seals. The remaining budget is programmed for more expensive asphalt overlays and reconstruction. Why is preventive maintenance important? Preventive maintenance treatments sustain a street's PCI at a high level and at relatively low cost. Preventive maintenance treatments can be applied to many streets (large pavement area) with a positive effect of raising the system PCI for a fraction of the cost to asphalt overlay one street (small pavement area).

◆ Pavement mileage & replacement value

The City of Clearlake has approximately 65 miles of paved streets and 49 miles of unpaved (gravel) streets, divided into 440 pavement management segments. The following is the breakdown of Clearlake's street pavement mileage grouped by functional class:

CLASSIFICATION	Miles
Arterial	29.9
Collector	12.1
Residential	71.8
TOTALS	113.8

It is important to consider the overall investment the City has in its pavements. The unit cost for a surface reconstruction (consisting of moderate base failure repair, removal of existing surface, and pavement overlay) is \$10 to \$14 per square yard. The cost to reconstruct all streets is over \$10 million. This is a minimal reconstruction approach. Full replacement of the pavement, base, and structure of the streets would cost substantially more.

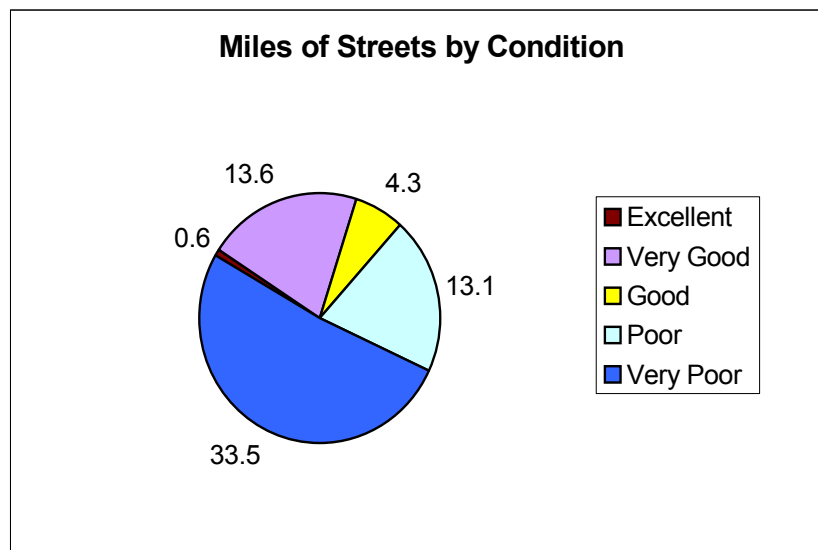
◆ **Condition of Clearlake’s Street Asphalt Pavement**

The City’s average Pavement Condition Index (PCI) is 38 on a 100-point scale, with 100 being a new street. PCIs for the City’s pavement network are based on a visual distress rating system‡. The overall condition of the City of Clearlake’s street pavement is in the mid range of MTC’s designation “Poor”. The 2003 MTC State of Repair report states, “approximately 75 percent of a pavement’s serviceable life has been expended by the time its PCI rating falls to 60.” Clearlake’s average PCI (38) suggests that most portions of its streets are due for rehabilitative maintenance work soon. Clearlake’s average PCI condition value by street classification is as follows:

CLASSIFICATION	2005 PCI*
Arterial	34
Collector	45
Residential	38
TOTAL SYSTEM	38

The following figure i-2 shows the City’s total pavement mileage by condition category. Figure i-3 describes the condition categories, their equivalent PCI range, and typical prescribed maintenance treatments:

Figure i – 2



‡Note: PCI weighted by area.

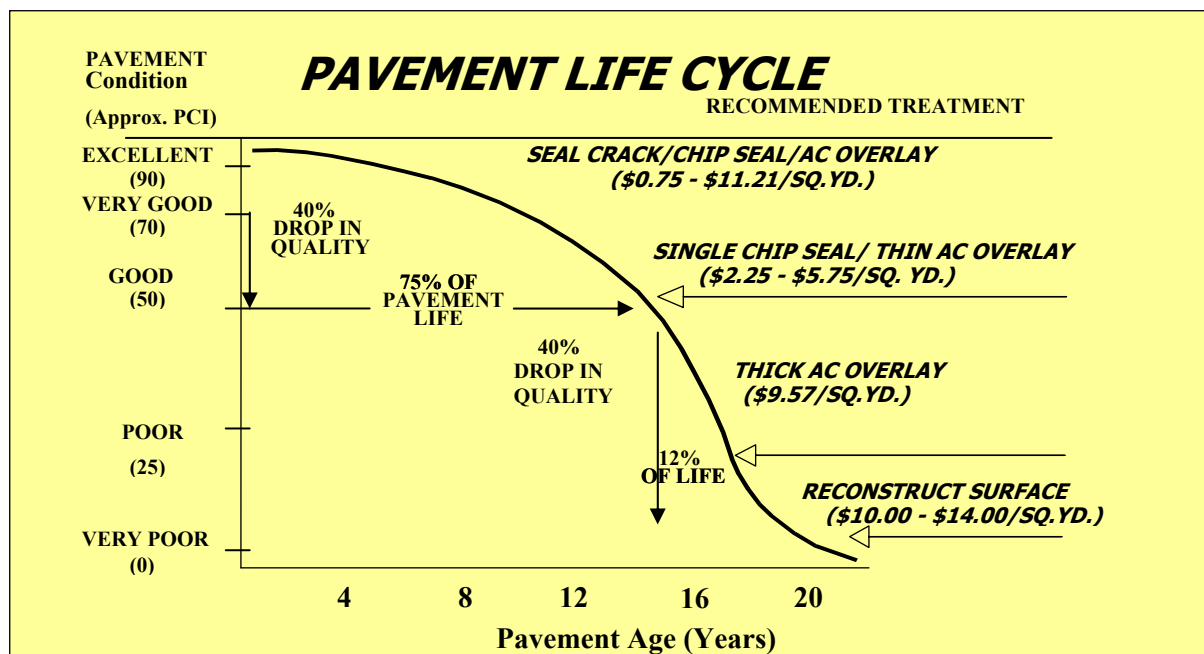
*Calculated by an algorithm developed by the Army Corps of Engineers.

Figure i – 3

Condition	PCI Range	Typical Maintenance Treatment
Excellent	90-100	Do Nothing.
Very Good	70-89	General preventative maintenance such as Seal Cracks or Single/Double Chip Seals or AC Overlay.
Good	50-69	Single Chip Seal or Thin AC Overlay (1.5 Inches).
Poor	25-49	Thick AC Overlay (2.5 Inches).
Very Poor	0-24	Reconstruct Surface.

◆ **Budget Analysis**

Following the treatment strategy described in the table above and an inflation rate of 4%, the MTC PMP software generates a Budget Needs analysis. The Budget Needs analysis projects the total budget needed to bring the City’s pavement system to a condition where most pavement sections require only minor preventive maintenance (i.e., PCI = 70 or higher). The following chart illustrates the cost effectiveness of keeping the pavement condition index above 70 for a typical street.



The current PCI is reduced annually based on this deterioration curve. Maintenance activities increase the PCI value as they are applied to the segment. The overall program is dynamic in that each strategy consists of a cyclic series of actions that simulates the pavement's anticipated life cycle. As shown in the above picture, a typical pavement section will deteriorate approximately 40% in the first 75% of its lifespan. However, that same pavement section, if untreated, will experience another 40% reduction in overall quality in only the next 12% of lifespan, effectively deteriorating an equivalent amount in only one-sixth (1/6) the time. As a result of this continued

deterioration, the quantity and cost of the maintenance activities needed to rehabilitate the pavement will increase in both scope and costs. In other words, it is not simply “pay today or pay tomorrow”, but rather a “pay today or pay more tomorrow” proposition. Overall pavement maintenance cost is reduced by the timely application of crack sealing, slurry seals and pavement overlays before the subgrade fails and requires a total pavement reconstruction.

To reach that level of minor preventative maintenance in ten (10) years, the Budget Needs analysis determined a total need of approximately \$10.5 million for the years 2005-2014. See section IV-A for the Needs - Projected PCI/Cost Summary.

After Budget Needs, Budget Scenarios are run to determine the funding levels required to maintain and/or improve the current PCI level and generate a list of street maintenance for the next ten (10) years. The software analyses each pavement section and picks specific maintenance to maximize the improvement of the entire pavement system. Maintenance treatments are allocated to as many streets as the annual budget will allow. For the City of Clearlake, five annual budgets, \$100,000 (Expected Budget), \$300,000 (Test Budget I), \$400,000 (Test Budget II), \$600,000 (Test Budget III) & \$1.05 million (Needs Average) were tested, with 24 percent of the annual budget applied towards preventative maintenance. The MTC PMP software recommends spending 24 percent of the budget toward preventative maintenance because it is the optimum level according to the specific conditions of the City’s system. This means that 24 percent of the annual budget is spent on chip seals or crack sealing while the remainder of the budget is spent on overlays and reconstruction. These budgets do not account for stopgap maintenance repairs, such as emergency pothole repair.

◆ **Budget Analysis Results**

After the MTC PMP software analyzes the pavement system according to the specified annual budget over a period of ten (10) years, trends are evident in the PCI and Deferred Maintenance backlog (the amount of necessary reconstruction and overlays not performed each year due to budget constraints). An increase in deferred maintenance shows that necessary rehabilitation is not being performed. The total deferred maintenance in 2005 before any suggested maintenance is around \$5.2 million. The following PCI values reflect the average PCI and deferred maintenance after suggested treatments are applied.

- \$100,000 Annual Funding Level (Expected Budget).
PCI Trend: Decreases from a 38 PCI in 2005 to a 22 PCI in 2014.
Deferred Maintenance Trend: Increases from \$5.3 million in 2005 to \$9.9 million in 2014.
- \$300,000 Annual Funding Level (Test Budget I).
PCI Trend: Decreases from a 38 PCI in 2005 to a 32 PCI in 2014.
Deferred Maintenance Trend: Increases from \$5.3 million in 2005 to \$8.5 million in 2014.
- \$400,000 Annual Funding Level (Test Budget II).
PCI Trend: Decreases from a 38 PCI in 2005 to a 37 PCI in 2014.

- Deferred Maintenance Trend:* Increases from \$5.3 million in 2005 to \$7.6 million in 2014.
- \$600,000 Annual Funding Level (Test Budget III).
PCI Trend: Increases from a 38 PCI in 2005 to a 47 PCI in 2014.
Deferred Maintenance Trend: Decreases from \$5.3 million in 2005 to \$5.8 million in 2014.
 - \$1.05 million (Needs Average)
PCI Trend: Increases from a 38 PCI in 2005 to a 77 PCI in 2014.
Deferred Maintenance Trend: Decreases from \$5.3 million in 2005 to \$1.8 million in 2014.

Scenario charts showing the impact of the five budgets on street condition and deferred maintenance backlog over a ten (10) year period is shown on the following pages and in Sections IV-B and IV-C. The Cost Summary Reports, which provide information on pavement funding distribution by pavement condition, and the Network Condition Summary Reports, which project pavement condition trends, can be found in Section IV-D.

◆ **Recommendations**

Harris & Associates recommends that, at a minimum, annual budgets for asphalt pavement work alone should be increased to \$450,000. Raising the budget to \$450,000 will begin an increasing trend in overall pavement condition while slowing the growth of the deferred maintenance backlog. At this budget level, the overall PCI will increase from a 38 PCI in 2005 to a 40 after treatments are applied in 2014.

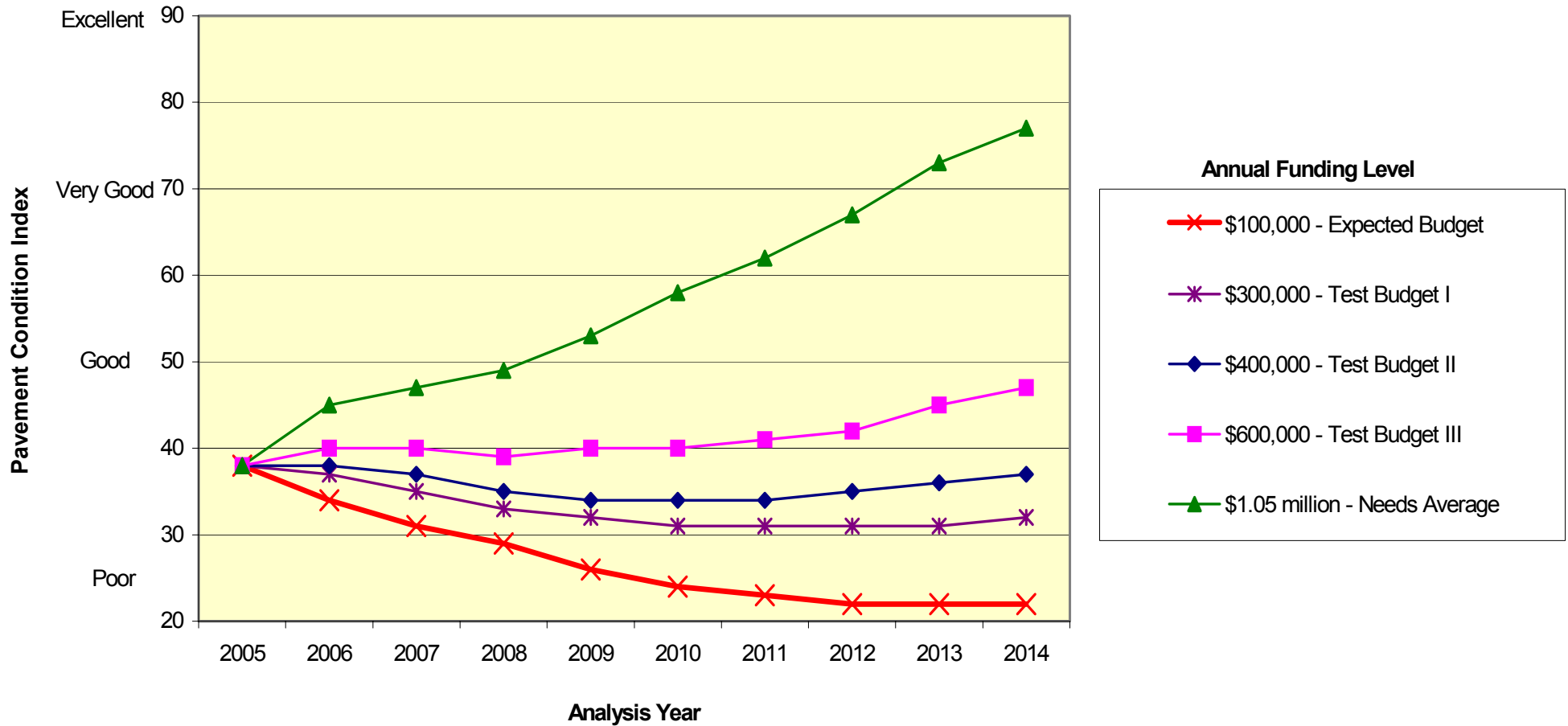
The City should continue its effort to utilize cost effective treatments where appropriate, such as crack sealing and chip sealing and evaluate emerging cost effective techniques like thin-bonded wearing courses, rubberized chip seals, rubberized overlays and polymer modified asphalt emulsions. Maintenance and rehabilitation performed annually must also be recorded in the MTC PMP software. The software allows the City to track the performance of past treatment strategies to determine their effectiveness.

Harris & Associates also recommends that the City maintain its pavement management program to be eligible for grants and state gas tax funding. All collector routes should be re-inspected every two years and all residential streets every five years. The costs for the re-inspection should be included in the annual pavement management budget.

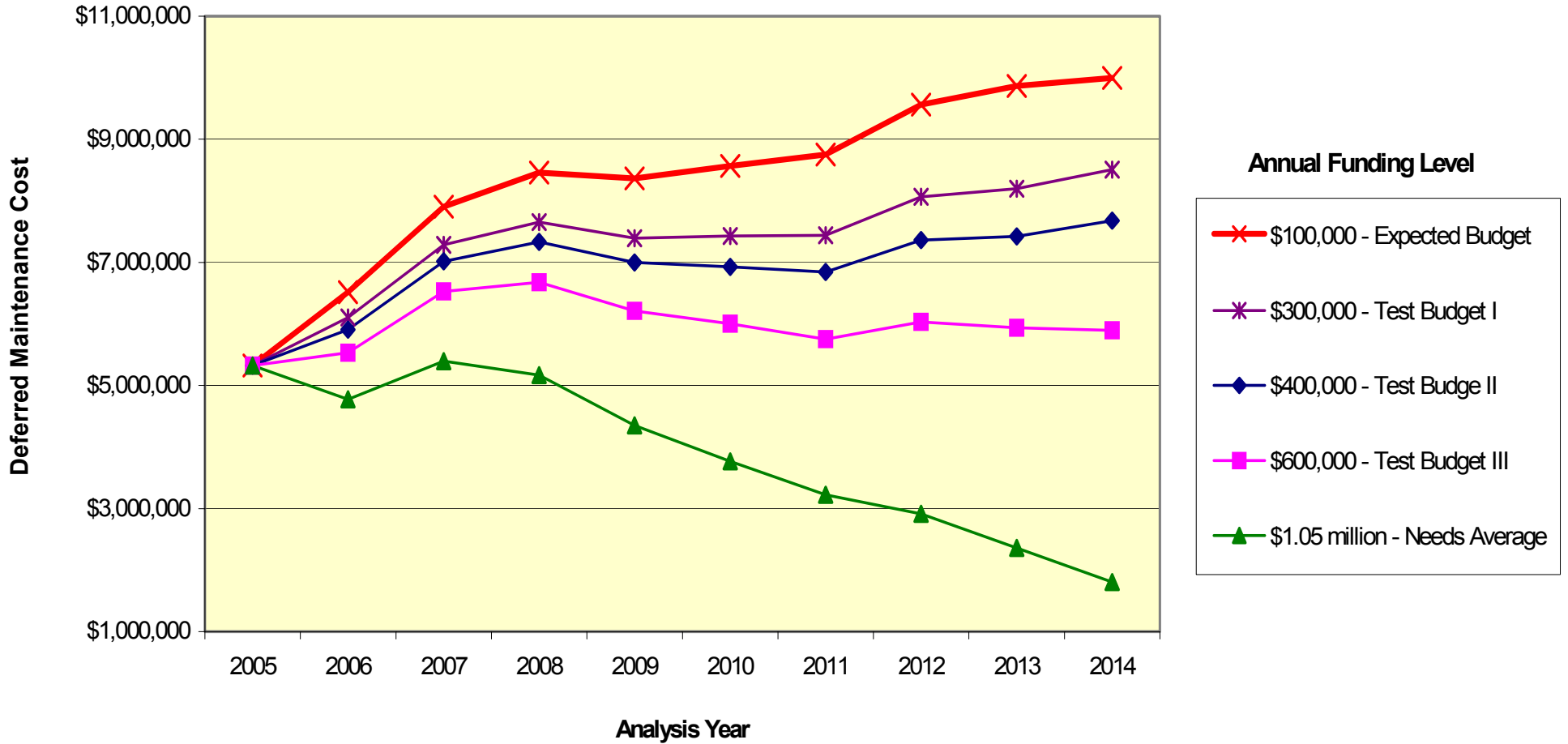
Clearlake's overall street system is currently in the mid range of MTC's "Poor" condition. To help maintain and improve the current condition, certain projects have been recommended within the context of this program. An annual work program for the \$100,000 budget level can be found in Section IV-E. This report provides detailed listings of suggested maintenance projects for the City of Clearlake based on the overall PMP suggested needs funding and base annual budgets. This report provides a first step in identifying segments to be repaired under Clearlake's annual work programs.

Although these project listings are recommendations generated by the PMP, they are for planning purposes only and are not intended to replace sound engineering judgment. Final project recommendations should be weighed against the actual approach the City wishes to utilize in scheduling the workloads for contracting purposes. Once a street segment is identified for repair, a closer site inspection and detailed project repair scope is required.

Pavement Condition Index by Annual Funding Level



Deferred Maintenance Trend by Annual Funding Level



SECTION I

INTRODUCTION

NEED FOR A PAVEMENT MANAGEMENT PROGRAM

A Citywide Pavement Management Program assists the City by providing current inspection data used to evaluate current pavement condition. This helps to maintain a City-defined desirable level of pavement performance while optimizing the expenditure of limited fiscal resources. A PMP system is also often required to obtain state and federal funds.

Specifically, the program provides administrators and maintenance personnel with:

- A current inventory of all public roadways
- The current pavement condition for all public roadways
- A project listing of all pavement needing maintenance, rehabilitation, or replacement
- The most cost effective level of maintenance or repair appropriate at the time of the inspection
- A forecast of budget needs for maintenance, rehabilitation, or replacement of deficient pavement sections for a ten (10) year Capital Improvement Program, at various alternative overall condition levels

LIMITS OF STUDY

It must be recognized that this report is limited to the existing pavement repairs. It does not include existing deficiencies for right-of-way concrete sidewalks, curb & gutter, drainage, trees, bus pads and non-structural improvements such as decorative crosswalks, medians, lighting and street furniture. Costs for these right-of-way repairs and improvements throughout the City would easily exceed the deferred maintenance costs (the cost of crucial maintenance work not performed in a specific year) identified in this report and can be identified and estimated separately in future reports.

The following recommendations generated by the Pavement Management Program are for planning purposes only. The resulting general recommendations are not intended to replace sound engineering judgment, which should dictate specific needs for an individual project. Maintenance and rehabilitation projects should be based on a combination of the system's recommendations weighed against the City's preferences, budget constraints, and other contributing factors. In addition, further refinements may be warranted from an engineering staff review of the pavement condition. For example, a particular pavement section may require treatment earlier (or later) than the rest of the roads in its localized area.

THE PAVEMENT SYSTEM

The entire pavement system within the City of Clearlake is composed of approximately 65 centerline miles of paved surfaces and 49 centerline miles of unpaved surfaces and is divided into 440 pavement management segments. To assist in planning maintenance needs, the City's streets were grouped by functional class (arterial, collector and residential). The table below shows the City's pavement mileage by functional class.

Table I – 1

CLASSIFICATION	Miles
Arterial	29.9
Collector	12.1
Residential	71.8
TOTALS	113.8

The entire pavement system has a current reconstruction value of over \$10 million. The current system reconstruction value (consisting of moderate base failure repair, removal of existing surface, and pavement overlay) by functional class is as follows:

Table I – 2
System Reconstruction Value

CLASSIFICATION	Square yards	Unit Cost for Reconstruction (per square yard)	Total Reconstruction Value	Percent of Reconstruction Value
Arterial	232,186	\$14.00	\$3,250,604	32.3%
Collector	161,324	\$14.00	\$2,258,536	22.4%
Residential	455,443	\$10.00	\$4,554,430	45.3%
TOTALS	848,953		\$10,063,570	100%

CURRENT PAVEMENT CONDITION

A visual survey of the City's streets was conducted to assess the existing surface condition of each individual pavement segment. Upon completion of this survey, a Pavement Condition Index (PCI) was calculated for each segment to reflect the overall pavement condition. Ranging between 0 and 100, a PCI of 0 would correspond to a badly deteriorated pavement with virtually no remaining life. A PCI of 100 would correspond to a new pavement with proper engineering design and construction at the beginning of its life cycle.

Table I – 3 relates PCI ranges to general pavement condition definitions and gives a general description for each pavement condition.

Table I – 3

PCI Range	Condition	Description
90-100	Excellent	Little or no distress.
70-89	Very Good	Little or no distress, with the exception of utility patches in good condition, or minor to moderate hairline cracks; typically lightly weathered.
50-69	Good	Light to moderate weathering, light load-related base failure, moderate linear cracking.
25-49	Poor	Moderate to severe weathering, moderate levels of base failure, moderate to heavy linear cracking.
0-24	Very Poor	Extensive weathering, moderate to heavy base failure, failed patches, extensive network of moderate to heavy linear cracking.

The overall conditions of the City of Clearlake’s road network rests in the mid “Poor” range with an average PCI of 38.

MAINTENANCE STRATEGY DEVELOPMENT

Based on the results of the condition survey and on input from the City, pavement maintenance/rehabilitation strategies were developed. A standard agreement at the outset was to identify the City’s maintenance work program for the next ten (10) years, showing resource alternatives that affect the maintenance backlog and increase the overall condition of the pavement system.

Certain strategies are recommended for the most cost-effective work program. A listing of the maintenance activities utilized in the strategy development is presented in Section II. Each activity represents the type of work that has been recommended for the long-term maintenance recommendations of the City’s streets.

ANNUAL BUDGET PROJECTIONS

The budgeting process was approached with the following in mind: generate a work program for the next ten (10) years based upon actual road pavement conditions and determine the funding levels required to maintain and/or improve the current level (PCI) of overall condition.

Based on current and projected pavement maintenance needs, annual work program alternatives have been prepared. A detailed work program for \$100,000 annual budget can be found in Sections IV-E of this report.

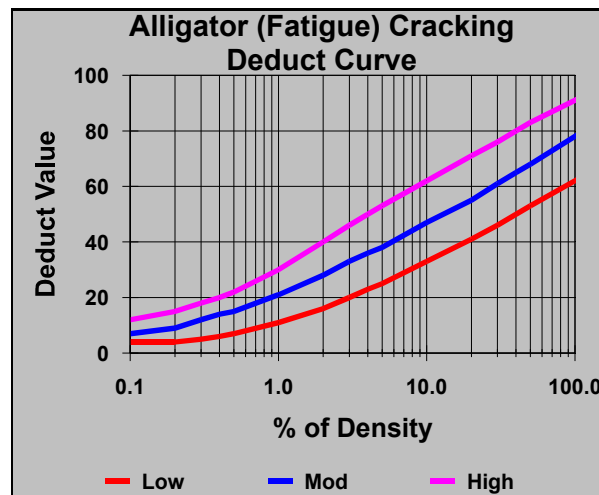
SECTION II METHODOLOGY

The following section provides a description of the methodology and rationale utilized in determining the recommended actions identified in this report.

Field Survey

For this inspection update, all the paved streets in the City of Clearlake’s system were re-inspected. Data, including distress types and quantities, segment length and width, etc. was collected for all inspected roads. Using a combination of City street maps and laptop computers to collect field information, a field crew visually surveyed each of these streets. Data was categorized by street and “pavement” segment. Pavement segment limits were identified by determining the logical maintenance practices that would apply to each street and may vary from street to street, i.e. intersection to intersection, change in pavement width, drainage conditions, crown of the roadway, etc. All inspection data was entered into the MTC pavement management software.

After the data entry procedures were completed, a distress rating was calculated for each segment. The distress rating is calculated using MTC developed algorithms. The algorithm assigns each pavement section a score of 100 then deducts point values based on the pavement distresses found within the section weighted by the quantity of each distress. The algorithm assigns deduct values based on the severity (see graphic below) and the density of each distress.



The algorithm weighs the total deduct value within a section and calculates a total distress rating between 0 (failed) and 100 (excellent).

The PCI is an overall measure of the condition of the road surface based on a scale of zero (0) (failed) to one hundred (100) (excellent). Table II – 1 relates PCI ranges to general pavement condition definitions.

PCI Ranges
Table II – 1

<u>PCI RANGE</u>	<u>CONDITION</u>
90 - 100	Excellent
70 - 89	Very Good
50 - 69	Good
25 - 49	Poor
0 - 24	Very Poor

The summary of all road condition data and the representative PCI's is located in the Pavement Condition Index Report in Section III.

Once the PCI has been established for a pavement section, budget analyses and workload predictions commence. Predictions of future pavement performance are based on a pavement deterioration curve developed by MTC. As a pavement ages, the system predicts the PCI of the pavement based on the deterioration curve.

MAINTENANCE STRATEGY ASSIGNMENTS

The PCI is used by the system to schedule maintenance activities for each pavement segment. The MTC PMP software recommends a specific maintenance activity based on the PCI and budget constraints. Harris & Associates and the City have selected a series of maintenance activities to apply to the pavement network. The City was presented with a list of suggested maintenance and rehabilitation strategies and asked to select the activities and unit costs that were appropriate for their purposes. The unit costs for each maintenance activity account for various construction costs. Definitions of each maintenance activity per category are defined as follows:

1. Seal Cracks - A surface treatment generally utilized to prevent entry of water or other non compressible substances into the pavement.

Crack seals are used to fill individual pavement cracks to prevent entry of water or other non-compressible substances such as sand, dirt, rocks or weeds. Crack sealant is typically used on early stage longitudinal cracks, transverse cracks and reflection cracks. It is placed over the existing pavement surface and is typically applied by the City at three (3) year intervals. The typical cost for a seal crack is \$0.08 per square foot (\$0.75 per square yard).

2. Chip Seals - A surface treatment generally utilized to provide new wearing surfaces via a crushed stone cover and prevent water penetration of the pavement surface, thereby extending pavement life.

Chip seals are surface treatments applied to pavements with minimal surface distress to provide new wearing surfaces and extend pavement life. A chip seal is a slurry seal with a uniform crushed stone cover. It is placed over the existing pavement surface and is typically applied by the City at seven (7) year intervals. The typical cost for a chip seal is \$0.20 to \$0.30 per square foot (\$1.80 to \$2.70 per square yard).

3. Overlays - The application of treatments that are more cost-effective alternatives to reconstruction of the entire pavement surfaces, but provide the required structural support.

An asphalt layer is placed over the existing pavement surface. Cold panning is typically performed prior to the overlay to reduce the total height of asphalt and assure alignment with existing gutter line. This typically includes base repair and crack sealing prior to the application of an overlay. This treatment provides a new wearing surface and increased structural strength to the pavement section. An overlay is typically designed for a ten to fifteen (10-15) year life. This type of treatment is estimated to cost \$5.75 to \$9.57 per square yard depending on the thickness.

4. Reconstruction – The removal and replacement of either the pavement surface only or both the pavement and base.

Clearlake's typical cost for reconstruction is \$10.00 to \$14.00 per square yard. After a reconstruction the pavement segment is again considered new with a full life extension (typically 28 years).

MAINTENANCE DECISIONS

Once the City selected the appropriate activities, a Maintenance Decision Tree (found in Section V) was defined that assigned the appropriate actions to the specific needs of the streets. Emphasis was placed on defining pavement condition thresholds and using the PCI, in conjunction with the functional classification, to determine the specific maintenance activities within these categories.

Once the decisions were set within the system, budgets and work assignments were generated for each work program on an annual basis. Using the MTC recommended pavement deterioration curve for each pavement surface type and functional class, both current and future work requirements for each pavement segment within the City were determined.

PAVEMENT MANAGEMENT PROGRAM REPORTS

This report contains a comprehensive assemblage of pavement management reports ranging from summary reports to annual maintenance and rehabilitation schedules. Collectively, as well as individually, the reports represent reasonable projections of pavement maintenance needs and performance based on visual condition assessments, unit cost estimates, and pavement deterioration models.

It is important to note that pavement segment dimensions and surface area, along with the action and repair costs (as presented in the reports), are accurate within tolerable limits to general project costs on average. This is noteworthy due to the "implied" accuracy of reporting length and width to the nearest foot, surface area to the nearest square foot, and action and repair unit costs and project estimates to the nearest penny and dollar, respectively, which will vary with each project.

SYSTEM MAINTENANCE

It is recommended that the City continue its commitment to a preventative maintenance system for developing annual maintenance plans while also working towards reducing the City's present backlog of rehabilitation projects.

In order to ensure that report outputs are accurate and credible, it is essential that the integrity of all data files be maintained. This will require performing all necessary updates when changes are made to scheduling scenarios, unit cost information, historical data, etc. In addition, the entire pavement network will have to be re-inventoried at regular intervals, as noted earlier in this report. This will not only allow work to be scheduled based on the most current condition data available, but it will also provide City personnel with a means to monitor actual rates of pavement deterioration so appropriate modifications can be made to the system curves in future iterations.

SECTION III
PAVEMENT CONDITION INDEX (PCI) REPORT

SECTION IV
BUDGET ANALYSIS REPORTS

- A. Budget Needs Report - Ten Year**
- B. Average PCI by Annual Funding Chart**
- C. Deferred Maintenance Cost Trend by Annual Funding Chart**
- D. Budget Scenario Cost and Network Summaries**
- E. Annual Work Program - \$100,000 Annual Budget**

SECTION V
BACKUP DATA

- A. Section Description Inventory Report**
- B. Inventory of Inspection Units Report**
- C. Maintenance Treatment Decision Trees**