CHAPTER 4 SUMMARY AND CONCLUSIONS

4.1 Summary

Life-cycle cost analysis is a project cost evaluation tool that compares the economic impacts of different pavement alternatives. The data and procedures in this manual are not designed to provide cost-benefit (non-economic) or network level analysis. The goal of this LCCA Procedures Manual is to provide consistent analysis by making the same assumptions between pavement alternatives in order to determine the most cost effective strategy in the long term by comparison.

LCCA is focused around quantifying two distinct types of costs throughout the project limits over a given analysis period: agency costs and user costs.

- Agency costs are direct costs that Caltrans pay for – initial construction, future maintenance and rehabilitation including support costs.
- User costs are an estimate of the costs associated with delaying the traveling public during the various construction activities within the analysis period converted to a dollar amount. User costs are not borne by Caltrans.

The results are in Present Value dollar amounts generated by *RealCost Version 2.5CA.* These results should not be used for project budgeting or estimating. The costs are not an estimate of the actual cost to Caltrans or the public. Although life-cycle costs are reported in dollars, the results should be viewed as a relative comparison of cost effectiveness between the pavement alternatives analyzed. By using the same LCCA methodology to analyze alternative pavement strategies over the same analysis period, most differences between assumptions inherent in the analysis and future development are negated by the comparison between alternatives.

LCCA is not a means to predict the future. Calculations are based on today's prices and historical average costs for similar projects. Market factors and other events could have dramatic impact on the actual long-term costs but not in the comparison. The results of the analysis don't reveal any information about the merits or benefits of a single project, just how the long-term costs of one pavement alternative compare to another. **Sound engineering judgment is required when comparing results.**

To generate reasonable and consistent results, the pavement alternatives being evaluated must provide equivalent benefits, although the costs and scheduled maintenance activities between alternatives will typically vary in dollar amount and timing over the analysis period. For example, alternatives that only differ in design life or pavement surface type are considered to have equivalent benefits. Conversely, an alternative that includes widening or increases vehicle capacity is not equivalent to a strategy that only rehabilitates an existing pavement structure. Similarly, a preventative maintenance strategy such as a slurry or chip seal is not equivalent to a pavement rehabilitation overlay that adds strength to the pavement structure.

4.2 Limitations of *RealCost Version 2.5CA*

RealCost is a tool to calculate the life-cycle costs. As with any tool, *RealCost* has limits. It is a software program designed to model project conditions in order to compare the costs of selected pavement alternatives over a given analysis period, also known as the life-cycle.

Engineers should be mindful of the "garbage in, garbage out" mentality. How well *RealCost* models a project is determined by how well the engineer is able to match the project conditions with the program's data input. To assure the consistency of the analysis and to minimize the amount of time needed to perform an analysis, data tables for costs, schedules, and user cost inputs have been generated using existing Caltrans data and other sources.

Although data tables and instructions are intended to cover nearly all the situations that may be encountered with a project, situations will arise that are not covered in the manual. Because LCCA involves nearly every aspect of a project, it is advisable to seek out experience within an office, district, or region to take advantage of their familiarity with the area where the project is located. This will help the engineer verify any assumptions beyond what is found in this manual made as part of the analysis. LCCA calculations should be checked and verified to ensure that the results are realistic. At a minimum, the results should be analyzed for input errors, excessive cost differences between alternatives, and given a reality check (e.g. do the inputs and outputs make sense?). The more time and care that are invested in developing accurate input data, the better the quality of the results. However, investing excessive time refining inputs is not always justified, since the models in *RealCost Version 2.5CA* may not be sensitive enough to change the ultimate results of the project alternatives comparison.

4.3 Project with Variable Conditions

Despite the numerous inputs in the *RealCost Version 2.5CA* program, the geometric and traffic models are relatively simple compared to typical project conditions. Projects may have multiple segments, routes, or project types (widening and rehabilitation together). The engineer should break these projects into segments before running *RealCost Version 2.5CA.* Each project segment should be run separately to get the most accurate results.

Variable closure windows (number of lanes, day of the week, month, traffic direction), and variable geometrics such as the number of lanes, may warrant multiple segments and may warrant running *RealCost Version 2.5CA* separately for each segment. Given the variable sensitivity of the software model to different inputs, an alternative solution is to vary the inputs and analyze the results to determine if more in-depth analysis is necessary. How a project is broken down is subject to the engineer's judgment. Potential methods include adjusting the post mile inputs in *RealCost Version 2.5CA* or using a percentage of the total cost based on relative project lengths or surface area. If the project requires a variable Traffic Management Plan (TMP), a reasonable assumption may be to use the requirements that cover the majority of the project. The engineer should consider how well an overall assumption applies to different selected project alternatives.

4.4 Comparing Pavement Alternatives Costs

RealCost Version 2.5CA is a valuable tool for the engineer to compare different rehabilitation strategies as well as new construction strategies over a long period time. Not only are the initial construction costs, but the annual maintenance costs, subsequent rehabilitation costs, and user costs are also considered.

The *RealCost Version 2.5CA* prepares a detailed report for the engineer with the cost comparisons and a recommendation based on the costs. However, costs alone may not be the deciding factor for project strategy selection. There may be environmental issues or right-of-way issues to be considered before a final strategy selection can be made. Also, initial project costs may exceed the funding for a rehabilitation project, and the district may decide to delay the rehabilitation and simply do a CAPM strategy until the funding can be secured for a later date. Project strategy selection is not always a clear choice based on costs alone.

The "Deterministic Results" shown in Figure 4-1 is an example of the results shown in the *RealCost Version 2.5CA* generated "Report". Alternative 1 is a Rehabilitation using an HMA, and Alternative 2 is CAPM using HMA.

Deterministic Results

Total Cost	Alternative 1:		Alternative 2:		Alternative 3:		Alternative 4:	
	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)	Agency Cost ($1000)	User Cost ($1000)
Undiscounted Sum	$23,336.67	$18,312.16	$20,440.50	$12,358.68				
Present Value	$15,529.71	$11,350.38	$10,342.97	$6,742.07				
EUAC	$494.21	$361.21	$420.74	$214.55				

Figure 4-1 Deterministic Results from *RealCost Version 2.5CA* Report

With the deterministic approach, life-cycle costs are computed based on the present values of the comparison of the differential pavement alternative costs. The results are a single present value for each pavement alternative.

Best-practice LCCA considers both, agency and user costs. User costs should also be compared to see if an alternative has a disproportionately high or low impact on users compared to other alternatives. If the lowest-agency-cost alternative has a disproportionately high user-cost impact, the engineer may use this information to revisit that alternative to mitigate user costs, or may recommend that an alternative with somewhat higher agency costs but much lower user costs be pursued in preference to the lowest-agency-cost (FHWA 2002).

In the example shown in Figure 4-1, the engineer should determine if there is a way to lower the User Costs for Alternative 1. Perhaps, by improving the traffic management plan the User Costs could be lowered.

4.5 *RealCost* Output Values

The deterministic outputs produced from *RealCost* are categorized by Undiscounted Sum, Present Value, and EUAC and by Agency and User costs.

- *Undiscounted Sums* are the costs as if all the costs occurred today. This is not relevant to the analysis result since all of the costs will not incur upfront.
- *Present Value* is all of the future expenditures over the analysis period converted to present value dollars. Caltrans use this approach to compare alternatives.
- *EUAC* or equivalent uniform annual costs are the total costs discounted to present value divided by the analysis period. In other words, it is the yearly costs of an alternative as if they occurred uniformly throughout the analysis period. This is not relevant to the analysis since costs will not expend uniformly.

4.6 Document the Preferred Pavement Alternative

Other than the mandatory design standards detailed in Topic 612, "Pavement Design Life," of the HDM, there is no absolute requirement to choose the pavement alternative with the lowest total life-cycle cost, although it is strongly encouraged. **If the lowest total life-cycle cost is not selected, reason must be documented.** Some possible reasons that another alternative other than the one with the lowest life-cycle cost might be chosen include safety, scope, schedule, constructability, environmental, accommodation of future growth or capacity improvements, or political reasons. LCCA project decisions should be documented in the PID, PR, or other appropriate project document (see PDPM Appendix O-O).

4.7 Status of LCCA Procedures Manual

This manual includes a variety of tables and data developed for Caltrans engineers to run the *RealCost Version 2.5CA* program. The data found in this manual are based on the most accurate information available at this time from Caltrans data, computer traffic modeling, FHWA, and other sources. Data and modeling updates will be made from time to time to improve the user-friendliness of LCCA process and the accuracy of the results. In particular, cost data will change periodically to reflect market fluctuation, inflation, and policy changes. Future updates of this manual will strive to capture the most accurate information available and meet changing needs and conditions.

4.8 Additional Information

Visit the LCCA website for LCCA examples, current economic values, and other examples.

4.9 Transmittal of Life-Cycle Cost Information

Submit your LCCA to HQ for data collection. Per PDPM Appendix O-O, a copy of the completed project initiation document, project report, or project scope summary report with life-cycle costs included shall be sent to:

Attn: HQ Program Advisor
HQ Division of Maintenance, Pavement Program
2389 Gateway Oaks, Suite 200, MS 91
Sacramento, CA 95833

or

e-mail PDF files to
LCCA@dot.ca.gov