# PAVEMENT SELECTION PROCESS FOR RAPID CITY

# PUBLIC WORKS COMMITTEE

# FEBRUARY 12, 2008

The choosing of a pavement type (asphalt or concrete) is a task that can be quantified and completed ahead of the project going to bid. This pavement selection is determined by using historical costs with future expected maintenance to determine the best economic pavement for the citizens of Rapid City. This process is called **Life Cycle Cost Analysis** (LCCA). The logic behind the selection is done with an understanding that each pavement is designed with equivalent sections therefore allowing them to be compared over time.

The Rapid City economic environment is solid and growth is continuing at a faster pace even as our national economies are slowing down. Therefore as public servants your decisions on your city's infrastructure will be felt for many years.

It is with this premise that I want to present to you a process that has been tried and proven across cities, counties, states and even national projects.

As your Public Works Department looks at future infrastructure needs to new facilities a preliminary design of pavements can be accomplished. The needed imputs are: ADT- Average Daily Traffic, ATT- Average Truck Traffic, geotechnical reports on soils, and a typical cross section of the geometrics needed to handle the traffic. With these imputs an engineer using pavement design software tendered with proven performance of past designs can design the required surfacing thicknesses. Each imput is critical to determine the correct thickness. Also used is the length of time this facility will need to function as with all improvements they have an expected length of service life. With each design a degree of reliability is assigned.

Knowing these parameters can lead us to answer the questions of best value for each individual capitol improvement project. Let's take a look at **LCCA** in more depth.

# LIFE CYLCE COST ANALYSIS

Life Cycle Cost Analysis (LCCA) is a procedure to economically compare competing design alternates considering all significant costs and benefits over the economic life of each alternate. LCCA equates all present and future costs (and benefits) over the life of a project by accounting for the effects of the time value of money. Because life cycle costing compares alternates, it is necessary that **each alternate be equivalently designed** and provides **similar performance results.** Comparing alternates that do not provide similar performance results is neither realistic nor reliable because the two alternates are not equivalent. An economic assessment between non-equivalent alternates yields erroneous results.

Present Worth (PW) and Equivalent Uniform Annual Cost (EUAC) are the two most common methods to express the time value of money. PW is the sum of all costs over the project life in today's dollars. It combines initial costs with the anticipated costs of the future rehabilitation. Future costs are discounted to present costs using the discount rate. Present worth analysis is limited to comparisons of alternates with equal service lives.

EUAC spreads all costs (initial, rehab, and anticipated rehab) to an annual cost over the analysis period. EUAC is advantageous because it more effectively compares alternates with different service lives.

The fundamental factors that should be considered in LCCA are:

- Agency costs (initial cost, rehab and operation costs and maintenance costs
- Discount rate
- Rehabilitation election and service life between rehabilitations
- Comparable sections
- Analysis Period
- User costs

Other factors, such as construction duration, rideability over time, safety, and environmental friendliness can also enter pavement type selection. However, it is difficult to relate these factors to cost or performance and put them into an economical analysis.

# LIFE-CYCLE COST ESTIMATING WORKSHEET

Enter Initial Analysis Year: 2008
Enter Analysis Period: 30
Enter Annual Discount Rate, %: 4.00

Project Identification: Eglin Street
Rapid City SD

| | | | | Alternative 1 Project Description: | | Alternative 2 Project Description: | |
|---|---|---|---|---|---|---|---|
| **Initial Costs** Item No. | Item Description | Analysis Year | Calendar Year | Estimated Cost | Present Worth | Estimated Cost | Present Worth |
| 1 | Asphalt Concrete Alternate | 1 | 2008 | $1,746,481 | $1,746,481 | | |
| 2 | PCC Pavement Alternate | 1 | 2008 | | | $1,907,739 | $1,907,739 |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| **Total Present Worth of Initial Costs** | | | | $1,746,481 | $1,746,481 | $1,907,739 | $1,907,739 |
| **Periodic Costs** Item No. | Item Description | Analysis Year | Calendar Year | Estimated Cost | Present Worth | Estimated Cost | Present Worth |
| 1 | Crack Seal | 2 | 2010 | $3,000 | $2,774 | | |
| 2 | Chip Seal | 3 | 2011 | $30,000 | $26,670 | | |
| 3 | Mill & Overlay | 14 | 2022 | $396,000 | $228,680 | | |
| 4 | Crack Seal | 16 | 2024 | $3,000 | $1,602 | | |
| 5 | Chip Seal | 17 | 2025 | $30,000 | $15,401 | | |
| 6 | Mill & Overlay | 27 | 2035 | $396,000 | $137,339 | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | Minor Joint and Spall Repair | 18 | 2026 | | | $40,000 | $19,745 |
| 15 | Major Joint and Spall Repair | 30 | 2038 | | | $100,000 | $30,832 |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| **Total Present Worth of Periodic Costs** | | | | | $412,466 | | $50,577 |

| | | First Yr. of Ann. Costs | | Last Yr. of Ann. Costs | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Annual Costs** Item No. | Item Description | Analysis Yr. | Cal Yr | Analysis Yr | Cal Yr | Estimated Annual Cost | Present Worth | Estimated Annual Cost | Present Worth |
| 1 | Maint Activity for Alt 1 | 1 | 2009 | 40 | 2048 | $2,578 | $51,026 | | |
| 2 | Maint Activity for Alt 2 | 1 | 2009 | 40 | 2048 | | | $1,800 | $35,627 |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| **Total Present Worth of Annual Costs** | | | | | | | $51,026 | | $35,627 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Replacement/Salvage Value** Item No. | Item Description | Analysis Year | Calendar Year | Estimated Value | Present Worth | Estimated Value | Present Worth |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| **Total Present Worth of Replacement/Salvage Value** | | | | | $0 | | $0 |

| **TOTAL LCC** | Alternative 1 | Alternative 2 |
|---|---|---|
| **Present Worth LCC** | $2,209,973 | $1,993,943 |
| **Equivalent Uniform Annual LCC** | $127,803 | $115,310 |

| | | |
|---|---|---|
| **Lowest LCC Alternative** | | **Alternative 2** |
| **PW Cost Difference From Lowest LCC Alternative** | $216,030 | $0 |
| **% Difference From Lowest LCC Alternative** | 11 | 0 |

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