Determining the Value of Information in Asset Management Decisions

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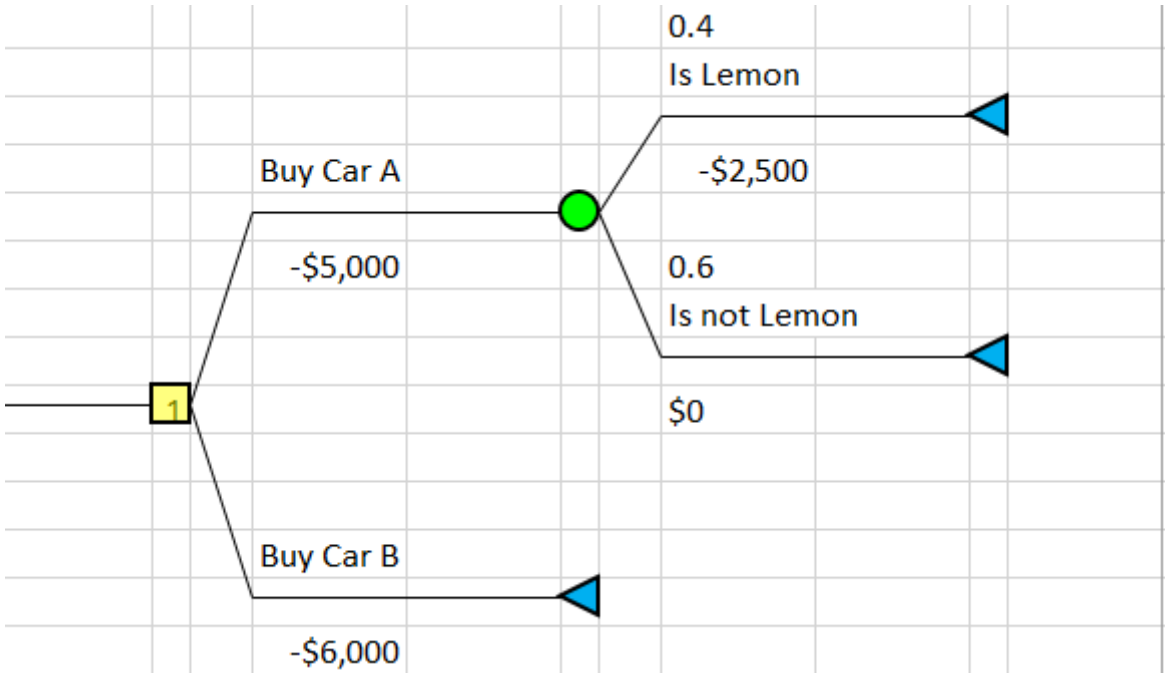
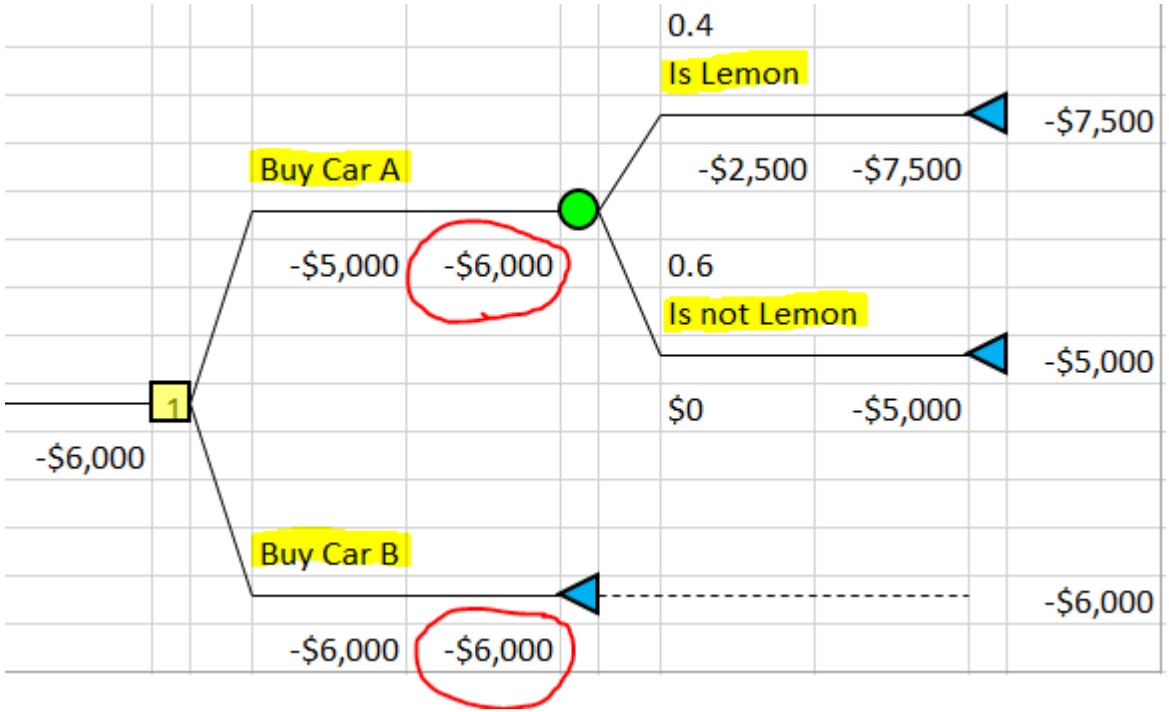
Simple Decision Tree

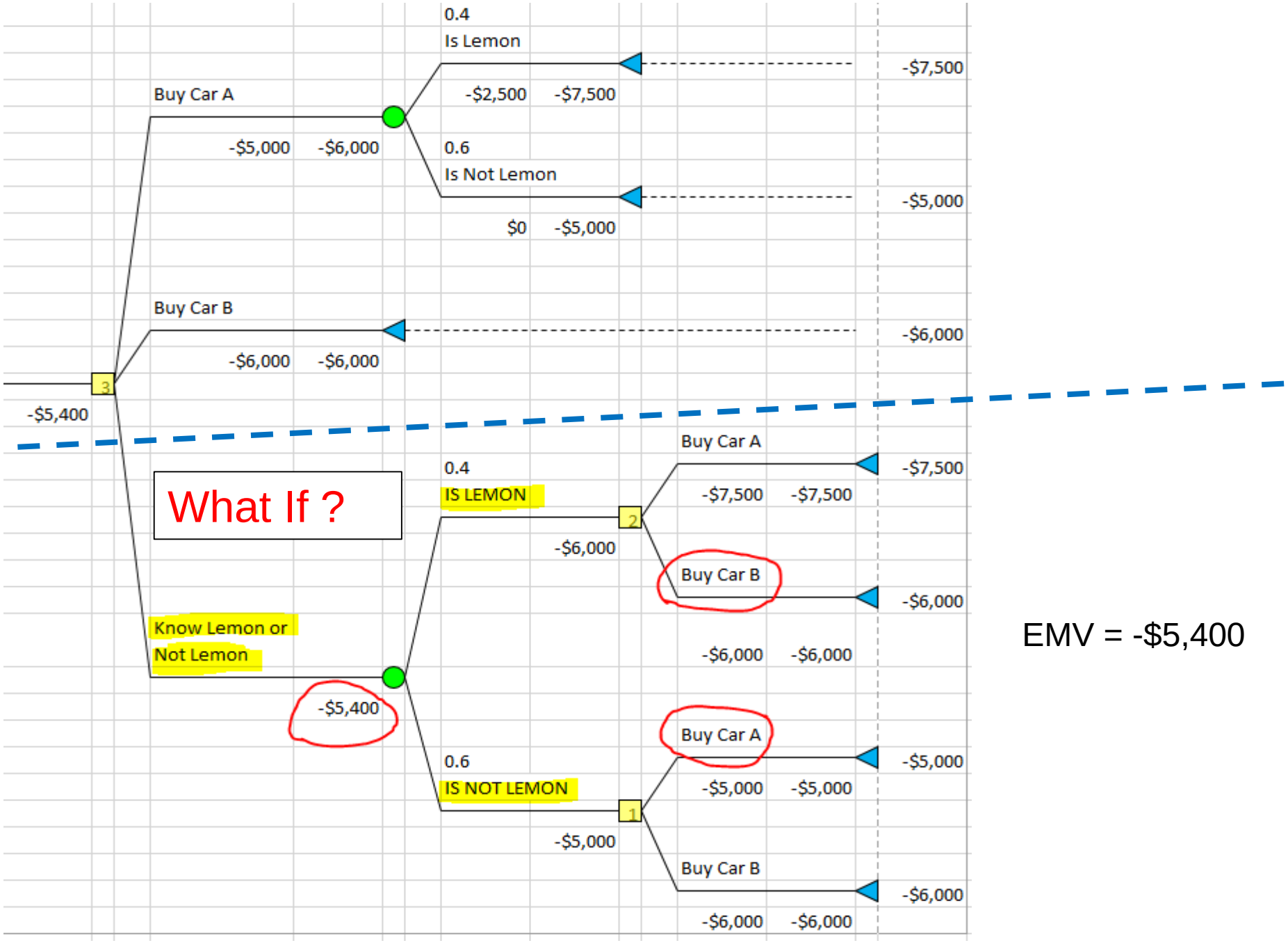


Solve by calculating Expected Monetary Value (EMV)

Decision Tree (cont.)



EMV of Buying Car A and Buying Car B are identical (EMV = -$6,000)


0.4
Is Lemon
-$7,500
Buy Car A
-$2,500
-$7,500
-$5,000
-$6,000
0.6
Is Not Lemon
-$5,000
$0
-$5,000
Buy Car B
-$6,000
-$6,000
-$6,000
3
-$5,400
Buy Car A
0.4
IS LEMON
-$7,500
-$7,500
-$7,500
2
-$6,000
What If ?
Buy Car B
-$6,000
Know Lemon or
Not Lemon
-$6,000
-$6,000
-$5,400
Buy Car A
0.6
IS NOT LEMON
-$5,000
-$5,000
-$5,000
1
-$5,000
Buy Car B
-$6,000
-$6,000
-$6,000

EMV = -$5,400

Value of Information

<u>Expected Value of Perfect Information (EVPI)</u>

$$EVPI = EMV_{(Perfect\ Information)} - EMV_{(Baseline)}$$

$$EVPI_{(car\ buy)} = -\$5{,}400 - (-\$6{,}000)$$

$$= \$600$$

Value of Information Analysis in Related Applications

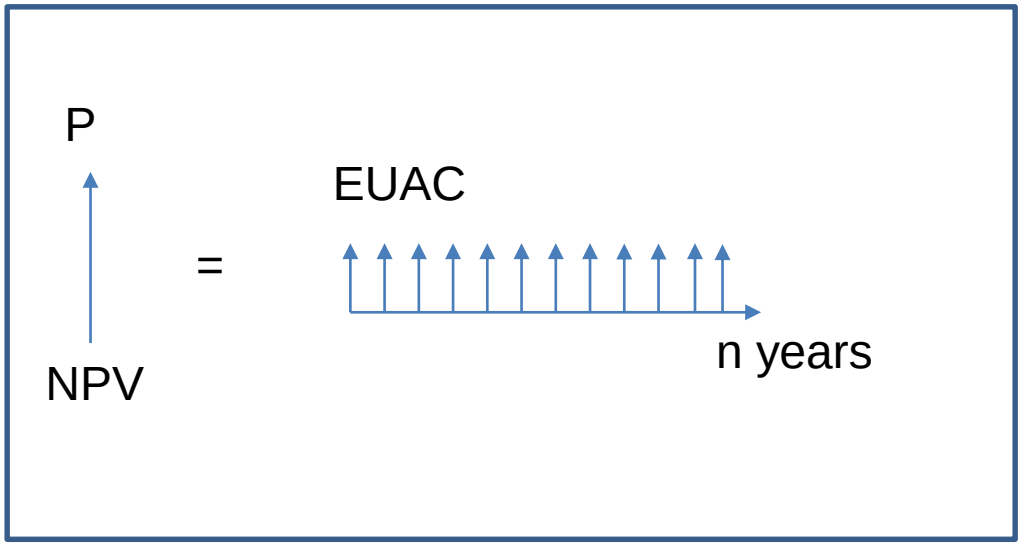
Medicine

- Used to evaluate the value of expensive tests and procedures that are important to medical decisions
- Important in determining the cost-effectiveness of medical procedures

WSDOT Key Performance Measure: Cost-Effectiveness

- The principal objective of WSDOT's pavement management program is to deliver acceptable performance at the lowest life-cycle cost
- The thresholds of the "acceptable performance" are established by several metrics: roughness, rutting, faulting, friction and pavement distress.
- Life-cycle cost is evaluated using Equivalent Uniform Annual Cost (EUAC) ($ per lane-mile per year)

Equivalent Uniform Annual Cost (EUAC)

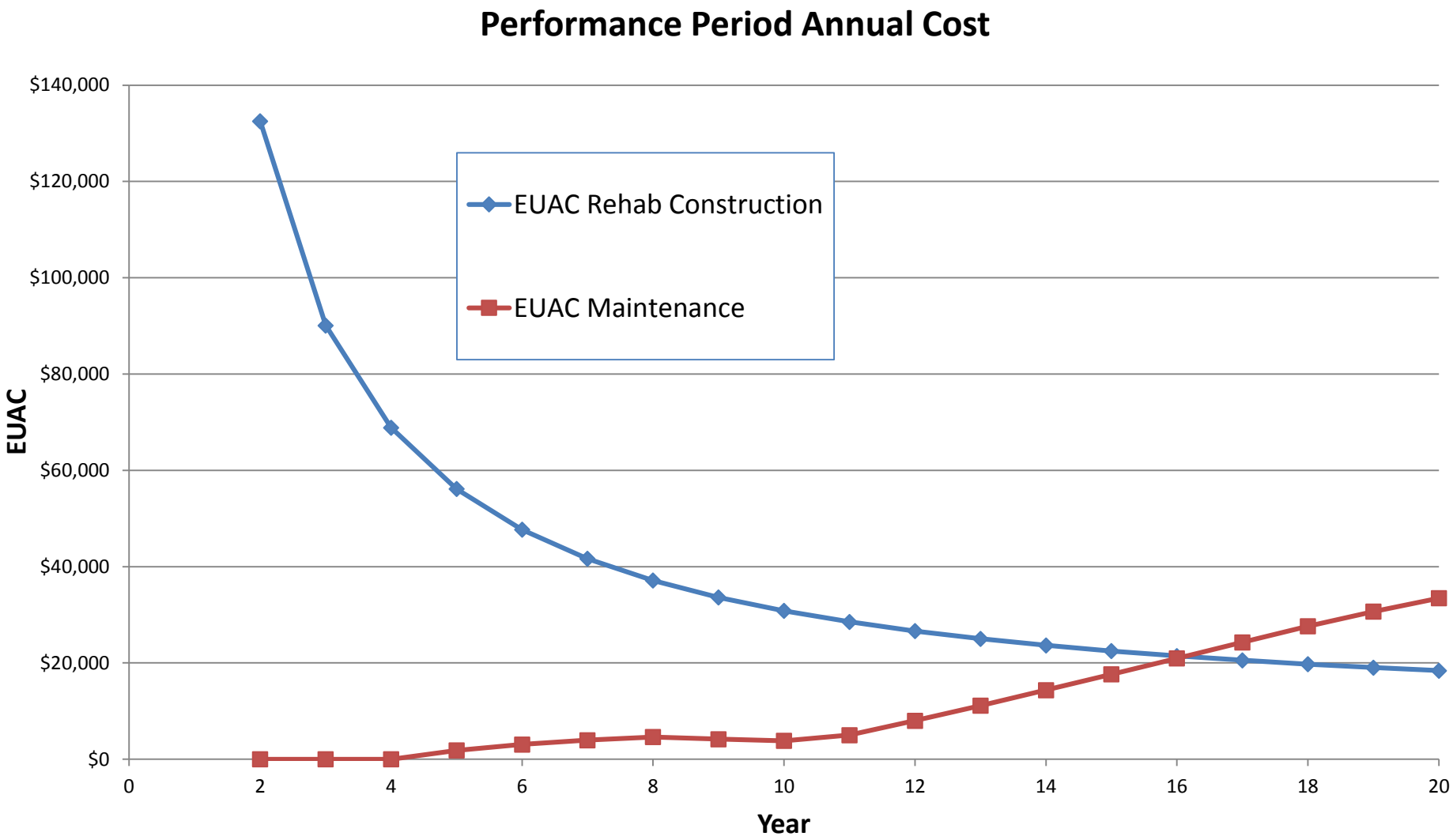


$$EUAC = P \frac{i(1+i)^n}{(1+i)^n - 1}$$

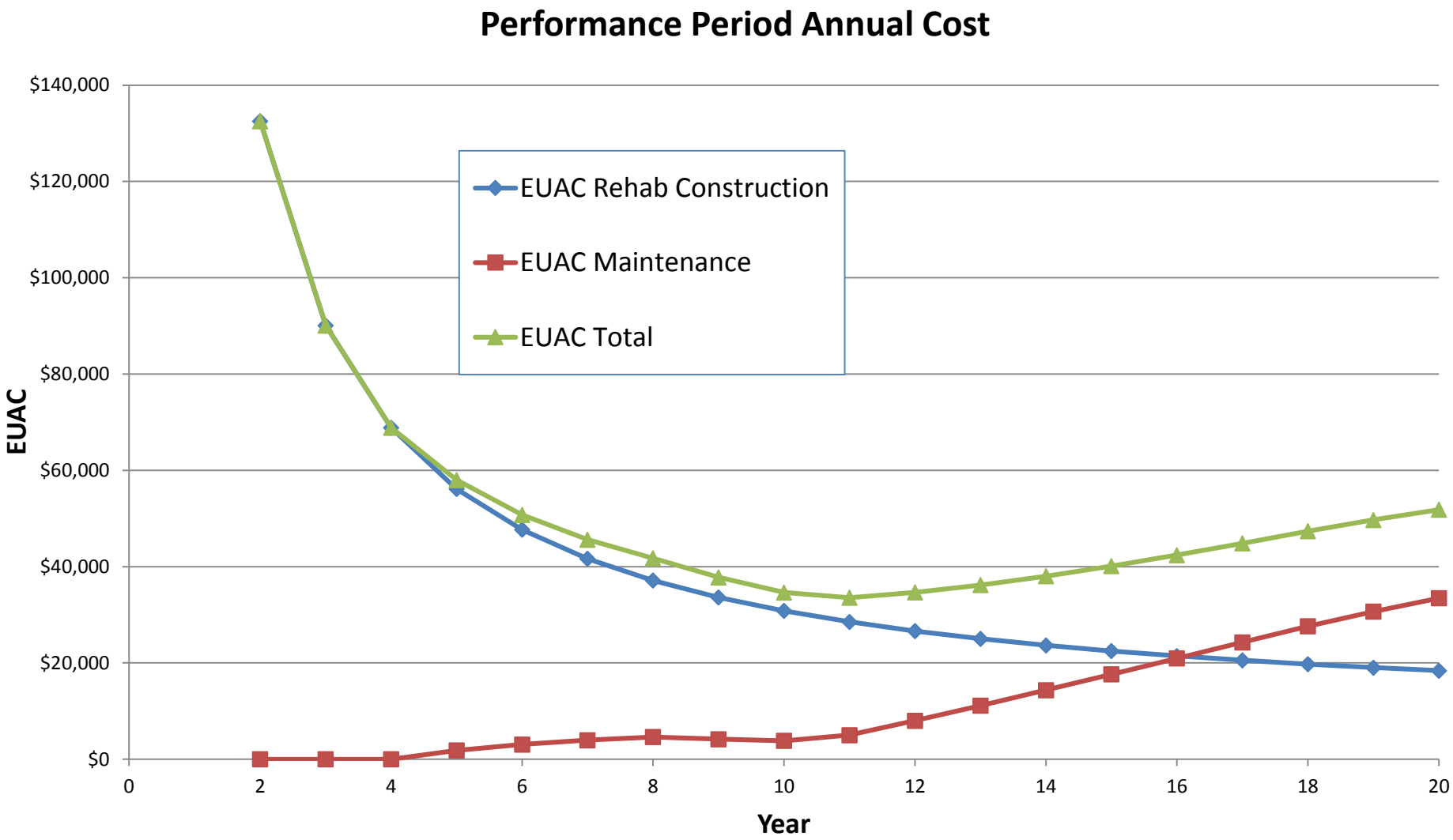
where

P = Present Value of all costs
i = Discount Rate = 4%
n = number of years

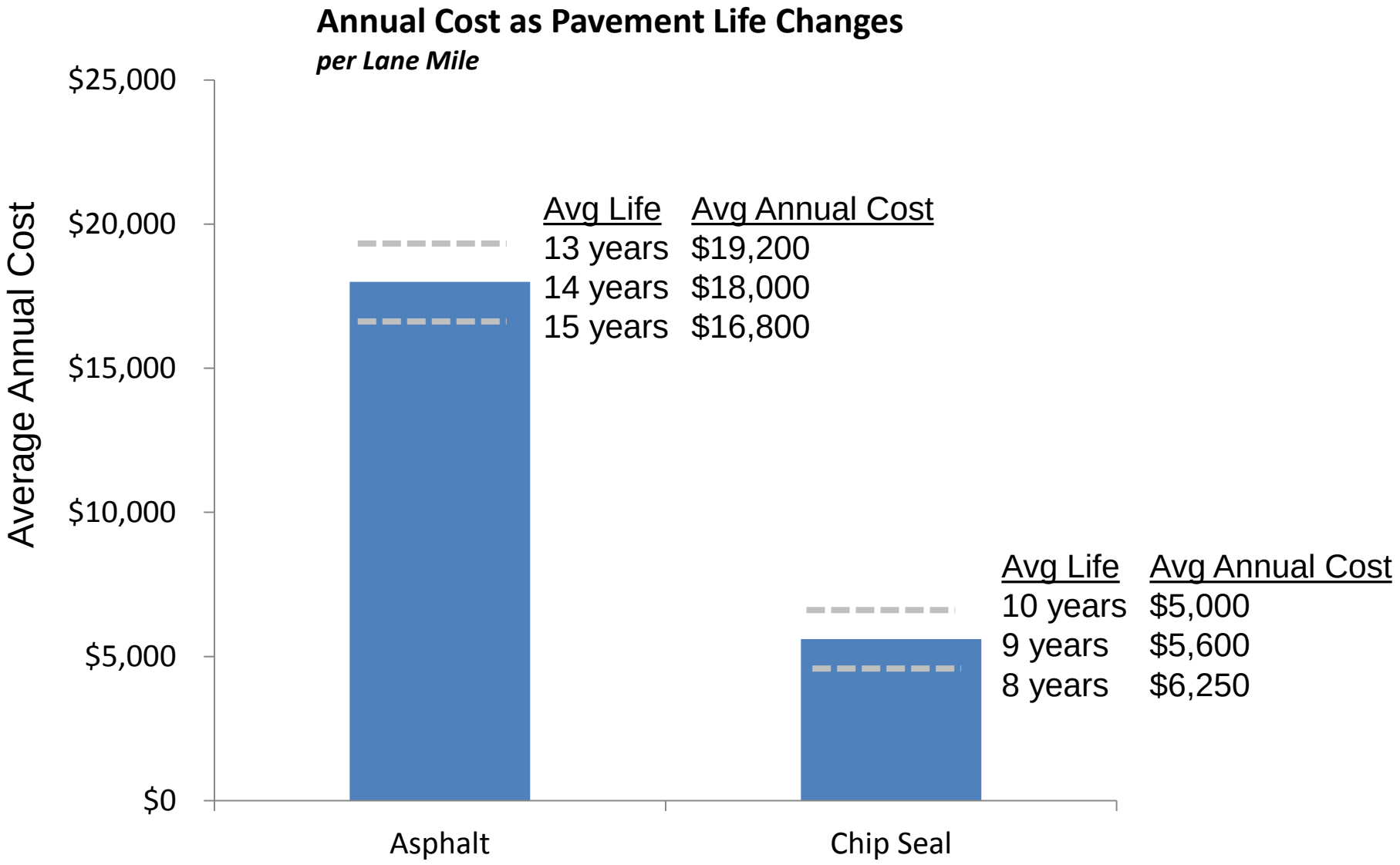
EUAC vs. Time


Performance Period Annual Cost
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
EUAC
0
2
4
6
8
10
12
14
16
18
20
Year
EUAC Rehab Construction
EUAC Maintenance

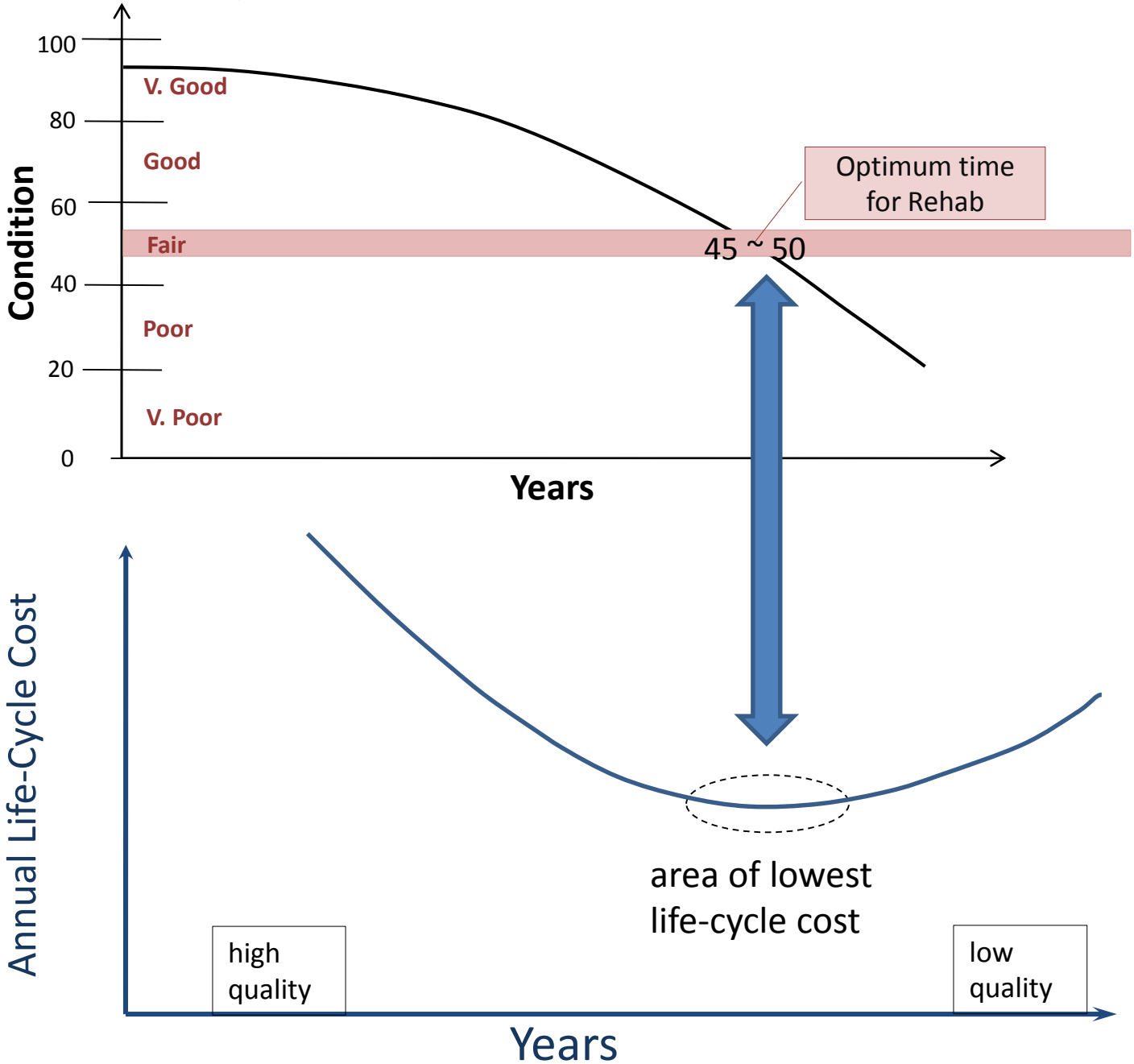
EUAC vs. Time (cont.)



Effect of One Year Difference in Pavement Life

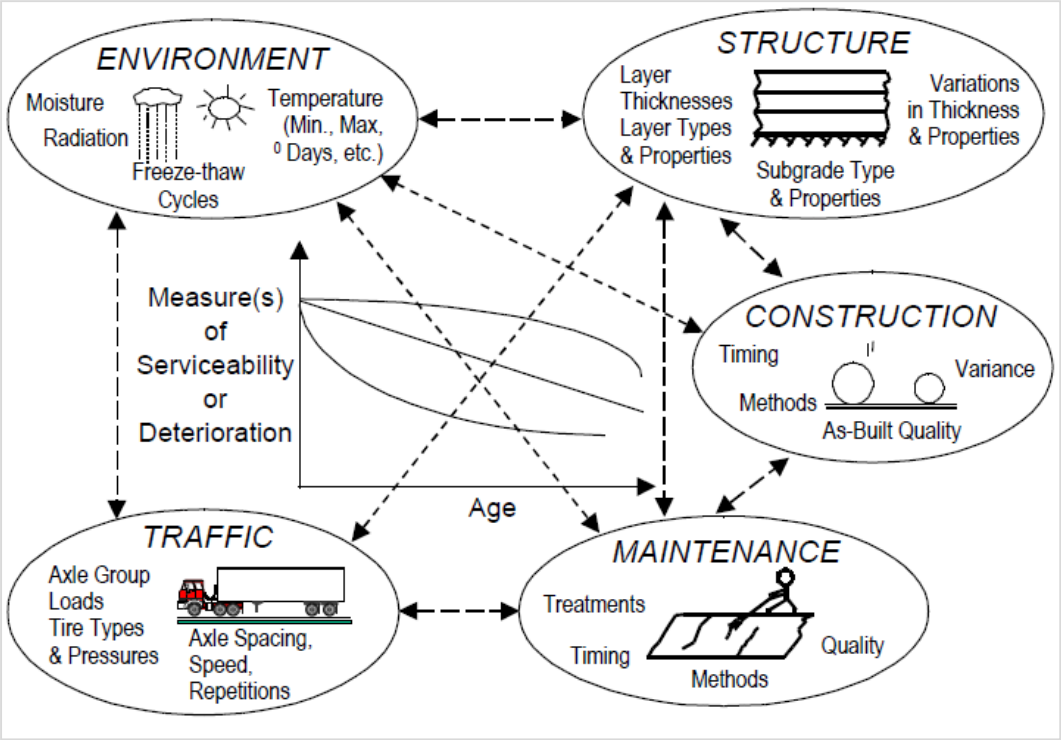


Pavement Quality and LLCC

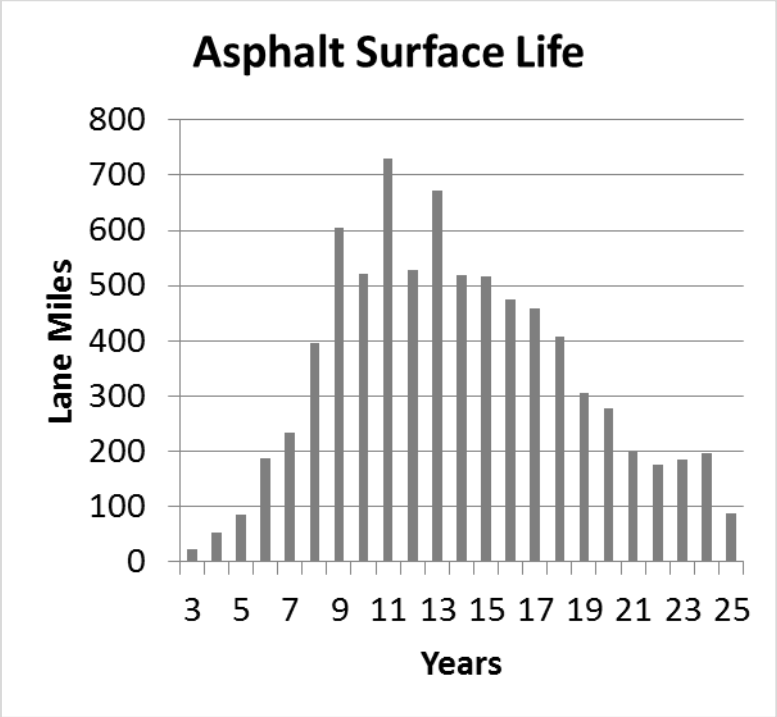


Variability

Significant variability in pavement life due to variability in conditions. Because of this, WSDOTdoes <u>close monitoring on a site specific basis</u>.

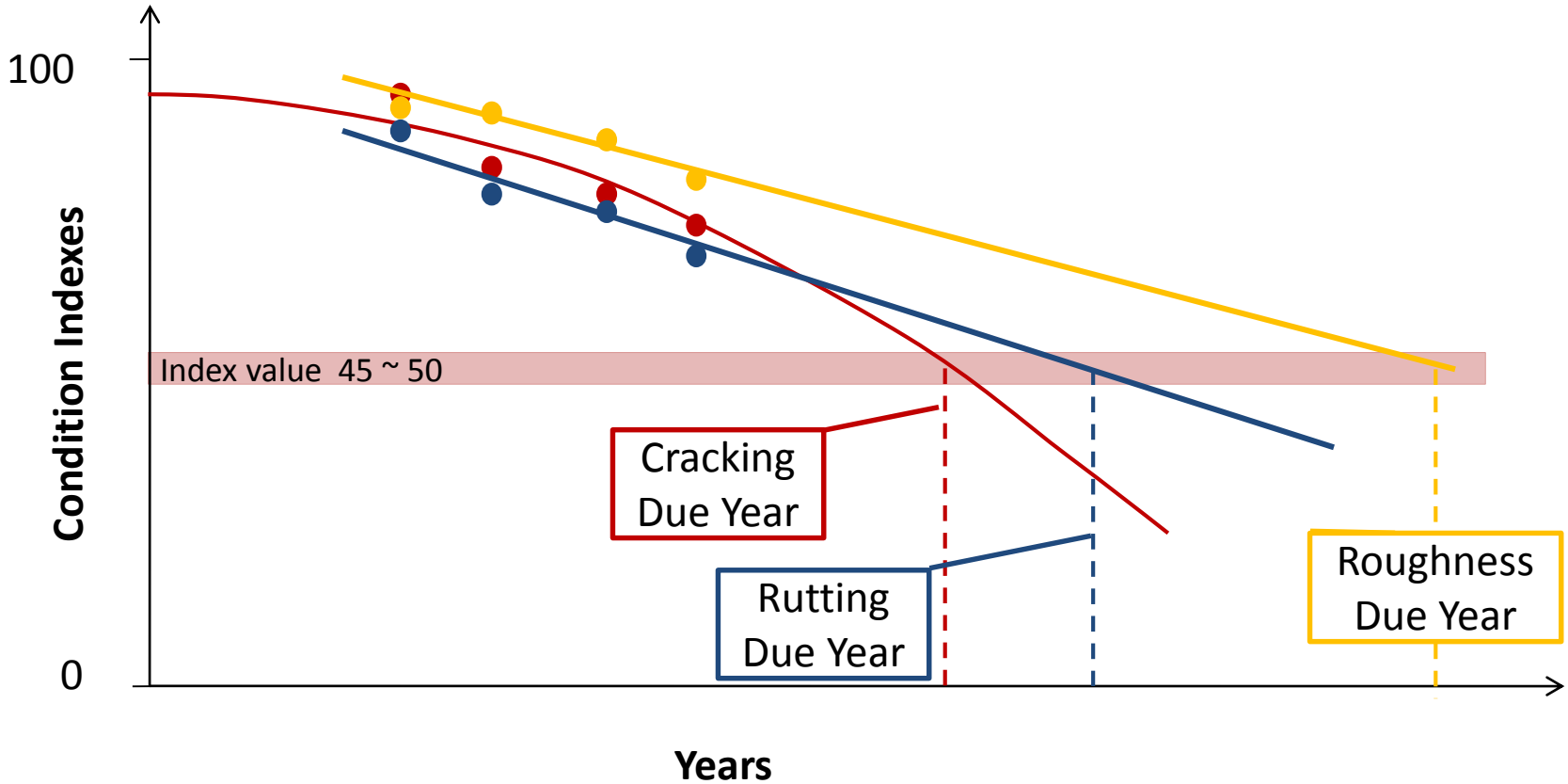


Factors affecting pavement performance (after Haas 2001)



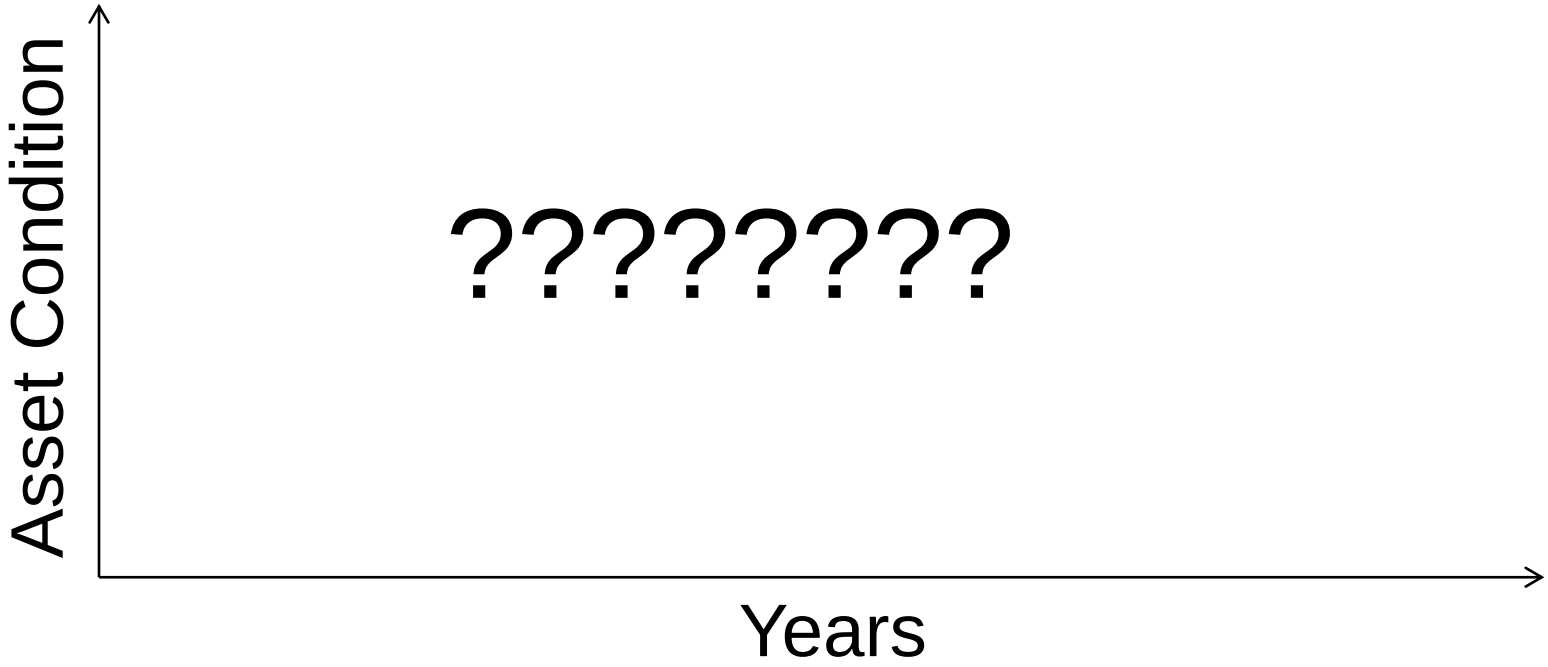
Variability in asphalt surface life for WSDOT

Determining Time to Rehabilitation



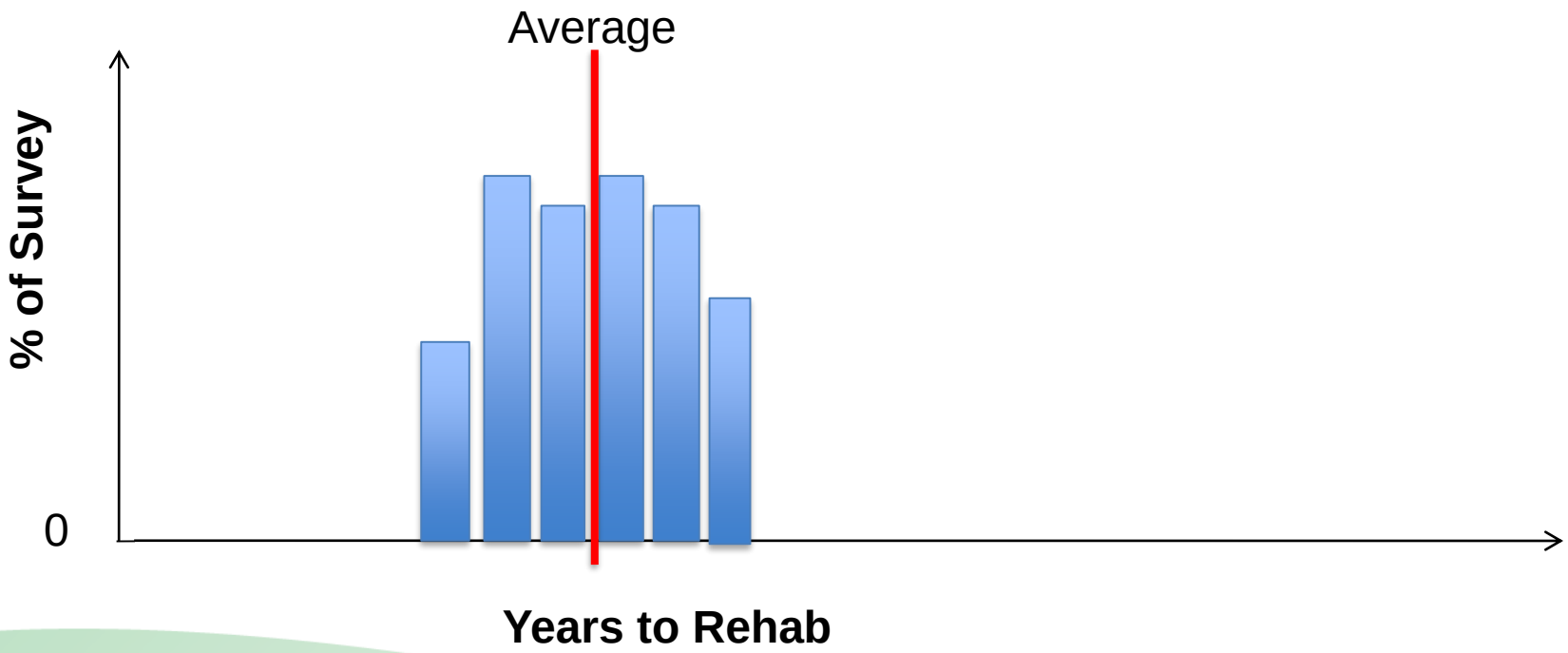
- The Due Year is the <u>minimum</u> of the three condition due years.

What About Assets without Condition History?



Assets without Condition History?

Estimate time to rehab based on group opinion?



How Important is Condition History?

- Assets are replaced primarily due to condition (ability to function). Age is correlated, but lots of variability.
- What is the value of condition history data, versus using age alone?

Cost of Incorrect Rehab Timing

Rehab Timing	6 years early	3 years early	On Time	3 years late	6 years late
Year of Rehab	9	12	15	18	21
Cost of Rehab	$250k	$250k	$250k	$350k	$900k
EUAC	$27,900	$24,900	$22,500	$23,300	$32,600
% higher than lowest	24.2%	10.6%	---	3.6%	44.9%

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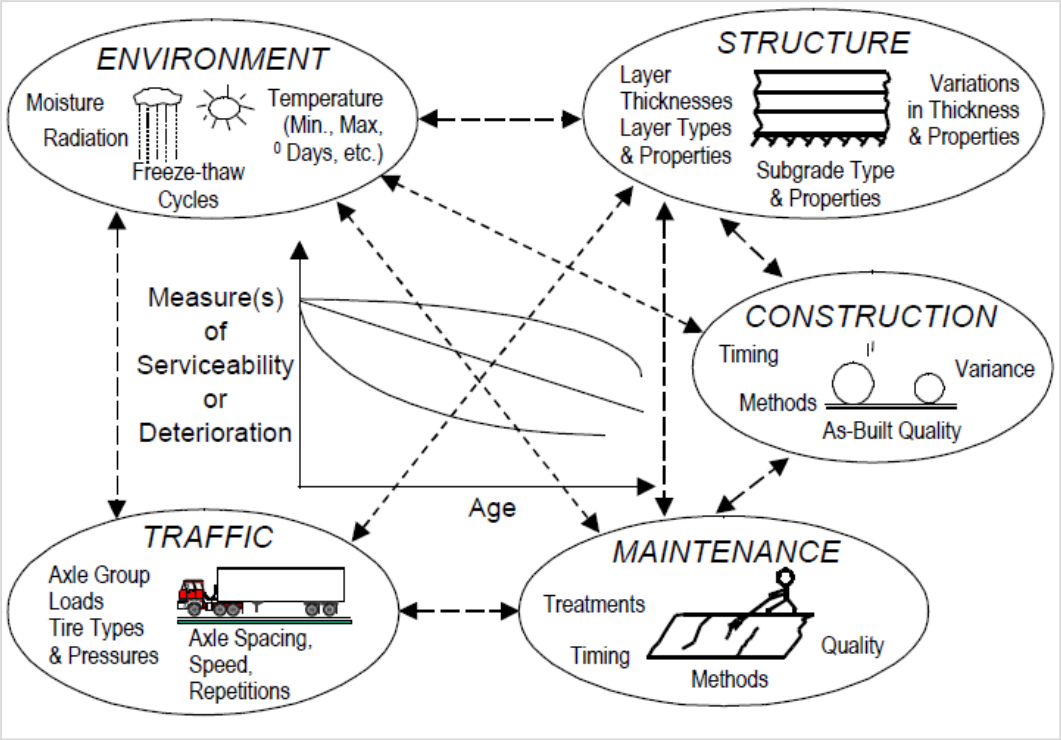

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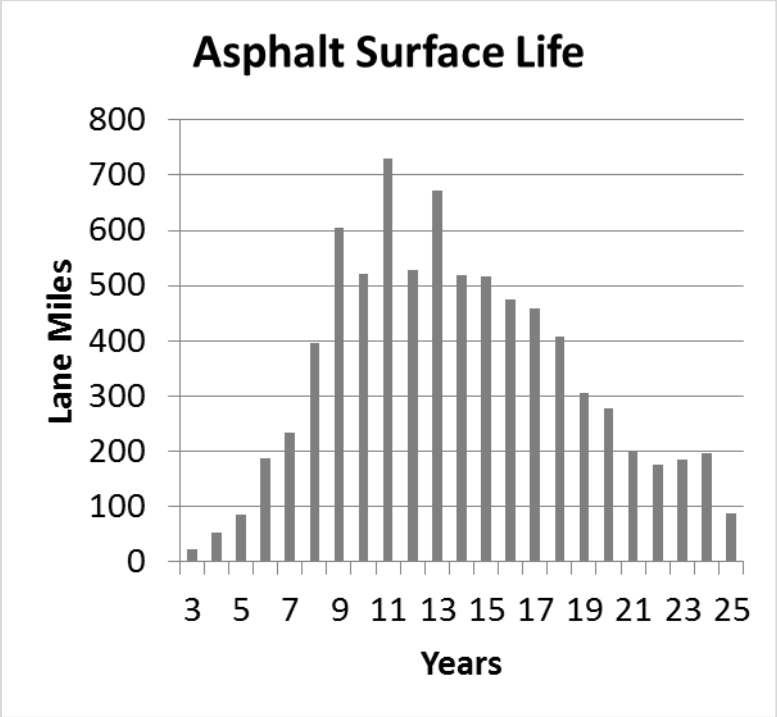
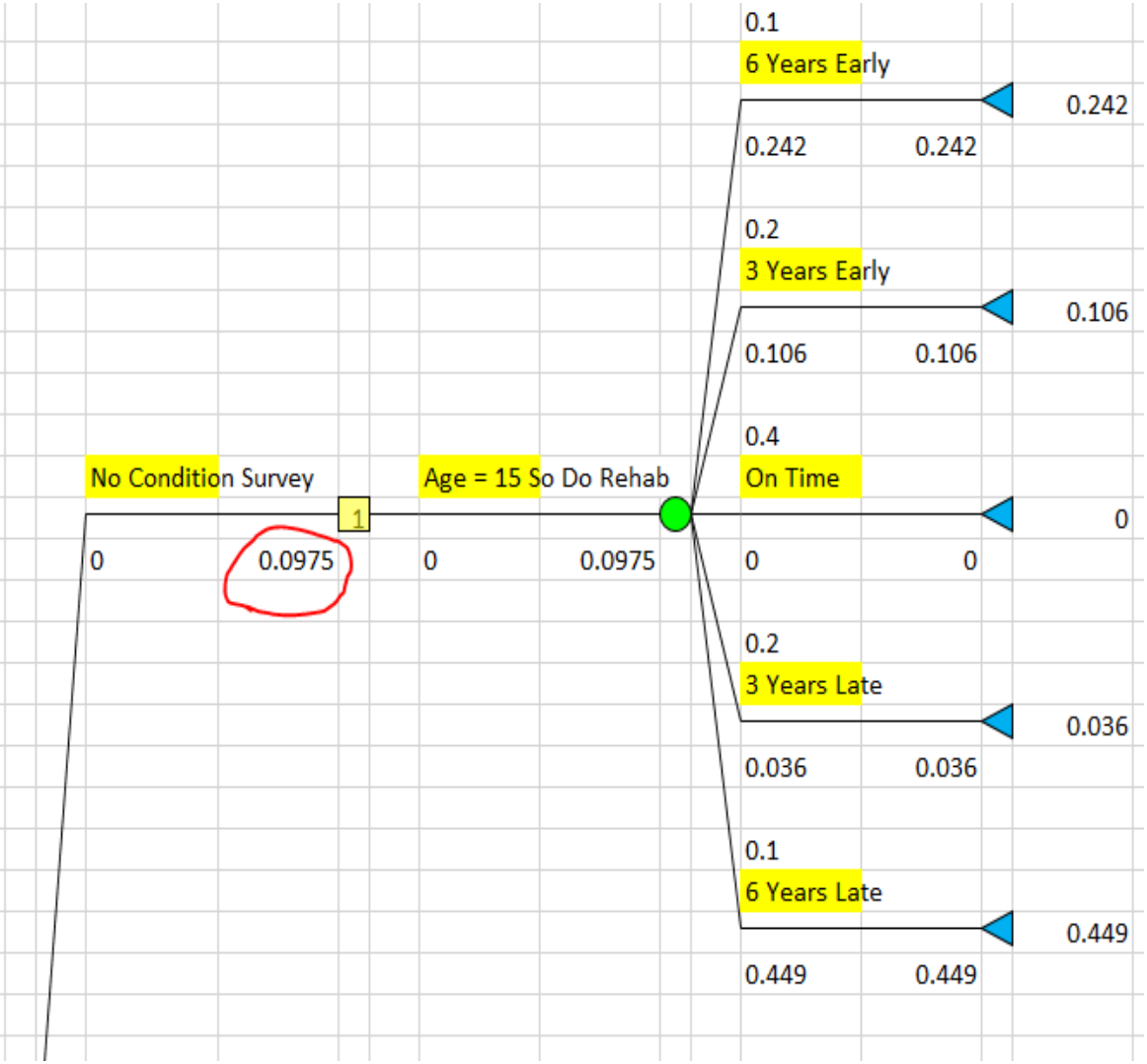


Variability in asphalt surface life for WSDOT

Comparing No Condition Survey with Condition Survey

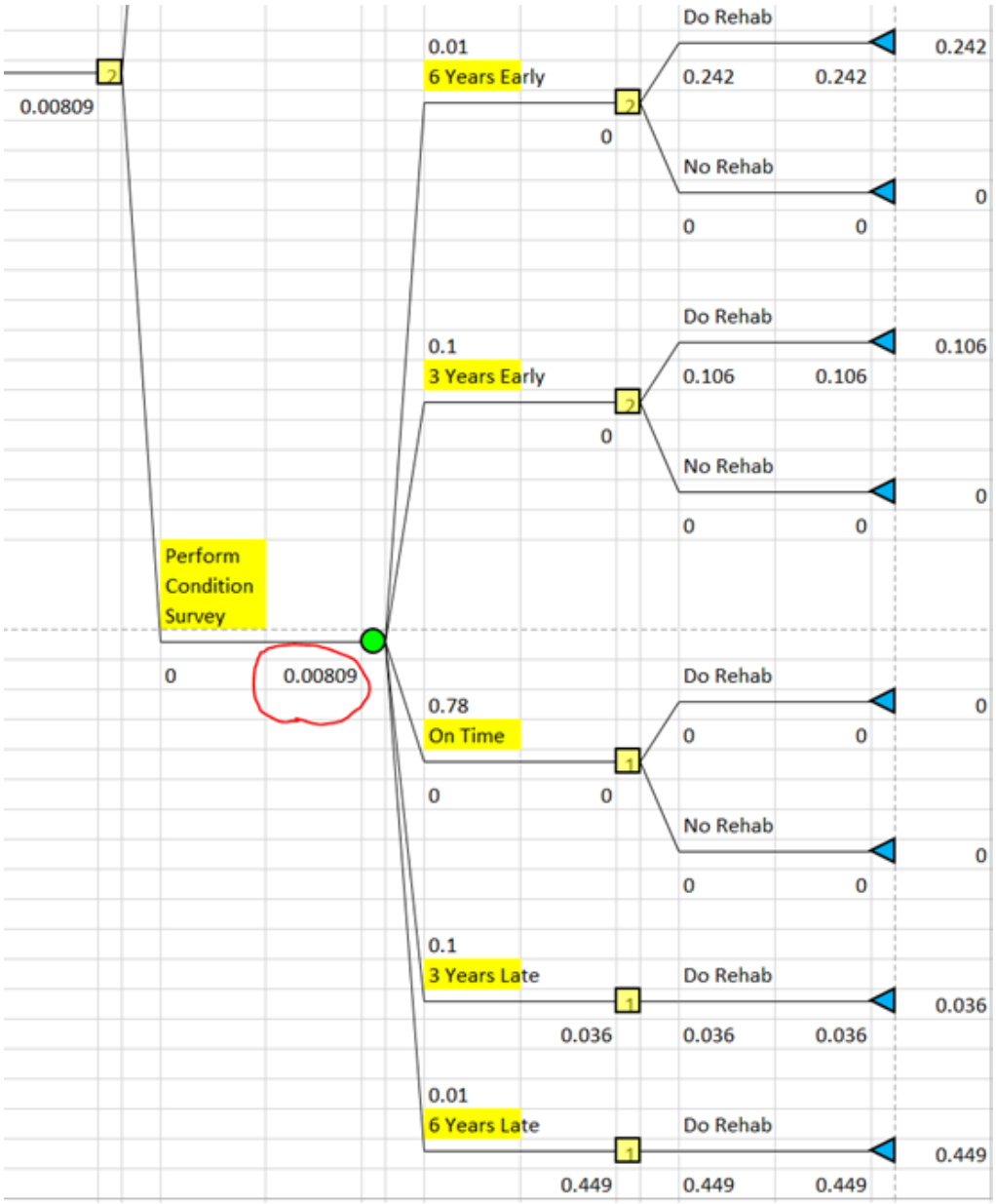


Expected Value with No Condition Survey

= 9.75% additional cost

x $150 mill = $14.6 million

Comparing No Condition Survey with Condition Survey



Expected Value
with Condition Survey

= 0.89% additional cost

x $150 mill = $1.3 million

Expected Value of Imperfect Information (EVII)

EVII = $14.6 mill - $1.3 mill

EVII = $13.3 mill

Cost of
Pavement Management = $1 mill

Value of Information to Cost Ratio = 13.3 to 1

Conclusions

- Value of Information is an example of a Decision Analysis tool that is very useful in analyzing asset management decisions.

- Many more Quantitative Analysis tools are available (Linear Programming, Dynamic Programming, Utility Theory, Sensitivity Analysis, etc.) that can be applied to asset management decisions.

- Quality data for making decisions is important, and can be justified using techniques like Value of Information.

Questions?

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