Cost-Effective Pavement Performance Management of Indiana's Enhanced NHS through Strategic Modification of the Pavement Rehabilitation Treatment Trigger Values

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Expansion of the National Highway System

• Because of the MAP-21 legislation, the NHS now includes all principal arterials, intermodal connectors and the STRAHNET.

• Nationally,
  ▪ Expansion from 164,000 to 224,000 center-line miles (1)
Challenge of preserving the NHS

• The National Highway Performance Program was created as a dedicated funding source.

• A performance-based approach is expected to maximize the benefit of allocated funding.
Purpose for the Forthcoming Analysis

- States must explore what condition outcomes can be expected from different network preservation strategies.

- Examine the potential for leveraging treatment trigger levels to obtain better outcomes at the same funding level.
CURRENT CONDITION
Indiana’s National Highway System

• **Current:**
  - Length ~ 4800 center-line miles
  - 25 billion VMT for 4-tire vehicles
  - 7.5 billion VMT for trucks

• **Anticipated for the year 2029:**
  - 32 billion VMT for 4-tire vehicles
  - 10 billion VMT for trucks
Current pavement condition

- **Total Network Life**: ~66,400 mile-years
  - 25\textsuperscript{th} percentile: 8.3 years
  - 50\textsuperscript{th} percentile: 14.6 years
  - 75\textsuperscript{th} percentile: 20.0 years
  - RSL<5 years: 16.2% miles
ANALYSIS FRAMEWORK
Optimum Work Plan Problem:

- **Objective**: Minimize User Cost due to poor network condition

- **Constraint**: Candidate list of projects

**Outcomes**

1) Remaining Service Life for the Pavement Network
2) Vehicle operating costs

- **Agency Expenditure**

- **Controlled by the Treatment triggers**
Analysis Parameters – Trigger Values

• Triggers expressed in terms of PSR condition to enable the uniform shift in trigger values for treatments of similar intensity.

• PSR has good correlation with IRI and also captures the magnitude of non-roughness distresses on a pavement section.
The Medium Level Trigger Policy is an approximation of INDOT’s current policy in identifying sections eligible to receive rehabilitation.

<table>
<thead>
<tr>
<th>Trigger Policy Label</th>
<th>Heavy Rehabilitation Trigger (PSR)</th>
<th>Heavy Rehabilitation Trigger (equivalent IRI in inches/mile) (3)</th>
<th>Moderate Rehabilitation Trigger (PSR)</th>
<th>Moderate Rehabilitation Trigger (equivalent IRI in inches/mile) (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2.3</td>
<td>156</td>
<td>2.9</td>
<td>129</td>
</tr>
<tr>
<td>Medium</td>
<td>2.4</td>
<td>151</td>
<td>3.0</td>
<td>126</td>
</tr>
<tr>
<td>High</td>
<td>2.5</td>
<td>146</td>
<td>3.1</td>
<td>122</td>
</tr>
</tbody>
</table>
RESULTS
HORIZON YEAR: 2029
Total Pavement Network Service Life (mile-years)

- **Funding Effect**
  - Increase in Network Life (for each additional $10 million annual investment)

<table>
<thead>
<tr>
<th>Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>3179</td>
</tr>
<tr>
<td>Medium</td>
<td>3130</td>
</tr>
<tr>
<td>High</td>
<td>3181</td>
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</tbody>
</table>

- **Trigger Effect at low funding levels**
  - Low to Medium: +3300
  - Medium to High: +2200
  - Low to High: +5500

- **Trigger Effect at high funding levels**
  - Low to Medium: +2600
  - Medium to High: +2900
  - Low to High: +5500
25th Percentile RSL

- Funding Effect
  Increase in Network Life (for each additional $10 million annual investment)

<table>
<thead>
<tr>
<th>Level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.85</td>
</tr>
<tr>
<td>Medium</td>
<td>0.89</td>
</tr>
<tr>
<td>High</td>
<td>0.95</td>
</tr>
</tbody>
</table>

- Trigger Effect at high funding levels
  - Low to Medium: +0.75 year
  - Medium to High: +0.75 year
  - Low to High: +1.5 years

-A higher trigger policy is more efficient in increasing the 25th percentile pavement RSL per unit of increased funding.
50th Percentile RSL

- **Funding Effect**
  
  Increase in Network Life (for each additional $10 million annual investment)

<table>
<thead>
<tr>
<th>Low</th>
<th>0.57</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>0.52</td>
</tr>
<tr>
<td>High</td>
<td>0.52</td>
</tr>
</tbody>
</table>

- **Trigger Effect at low funding levels**
  - Low to Medium: +1 year
  - Medium to High: +0.75 year
  - Low to High: +1.75 years

- **Trigger Effect at high funding levels**
  - Low to Medium: +0.5 year
  - Medium to High: +0.8 year
  - Low to High: +1.3 years
75th Percentile RSL

- **Funding Effect**
  Increase in Network Life (for each additional $10 million annual investment)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Low</td>
<td>0.63</td>
</tr>
<tr>
<td>Medium</td>
<td>0.6</td>
</tr>
<tr>
<td>High</td>
<td>0.59</td>
</tr>
</tbody>
</table>

- **Trigger Effect at low funding levels**
  - Low to Medium: +1 year
  - Medium to High: +0.75 year
  - Low to High: +1.75 years

- **Trigger Effect at high funding levels**
  - Low to Medium: +0.6 year
  - Medium to High: +0.7 year
  - Low to High: +1.3 years
Funding Effect

Increase in Network Life (for each additional $10 million annual investment)

<table>
<thead>
<tr>
<th>Level</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>3.1</td>
</tr>
<tr>
<td>Medium</td>
<td>2.9</td>
</tr>
<tr>
<td>High</td>
<td>2.7</td>
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</table>

- A lower trigger policy is slightly more efficient in reducing the percent of Indiana NHS’ miles with pavement RSL< 5 years.
Vehicle operating cost due to pavement condition (dollars per 1000 VMT)

Annual Pavement Rehabilitation Funding for the Indiana NHS (millions of 2008 constant dollars)

- Low Trigger Policy
- Medium Trigger Policy
- High Trigger Policy

$113
$79
$62
$52
$44
$37
$32

~$4.9 billion
~$1.3 billion
User Cost Savings due to a switch from the Low Trigger Policy to a higher trigger policy

Vehicle operating cost savings (millions of 2008 constant dollars)

Annual Pavement Rehabilitation Funding for the Indiana NHS (millions of 2008 constant dollars)

- Low to Medium Trigger Policy
- Medium to High Trigger Policy
Summary

• For the Indiana NHS system, displayed the effects of:
  ▪ Agency Expenditure,
  ▪ Treatment Trigger Policy

on pavement network condition and outcomes.

• Examined the feasibility of leveraging the treatment trigger policy to improve network condition at all agency expenditure levels.
Findings for the Indiana NHS

- In the long term, a higher trigger policy increases:
  - Overall Network Condition and,
  - User Cost Savings at the network level.

- A lower trigger policy is slightly more efficient in reducing the percent of roads with RSL< 5 years.

- At both low and high agency funding levels:
  - An increase in the trigger policy results in user cost savings.
Acknowledgment

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References


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Questions?