# Advanced Pavement Management:

## Incorporating Nondestructive Testing in Treatment Selection and Timing

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NWPMA Conference
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Seattle, WA

*PAVEMENT SERVICES, INC.*

# Federal Highways Research into Network Level Structural Analysis

- Texas DOT
- Virginia DOT
- Alaska DOT
- CALTRANS


Reference: FHWA Publication HRT-12-023

# Overview

- Project-level vs. Network-level Evaluation
- Review of the PCI Rating
- Need for Network Level Structural Evaluation
- Network Level Structural Evaluation Methods
- Summary and Future Direction

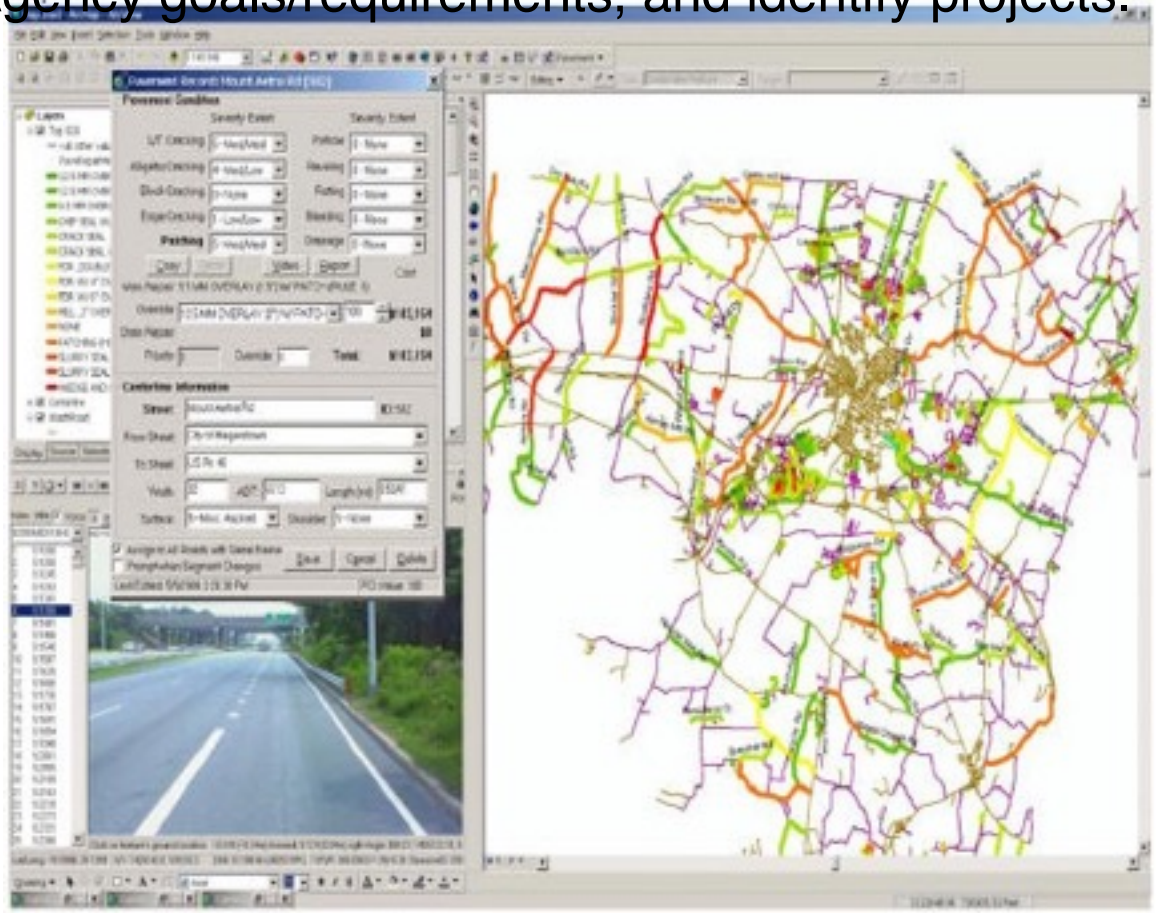
# Project-Level Evaluation

A project in-depth pavement evaluation (often structural). It includes the selection of specific M&R type(s), such as overlay or surface reconstruction, and layer thickness design.

- **Backcalculation Software**
- **AASHTO**
- **Asphalt Institute**
- **StreetPave**

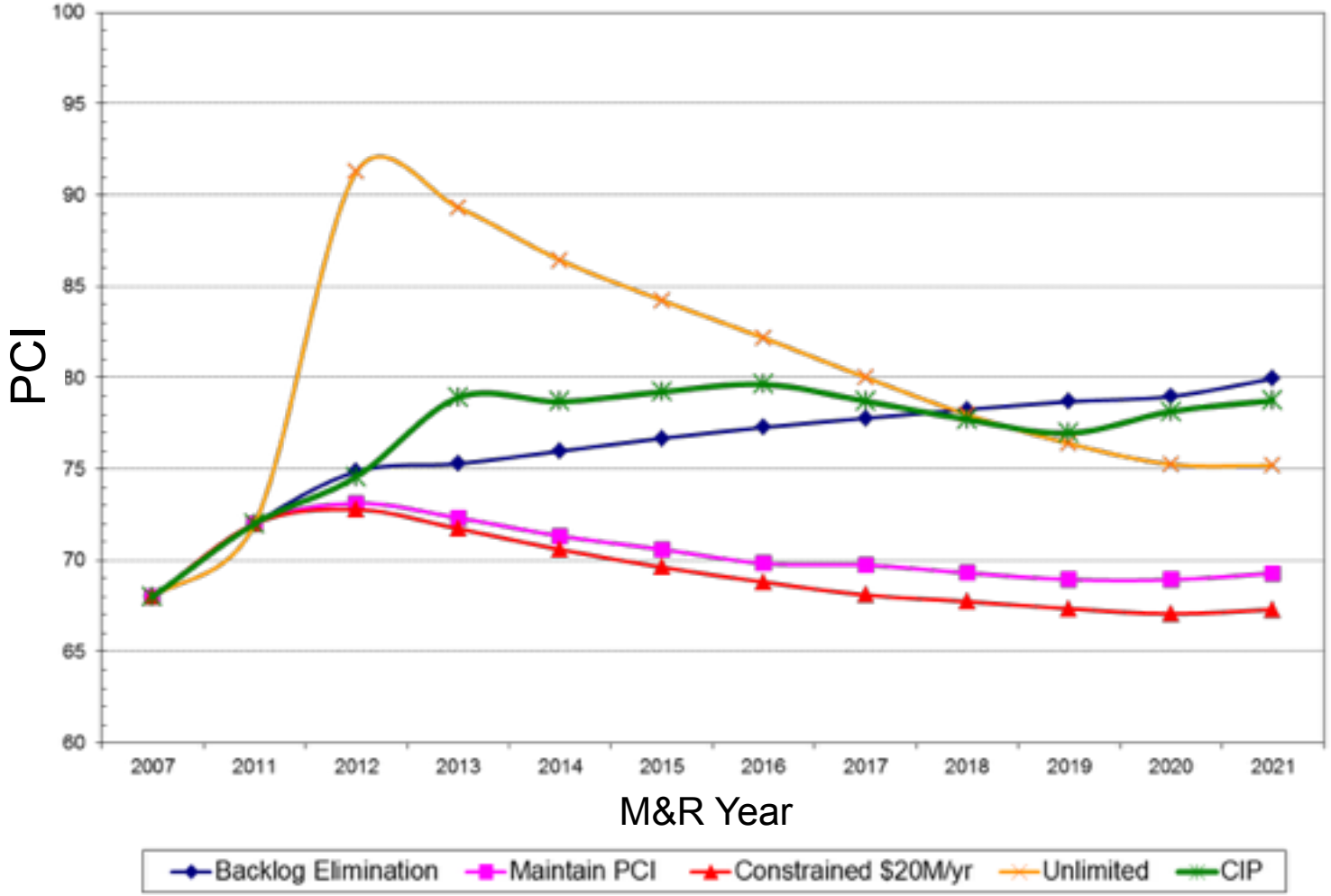
# Network-Level Evaluation

A systematic approach to inventory the pavement network,  analyze pavement performance, ensure optimum return on investment, meet Agency goals/requirements, and identify projects.

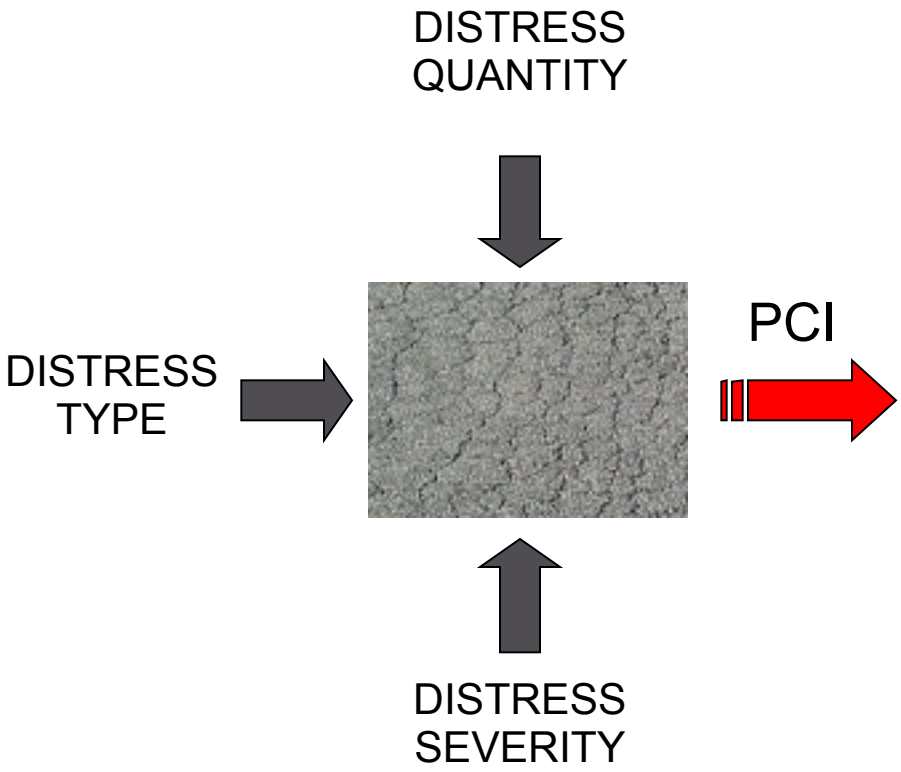


- **PAVER**
- **StreetSaver**
- **Cartegraph**

# Network Level Evaluation Allows Analysis of Budget Alternatives



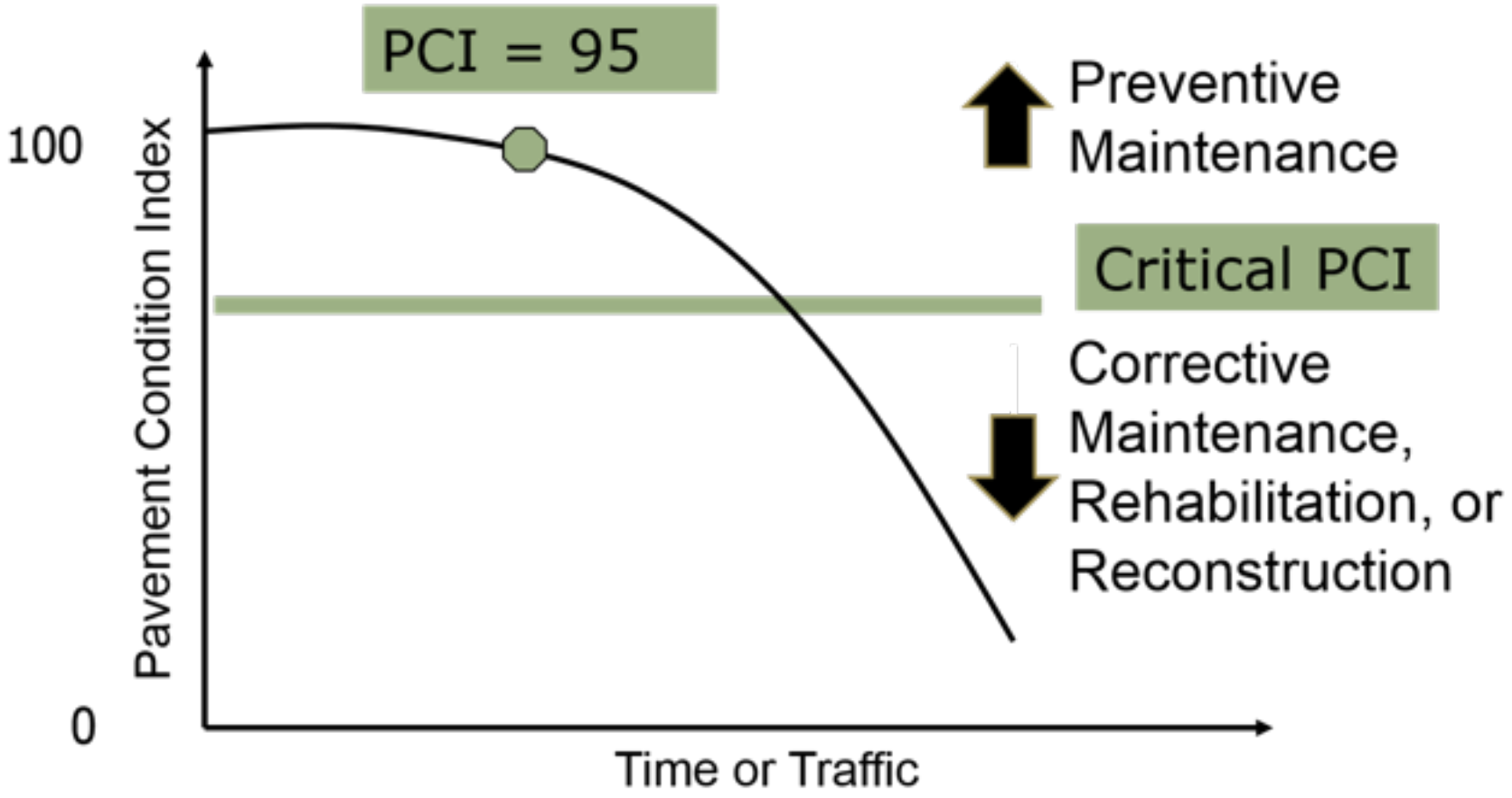
# PCI Rating

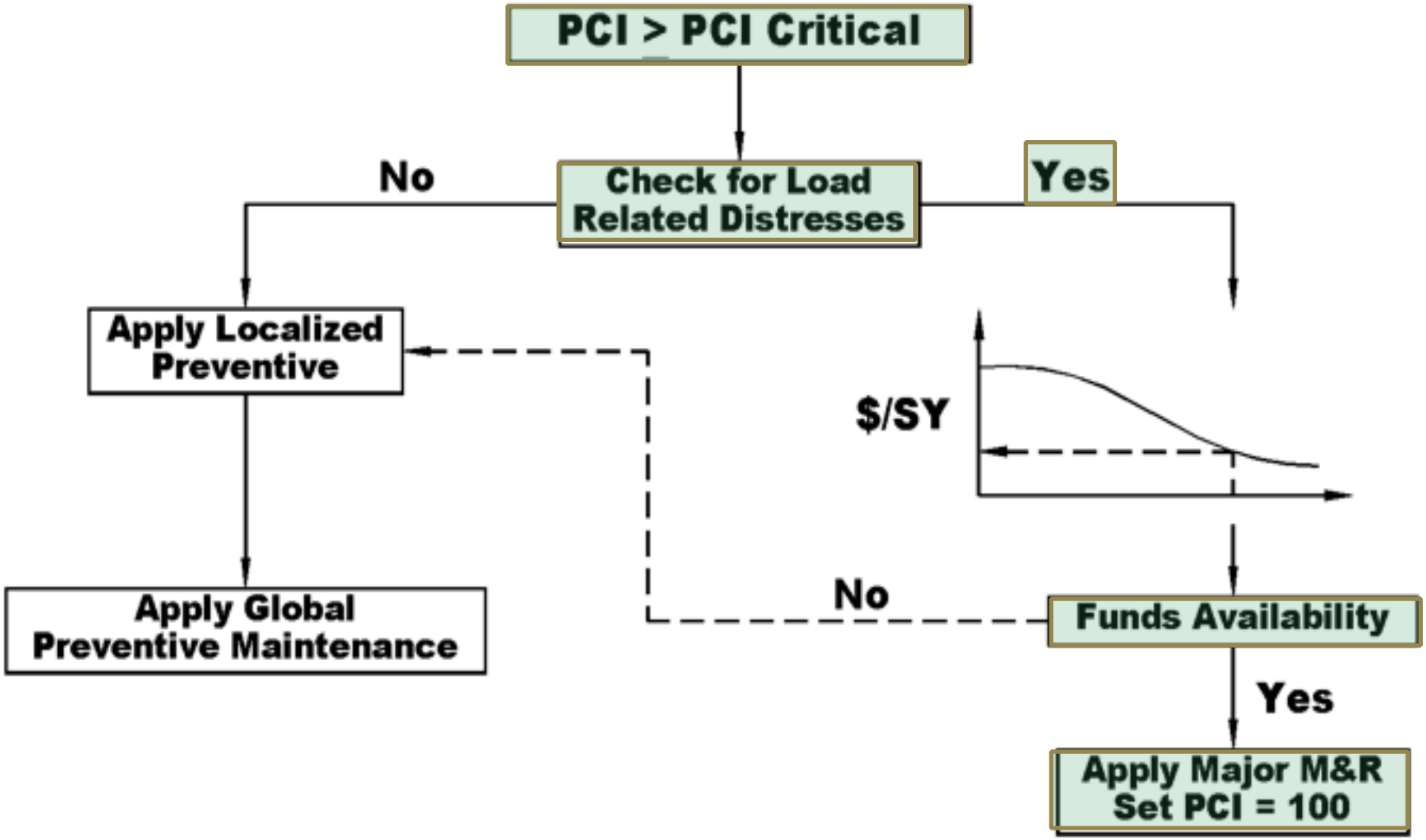



| PCI | COLOR | RATING |
|---|---|---|
| 100<br>86 | | GOOD (EXCELLENT) |
| 85<br>71 | | SATISFACTORY(VERY GOOD) |
| 70<br>56 | | FAIR (GOOD) |
| 55<br>41 | | POOR (FAIR) |
| 40<br>26 | | VERY POOR (POOR) |
| 25<br>11 | | SERIOUS (VERY POOR) |
| 10<br>0 | | FAILED (FAILED) |

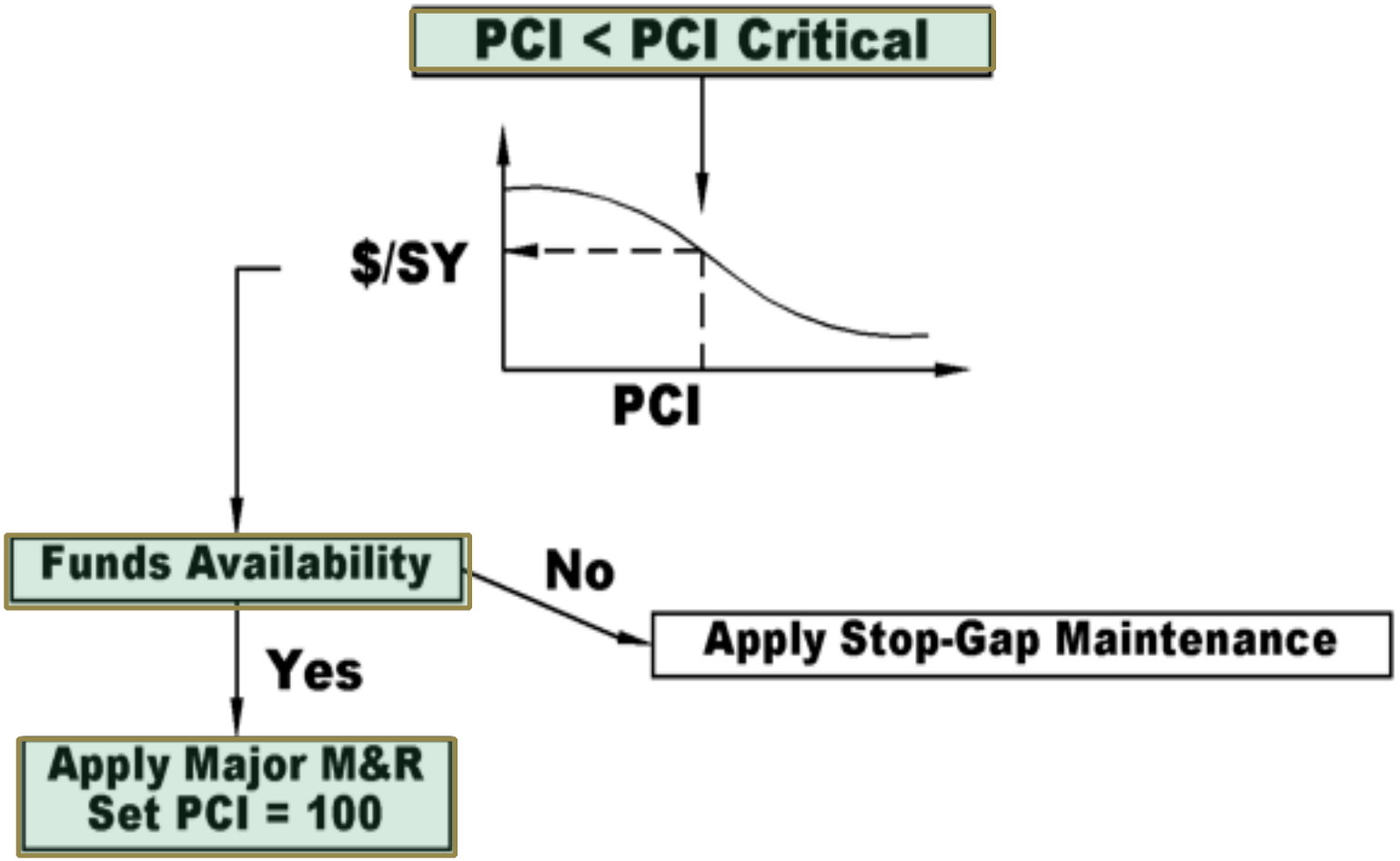
Reference: ASTM D 6433

# Pavement Deterioration Curve






Reference: Shahin (1994)

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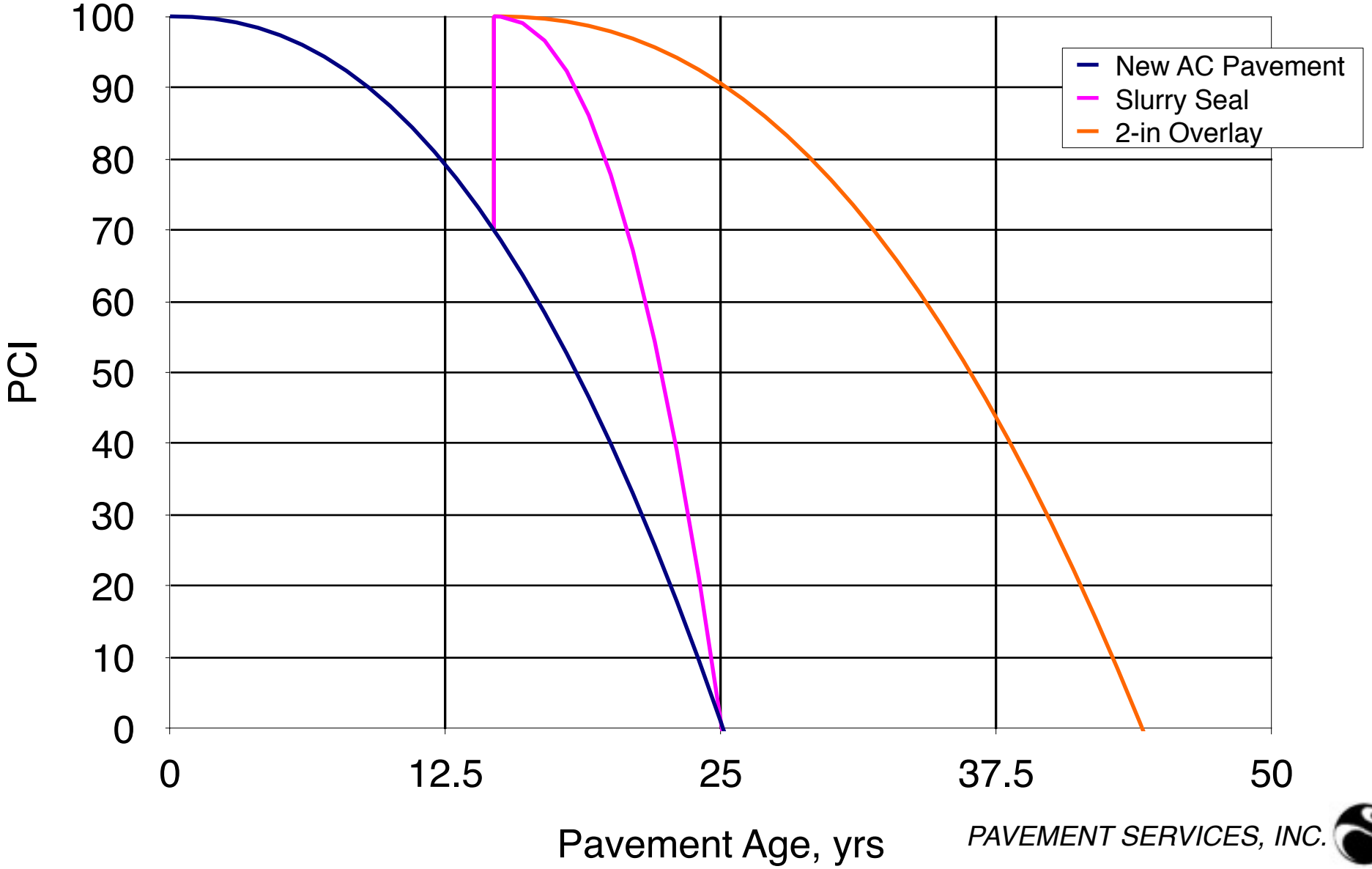
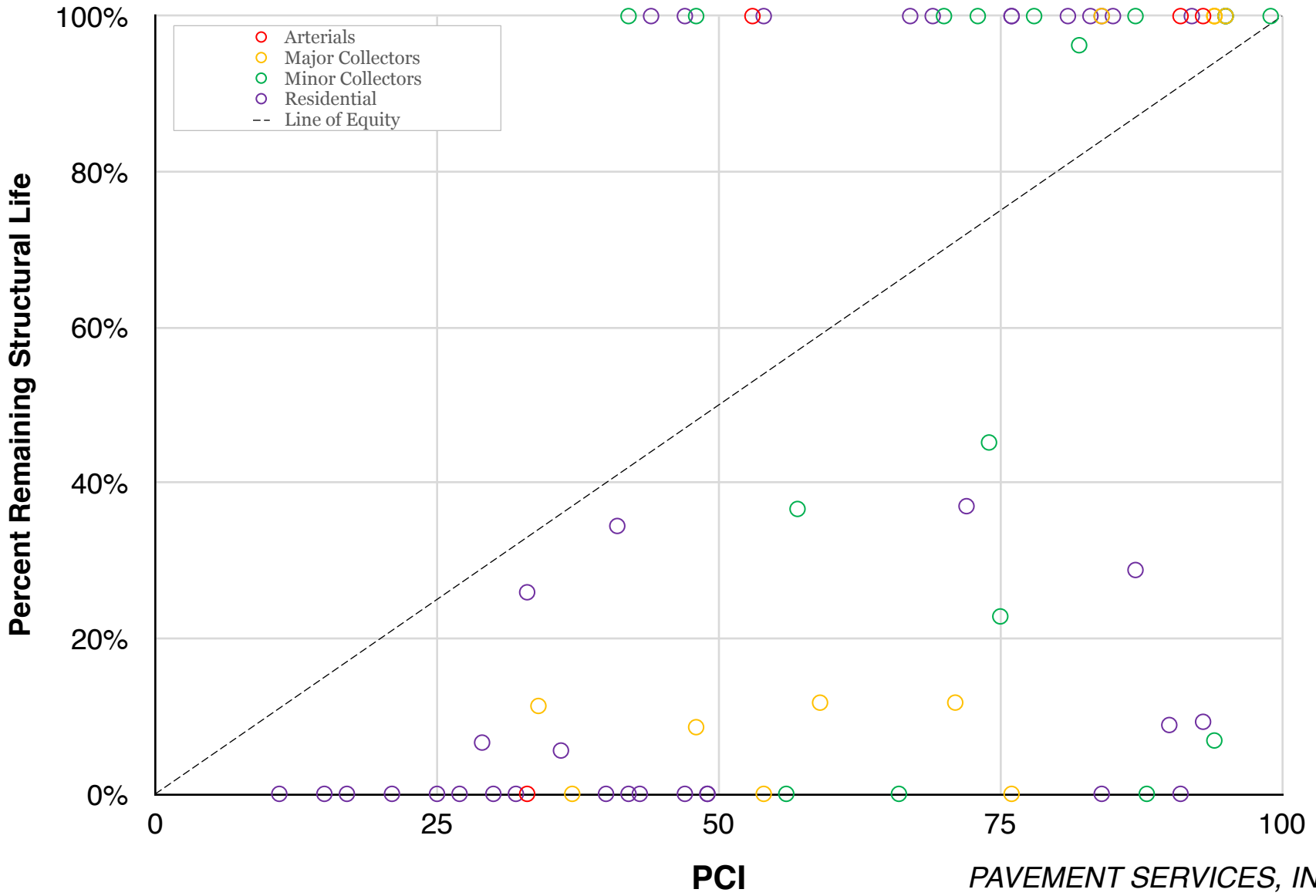
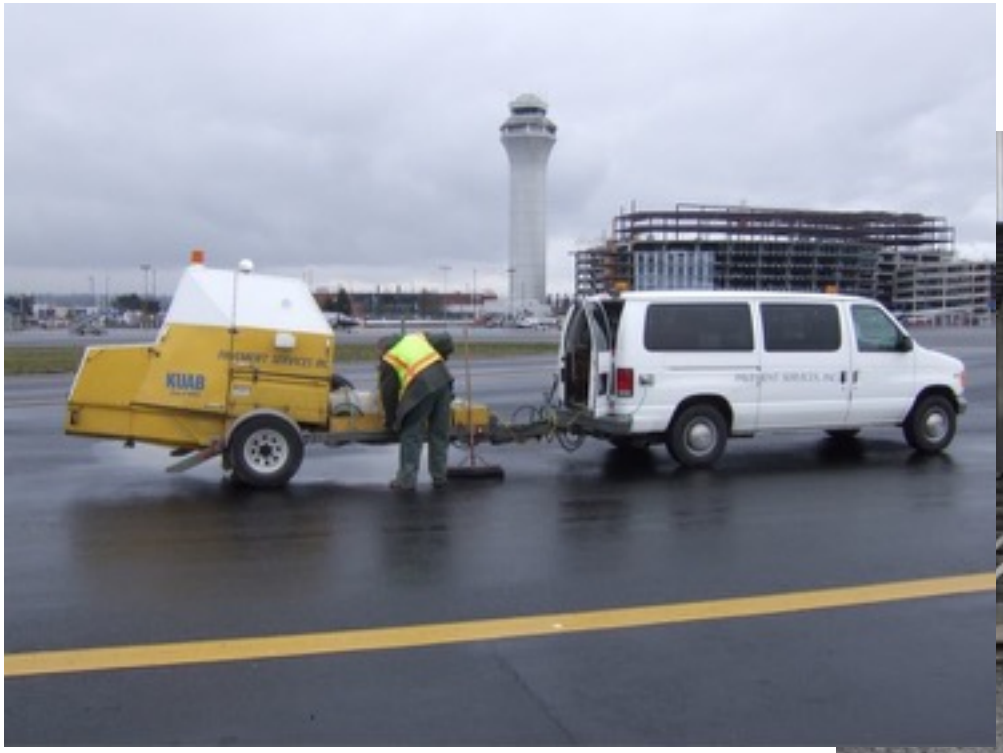
# Pavement Performance Curves for Example Cases



# City of Newberg Study

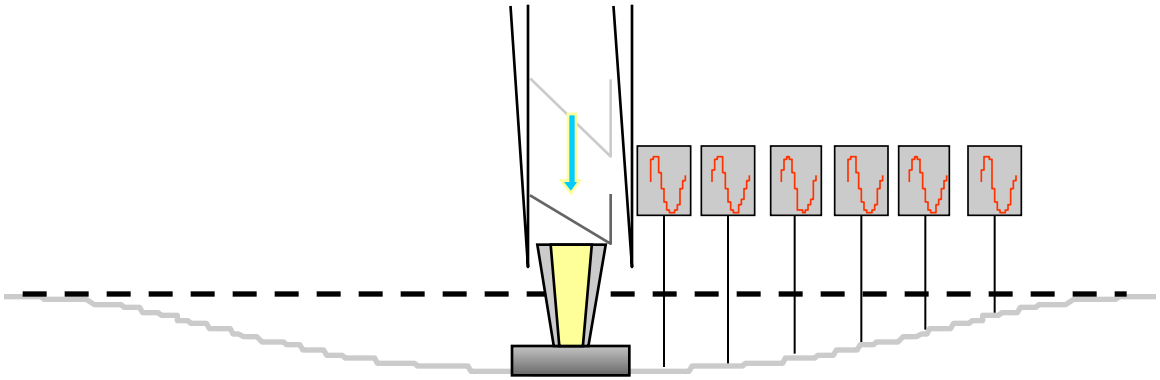


# Falling Weight Deflectometer




# NDT in Network Level Applications

- Overlay analysis
- Determination of subgrade support characteristics
- **Analysis of structural condition and remaining life**



# NDT Data in a PMS

**Screening Tool**

- Evaluate structural capacity based on center deflection

**Develop Treatment Recommendations**

- Individual streets in a small network
- M&R strategies in a PMS

**Prioritize Overlay Projects**

- Identify streets that may be rehabilitated with a single lift overlay, inlay or inlay/overlay combination.

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# NDT as a Screening Tool – Ashland Street

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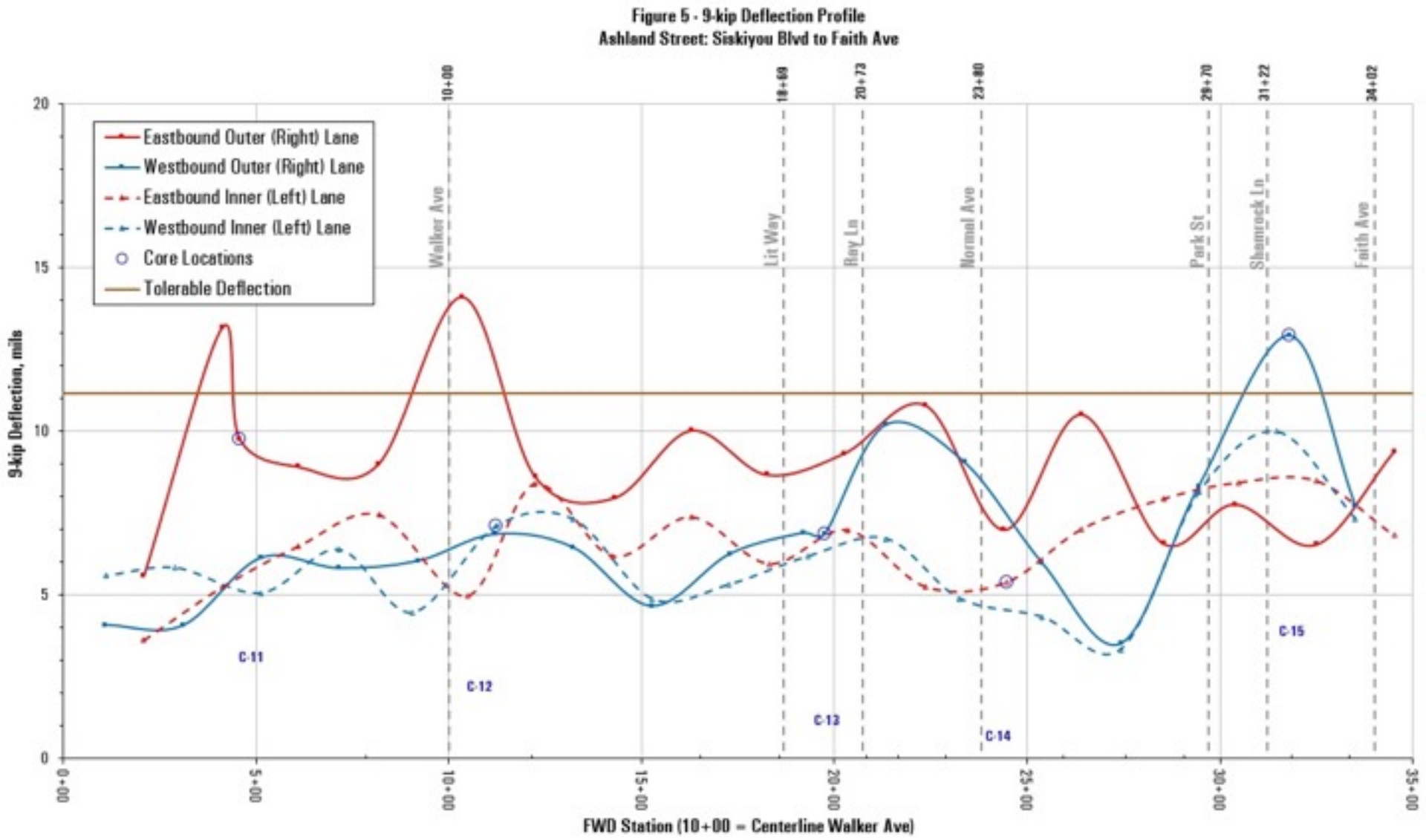

# NDT as a Screening Tool – Rosa Parks

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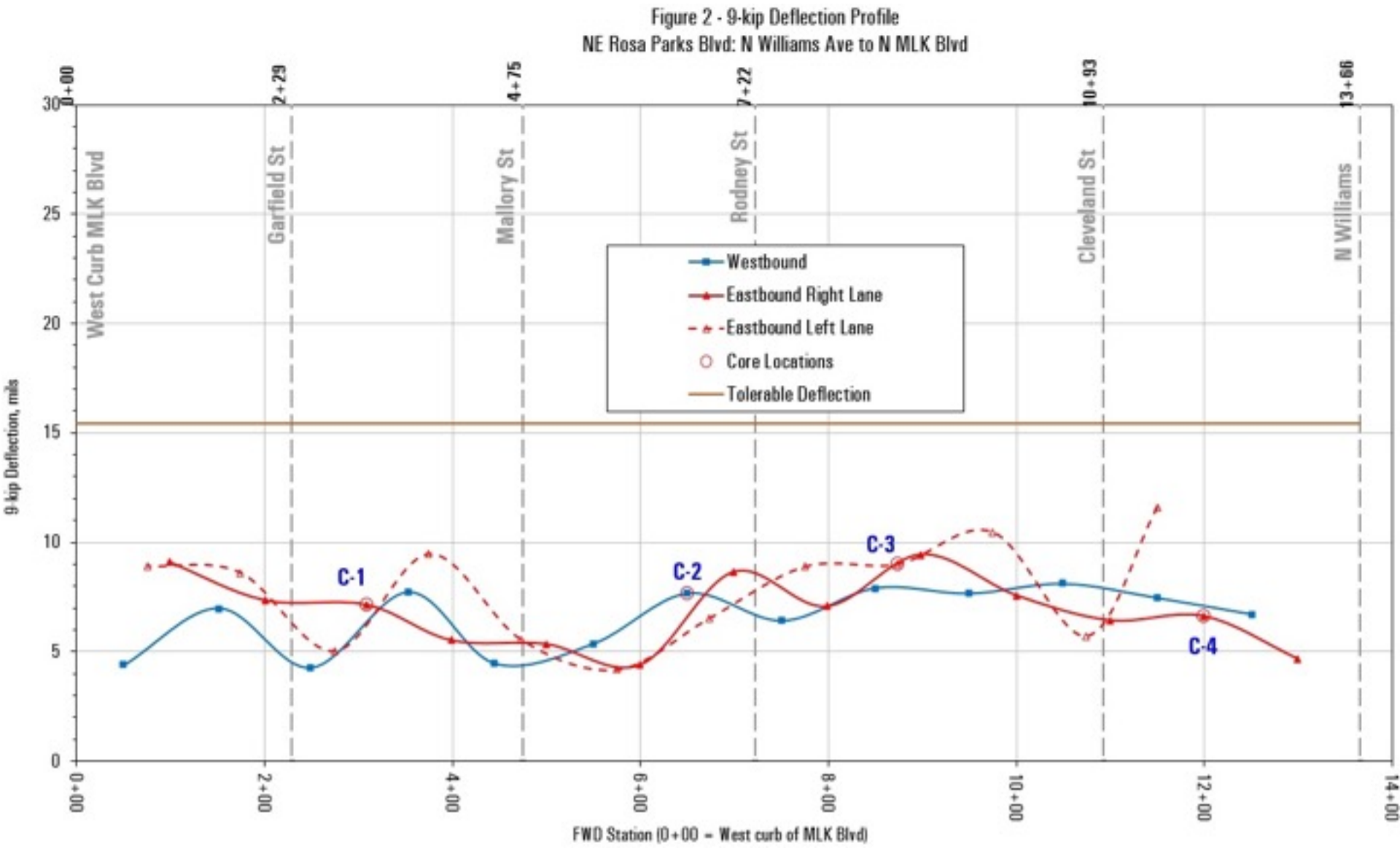

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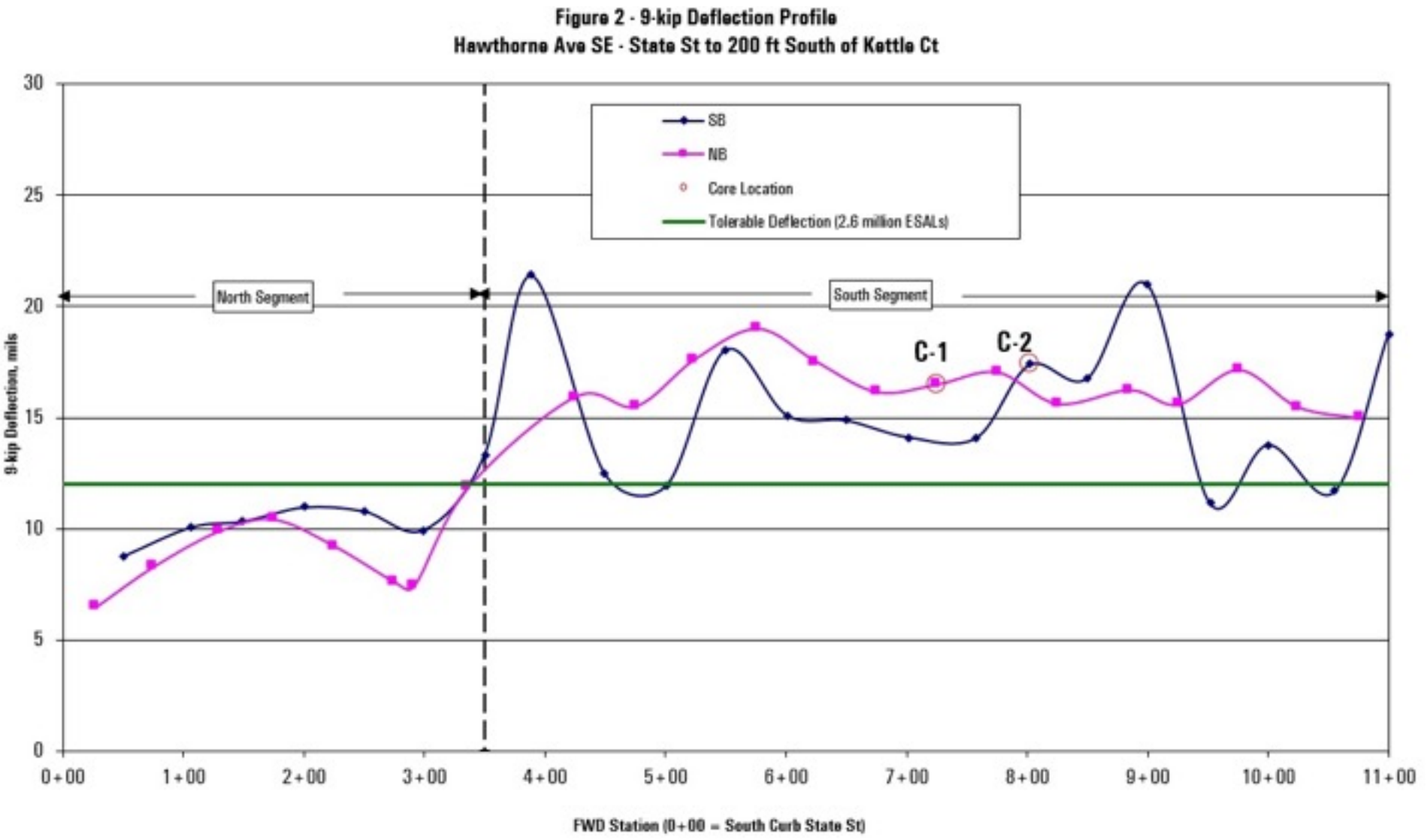

# NDT as a Screening Tool – Hawthorne Ave

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# Structural Condition Index

$$SCI = \frac{SN_{eff}}{SN_{required}}$$

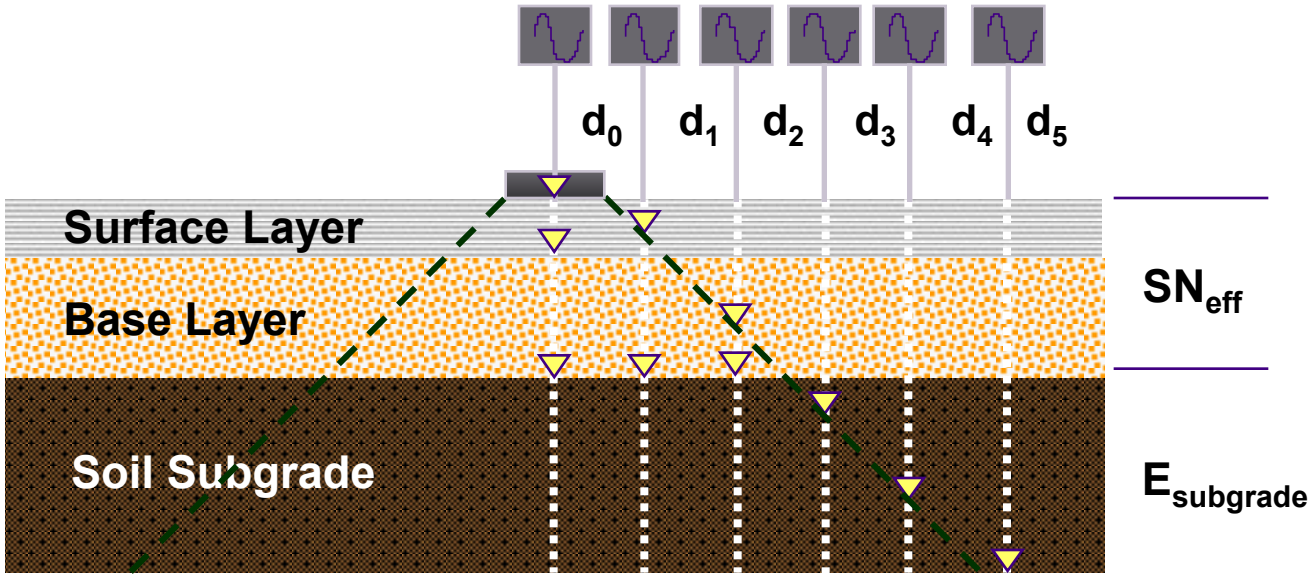
Where:

SCI = Structural Condition Index

$SN_{eff}$ = Effective Structural Number of the existing pavement

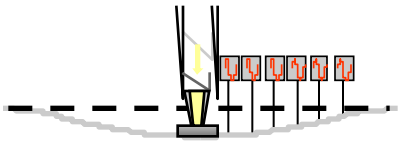
$SN_{required}$ = Required Structural Number for a New Pavement

# Equivalent Pavement Thickness (EPT) Backcalculation



# NDT Used for Overlay Calculations

FWD Testing



$M_r$

and

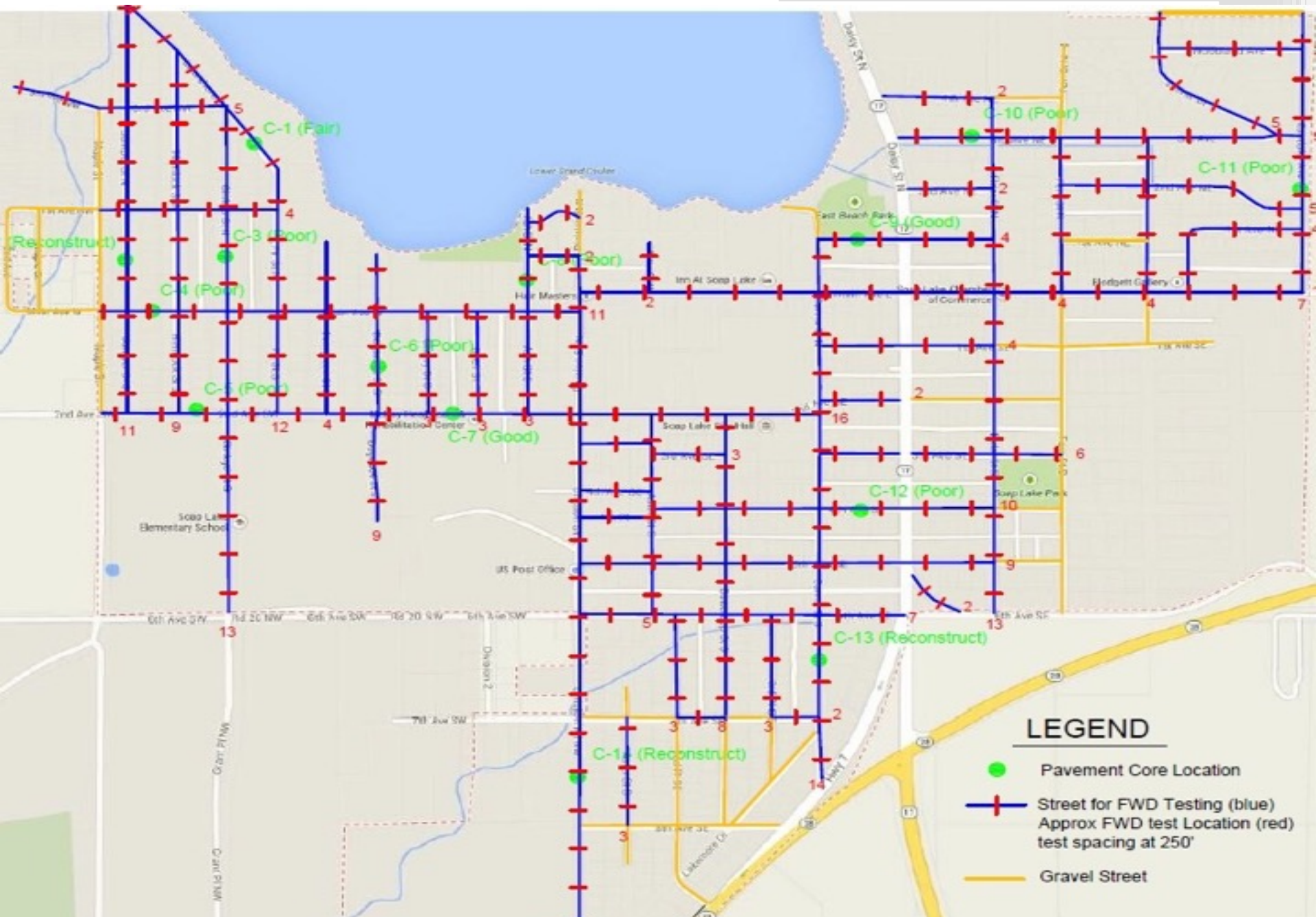
$SN_{eff}$

Reliability

Overlay Calculation

ESAL

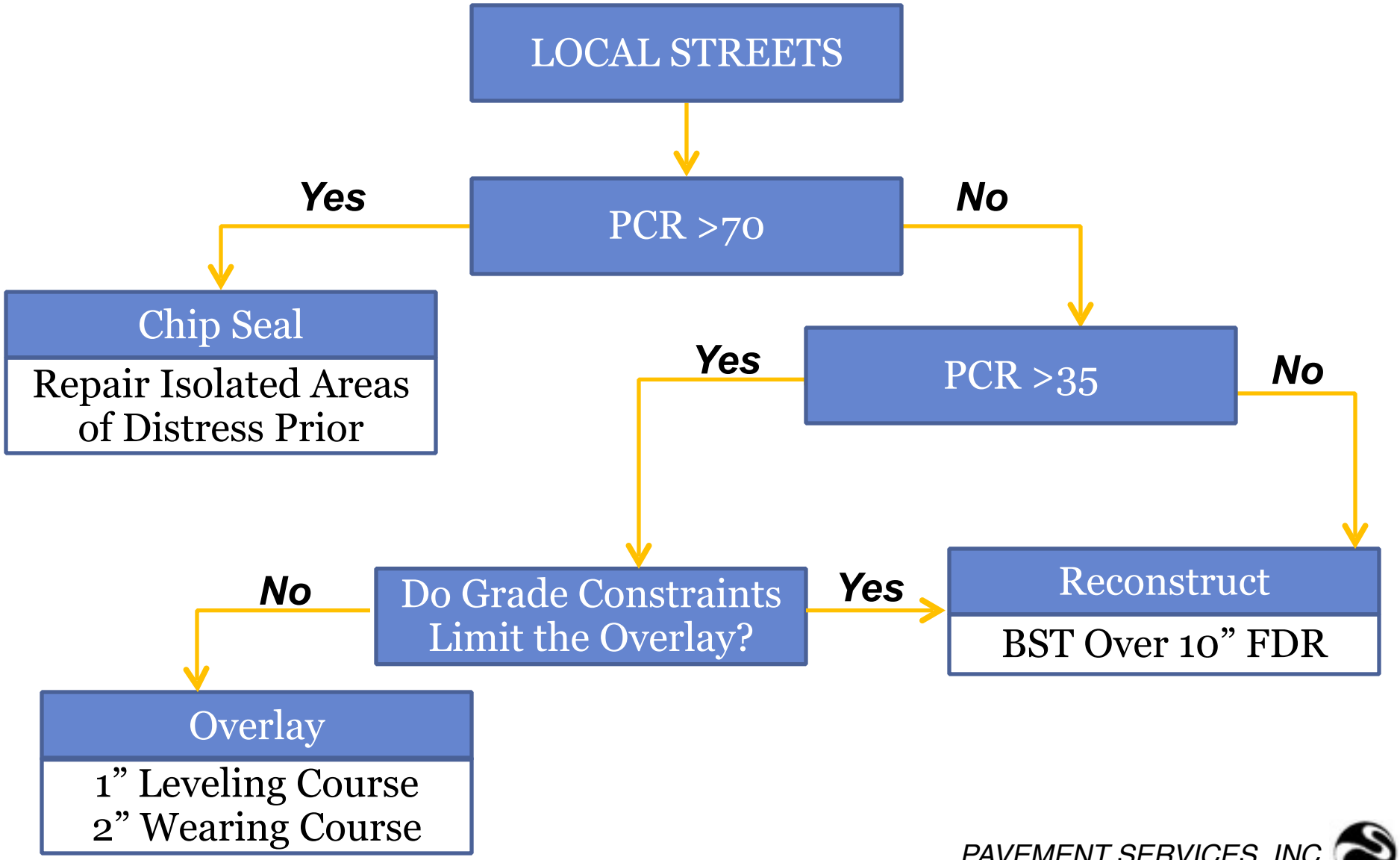
# NDT used to Develop Treatment Recommendations



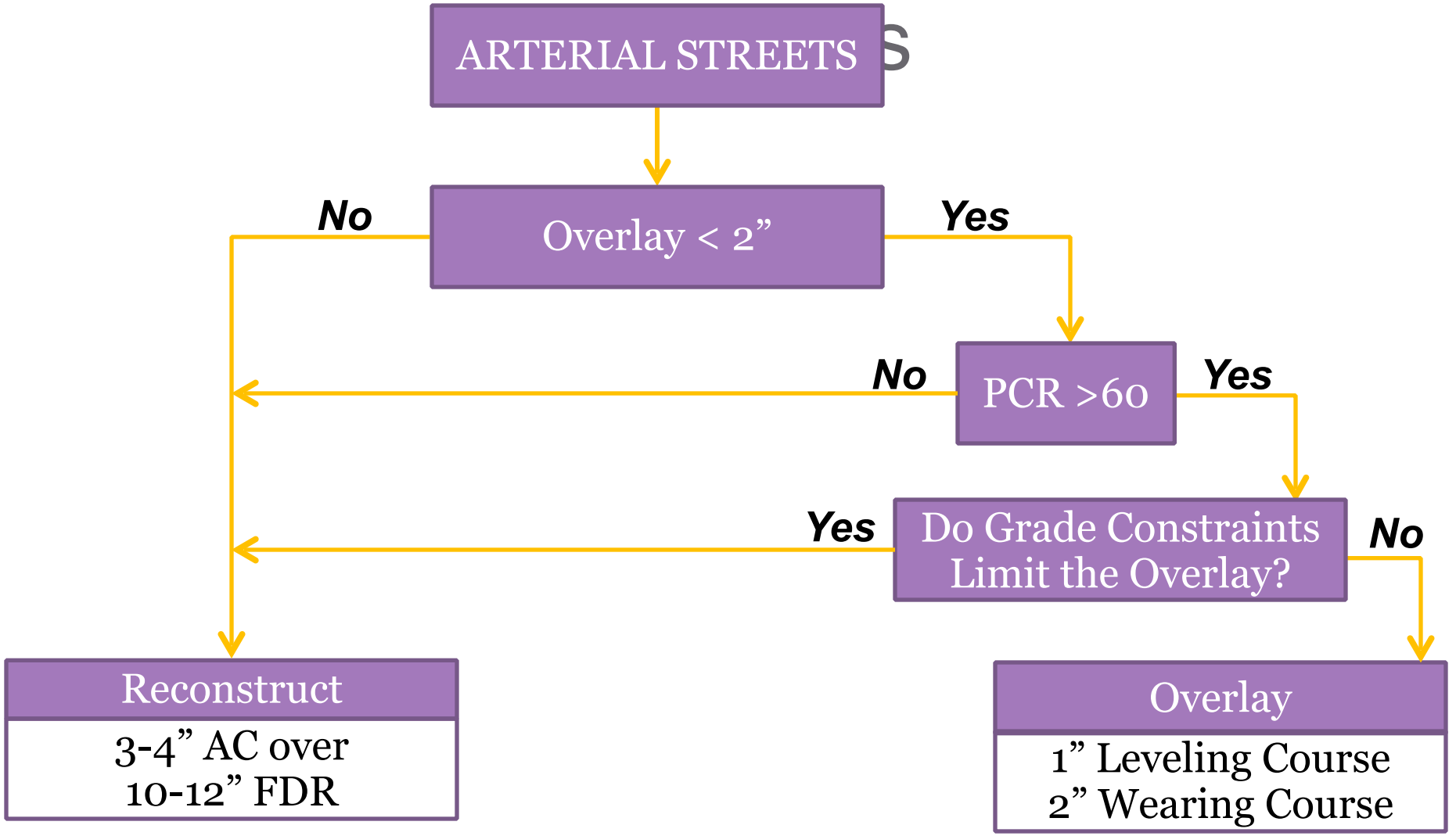
**Statistical Summary of Data**

| Analysis Unit | Street | Street Classification | Traffic Loading, ESAI`s | Reliability | Average Subgrade Modulus, psi | Average SNeff | Average "non zero" Overlay, in. |
|---|---|---|---|---|---|---|---|
| 1a | Division | Arterial | 500,000 | 85 | 10,695 | 4.44 | Zero |
| 1b | Division | Arterial | 500,000 | 85 | 10,794 | 3.73 | Zero |
| 2 | Division | Arterial | 500,000 | 85 | 6,005 | 2.91 | 3.79 |
| 3 | Main Ave E | Arterial | 500,000 | 85 | 13,202 | 3.24 | 0.30 |
| 4 | 6th Ave SE | Arterial | 100,000 | 85 | 5,756 | 2.14 | 1.61 |
| 5 | 6th Ave Ramp | Arterial | 250,000 | 85 | 10,148 | 3.34 | 0.81 |
| 6a | Canna St | Arterial | 100,000 | 80 | 3,540 | 0.92 | 4.97 |
| 6b | Canna St | Arterial | 100,000 | 80 | 8,587 | 1.84 | 1.76 |
| 7a | Main Ave W | Arterial | 100,000 | 80 | 3,878 | 1.56 | 3.25 |
| 7b | Main Ave W | Arterial | 100,000 | 80 | 13,213 | 1.76 | 1.01 |
| 7c | Main Ave W | Arterial | 100,000 | 80 | 17,412 | 3.52 | zero |
| 8a | 2nd Ave SE | Arterial | 250,000 | 85 | 10,345 | 2.80 | 1.40 |
| 8b | 2nd Ave SW | Arterial | 100,000 | 80 | 4,394 | 2.08 | 1.60 |
| 9a | Ginkgo St | Arterial | 50,000 | 75 | 5,754 | 1.05 | 2.64 |
| 9b | Ginkgo St | Arterial | 50,000 | 75 | 8,564 | 3.60 | zero |
| 10 | Lakeshore/Fir | Arterial | 50,000 | 75 | 5,932 | 1.63 | 1.68 |
| 11 | Various | Local NE | 10,000 | 65 | 9,989 | 1.60 | 0.74 |
| 12 | Various | Local NW | 10,000 | 65 | 6,446 | 1.34 | 1.26 |
| 13 | Various | Local S | 10,606 | 65 | 7,361 | 1.29 | 1.31 |

# Treatment Selection from FWD Testing



# Treatment Selection from FWD Testing



**Statistical Summary of Data**

| Analysis Unit | Street | Average "non zero" Overlay, in. | Average FDR Depth, in. | Average Required AC above FDR, in. | Avg PCR (at FWD locations) | Surface Treatment | Overlay, in | Recommended Treatment |
|---|---|---|---|---|---|---|---|---|
| 1a | Division | Zero | NA | NA | 81 | None | None | None |
| 1b | Division | Zero | NA | NA | 92 | None | None | None |
| 2 | Division | 3.79 | 12.00 | 4.15 | 24 | NR | NR | 4.0" AC over 12" FDR |
| 3 | Main Ave E | 0.30 | 10.00 | 2.59 | 77 | Chip Seal | See Note 2 | NR |
| 4 | 6th Ave SE | 1.61 | 12.00 | 2.23 | 90 | NR | See Note 2 | |
| 5 | 6th Ave Ramp | 0.81 | 10.00 | 2.50 | 81 | NR | See Note 2 | |
| 6a | Canna St | 4.97 | 12.00 | 3.24 | 20 | NR | NR | 4.0" AC over 12" FDR |
| 6b | Canna St | 1.76 | 10.00 | 2.04 | 59 | NR | See Note 2 | |
| 7a | Main Ave W | 3.25 | 12.00 | 2.98 | 42 | NR | NR | 3.0" AC over 12" FDR |
| 7b | Main Ave W | 1.01 | 10.00 | 0.96 | 30 | NR | NR | 3.0" AC over 12" FDR |
| 7c | Main Ave W | zero | 10.00 | 0.55 | 100 | None | None | |
| 8a | 2nd Ave SE | 1.40 | 10.00 | 2.41 | 78 | NR | See Note 2 | |
| 8b | 2nd Ave SW | 1.60 | 10.00 | 3.14 | 78 | NR | See Note 2 | |
| 9a | Ginkgo St | 2.64 | 10.00 | 1.86 | 30 | NR | NR | 3.0" AC over 10" FDR |
| 9b | Ginkgo St | zero | 10.00 | 1.23 | 76 | None | None | |
| 10 | Lakeshore/Fir | 1.68 | 10.00 | 1.83 | 66 | NR | See Note 2 | |
| 11 | Various | 0.74 | 10.00 | 0.18 | 40 | See Note 1 | See Note 3 | BST over 10" FDR |
| 12 | Various | 1.26 | 10.00 | 0.52 | 47 | See Note 1 | See Note 3 | BST over 10" FDR |
| 13 | Various | 1.31 | 10.00 | 0.49 | 45 | See Note 1 | See Note 3 | BST over 10" FDR |

**Abbreviations:**

AC = Asphalt Concrete; FDR = Full Depth Reclamation; NR = Not Recommended

PCR = Pavement Condition Rating

**Notes:**

**1)** Chip seal is, in our opinion, a viable rehabilitation alternative on local streets with a PCR rating above 70. Repair isolated areas of distress prior to placing chip seal

**2)** Overlay may be placed on arterial streets with PCR above 60 identified in the above table. Areas of high severity distress should be repaired prior to overlay. The overlay should consists of a nominal 1-inch thick leveling course followed by a 2-inch overlay. Overlay of Canna St should only be considered north of 2nd St

**3)** Overlay may be placed on local streets with a PCR above 35, if the following conditions are met: a) there are no grade constraints that would limit overlay, areas of high severity distress or potholes are repaired prior to overlay. The overlay should consists of a nominal 1-inch thick leveling course followed by a 2-inch overlay.

# NDT Data in a PMS

**Screening Tool**

- Evaluate structural capacity based on center deflection

**Develop Treatment Recommendations**

- Individual streets in a small network
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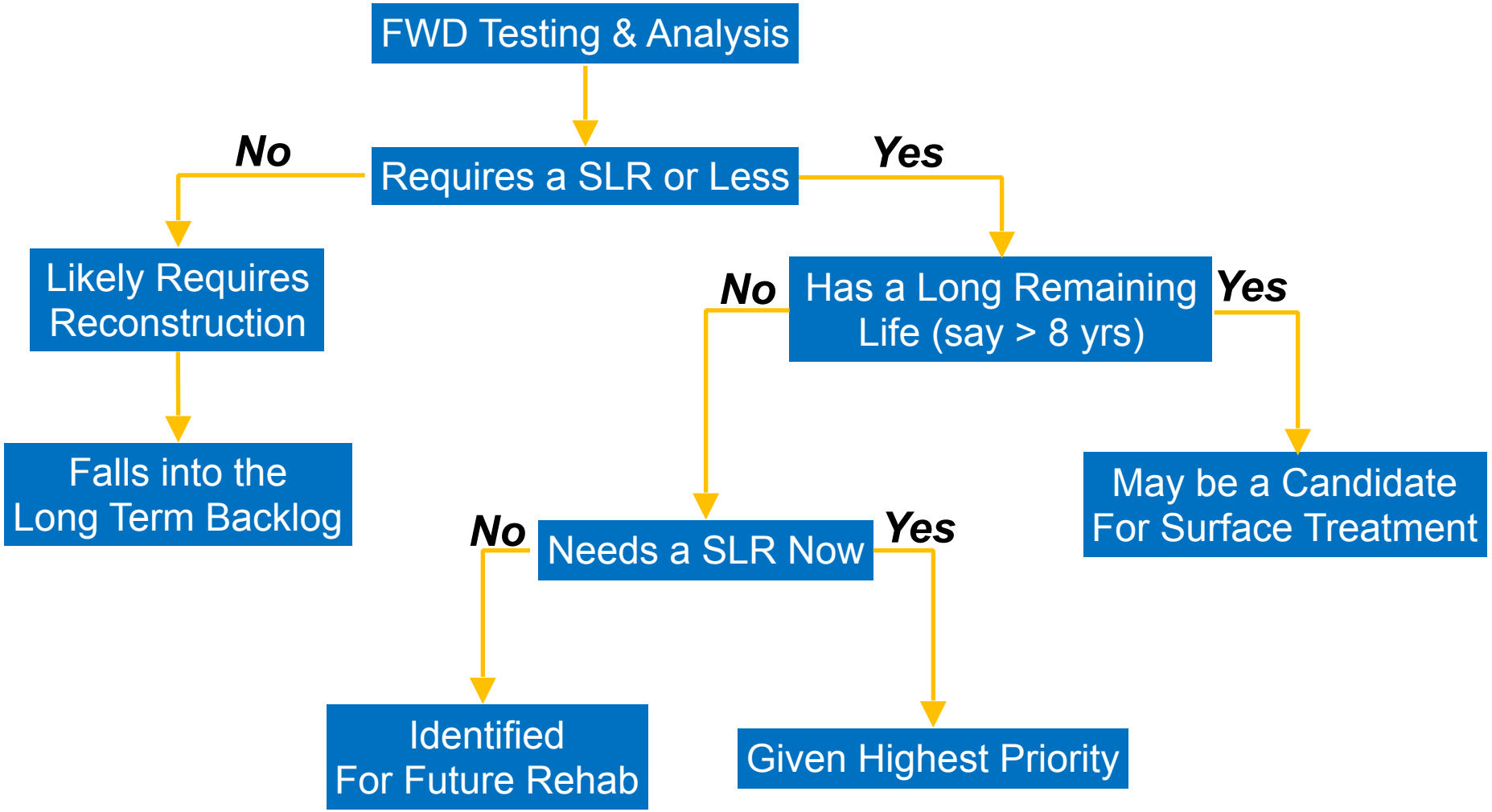
**Prioritize Overlay Projects**

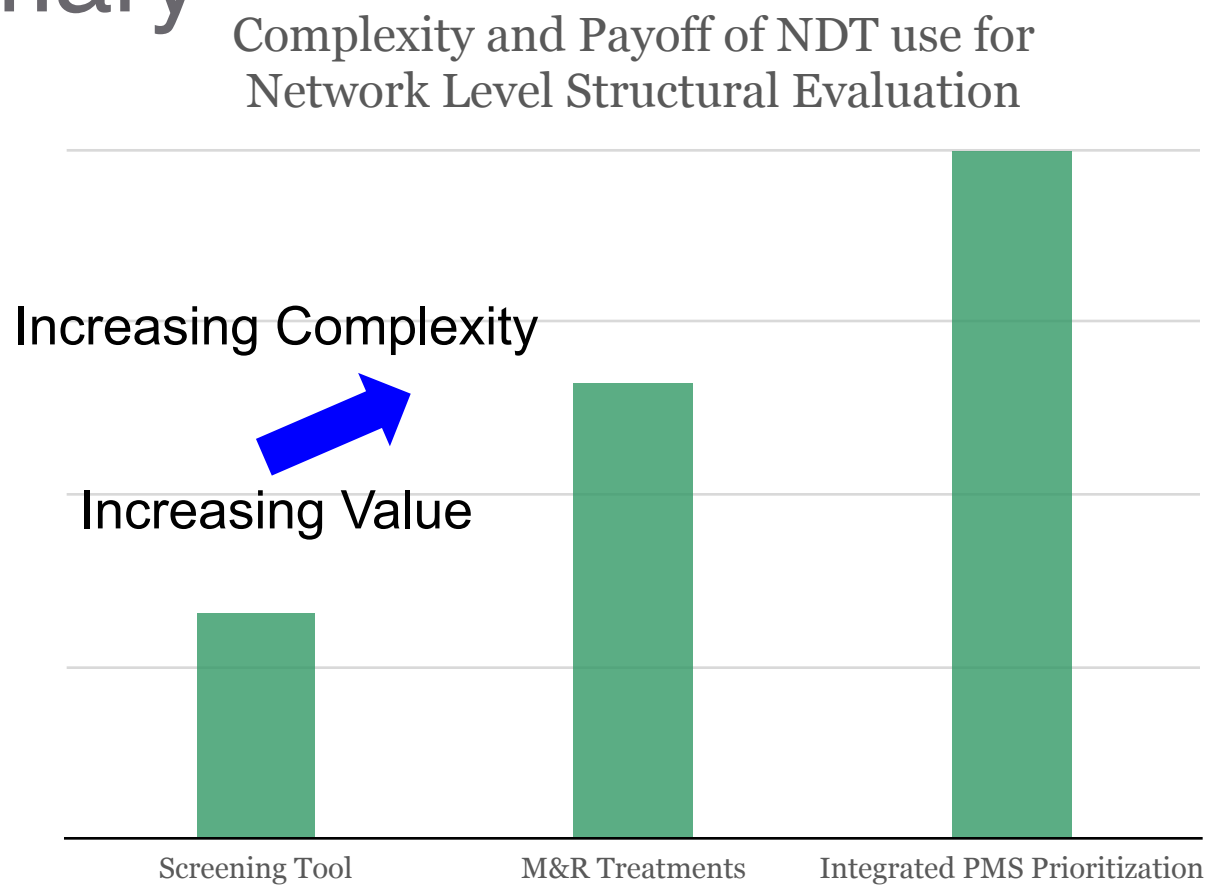
- Identify streets that may be rehabilitated with a single lift overlay, inlay or inlay/overlay combination.

# NDT used to Prioritize Projects

*Definition: Single lift rehabilitation (SLR) is a 2 to 3-inch inlay, overlay or inlay/overlay combination*



# Summary


Complexity and Payoff of NDT use for Network Level Structural Evaluation
Increasing Complexity
Increasing Value
Screening Tool
M&R Treatments
Integrated PMS Prioritization

# Questions?

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