NJDOT PAVEMENT MANAGEMENT SYSTEM

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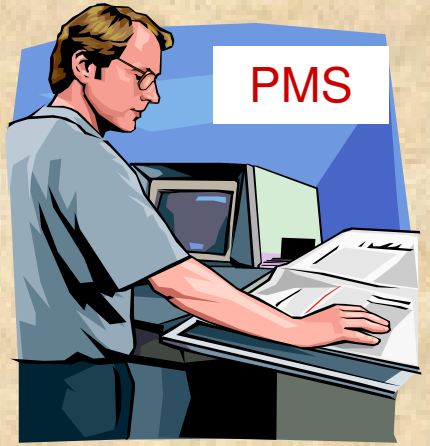
EXPECTATIONS OF PMS

"What's the condition of this road near the Mac Donalds?"

"Why aren't you fixing this road near my house?"

"Why is the system not improving even though we spent this amount?"



"Why are you working on that road and not this one?"

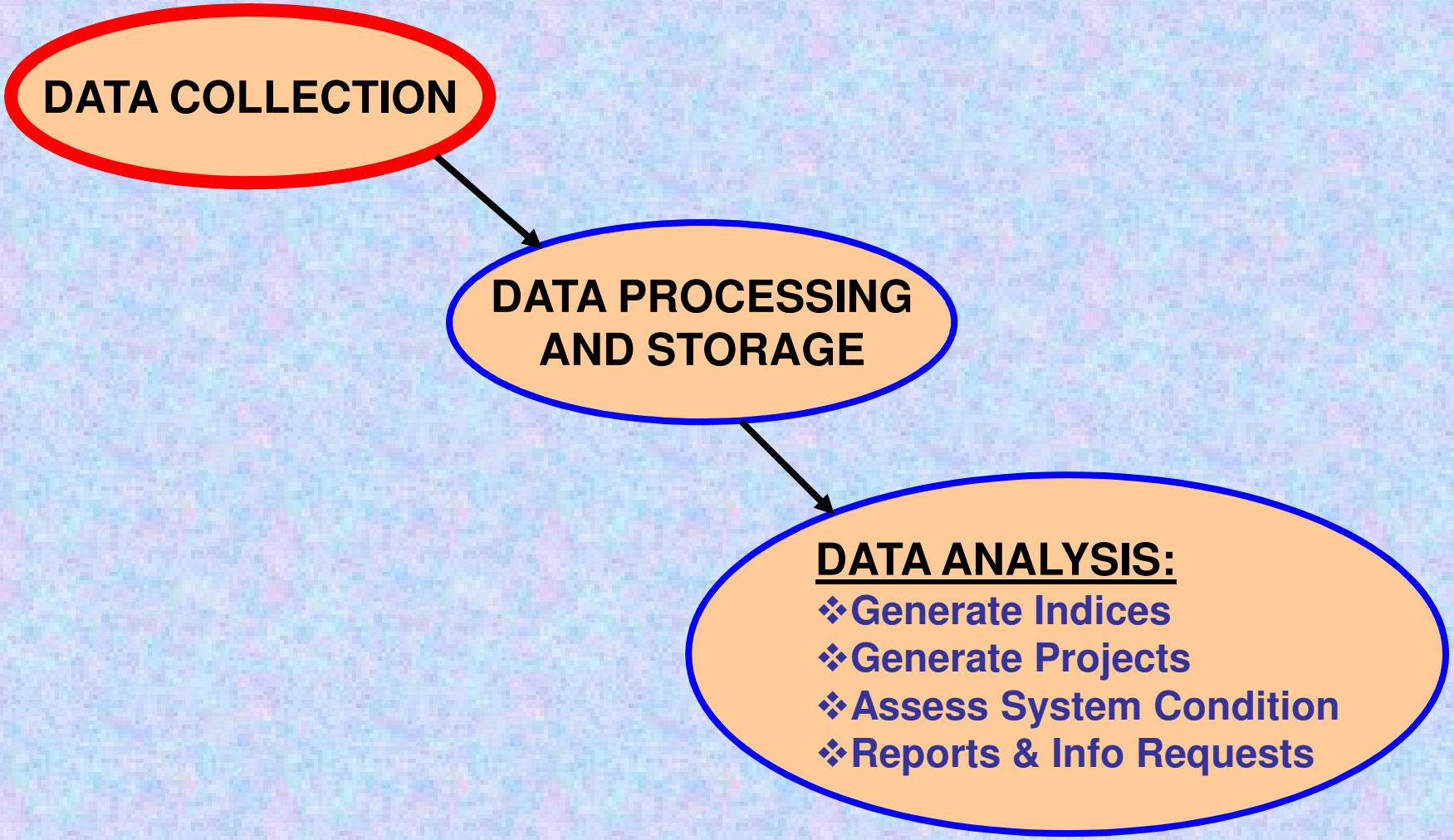
"What will the condition of the system be in ten years?"

"Give me a ranked list of the top 100 paving projects."

Pavement System – Difficult to Quantify & Predict

- Pavements are continuous – not discrete (thousands of miles)
- Pavement conditions & properties are highly heterogeneous
  - Details of material & construction can change as you move along or across the pavement.
  - Transverse sections can be highly variable
- Pavements depend on subsurface for support – very heterogeneous
- Placement techniques can cause different performances in the same area.
- Loadings are consistently increasing

PAVEMENT DATA ANALYSIS



State Highway System Pavement Data Collected

- Annual collection (4600 miles), except for skid data which is biannual
- Network inventory data from rightmost lane only in both directions of travel
- Data processed & recorded in 1/10 mile intervals

Pavement Data Collected

Calibrated Skid Resistance Trailer

- **Frictional Skid Resistance**
  - ***Skid numbers are measured in accordance with the ASTM E-274 method of testing using a wet condition wheel lockup. Measured numbers at various test speeds are normalized to equivalent skid resistance at 40 miles per hour called SN40R.***

International Cybernetics Corp (ICC) High Speed Profiler


NO SMOKING
DANGER
E350


CHIEFTAINS
New Jersey
TD10626
STATE GOVT


DANGER


SHFT = CLR ALL F5 F7 F9 MC LJ
ENT F2 F4 F6 F8 F10 M
ESC 1 3 5 7 9 S
2 4 6 8 10 CLR
MCLA TJ LC C LCLA LF P SC SD TC
M M M M M M M
S S S S S S C
CLR CLR CLR CLR CLR CLR CLR

Pavement Data Collected – Cont'd.

High Speed Profiler

- **High Resolution Video Images**
  - ***Two forward cameras and rear rut cameras.***
- **International Roughness Index (IRI)**
  - ***Lasers measure deviations of the pavement surface from a perfectly flat condition & develop road profile.***
  - ***A dynamic model of vehicle suspension used to predict occupant response to the imposed road profile.***
  - ***Generated in inches per mile, with a larger IRI representing a rougher road surface.***
  - ***Collected and recorded for the left and right wheel paths and an average of the two is also calculated.***

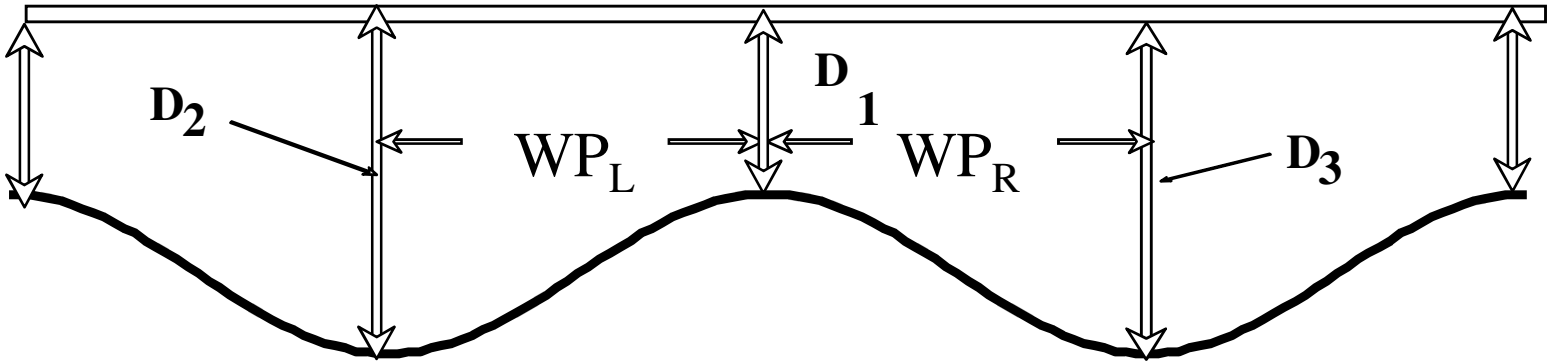
Pavement Data Collected - Cont'd

High Speed Profiler

- **Rut Depth**
  - ***Pavement depressions (inch) primarily in the wheel paths.***
  - ***Measured using a laser line scan applied to images of the transverse road profile for the collection lane.***
  - ***Average rut is calculated as the average for each wheel path over the tenth mile reporting interval.***
  - ***Also calculated is the maximum rut for the left and right wheel path using a moving average of approximately 15 feet.***

$$\text{Rut Depth} = \frac{D_2 + D_3}{2} - D_1$$

3-5 Point Measurement



Pavement Data Collected - Cont'd

High Speed Profiler

- **Surface Distresses**
  - ***Assessments based on windshield surveys.***
  - ***Rater uses a computer keyboard; each key represents a specific type of distress and a specific severity level.***
  - ***Computer software records the road locations when a particular key is toggled on and off. It then calculates the percentage of the tenth mile reporting interval that the particular distress and severity were present.***

Surface Distress Data

For Bituminous and Composite (asphalt over old concrete) Pavements:

Outside Wheel Paths

- Multiple Cracking
- Transverse Cracking
- Longitudinal Cracking

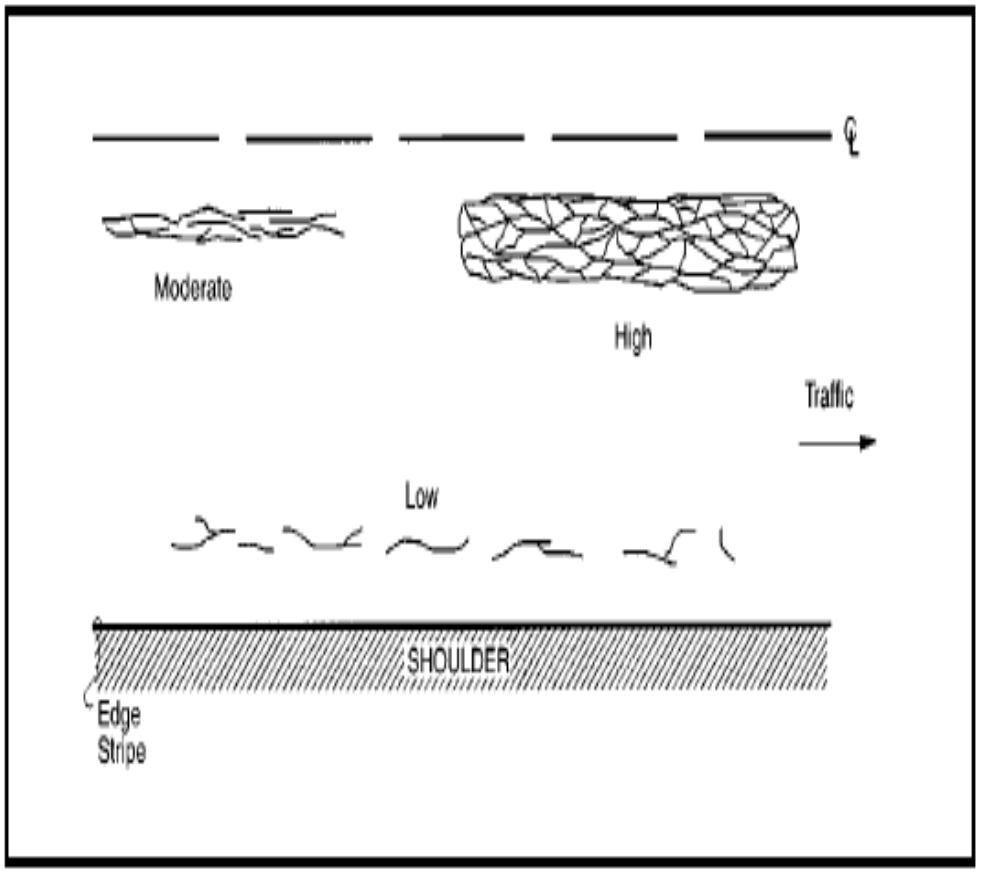
In Wheel Paths

- Load Related Multiple Cracking – indicative of fatigue cracking

Multiple Cracking Rt 9 Old Bridge

Transverse & Longitudinal Cracking

Load Related Multiple Cracking



For Concrete Pavements

- Cracking – any type of general cracking in the concrete slabs
- Faulting – differential vertical displacement between adjacent slabs
- Longitudinal and Transverse Joint Deterioration

Route 295 MP 46 - 53

Route 295 MP 46 - 53

Route 295 MP 46 - 53

Joint Deterioration

What Isn’t Wrong?

For Any Pavement Type

- Patching
- Shoulder Deterioration
- Shoulder Drop

Consolidate Distress Data → SDI

Outside Wheel Paths

- *Asphalt Multiple Cracking*
- *Asphalt Transverse Cracking*
- *Asphalt Longitudinal Cracking*
- *Concrete Cracking*
- *Concrete Faulting*
- *Concrete Longitudinal Joint Deterioration*
- *Concrete Transverse Joint Deterioration*
- *Patching*
- *Shoulder Deterioration*
- *Shoulder drop*

Distress Weight × *Severity Factor* / *Extent %*

NDI (0 – 5 scale)
Non Load Related Distress Index

In Wheel Paths

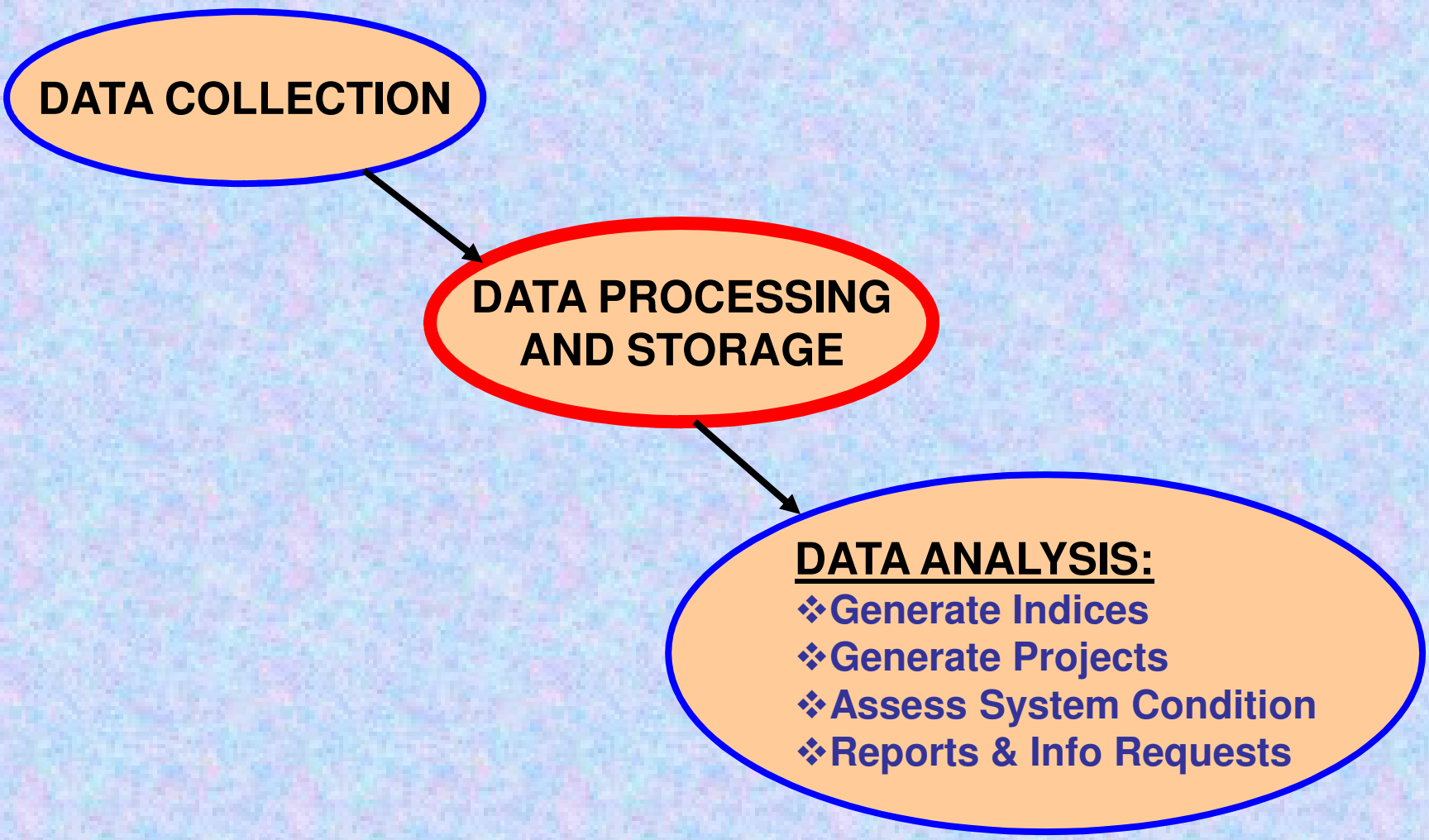
- *Load Related Multiple (Fatigue) Cracking*
- *Rutting*

Distress Weight × *Severity Factor* / *Extent %*

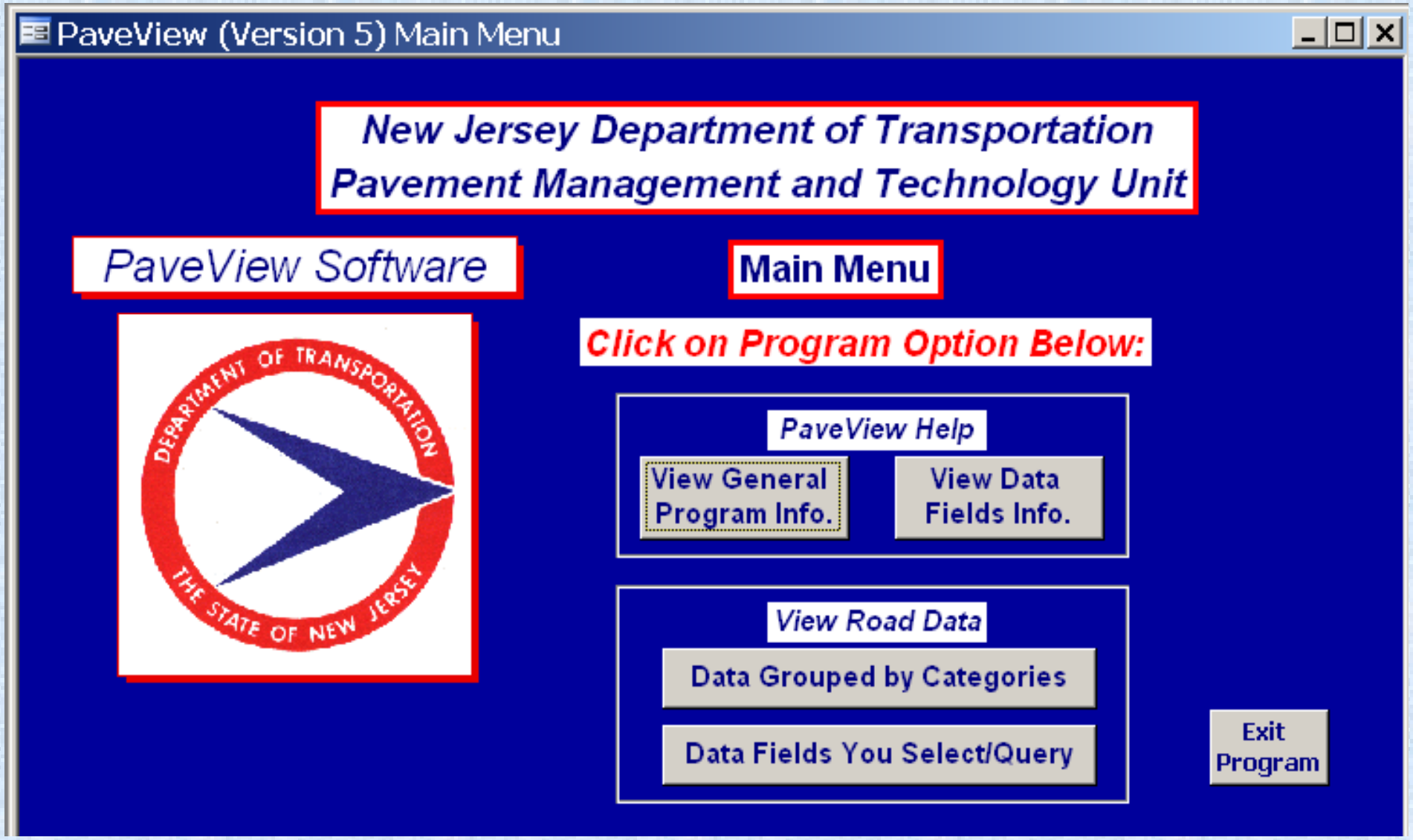
LDI (0 – 5 scale)
Load Related Distress Index

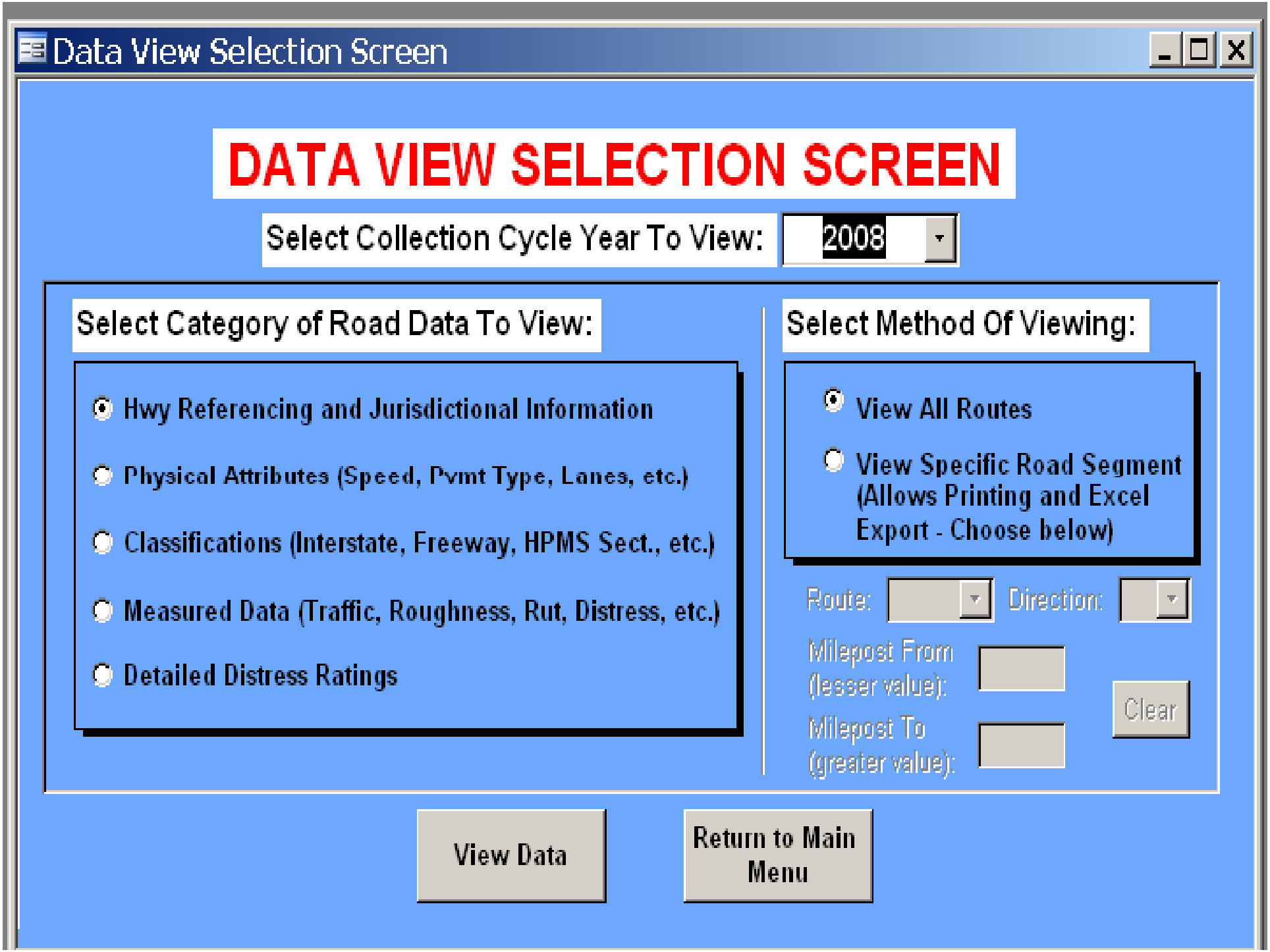
SDI (0-5 scale)
Surface Distress Index
5 = Distress Free

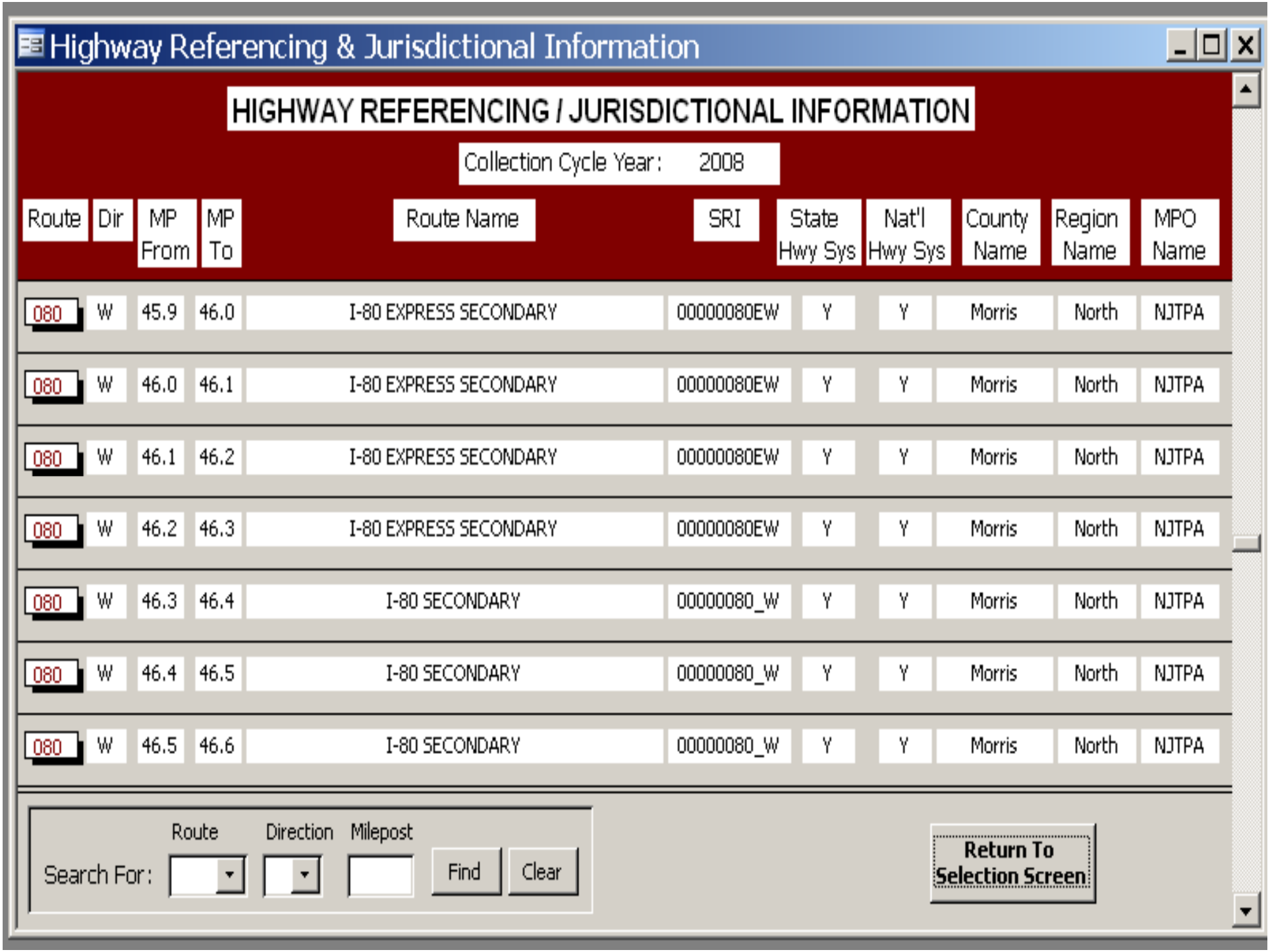
NJDOT PAVEMENT DATA ANALYSIS

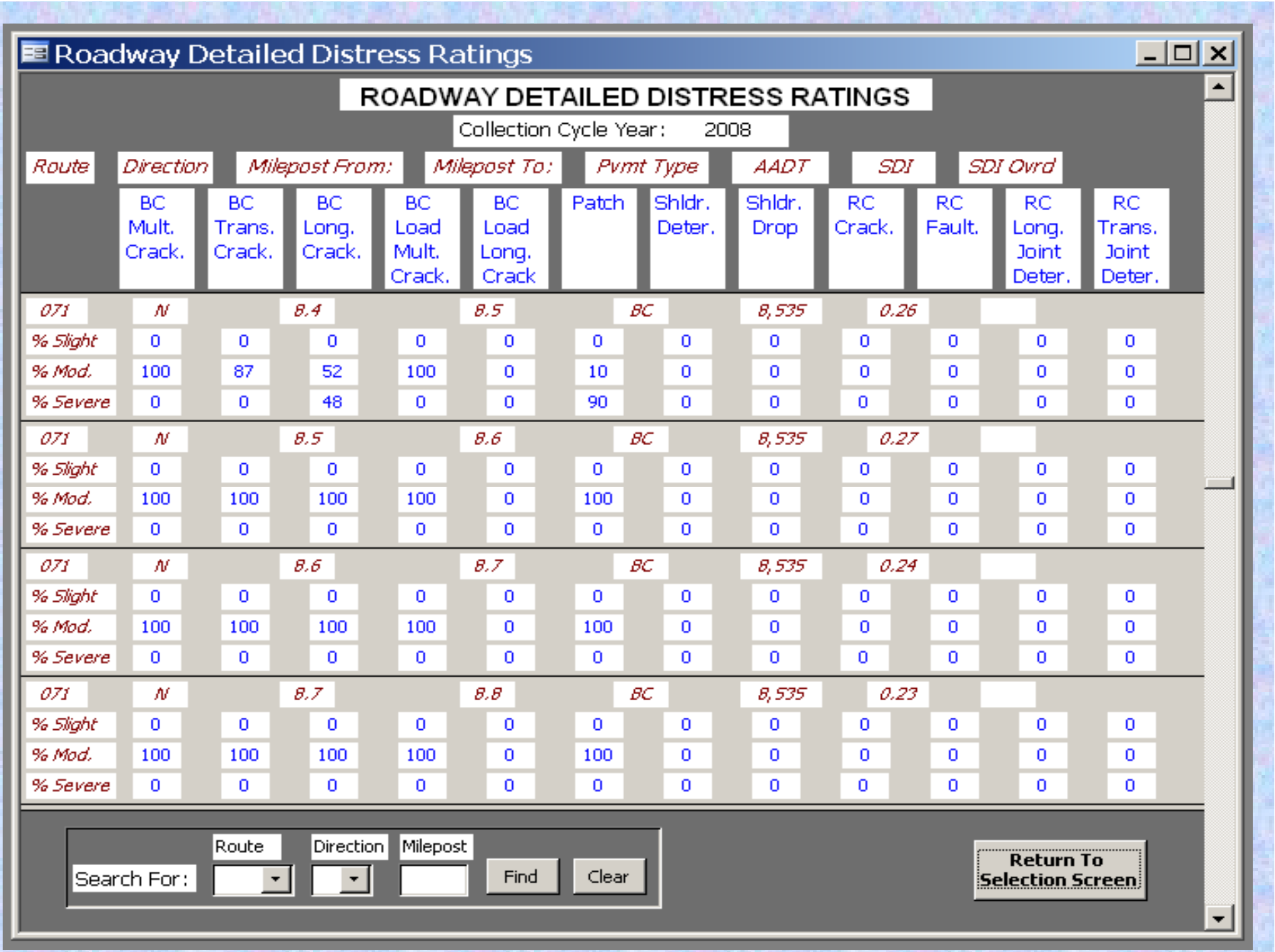


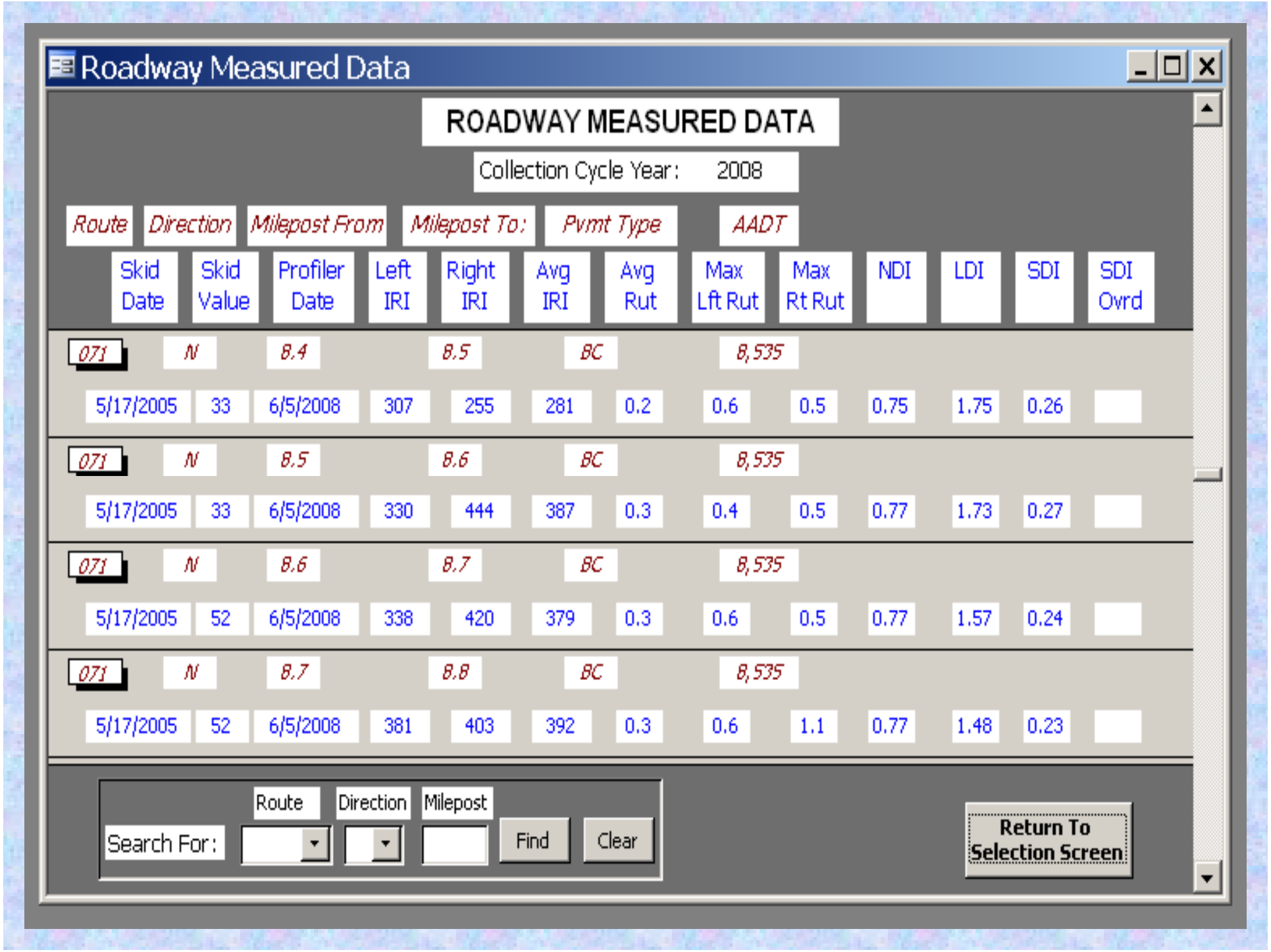
DATA PROCESSING AND STORAGE




Data View Selection Screen
DATA VIEW SELECTION SCREEN
Select Collection Cycle Year To View:
2008
Select Category of Road Data To View:
Hwy Referencing and Jurisdictional Information
Physical Attributes (Speed, Pvmt Type, Lanes, etc.)
Classifications (Interstate, Freeway, HPMS Sect., etc.)
Measured Data (Traffic, Roughness, Rut, Distress, etc.)
Detailed Distress Ratings
Select Method Of Viewing:
View All Routes
View Specific Road Segment (Allows Printing and Excel Export - Choose below)
Route:
Direction:
Milepost From (lesser value):
Milepost To (greater value):
Clear
View Data
Return to Main Menu

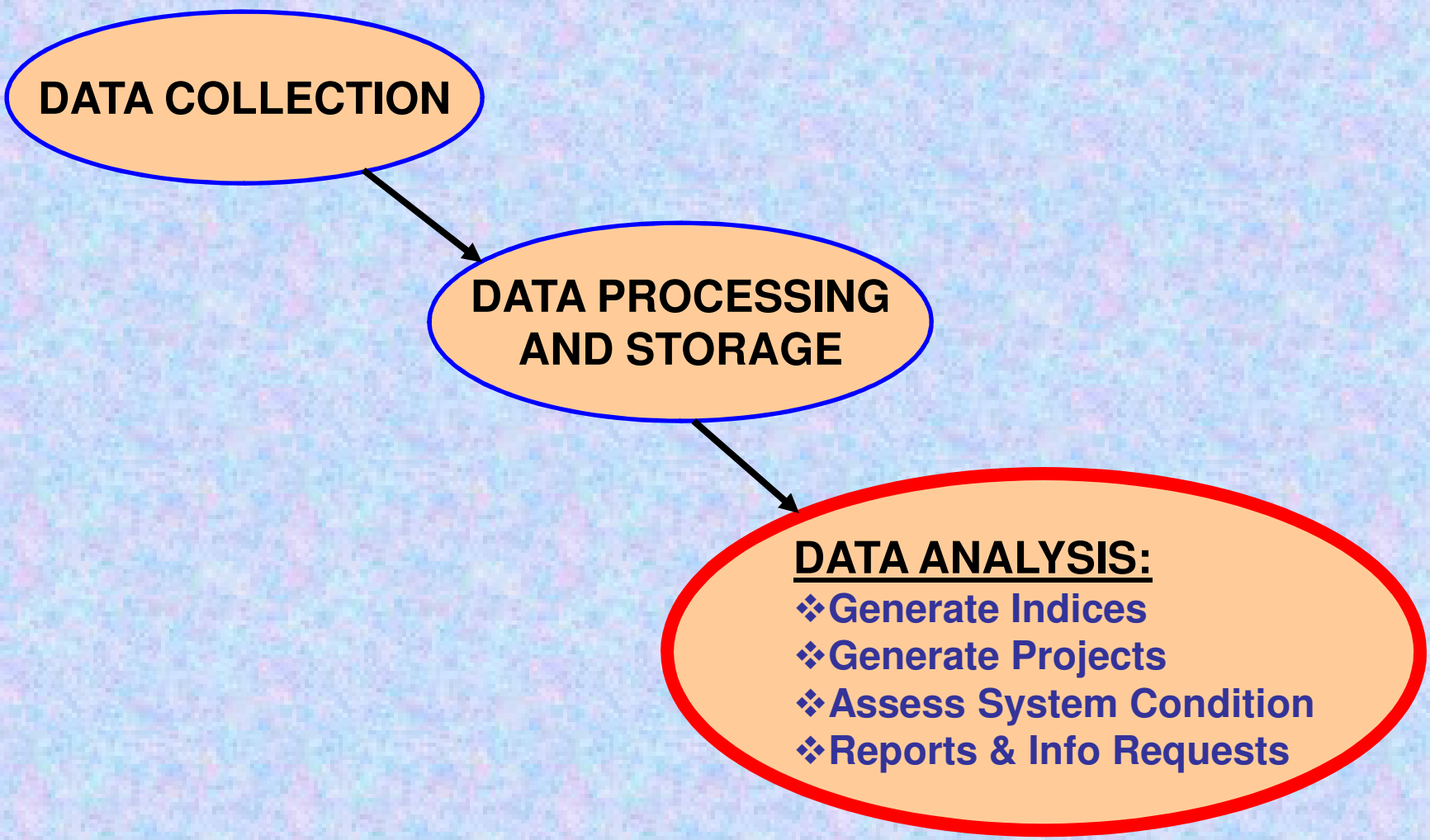

Highway Referencing & Jurisdictional Information
HIGHWAY REFERENCING / JURISDICTIONAL INFORMATION
Collection Cycle Year: 2008
Route
Dir
MP From
MP To
Route Name
SRI
State Hwy Sys
Nat'l Hwy Sys
County Name
Region Name
MPO Name
080 W 45.9 46.0 I-80 EXPRESS SECONDARY 00000080EW Y Y Morris North NJTPA
080 W 46.0 46.1 I-80 EXPRESS SECONDARY 00000080EW Y Y Morris North NJTPA
080 W 46.1 46.2 I-80 EXPRESS SECONDARY 00000080EW Y Y Morris North NJTPA
080 W 46.2 46.3 I-80 EXPRESS SECONDARY 00000080EW Y Y Morris North NJTPA
080 W 46.3 46.4 I-80 SECONDARY 00000080_W Y Y Morris North NJTPA
080 W 46.4 46.5 I-80 SECONDARY 00000080_W Y Y Morris North NJTPA
080 W 46.5 46.6 I-80 SECONDARY 00000080_W Y Y Morris North NJTPA
Search For:
Route
Direction
Milepost
Find
Clear
Return To Selection Screen


Roadway Detailed Distress Ratings
ROADWAY DETAILED DISTRESS RATINGS
Collection Cycle Year: 2008
Route
Direction
Milepost From:
Milepost To:
Pvmt Type
AADT
SDI
SDI Ovrd
BC Mult. Crack.
BC Trans. Crack.
BC Long. Crack.
BC Load Mult. Crack.
BC Load Long. Crack
Patch
Shldr. Deter.
Shldr. Drop
RC Crack.
RC Fault.
RC Long. Joint Deter.
RC Trans. Joint Deter.
071 N 8.4 8.5 BC 8,535 0.26
% Slight 0 0 0 0 0 0 0 0 0 0 0 0
% Mod. 100 87 52 100 0 10 0 0 0 0 0 0
% Severe 0 0 48 0 0 90 0 0 0 0 0 0
071 N 8.5 8.6 BC 8,535 0.27
% Slight 0 0 0 0 0 0 0 0 0 0 0 0
% Mod. 100 100 100 100 0 100 0 0 0 0 0 0
% Severe 0 0 0 0 0 0 0 0 0 0 0 0
071 N 8.6 8.7 BC 8,535 0.24
% Slight 0 0 0 0 0 0 0 0 0 0 0 0
% Mod. 100 100 100 100 0 100 0 0 0 0 0 0
% Severe 0 0 0 0 0 0 0 0 0 0 0 0
071 N 8.7 8.8 BC 8,535 0.23
% Slight 0 0 0 0 0 0 0 0 0 0 0 0
% Mod. 100 100 100 100 0 100 0 0 0 0 0 0
% Severe 0 0 0 0 0 0 0 0 0 0 0 0
Search For:
Route
Direction
Milepost
Find
Clear
Return To Selection Screen

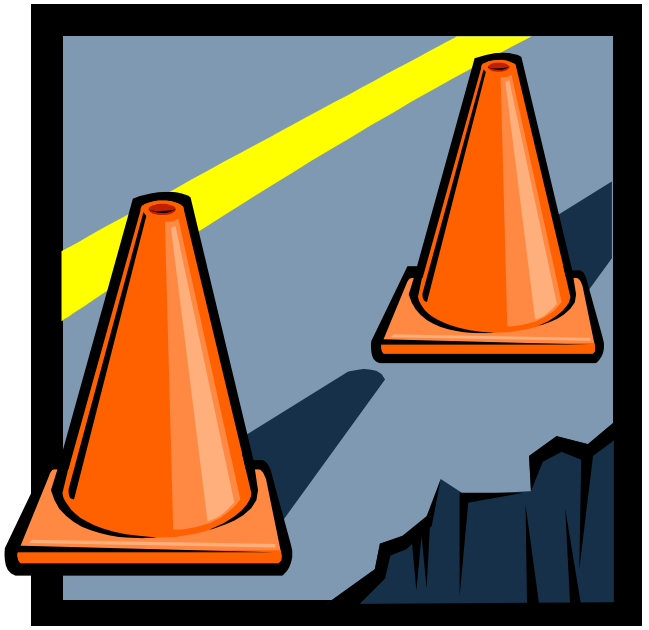

Roadway Measured Data
ROADWAY MEASURED DATA
Collection Cycle Year: 2008
Route
Direction
Milepost From
Milepost To:
Pvmt Type
AADT
Skid Date
Skid Value
Profiler Date
Left IRI
Right IRI
Avg IRI
Avg Rut
Max Lft Rut
Max Rt Rut
NDI
LDI
SDI
SDI Ovrd
071 N 8.4 8.5 BC 8,535
5/17/2005 33 6/5/2008 307 255 281 0.2 0.6 0.5 0.75 1.75 0.26
071 N 8.5 8.6 BC 8,535
5/17/2005 33 6/5/2008 330 444 387 0.3 0.4 0.5 0.77 1.73 0.27
071 N 8.6 8.7 BC 8,535
5/17/2005 52 6/5/2008 338 420 379 0.3 0.6 0.5 0.77 1.57 0.24
071 N 8.7 8.8 BC 8,535
5/17/2005 52 6/5/2008 381 403 392 0.3 0.6 1.1 0.77 1.48 0.23
Search For:
Route
Direction
Milepost
Find
Clear
Return To Selection Screen

Route 71 North MP 8.4

NJDOT PAVEMENT DATA ANALYSIS



Project Generation



Project Generation

Generate Tenth Mile Segments Needing Work

Query the PMS database

"Give me all road segments in the State Highway System where the SDI is less than 2.0"

Route	Direction	MP From	Mp To	SDI
046	E	2.0	2.1	1.83
046	E	2.1	2.2	1.72
046	E	2.4	2.5	0.82
046	E	2.7	2.8	0.95
046	E	2.9	3.0	1.90

Combine Segments Into Candidate Projects

Route	Direction	MP Start	MP End
046	E	2.0	3.0

Analyze & Prioritize Candidate Projects

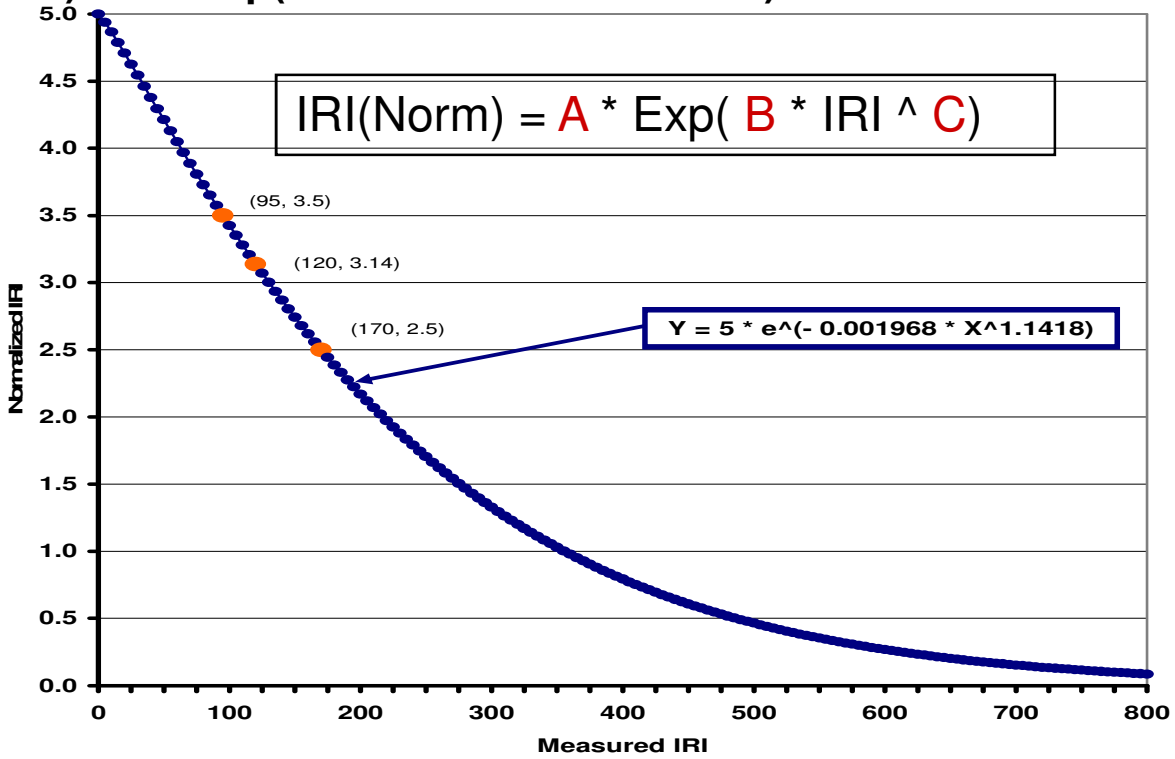
1. **For each candidate project generate tenth mile data:**

   Example: Rte 10 W 12.1-12.8

   - **Traffic (AADT)**
   - **IRI (inches/mile)**
   - **SDI (0 – 5 scale)**

Rte	Dir	MP Start	MP End	Lane Miles	AADT	IRI	SDI
010	W	12.1	12.2	0.3	33580	162	0.95
010	W	12.2	12.3	0.3	33580	252	0.75
010	W	12.3	12.4	0.4	33580	104	0.70
010	W	12.4	12.5	0.4	33580	109	0.63
010	W	12.5	12.6	0.4	33580	122	0.71
010	W	12.6	12.7	0.4	33580	149	0.68
010	W	12.7	12.8	0.2	33580	159	1.15

2. **IRI(Normalized) = 5 * Exp(- 0.001968 * IRI ^ 1.1418) – allows IRI & SDI comparison**



Analyze & Prioritize Candidate Projects – Cont'd.

3. Combine Normalized IRI & SDI - Calculate **Final Pavement Rating (FPR)**

- Let *Small Index* be the smaller and *Large Index* be the larger of the Normalized IRI and SDI values for any tenth mile segment
- If *Small Index* < 2.0, then **FPR = *Small Index***
- If 2.0 ≤ *Small Index* ≤ 2.5, then **FPR = (0.75 x *Small Index*) + (0.25 x *Large Index*)**
- If *Small Index* > 2.5, then **FPR = (0.50 x *Small Index*) + (0.50 x *Large Index*)**

Rte	Dir	MP Start	MP End	Lane Miles	AADT	IRI	SDI	Normalized IRI	FPR
010	W	12.1	12.2	0.3	33580	162	0.95	2.59	0.95
010	W	12.2	12.3	0.3	33580	252	0.75	1.69	0.75
010	W	12.3	12.4	0.4	33580	104	0.70	3.36	0.70
010	W	12.4	12.5	0.4	33580	109	0.63	3.29	0.63
010	W	12.5	12.6	0.4	33580	122	0.71	3.11	0.71
010	W	12.6	12.7	0.4	33580	149	0.68	2.76	0.68
010	W	12.7	12.8	0.2	33580	159	1.15	2.63	1.15

Analyze & Prioritize Candidate Projects – Cont'd.

4. Calculate project statistics for each candidate project:

- ❑ Total Lane Miles
- ❑ Averages of AADT, IRI, Normalized IRI, SDI, FPR
- ❑ Project Benefit

FPR Improvement = (5.0 – Avg FPR)
Traffic Factor = 5.0 x (Avg AADT / 60000) with a max of 5.0
Benefit = (0.9 x FPR Improvement) + (0.1 x Traffic Factor)

5. Compile Needs List of Potential Projects – Rank By Benefit

Project Benefit Rank	Rte	Dir (B = Both)	MP Start	MP End	Len	Lane Miles	Avg AADT	Avg IRI	Avg Norm-lized IRI	Avg SDI	Avg FPR	Benefit
1	030	B	12.4	13.1	0.7	2.8	31938	256	1.69	0.15	0.15	4.494
2	009	N	128.1	129.1	1.0	3.0	39059	134	2.97	0.44	0.44	4.426
3	001	S	22.3	22.9	0.6	1.8	37630	162	2.60	0.48	0.48	4.378
4	047	B	59.8	61.5	1.7	3.4	12376	223	1.97	0.28	0.28	4.302
5	009	N	111.9	112.4	0.5	1.0	18756	143	2.97	0.40	0.40	4.293
6	202	S	11.5	12.6	1.1	2.2	14702	128	3.11	0.38	0.38	4.285
7	018	N	11.4	13.2	1.8	3.6	17512	201	2.25	0.40	0.40	4.282
8	001	S	9.0	9.5	0.5	1.5	38071	111	3.27	0.60	0.60	4.276

Pavement Project Development

Special Project Generation

- **Projects such as preventive maintenance treatments are generated by querying the condition data base for pavement sections which are not yet in poor condition and which exhibit the appropriate types of distress for crack sealing, thin overlays, diamond grinding, etc.**
- **Safety projects such as reduction of wet weather accidents are generated by correlating accident data with skid resistance data**

Reports & Requests For Info

- **Requests for road data / condition status from Project Planning, NJDOT personnel, outside agencies, and consultants.**

- **FHWA Smoothness Report for the National Highway System**

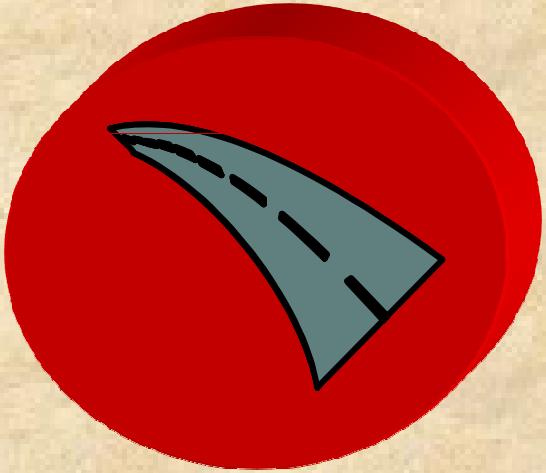
- **Capital Investment Strategy Report**
  - Pavement System 10 Year Performance Curves

- **Report to the Governor and the Legislature**
  - Assess State Highway System Condition
  - Report on Work Completed in Fiscal Year
  - Describe Work Needing to Be Done

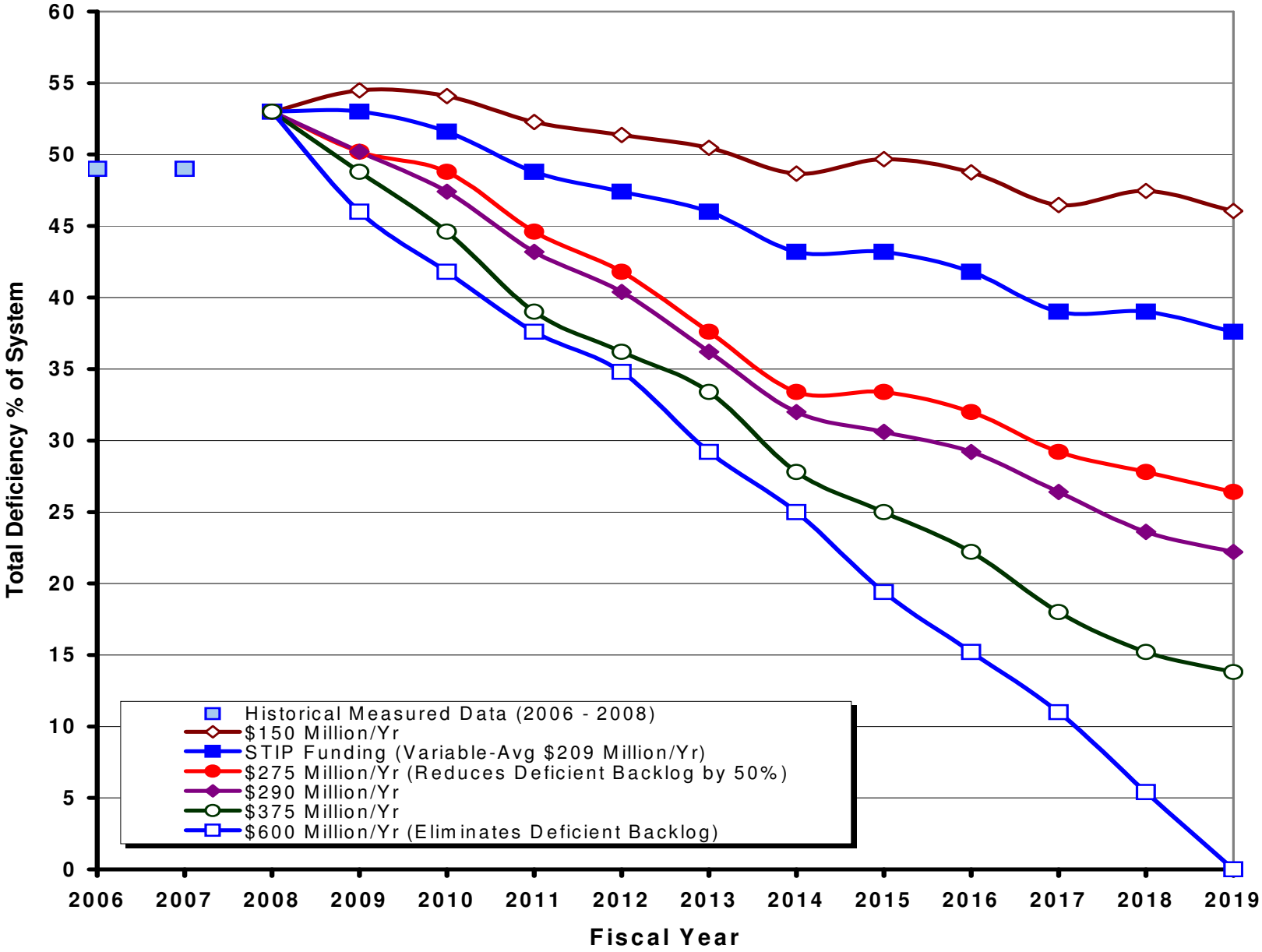
SMOOTHNESS RESULTS BY CATEGORIES (Based on 2008 Data)			
	Deficient VMT (IRI > 170)	**Fair VMT** (95 < IRI ≤170)	**Good VMT** (IRI ≤ 95)
Percent of Total System	**18%**	**41%**	**41%**
FHWA Goal For 2008	**5%**	**35%**	**60%**
Improvement Needed	**13%**	**6%**	**19%**

FY 2009-2018 Statewide Capital Investment Strategy

Roadway Assets Report



Multi-Year Performance Analysis
State Highway System Total Deficiency Based on IRI & SDI

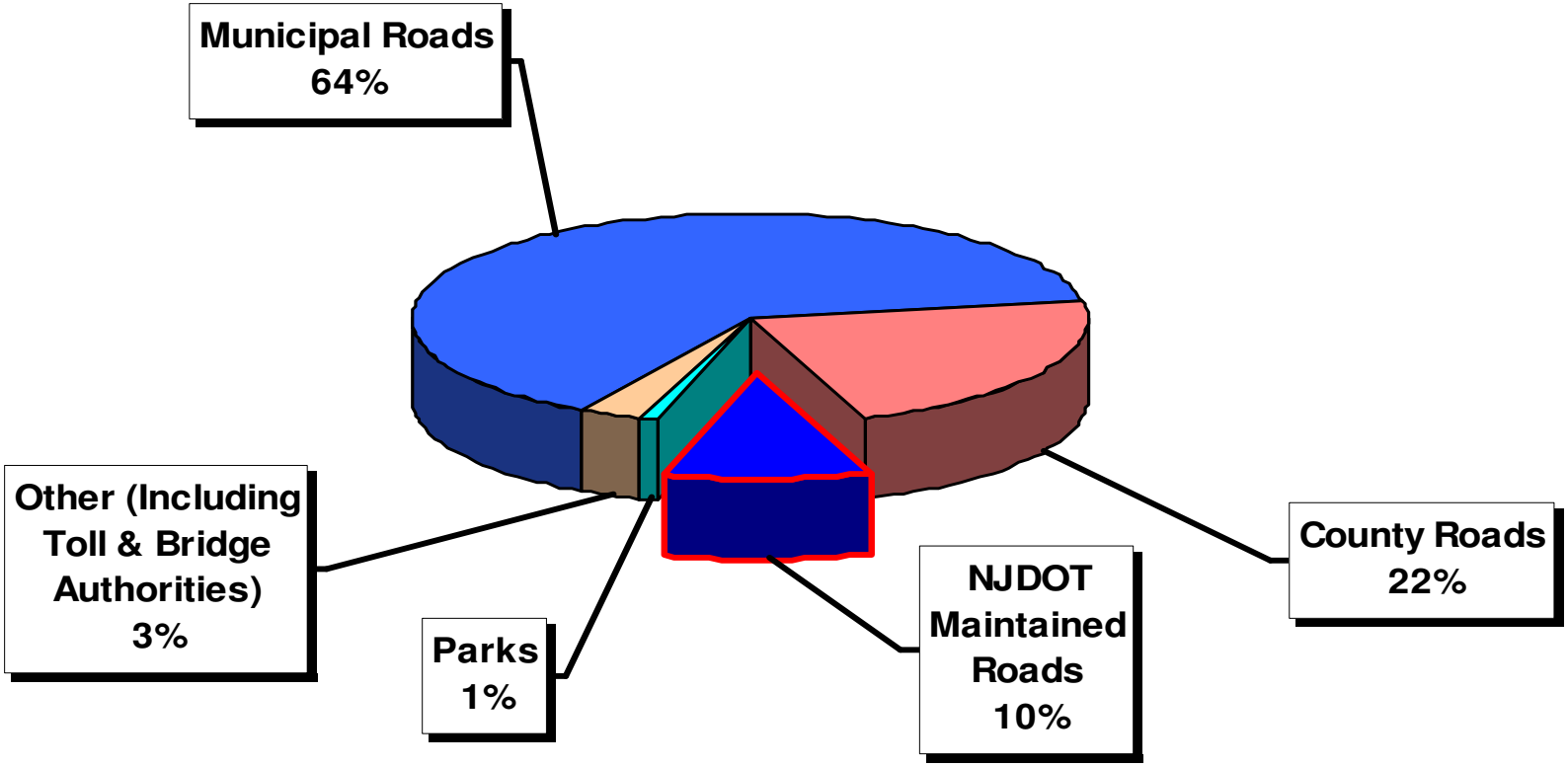


REPORT TO THE GOVERNOR AND THE LEGISLATURE ON NEW JERSEY'S ROADWAY PAVEMENT SYSTEM

FISCAL YEARS 2008 & 2009

DEPARTMENT OF TRANSPORTATION
STATE OF NEW JERSEY

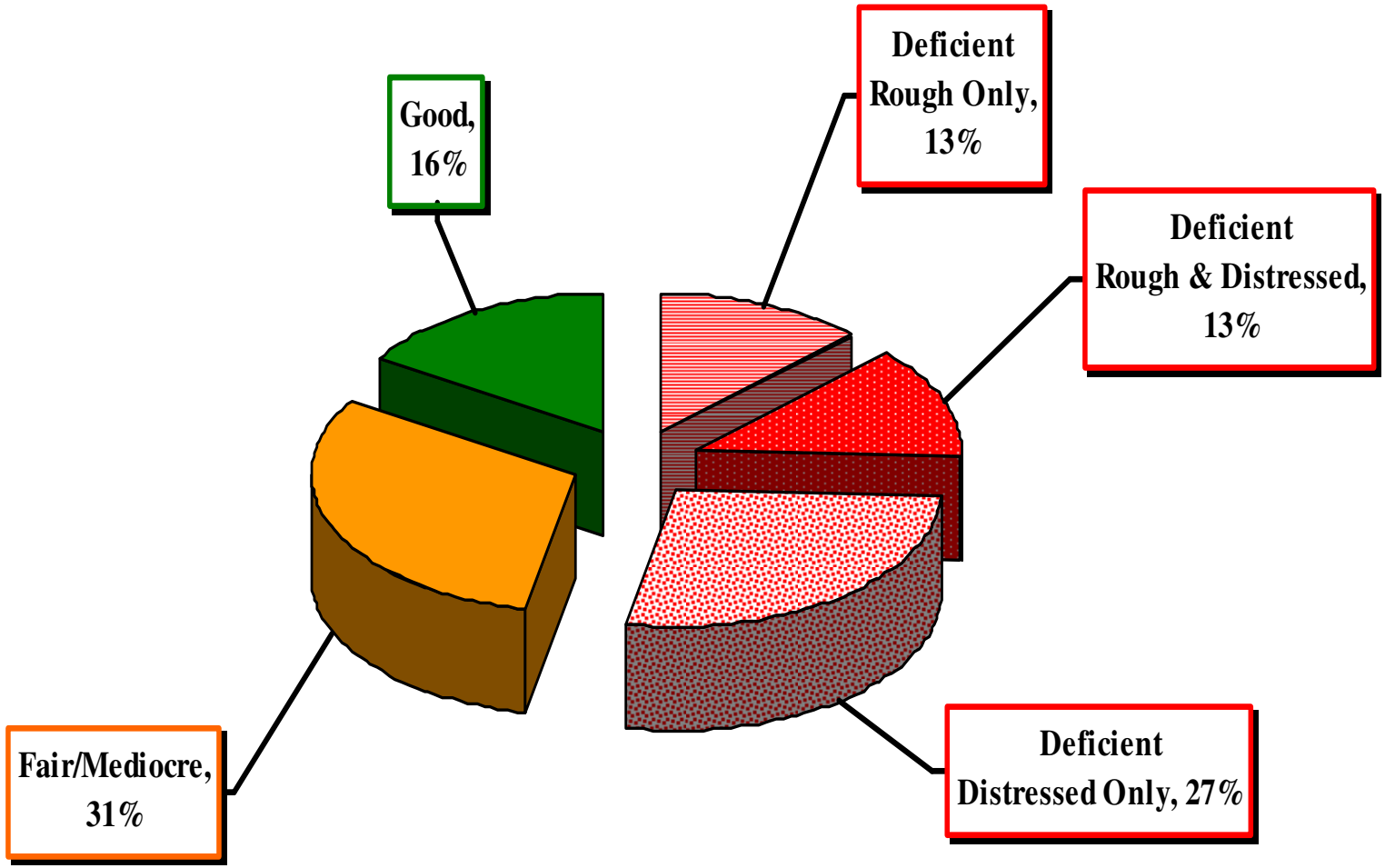
NJ Roadway System Breakdown by Lane Miles



Condition Criteria

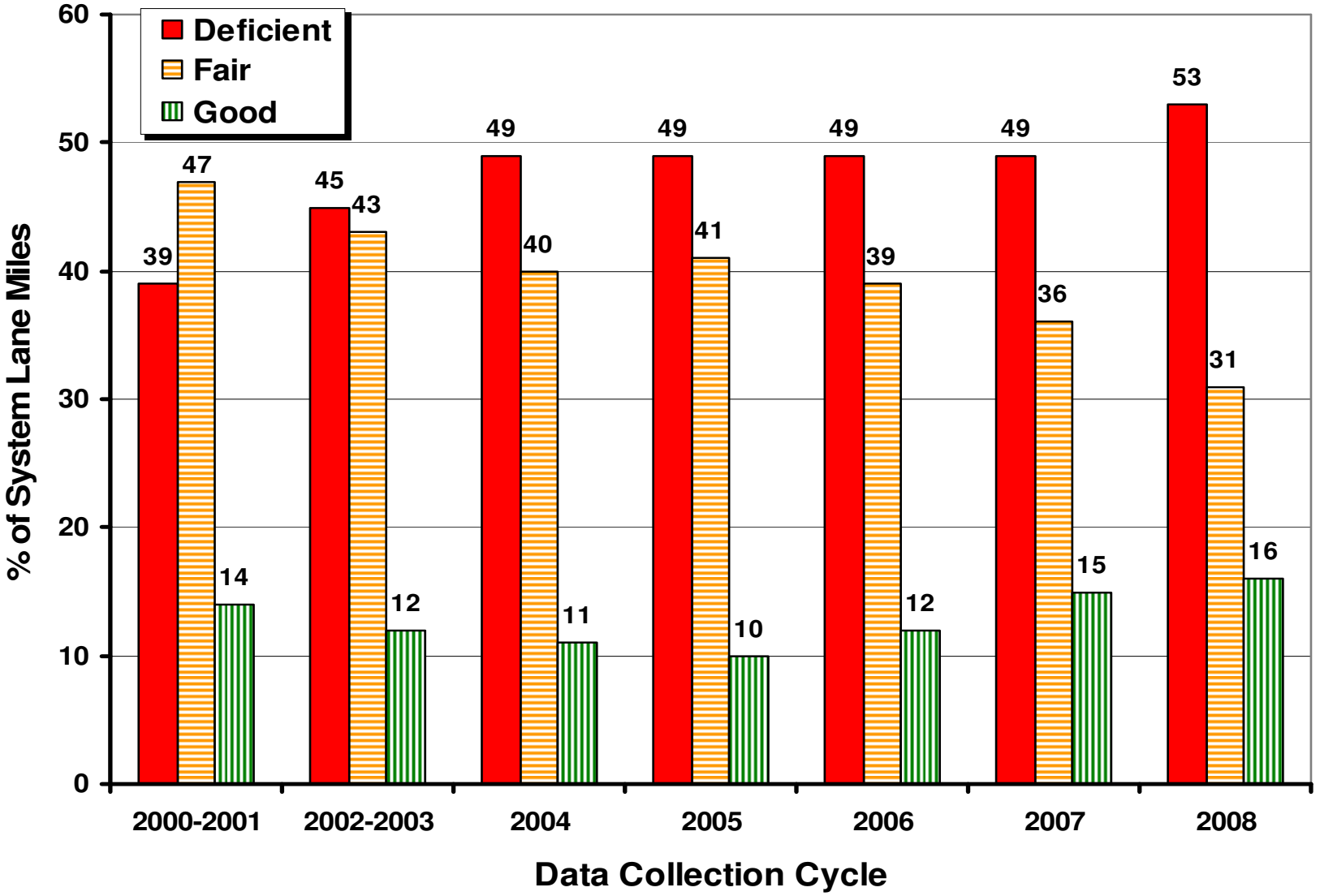
Condition Status	Condition Index Criteria (IRI = International Roughness Index, in/mi; SDI = Surface Distress Index, 0 – 5 Scale)	Engineering Significance
Deficient (Poor)	**IRI > 170 *OR* SDI ≤ 2.4**	**These roads are overdue for treatment.** Drivers on these roads are likely to notice that they are driving on a rough surface, which puts stress on their vehicles. These pavements may have deteriorated to such an extent that they affect the speed of free flow traffic. Flexible pavements may have large potholes and deep cracks. These roads often show significant signs of wear and deterioration, and may have significant distress in the underlying foundation. Roads in this condition will generally be most costly to rehabilitate.
Fair / Mediocre	**(95 ≤ IRI ≤ 170 *And* SDI > 2.4) *OR* (IRI < 95 *And* 2.4 < SDI < 3.5)**	**These roads exhibit minimally acceptable ride quality** that is noticeably inferior to those of new pavements and may be barely tolerable for high-speed traffic. These pavements may show some signs of deterioration such as rutting, map cracking and extensive patching. Most importantly, roads in this category are in jeopardy and should immediately be programmed for some cost-effective treatment that will restore them to a good condition and avoid costly rehabilitation in the near future.
Good	**IRI < 95 *AND* SDI ≥ 3.5**	**These roads exhibit good ride quality** with little or no signs of deterioration. A proactive preventive maintenance strategy is necessary to keep roads in this category as long as possible.

Current Functional Adequacy of NJ State Highway System
(Based on Roughness & Distress)



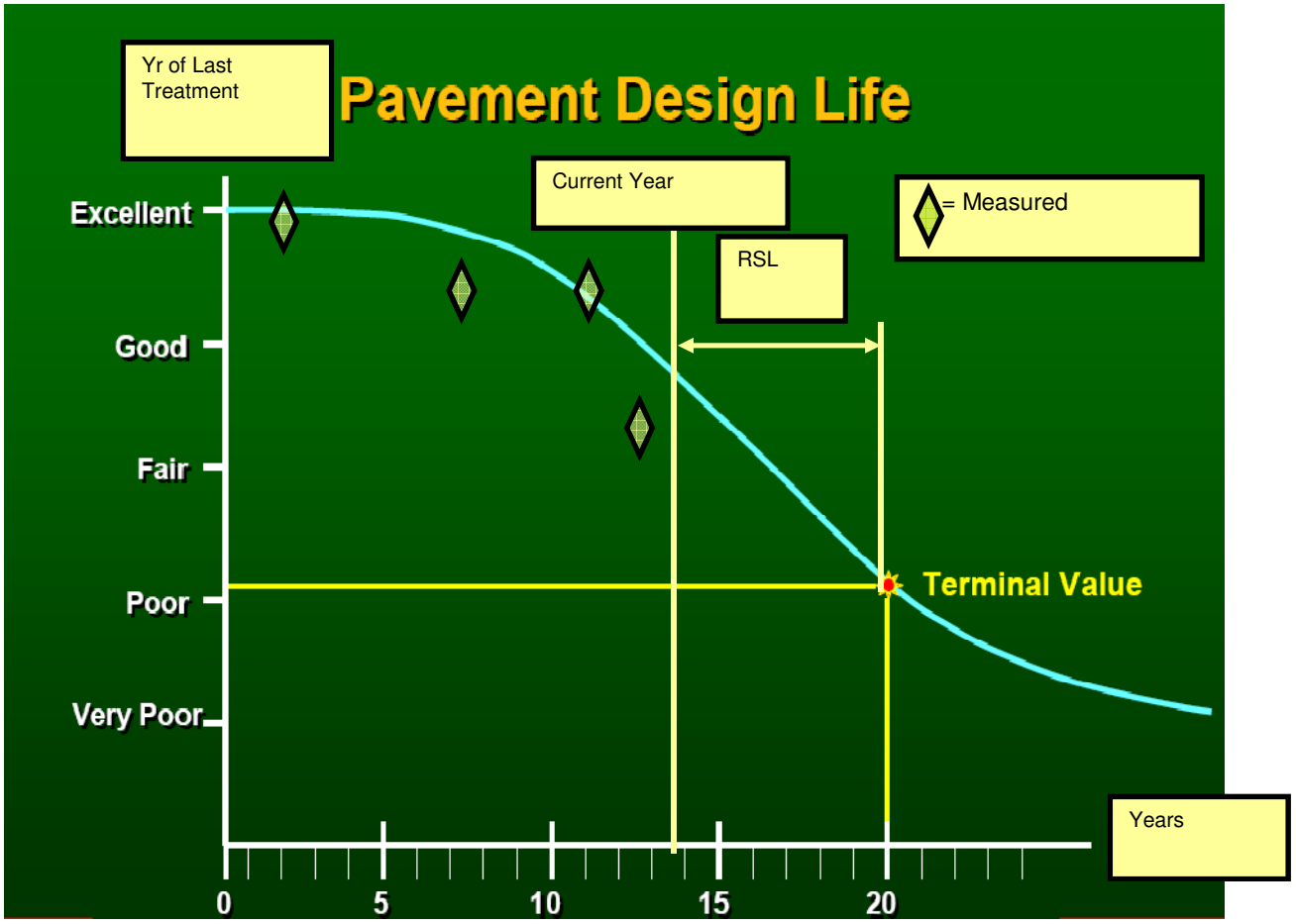
Source: NJDOT Pavement Management System, 2008 Data

Multi-Year Status of State Highway System

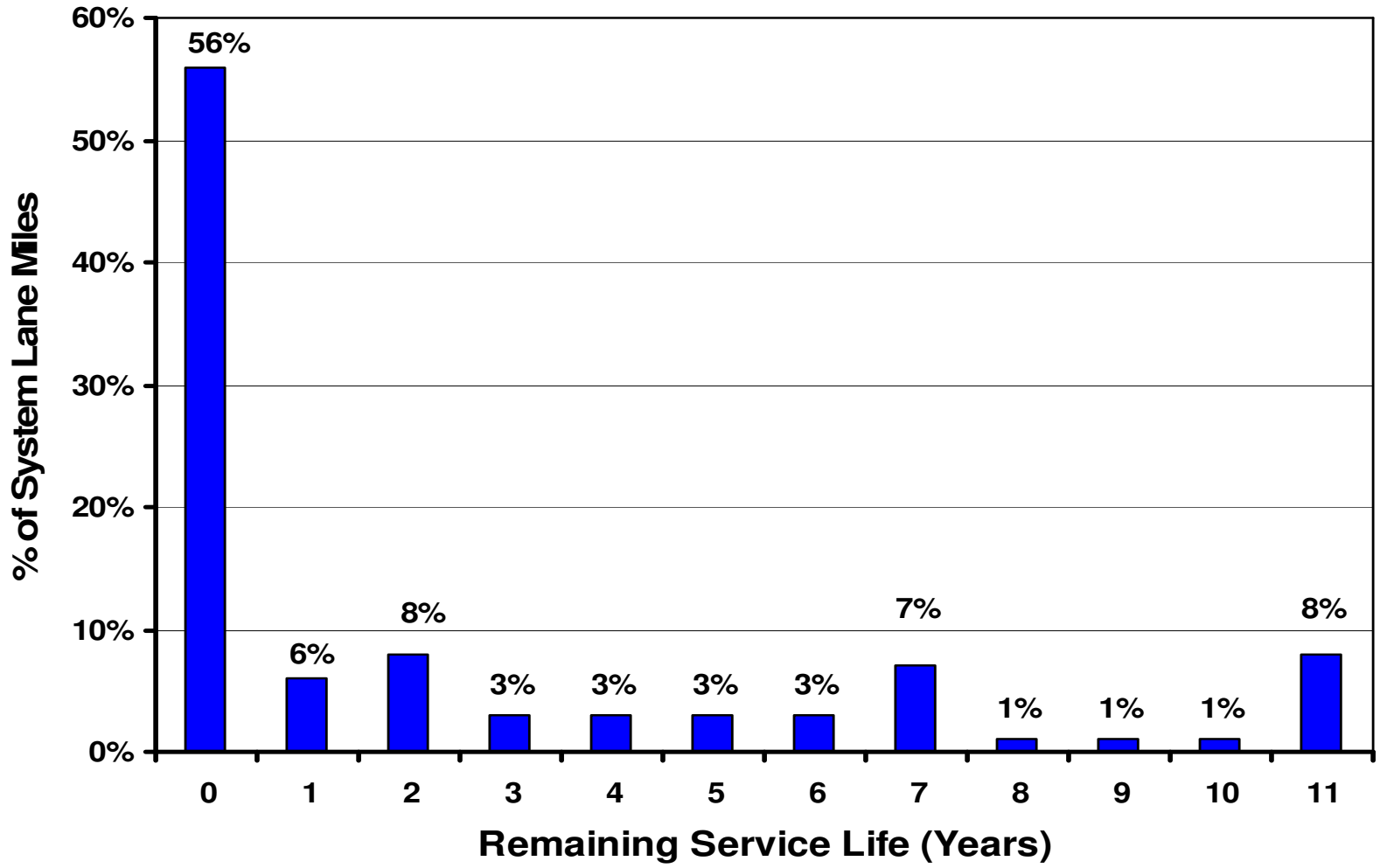


Source: NJDOT Pavement Management System

ANOTHER WAY TO EVALUATE PAVEMENT CONDITION
REMAINING SERVICE LIFE (RSL)



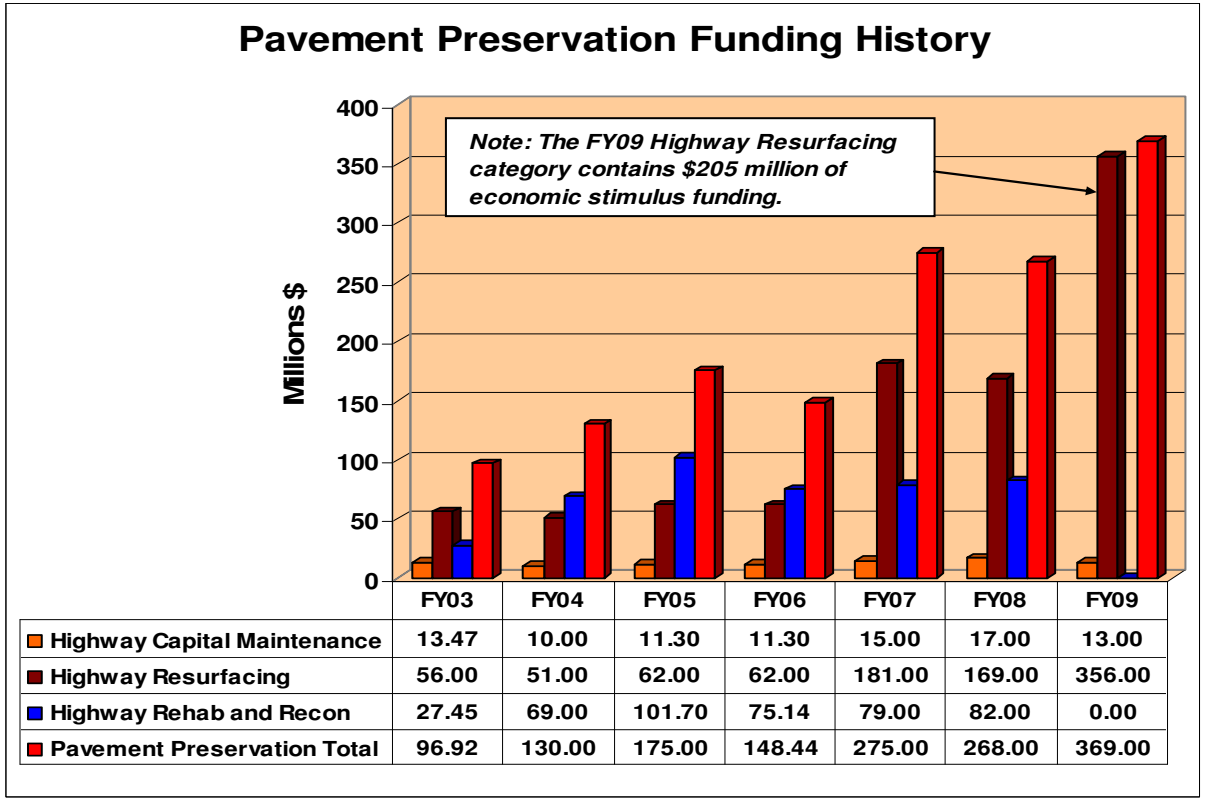
Pavement Remaining Service Life
State Highway System



Source: NJDOT Pavement Management System, 2008 Data

Why Are We Where We Are?

- **Phenomenal Traffic:** New Jersey, with the highest population density of the fifty states, experiences traffic volumes that are roughly 3.5 times the national average.
- **Under Funding and Deferred Maintenance:** Funding prior to fiscal year 2007 was markedly reduced. This situation allowed much of the pavement system to slip into serious disrepair and contributed to an enormous backlog of deficient pavement sections.



	FY03	FY04	FY05	FY06	FY07	FY08	FY09
Highway Capital Maintenance	13.47	10.00	11.30	11.30	15.00	17.00	13.00
Highway Resurfacing	56.00	51.00	62.00	62.00	181.00	169.00	356.00
Highway Rehab and Recon	27.45	69.00	101.70	75.14	79.00	82.00	0.00
Pavement Preservation Total	96.92	130.00	175.00	148.44	275.00	268.00	369.00

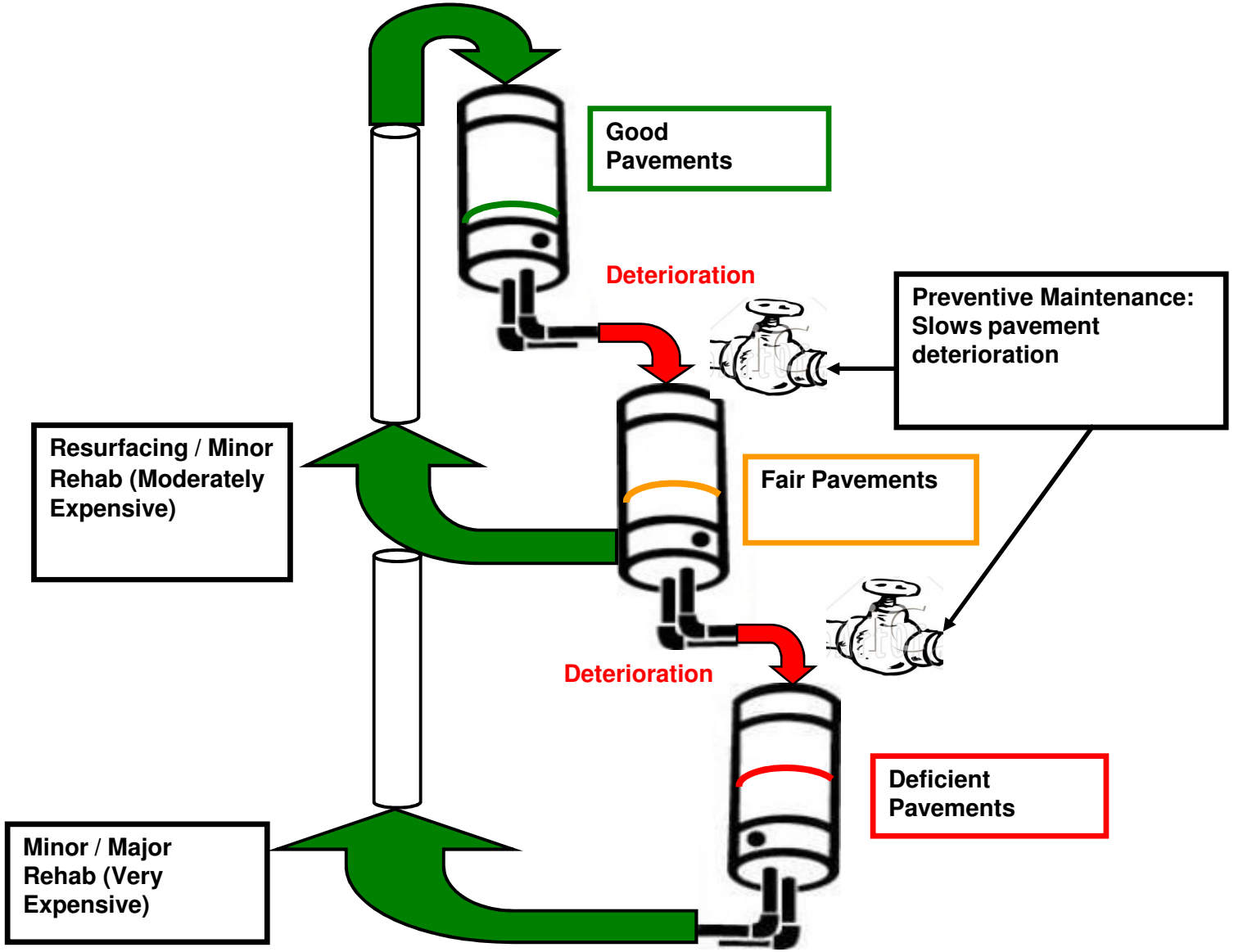
Why Are We Where We Are? – Cont'd

- **Deficient Roadways Cost More to Restore:** Costs per lane mile for rehabilitation or reconstruction after a roadway has deteriorated to a deficient condition can be three or more times the costs of preservation treatments during the life span of the pavement

- **Getting Less for Our Construction Dollar:** Soaring costs during the past five years have eroded our state's purchasing power on construction projects. By the summer of 2008, asphalt prices were up 70 percent and concrete was up 36 percent. Diesel fuel, used to operate heavy construction equipment, soared 305 percent, including a 63 percent jump in one year.

- **Composite Pavements Are Especially Difficult:** Approximately 50% of New Jersey's state highway system is composed of composite pavements (asphalt over concrete), which present special problems.

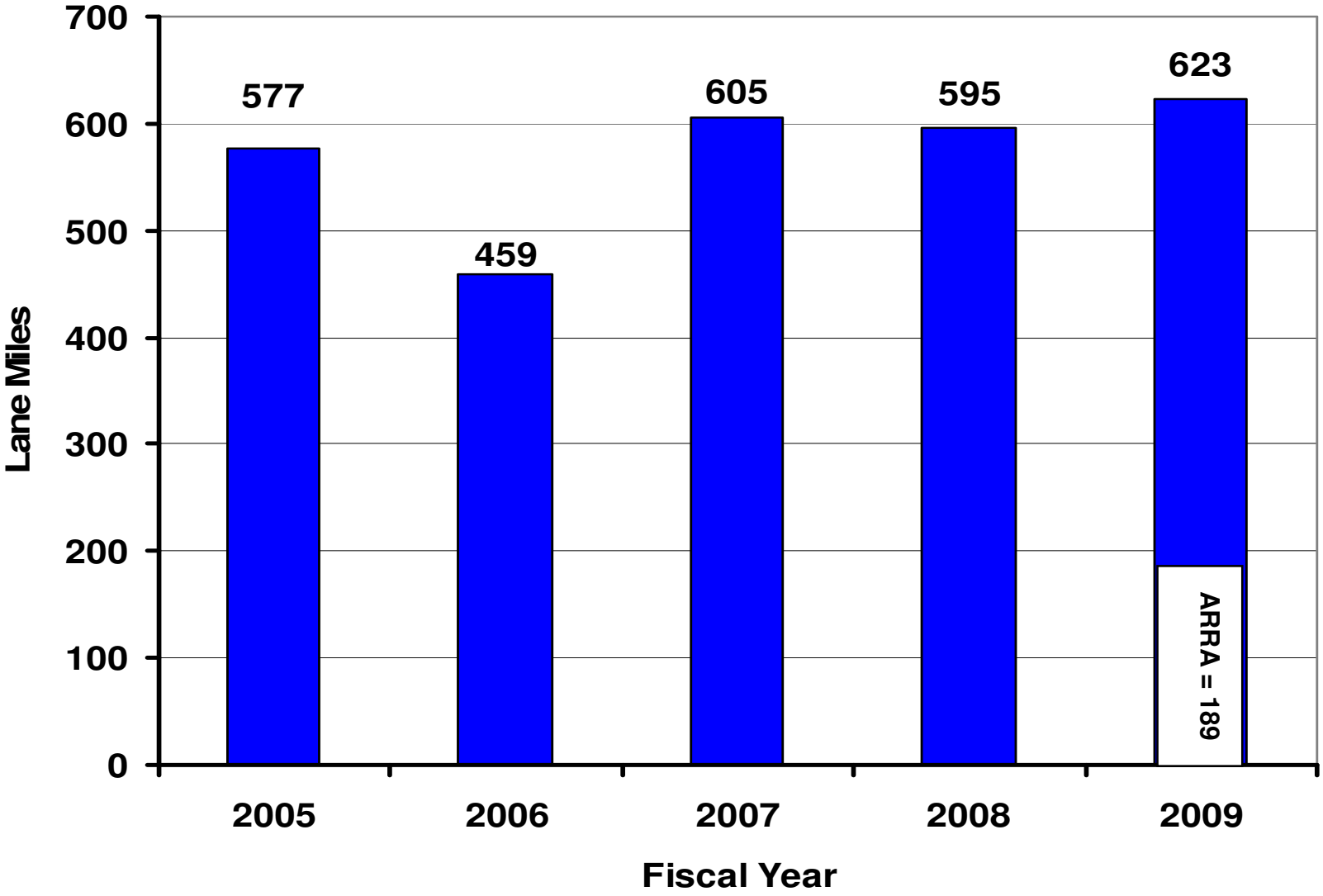
Our Strategy: Pavement Preservation Methodology



Innovations in Design and Construction

- **Advances through research & development:** Cutting edge technology to develop pavement treatments which last longer, reduce traffic noise, and employ recycled materials.
- **Use of in-house designers:** Design time and cost significantly reduced saving millions of dollars annually.
- **Accelerated project delivery system:** Procedures used to selectively fast track projects from design through construction.
- **Enhanced Quality Control for New Pavement Projects:** Performance based incentive/disincentive ride quality specification for new work.
- **Development of stronger pavements:** Special pavement mixes utilized and pavement thicknesses increased to produce stronger, more resilient pavements.
- **Dealing with problematic composite and concrete pavements:** Special mixes, increased thicknesses, precast slab replacement, rubblization.

NJ State Highway System
Lane Miles of Major Pavement Work Completed
(Total system mainline lane miles = 8378)



THE PROGNOSIS: WHERE ARE WE HEADED?

NJDOT recommends that the following initiatives be continued as part of its ten year strategic plan to rehabilitate and preserve New Jersey's state highway pavement system:

- **Continue the increased level of funding for pavement preservation efforts on a consistent basis. In terms of dollars, it is recommended that approximately $290 million annually be dedicated to pavement preservation over the next decade.**

- **Continue to achieve cost effectiveness by utilizing in-house design professionals.**

- **Continue to employ the construction quality assurance specification based on roadway smoothness to encourage the highest quality of construction materials and practices.**

- **Continue to eliminate the "band-aid" fixes applied in the past to seriously deteriorated pavements, especially composite (asphalt over old concrete) and concrete pavements, and replace them with stronger and more resilient restorations.**

- **Expand on the use of preventive maintenance treatments (e.g. crack sealing, microsurfacing, and other sealant overlays) to slow pavement deterioration.**

- **Continue to use innovative designs and materials like Stone Matrix Asphalt and Crumb Rubber Asphalt mixes.**

Summary

DATA COLLECTION

- Video
- Roughness (IRI)
- Distresses (SDI)
- Rutting
- Skid Resistance

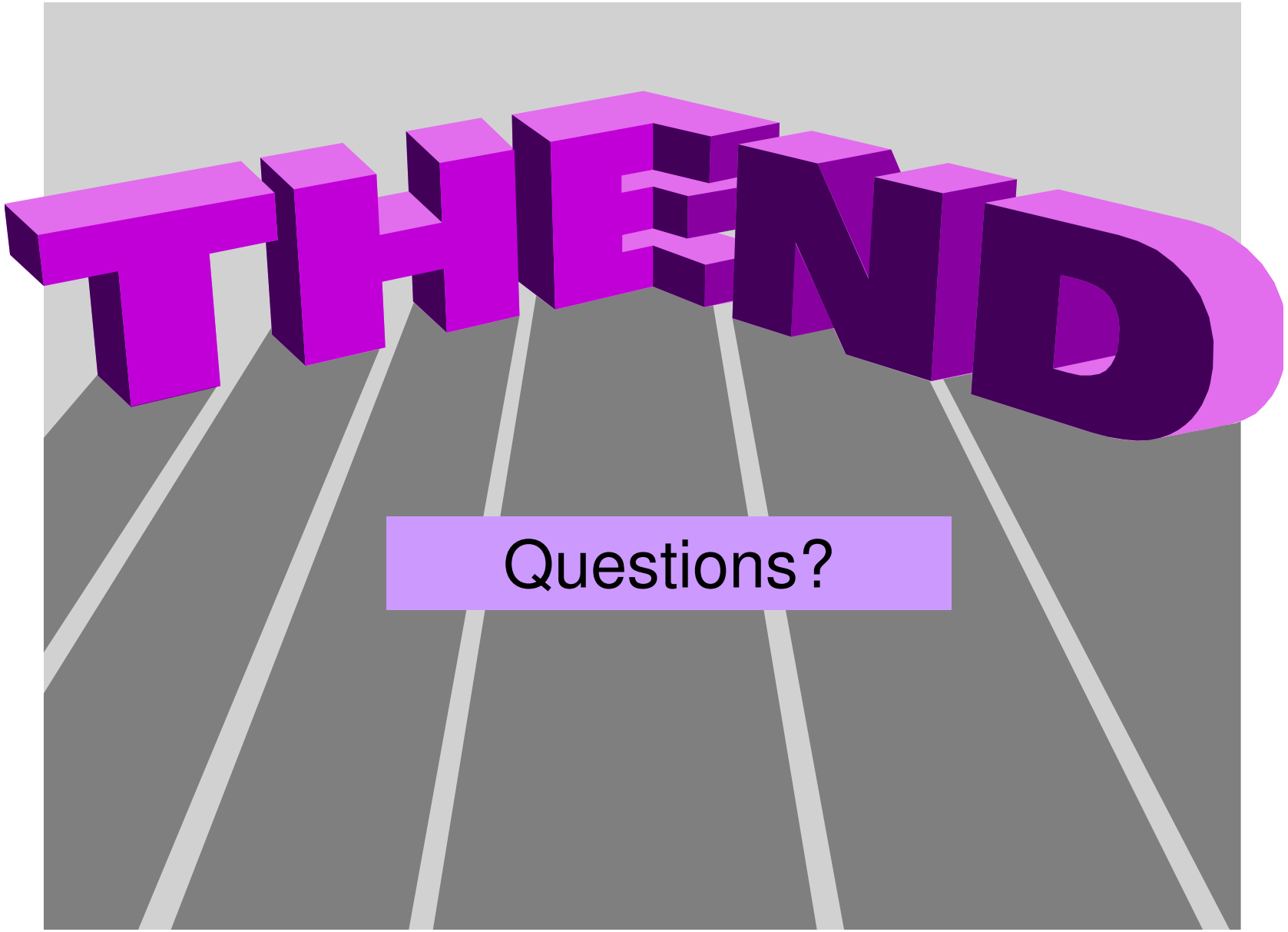
DATA PROCESSING AND STORAGE

- Non Load Related Distress Index (NDI)
- Load Related Distress Index (LDI)
- Surface Distress Index (SDI)
- Databases - PaveView Software
- Video Viewing Software

DATA ANALYSIS:

- Generate Indices
- Generate Projects
- Assess System Condition
- Reports & Info Requests

- Query Database
- Combine Segments Into Projects
- Calculate Normalized IRI
- Calculate Final Pavement Rating (FPR)
- Calculate Project Benefits
- Rank Projects & Check For Conflicts
- Generate Special Projects (Prev. Maint.)
- Reports (Legislature, Nat. Hwy Sys., CIS)
- Requests for Pavement Info (Project Screening, MPO's, Consultants)


THE END
Questions?