STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION

Scoping & Design – Project Level Data Collection & Analysis

By Robert J. Blight
Principal Engineer
Pavement Management & Technology

Goals

- Share process
- Provide knowledge
- Identify key data
- Feedback

Reliable and cost-effective design of a project requires the collection and detailed analysis of key data from the existing pavement.

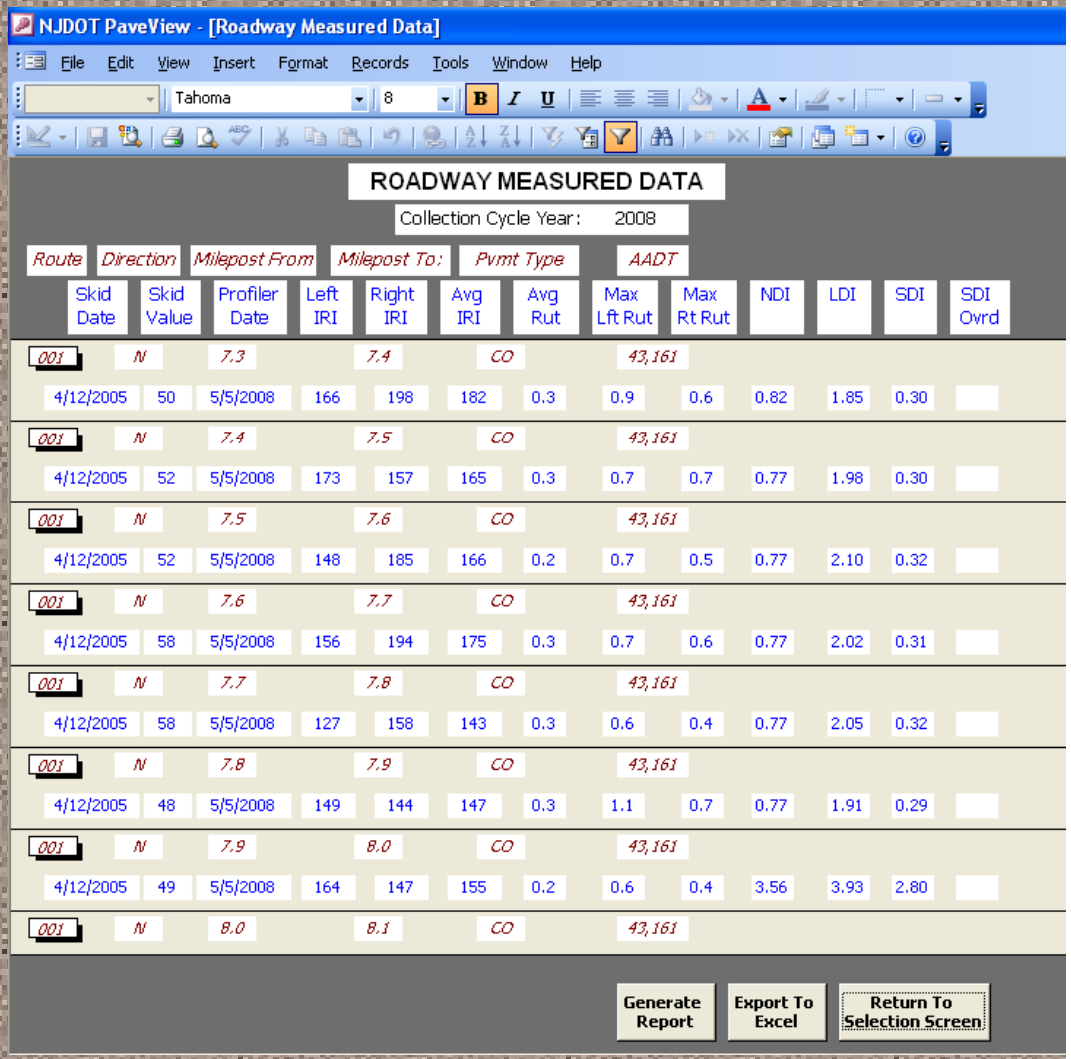
Analysis of key data, from simple to complex, will allow the pavement engineer to identify specific problems and their causes.

Basic Steps of Project Level Data Collection

- Review of existing data
- Perform field review
- Additional Data Collection
  - Constraints
- Analysis

Review Existing Data

- PMS data
  - Surface Distress (SDI)
  - Ride Quality (IRI)
  - Rutting (inches)
  - Skid Resistance (SN)
- Historical data
  - HPMA, SLD, Video, Falcon
  - Structural Adequacy
- Other pavement projects
- Project Limits



Review Existing PMS Data

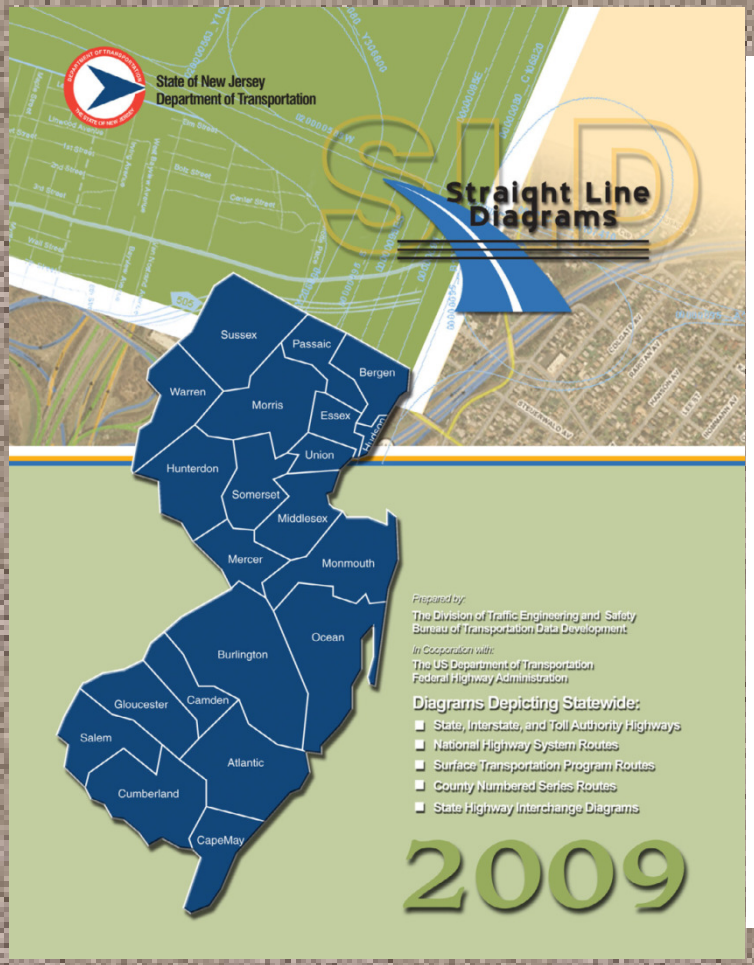
2008 ENGINEERING REVIEWED PAVEMENT PROJECTS LIST - MINIMUM 1/2 MILE
Sorted By Project Benefit

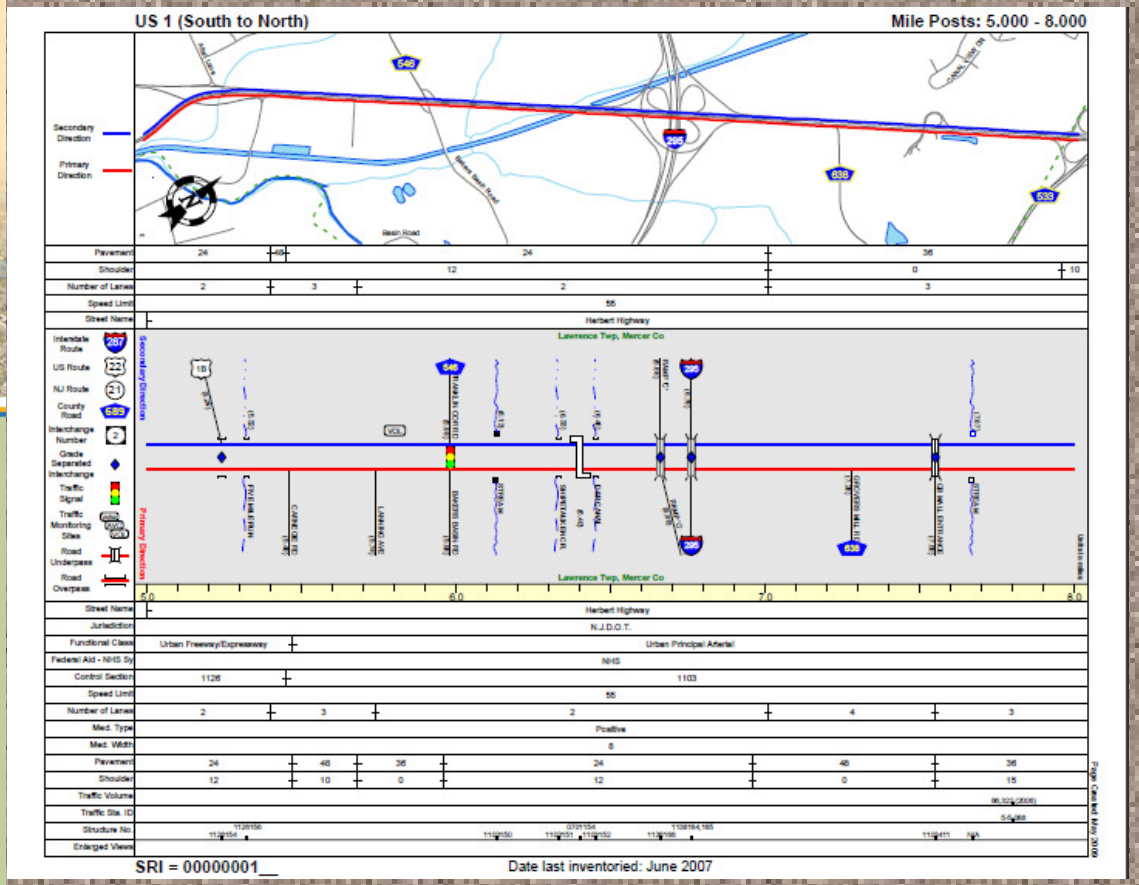
Notes:

(1) Selection criteria: SDI < 2.0, based on 2007 PMS data. Minimum project length is 0.5 mile.
(2) Allowable gap in consecutive segments meeting selection criteria and included in the same project = 0.2 mile.
(3) AADT = Average Annual Daily Traffic. IRI = International Roughness Index. Normalized IRI = IRI converted to 0 - 5 scale. SDI = Surface Distress Index. FPR = Final Pavement Rating
(4) Cost estimated as $300,000 per lane mile. *Benefit = 0.9(5.0-Avg FPR) + 0.1(Traffic Factor) and Traffic Factor = (5/60000)(Avg AADT), with Max = 5.0*
(5) For undivided routes (Dir = B): IRI, Normalized IRI, SDI, and FPR shown represent the most critical set of values considering both directions of travel.

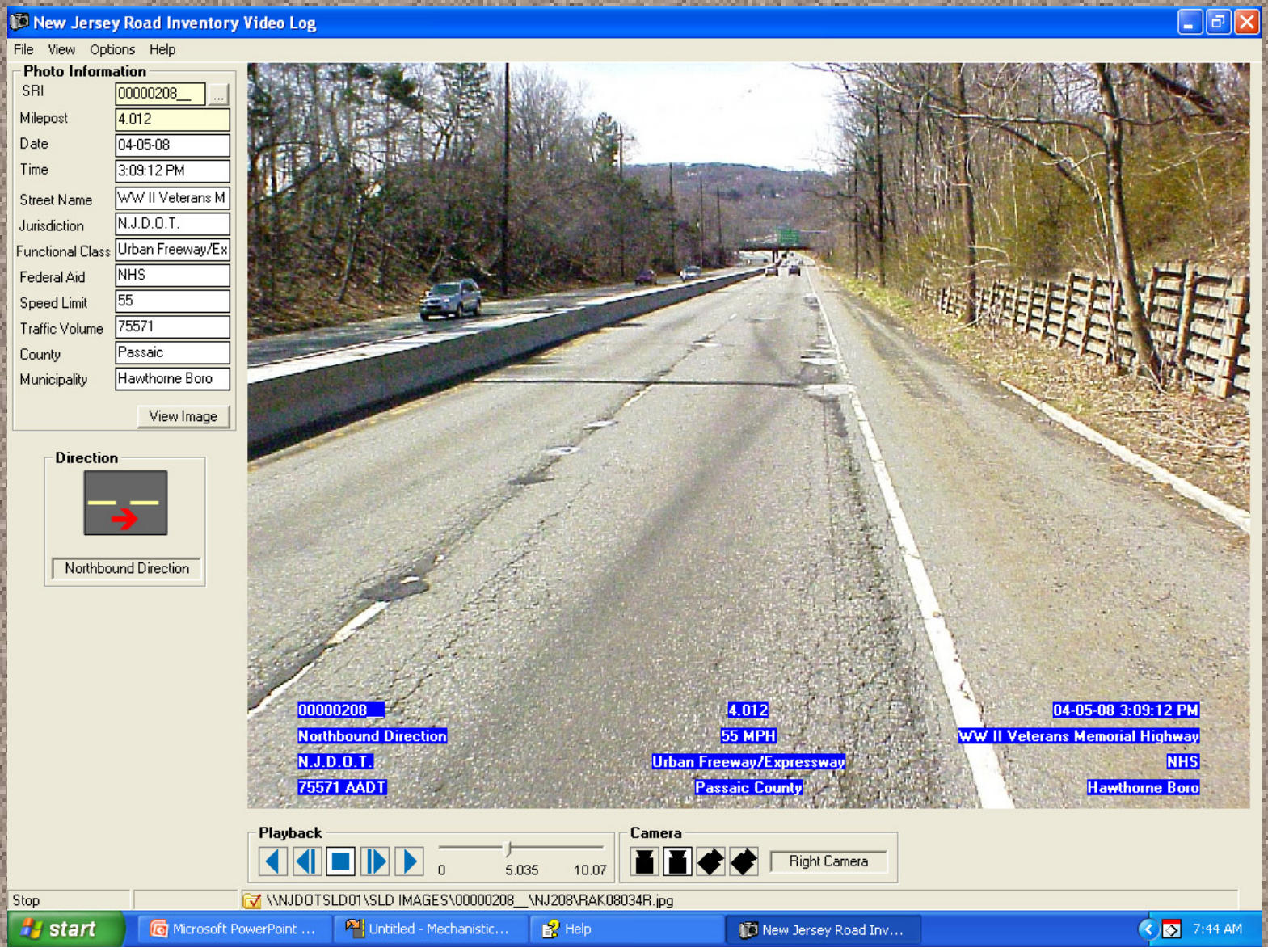
Proj #	Benefit Rank	Proj ID	Rte	Dir	MP Start	MP End	Len	Lane Miles	Avg AADT	Avg IRI	Avg Norm-alized IRI	Avg SDI	Avg FPR	Avg Ld Distress Percent	Benefit	Cost Estimate (Millions)	Planned Work in Proximity to Project			
																	MP Start	MP End	Constr Year	Description
1	1	U045	030	B	12.4	13.1	0.7	2.8	31938	256	1.69	0.15	0.15	98	4.494	$0.84				
	25	U046	030	B	13.8	16.3	2.5	10.0	15904	231	1.91	0.77	0.49	73	4.124	$3.00				
	11	U047	030	B	16.9	18.0	1.1	4.1	15416	221	2.01	0.38	0.38	93	4.219	$1.23				
2	2	D045R	009	N	128.0	129.8	1.8	4.7	39059	134	2.97	0.44	0.44	100	4.426	$1.41				
		D045AR	009	S	128.0	129.8	1.8	4.6								$1.38				
3	3	D018	001	S	22.3	22.9	0.6	1.8	37630	162	2.60	0.48	0.48	100	4.378	$0.54				
4	5	U109	047	B	59.8	61.5	1.7	3.4	12376	223	1.97	0.28	0.28	88	4.302	$1.02				
	329	U110	047	B	61.8	62.3	0.5	1.0	12376	222	2.02	1.66	1.54	0	3.167	$0.30				
5	6	D039	009	N	111.9	112.4	0.5	1.0	18756	143	2.97	0.40	0.40	100	4.293	$0.30				
	272	D049	009	S	111.7	112.2	0.5	1.0	18756	119	3.18	1.48	1.48	0	3.320	$0.30				
6	7	D286	202	S	11.5	12.6	1.1	2.2	14702	128	3.11	0.38	0.38	100	4.285	$0.66				
7	8	D072	018	N	11.4	13.2	1.8	3.6	17512	201	2.25	0.40	0.40	81	4.282	$1.08				
	28	D077	018	S	5.3	13.2	7.9	15.7	21762	137	2.95	0.63	0.63	97	4.114	$4.71				
8	9	D016	001	S	9.0	9.5	0.5	1.5	38071	111	3.27	0.60	0.60	87	4.276	$0.45	6.76	10.86		Congestion Management. Concept Development
	79	D002	001	N	9.7	11.0	1.3	3.9	38071	170	2.52	1.06	1.06	0	3.864	$1.17	6.76	10.86		Congestion Management. Concept Development
9	10	D104	023	S	9.3	9.8	0.5	1.5	29832	177	2.45	0.57	0.57	98	4.240	$0.45				
10	235	U217	206	B	107.7	109.3	1.6	3.5	17880	215	2.05	1.40	1.30	94	3.404	$1.05				
	133	U218	206	B	110.0	111.4	1.4	4.0	24478	167	2.56	1.04	1.04	90	3.670	$1.20				
	294	U219	206	B	114.7	115.3	0.6	1.2	17798	163	2.83	1.59	1.45	94	3.270	$0.36				
	12	U220	206	B	116.5	117.6	1.1	3.8	29280	161	2.64	0.45	0.45	99	4.215	$1.14				
11	14	D126	034	S	12.0	12.5	0.5	1.0	8962	110	3.30	0.41	0.41	100	4.203	$0.30				
	34	U069	034	B	12.5	13.1	0.6	1.3	15840	135	2.96	0.53	0.53	92	4.086	$0.39	12.80	13.60		Colts Neck Intersect-Operational Improvements. Concept Development
12	15	D031R	003	W	6.2	8.0	1.8	6.3	74482	140	2.89	0.90	0.90	0	4.187	$1.89	4.00	6.20	2009	Preliminary Design. Rt-3 Bridge over Passaic River
	76	D029R	003	E	6.2	10.8	4.6	14.7	71963	155	2.78	1.28	1.25	0	3.871	$4.41	4.00	6.20	2009	Preliminary Design. Rt-3 Bridge over Passaic River
13	16	D071	015	N	9.9	10.4	0.5	1.0	19450	233	1.96	0.53	0.53	97	4.186	$0.30				
14	17	D247R	124	E	11.5	12.4	0.9	1.8	8222	276	1.58	0.61	0.43	94	4.184	$0.54	11.11	11.47	2008	2008 Maintenance Resurfacing Schedule - MRRC #N303
	50	D248	124	W	11.9	12.4	0.5	1.0	8222	217	2.04	0.65	0.65	92	3.982	$0.30				
15	18	U076	035	B	20.5	21.0	0.5	2.0	20150	172	2.52	0.45	0.45	100	4.177	$0.60				

Review of Simple Data



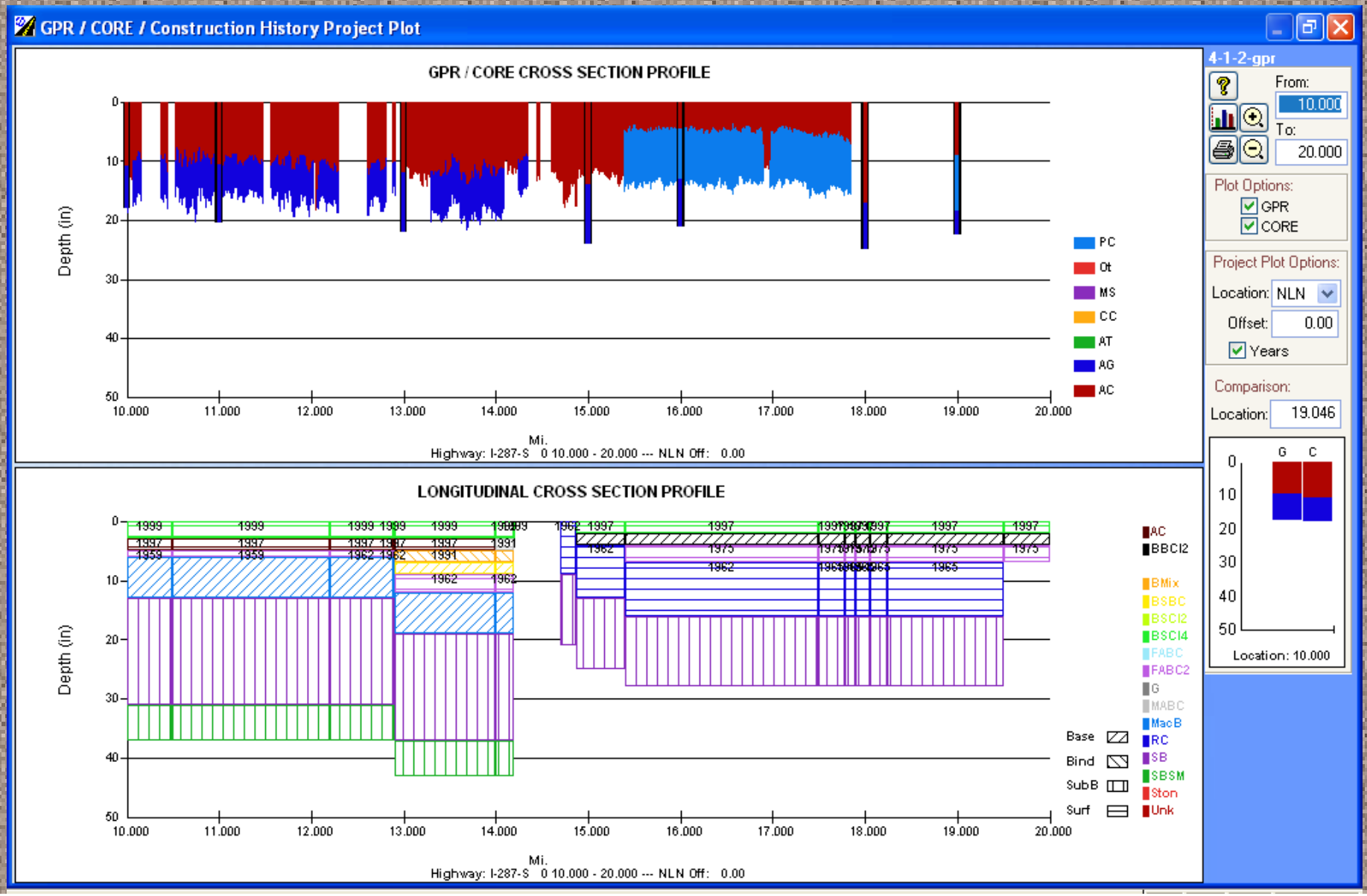


Review Existing Data - Video

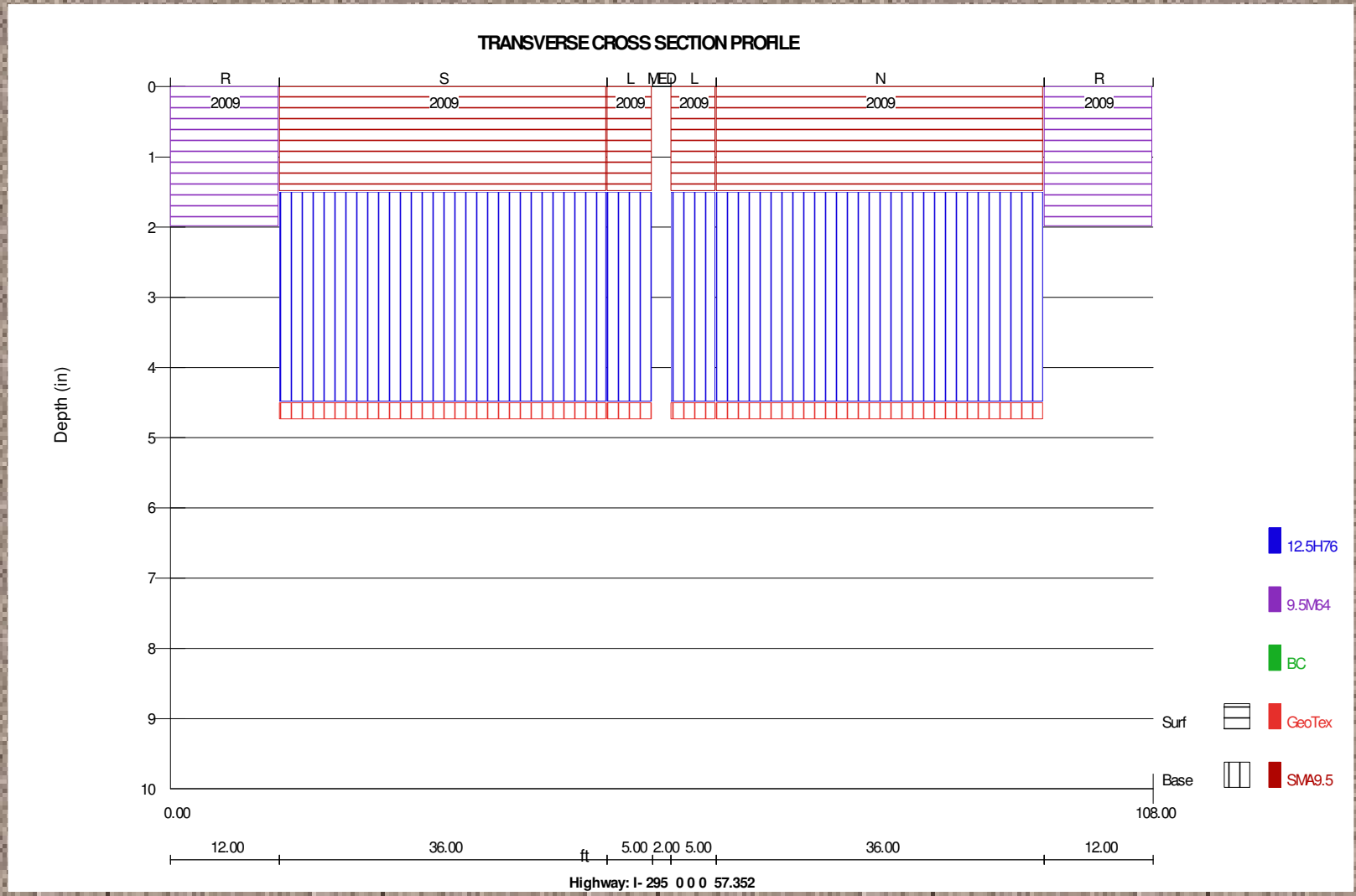


Review Existing Data - Video

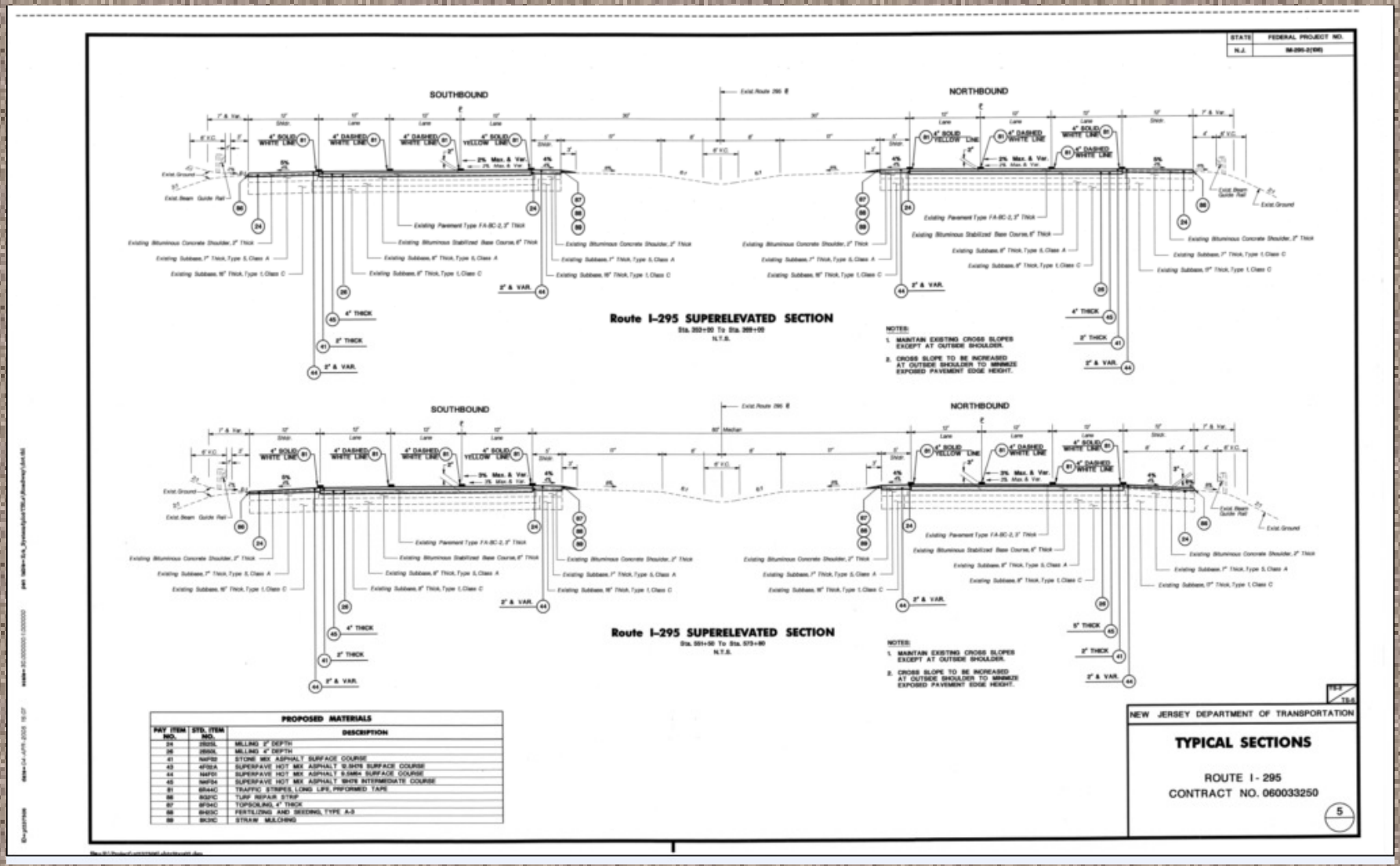
Existing Coring/GPR/As-built Data



Existing As-built Information

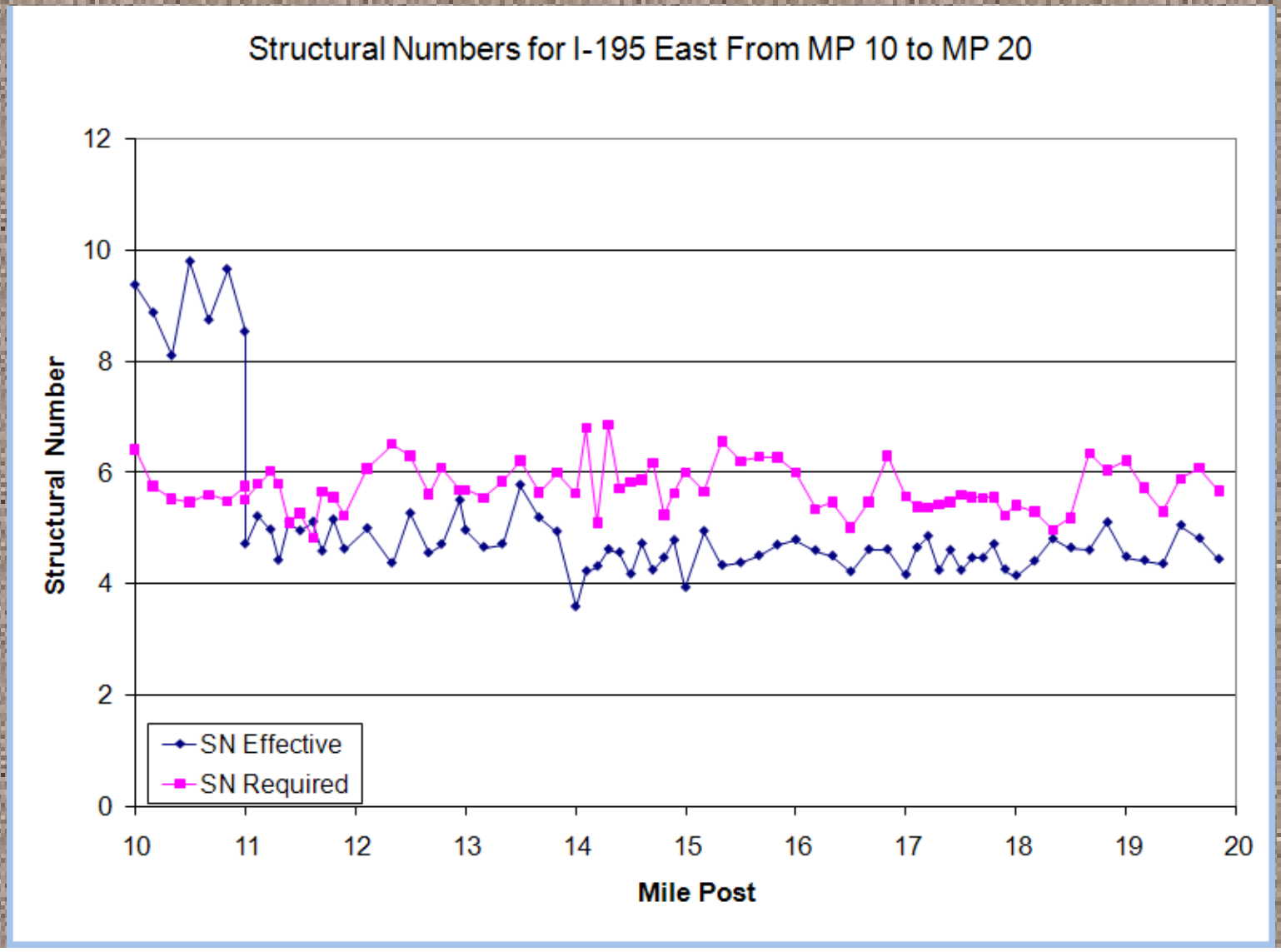


Existing As-builts (Falcon SVP)



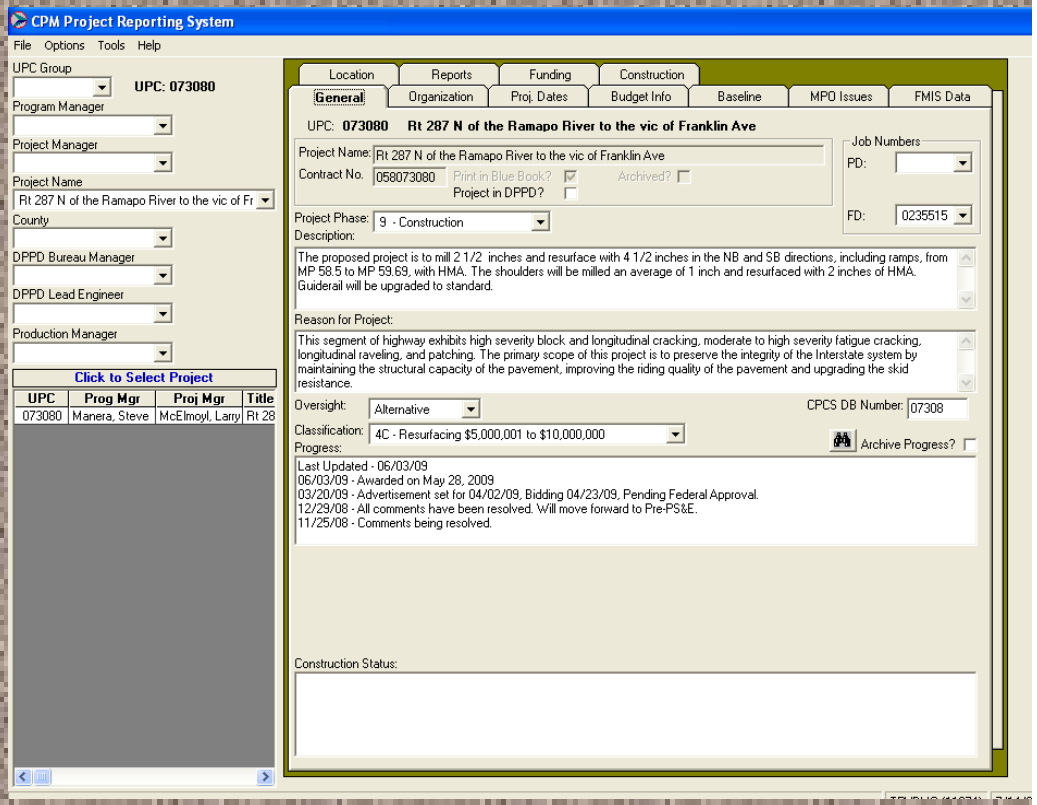
Existing Core Data

Existing Structural Data



Review Existing Projects

- This must be checked and rechecked throughout the process
- Past, present & future projects
- Conflicts
- Limits of the project
- Possibly combine with other project
- Pavement project files reviewed to review past designs

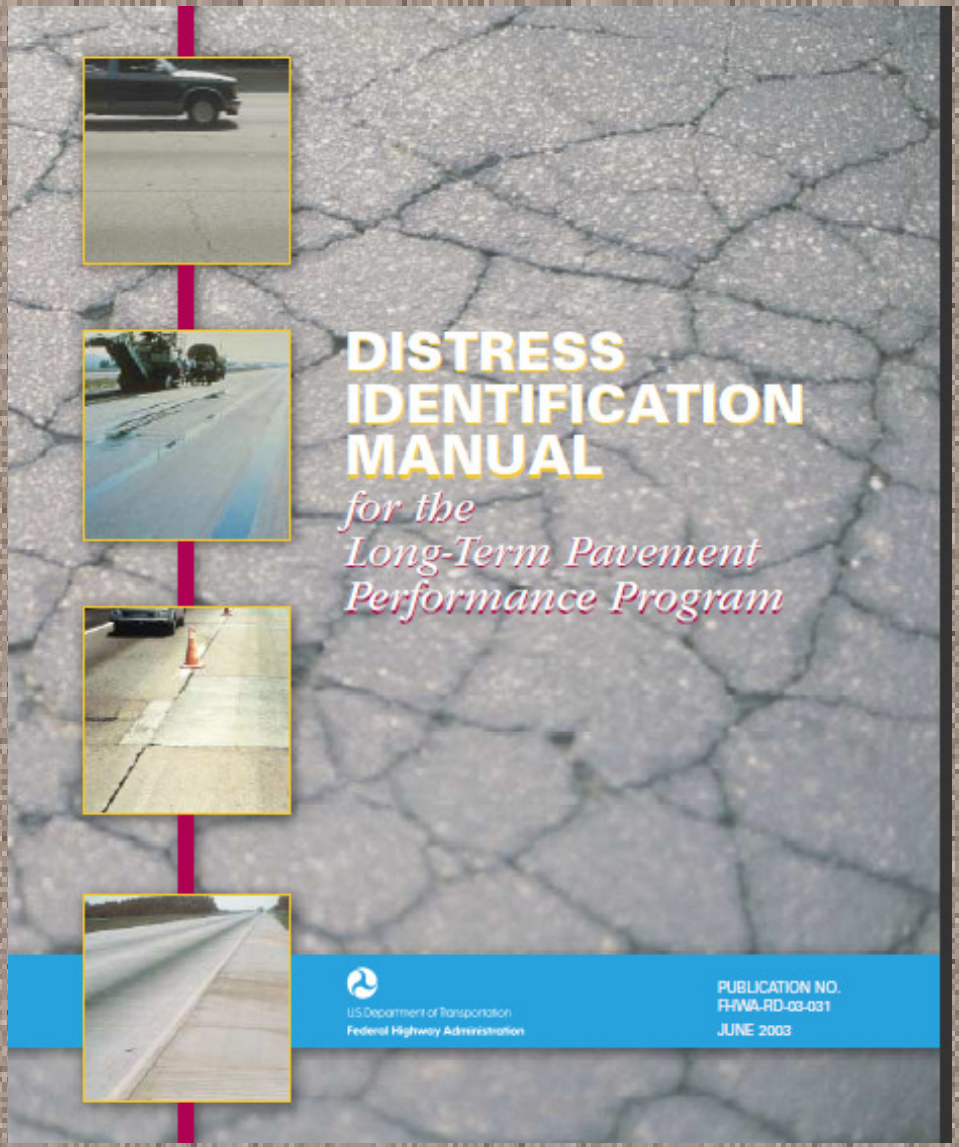


Future Improvements in Process

- GIS Mapping
- Project Tracking System
  - Rutgers-CAIT Pavement Resource Program
  - Advanced Infrastructure Design, Inc.

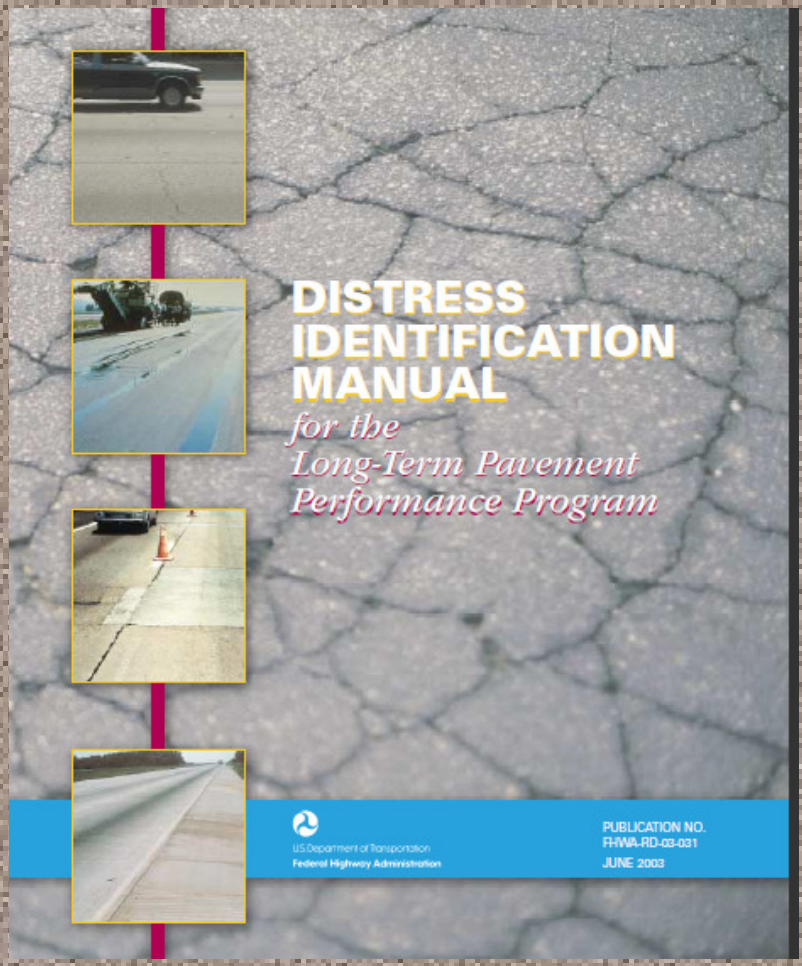
Field Review

- Distress Survey (video and field)
- Ramp conditions
- Shoulders
- Drainage (inlets)
- Geometric constraints
  - Bridge under-clearance
  - ROW impacts (driveways)
  - Barrier curb
  - Floodway/Floodplain
  - Curb, inlets, manholes, guide rail



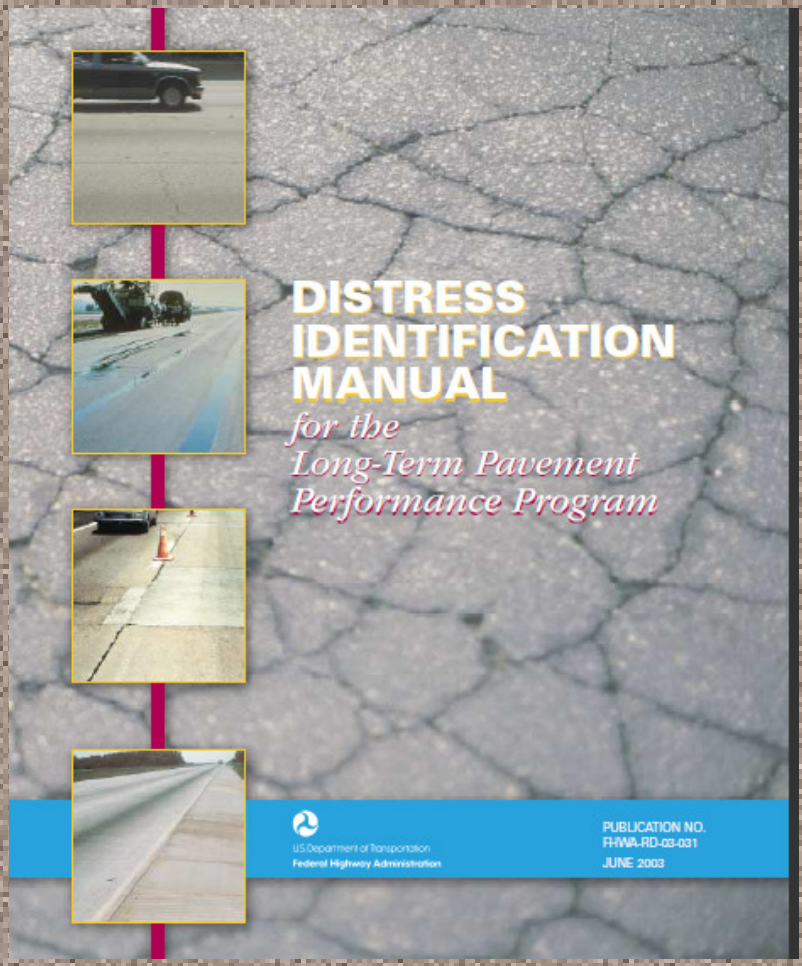
Distress Survey

- Routine Pavement Management and Pavement Design activity
- For project level design
  - Identify major distress types
  - Most harmful and most prevalent



Distress Survey

- Use data to evaluate options and/or trigger further investigation



General Categorization of Flexible & Composite Pavement Distress

General Description	Distress Type[1, 2, 3]	Major Contributing Factors
Cracking	Fatigue Cracking	Load
	Long. Cracking (wheelpath)	Load
	Reflection Cracking	Load, materials, climate, construction
	Transverse Cracking	Materials, climate
	Block Cracking	Materials, climate, construction
Surface deformation	Rutting	Load, materials
	Shoving	Load
Surface defects	Raveling	Materials, climate, construction
	Bleeding	Materials, climate, construction
Miscellaneous distress	Lane-to-Shoulder Drop-off	Materials, climate, construction
	Pumping	Load, materials, climate, construction
Patching and potholes	Patch Deterioration	Load, materials, climate, construction
	Potholes	Load

1. Note that the severity of the distresses listed is typically aggravated by harsh climatic conditions and a lack of adequate drainage.
2. Most of the distresses listed influence the functionality of the pavement which is typically characterized by smoothness and surface friction.
3. Some distresses such as reflection cracking and rutting have multiple causes.

Raveling

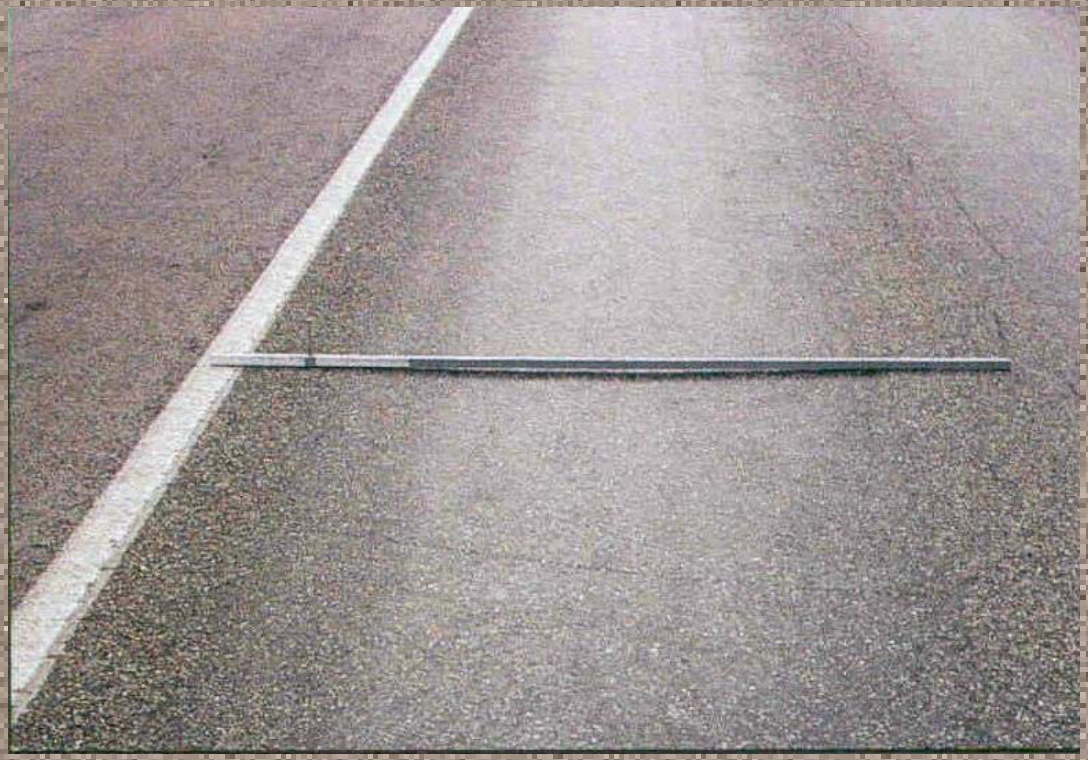
Raveling

- Improper compaction
- Lack of density
- High fines in mix
- Low asphalt content
- Oxidized asphalt

Rutting

Rutting

- Poor compaction
- Improper density
- Lateral movement of the asphalt layers
- Weak subgrade



Block Cracking

Block Cracking

- Materials (PG grade of binder)
- Climate (frost action)
- Construction (poor subbase or embankment)
- Traffic load (heavy trucks)

Wheel Path Fatigue Cracking

Fatigue Cracking

- Traffic Load
- Structurally deficient

Reflective Cracking

Reflective Cracking

- Load
- Materials
- Climate
- Construction

Reflective Cracking

- Joint Repair

Disintegrating Concrete

- Poorly compacted asphalt
- High voids (not enough AC binder)
- Water intrusion (cracks or pores)
- Deicing chemicals
- Traffic load

Concrete Pavement Distress

General Description	Distress Type[1, 2, 3]	Major Contributing Factors
Cracking	Corner breaks	Load
	Longitudinal cracking	Load, materials, climate, construction
	Transverse cracking	Load
Joint deficiencies	Transverse joint seal damage	Materials, climate, construction
	Longitudinal joint seal damage	Materials, climate, construction
	Spalling of longitudinal joints	Materials, climate, construction
	Spalling of transverse joints	Materials, climate, construction
PCC durability	Durability cracking	Materials, climate, construction
	ASR	Materials, climate, construction
Surface defects	Map cracking	Materials, climate, construction
	Scaling	Materials, climate, construction
	Polished aggregate	Materials, climate, construction
	Popouts	Materials, climate, construction
Miscellaneous distress	Blowups	Materials, climate, construction
	Faulting of transverse joints and cracks	Load, materials, climate, construction
	Lane-to-shoulder dropoff	Materials, climate, construction
	Lane-to-shoulder separation	Materials, climate, construction
	Patch deterioration	Load, materials, climate, construction
	Water bleeding and pumping	Load, materials, climate, construction

1. Note that the severity of the distresses listed is typically aggravated by harsh climatic conditions and a lack of adequate drainage.
2. Most of the distresses listed influence the functionality of the pavement which is typically characterized by smoothness and surface friction.
3. Some distresses such as longitudinal cracking have multiple causes.

Popouts

Joint Spalling

Joint Faulting

Transverse Crack

High Severity Cracks

High Severity Cracks/Faulting/Spalling

Alkali-Silica Reacting Concrete

- Disintegrating Concrete
- Caused by reaction between aggregate, cement paste and water

Shoulder Condition – Edge Cracking

Shoulder Condition

Shoulder Condition

Ramp Condition

Ramp Condition

Drainage

Drainage

Drainage

Unusual Condition

Unusual Condition

Unusual Condition - Geometric

Additional Data Collection

- Traffic Data
- Ground Penetrating Radar (GPR)
- Falling Weight Deflectometer (FWD)
- Coring
- Dynamic Cone Penetrometer (DCP)
- Soil Borings
- Unusual Conditions

Pavement Data Collection Resources

- NJDOT Pavement Management
- Operations Engineering
- Rutgers-CAIT PRP
- Pavement Engineering Task Order Consultants
  - Advanced Infrastructure Design, Inc.
  - Michael Baker Jr., Inc.

Traffic Data Collection

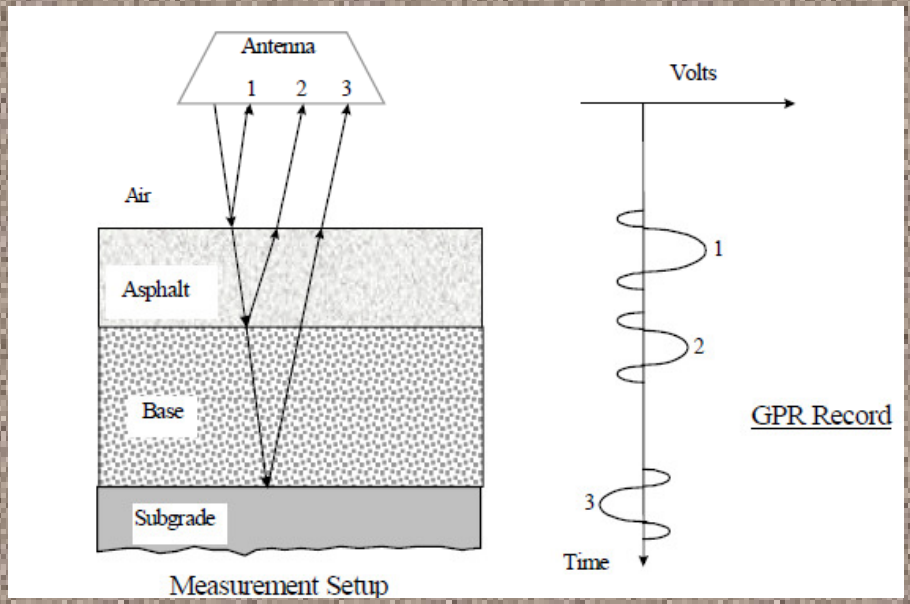
- DPD typically provides
  - Volumes (ADT)
  - Percent Trucks (Total & Heavy)
  - Directional Distribution
  - ESAL Factors on website at the following link
    - http://www.state.nj.us/transportation/refdata/roadway/wim_files/ESAL_Design_Factors.pdf

GPR Ground-Coupled Antennas

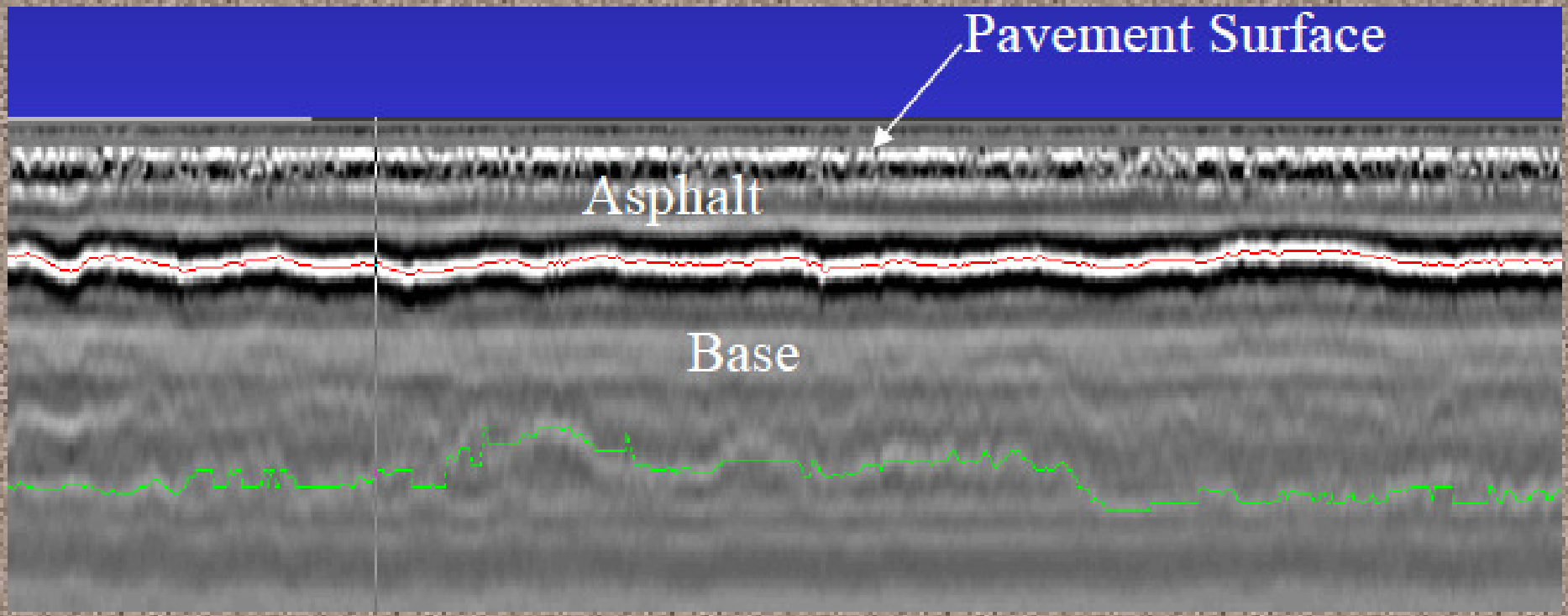
GPR Air-Coupled Antennas

How GPR Works

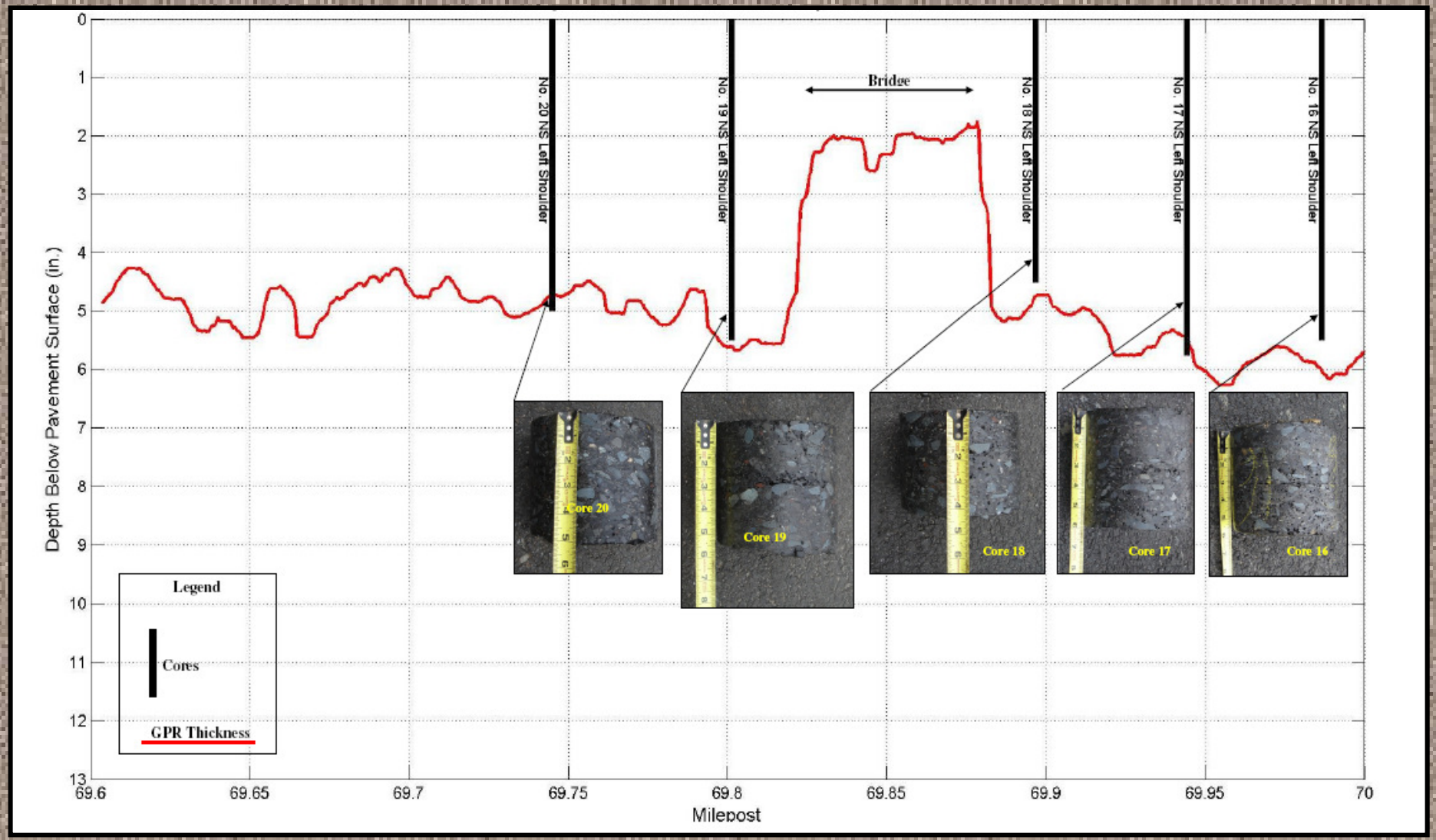
- Antenna sends electromagnetic pulses
- Pulses reflect back with amplitudes and arrival times
- Measured data relates to dielectric constants
- Verified /calibrated with core samples



Processed Graphic Data of GPR



GPR Plotted With Cores



What GPR gives you

- Layer Material
- Continuous Layer Thickness
- Void detection (large)
- Anomalies that need further investigation

Falling Weight Deflectometer (FWD)

Figure 9.22: FWD Impulse Loading Mechanism (foreground) and Sensors (background)

Figure 9.23: FWD

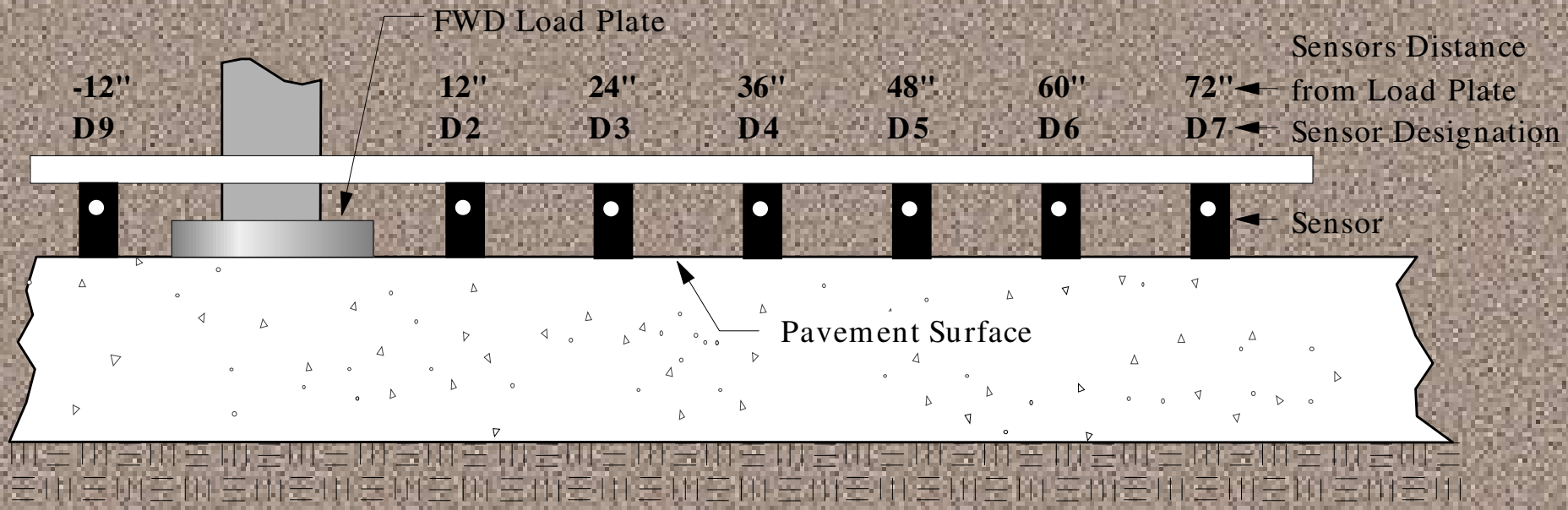
Figure 9.24: Dynatest 8000 FWD

Figure 9.25: KUAB FWD

Figure 9.26: JILS FWD

NJDOT Heavy Weight Deflectometer (HWD)

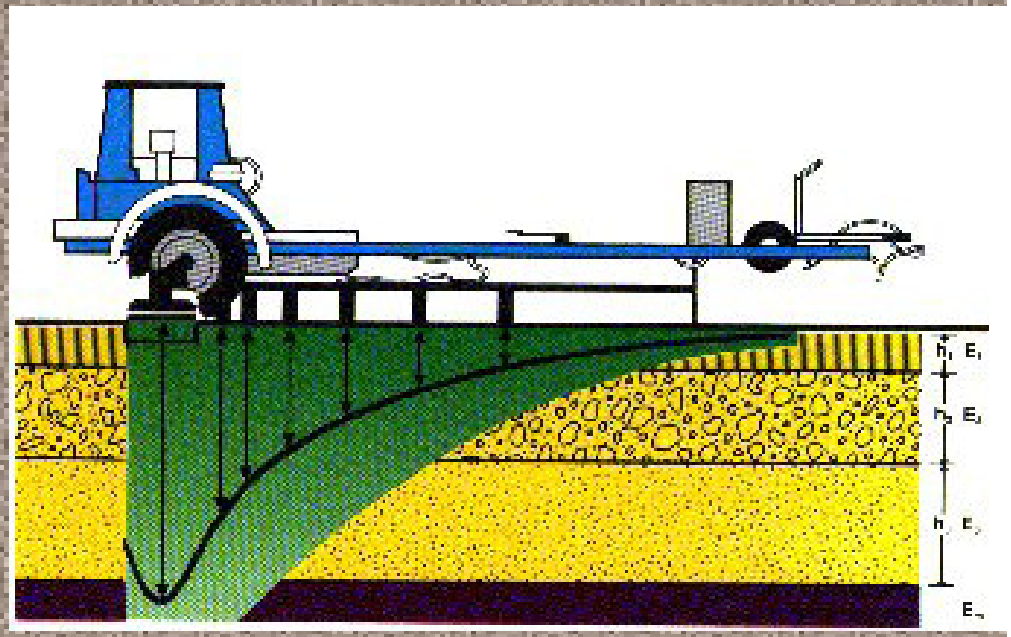
Typical FWD Load Plate and Geophone(s) Set-up



Note: Sensor D8 is located 12 inches to the right of the load plate.

How FWD Works

- FWD is an impulse deflection device
- Lift weight to given height and drops
- Weight strikes specially designed plate and transmits impulse force to the pavement
- Pavement deflections are measured



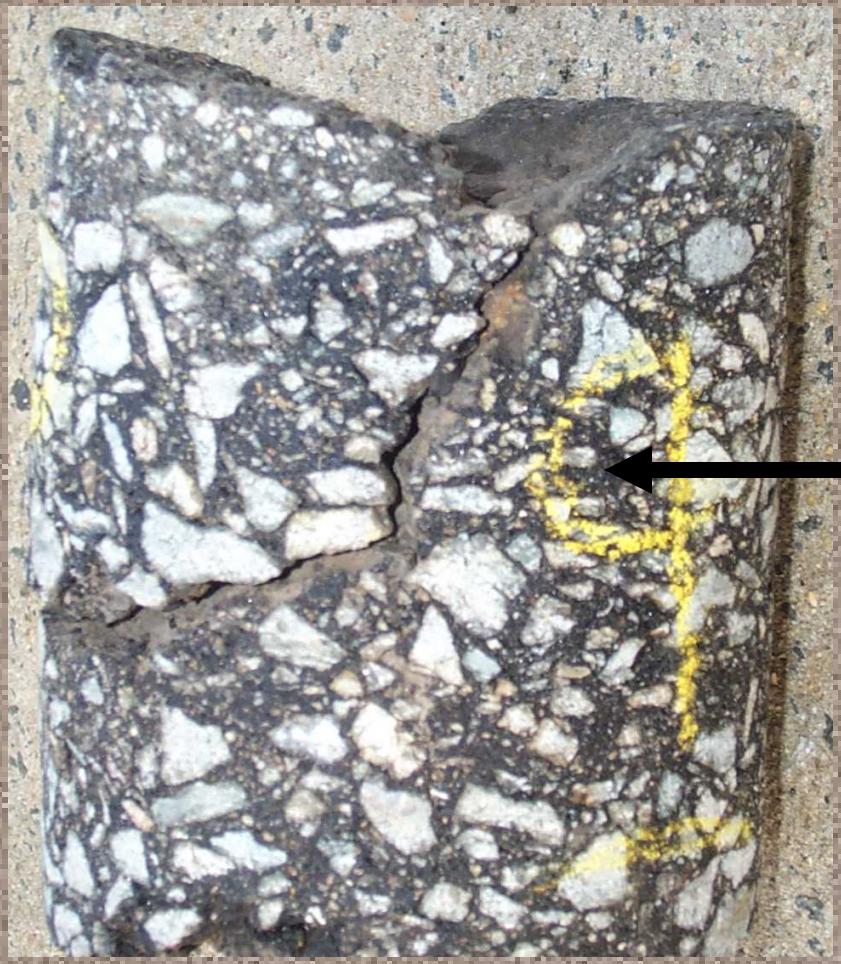
What FWD gives you

- Asphalt pavement
  - Elastic modulus of Structural Layers (at non-distressed locations)
  - Structural adequacy (at non-distressed locations)
- Concrete pavement
  - Modulus of concrete
  - Modulus of reaction for subgrade
  - Joint load transfer
  - Deflection at joint
  - Void detection
  - Structural adequacy

Coring

- Thickness
- Material determination
- Crack depth
- Debonding of layers
- Stripping
- Rutting
- Samples for testing

Top-Down Fatigue Cracking Verified by Coring



DCP

- Unbound layer strength
- Changes in unbound layers

Analysis & Design Next Week!

What’s the problem?

Russian Federal Freeway

Unusual Conditions!

Excelent!!!!

Thank you. Questions?

Contact Info.:

Robert J. Blight

Principal Engineer

NJDOT

Civil Engineering - Pavement Management &Technology

Phone (609) 530-4445

Fax (609) 530-5550

email: robert.blight@dot.state.nj.us