2009 Virginia Concrete Conference

Innovation and Concrete Paving I-64 Battlefield Boulevard

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Richmond , VA
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Presentation Outlines

1. Introduction
2. Project data/Overview
3. Soil Sampling
4. Placement of Cement Treated aggregate
5. Placement of OGDL and Edgedrain
6. What did we learn from Steel Feed Tube system
7. Placement of Concrete
8. Quality Assurance Measures
9. Data for MEPDG Level I
10. Areas of improvements

Concrete paving since 1913 (VTRC)

Project Need VS. Project Results/Improvements

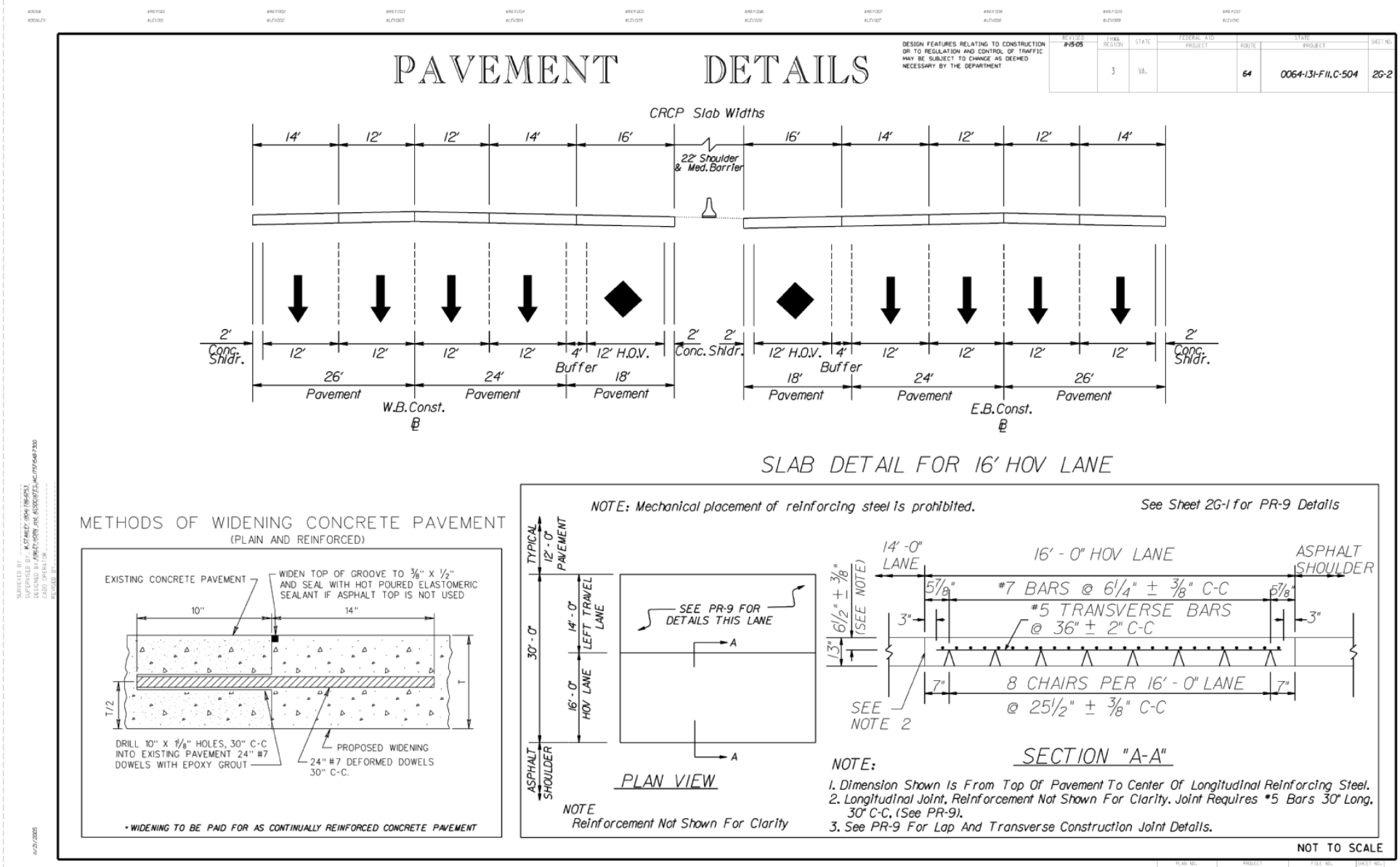
Project Need:

- **Less than two miles between three major interchanges:**
  - **Greenbriar to Battlefield: 1 mile**
  - **Battlefield to I-464: 1 mile**
- **Significant weave conditions between interchanges with traffic entering & exiting the interstate.**
- **Major business district with heavy congestion**
- **Current traffic volume (ADT): 108,000 vehicles; 133,000 by 2026**

Project Results/Improvements:

- **Increased interstate capacity from 6 lanes to 10 lanes including two 12 foot shoulders**
- **Added 4 CD lanes to separate local traffic from through traffic (2 lanes in each direction)**
- **Constructed 'Braided Bridges' in both directions**
  - **Braids eliminated the weave condition between the Greenbriar and Battlefield Interchanges.**
  - **Added dedicated lanes for exiting and entering the interstate**
  - **Improved traffic safety and reduced congestion**
- **Widened and reconstructed Battlefield Blvd. over the interstate from 4 lanes to 6 lanes**

Project Overview (10 lanes, one mile long)

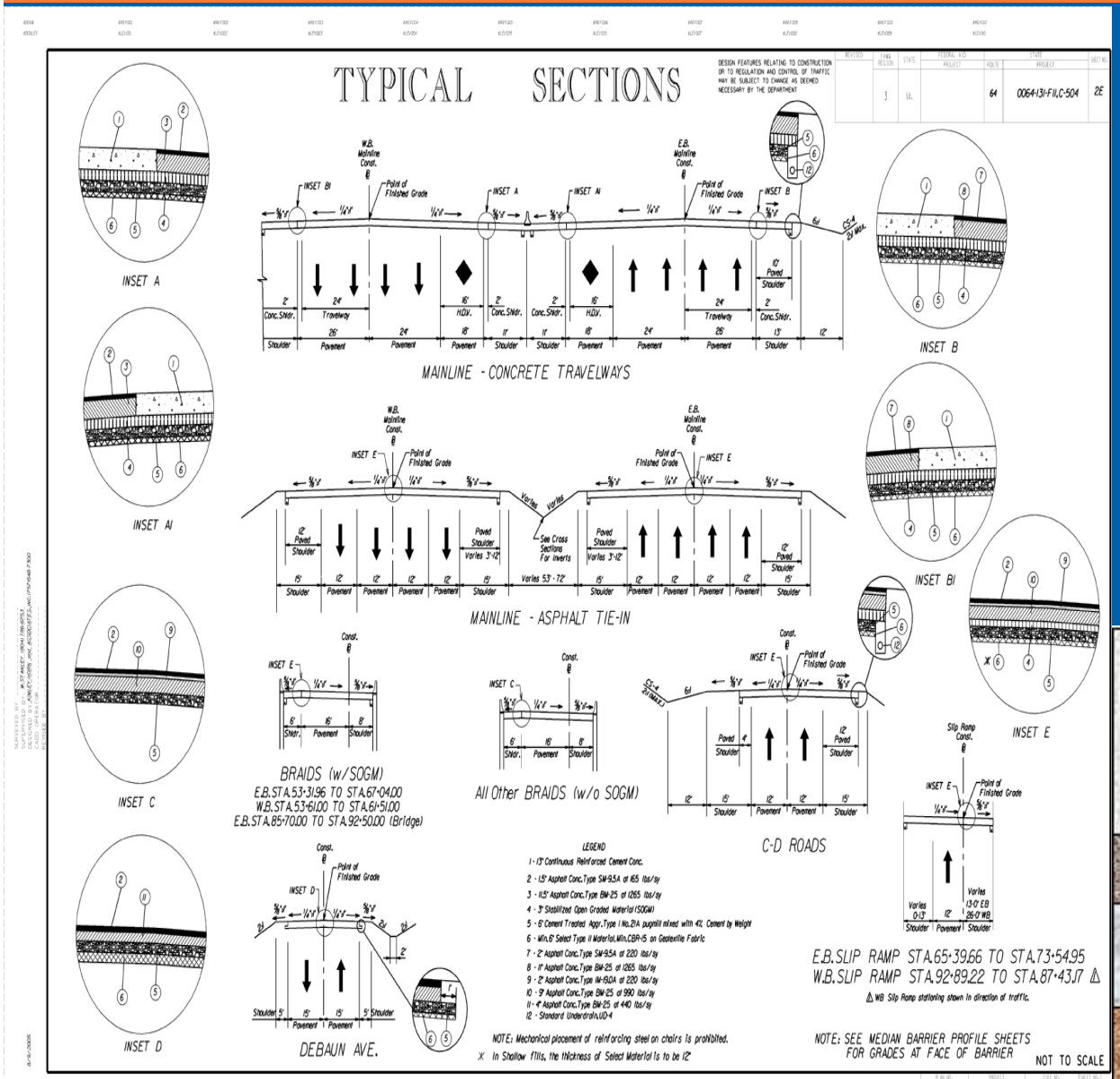


Project Features

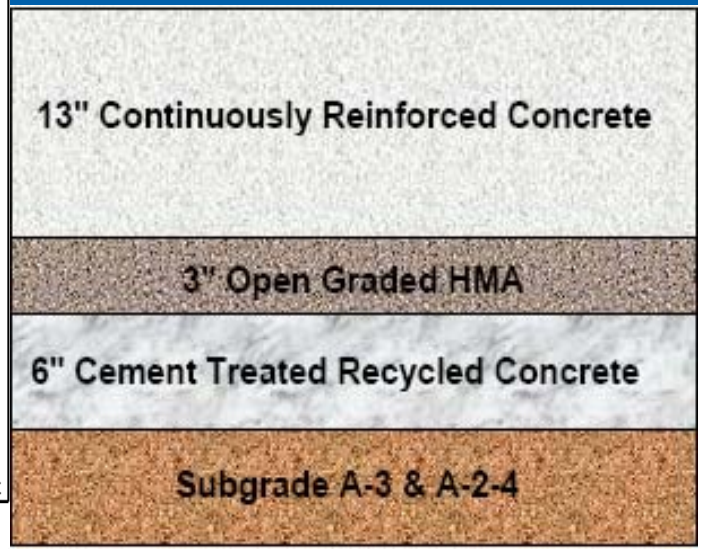
- Cost $100 million
- Six bridges:
  - Two braided ramp bridges
  - Two interstate bridges over the railroad
  - Two parallel bridges for complete reconstruction of Battlefield Blvd. over I-64

Overview

Typical Pavement Section



- Concrete Paving (CRCP): 29,000 cy
- Earthwork (Reg. Excavate. + Borrow): 500,000 cy
- Other Concrete: 63,000 cy
- Drainage pipe: 6 Miles
- Pavement Underdrain: 4 Miles
- Soundwall: 90,000 SF
- MSE Wall: 140,000 SF
- Asphalt: 180,000 Tons



CRCP Pre-start up meetings

- Initial meeting (June 2007) held one year prior to start of operations
- Allowed ample time for incorporation of lessons learned from other projects
- Included all key players: contractor, concrete industry, VDOT, FHWA and on-site management staff
- Enabled entire team to understand potential pitfalls and incorporate solutions
- Detailed discussion of key factors to result in a successful CRCP product including:
  - Logistics of haul routes and batch plant location
  - Proposed equipment
  - Transition details
  - Placement of chairs on asphalt open graded material
  - Survey control (at each lift, e.g. subgrade, CTA, open grade)
  - Used the same temporary bench marks at 50 foot stations for survey control
  - No location for a trial run therefore had to get it right the first time

Second Pre-start up meeting held three months prior to start of concrete paving

- Emphasized details of construction including quality control processes, submittals, water source and paving sequence
- Paving sequence, three pulls: 26 ft, 26 ft and 16 ft
- Detailed review of survey control and processes for grade verification
- Included details of batching CTA on-site using recycled, crushed aggregate from old JRCP
- Grade control included both survey control and string lines to check grades before and after each pavement section
- New equipment for placement of CTA, SOGM and CRCP

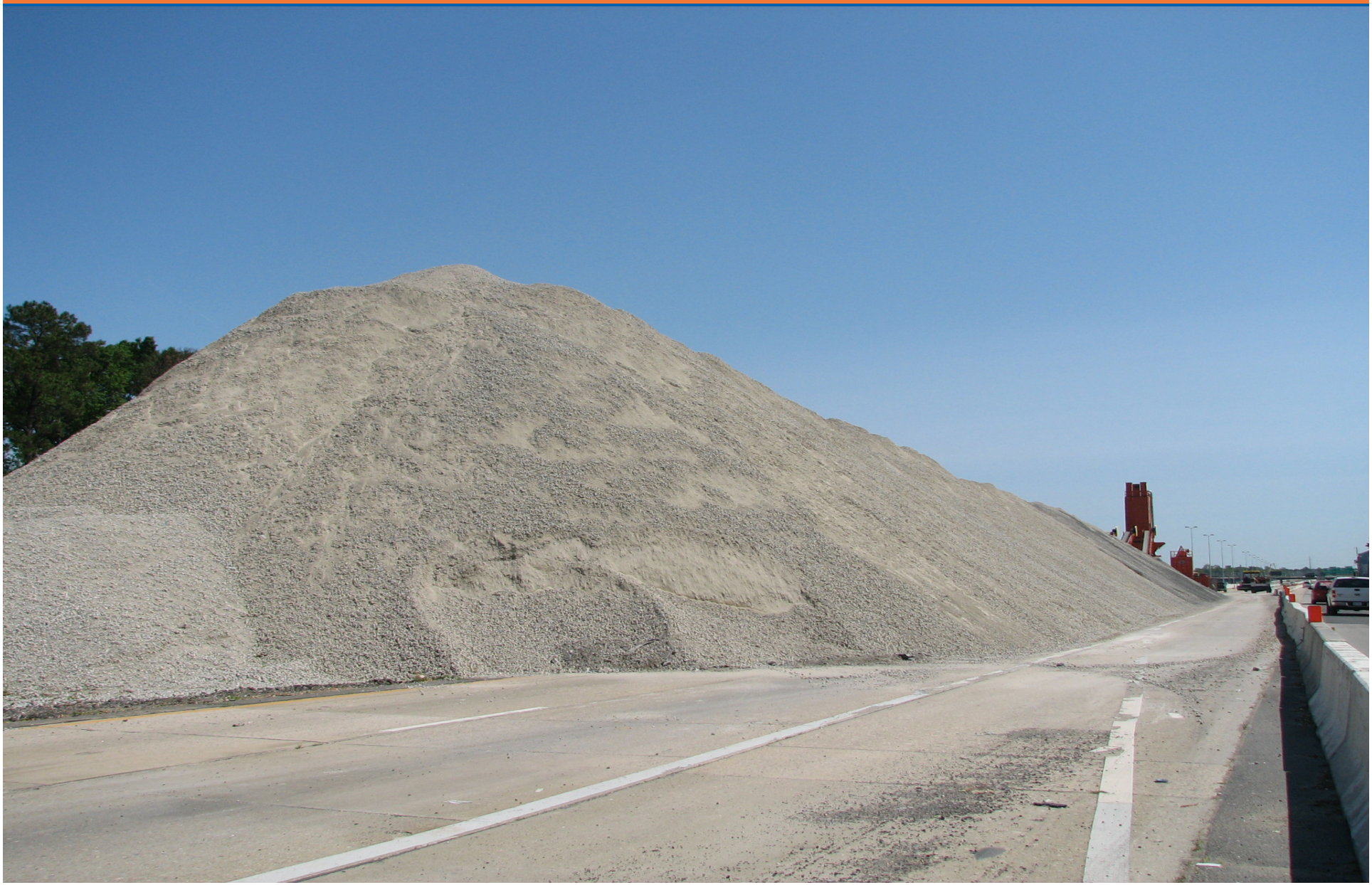
Construction Sequencing

- Original sequence anticipated 6 phases, including 2 phased to construct CRCP
- Revised phasing enabled 90% of CRCP paving in one phase
  - Improved quality
  - Reduced impacts to motorists
  - Enhanced safety of work zones
  - Provided ample space for on-site batch plant within the work zone
  - Increased cycle time during placement (2,500cy to 3,500cy per day)
  - Eliminated construction traffic moving into and out of the work zones
  - Provided needed space for paving equipment

Old doweled JRCP, River Gravel, 2 inch Top Size, 61.5 Ft Spacing

Demolition of Existing 8 inches JRCP

Recycled Concrete Pavement (>40,000 tons)



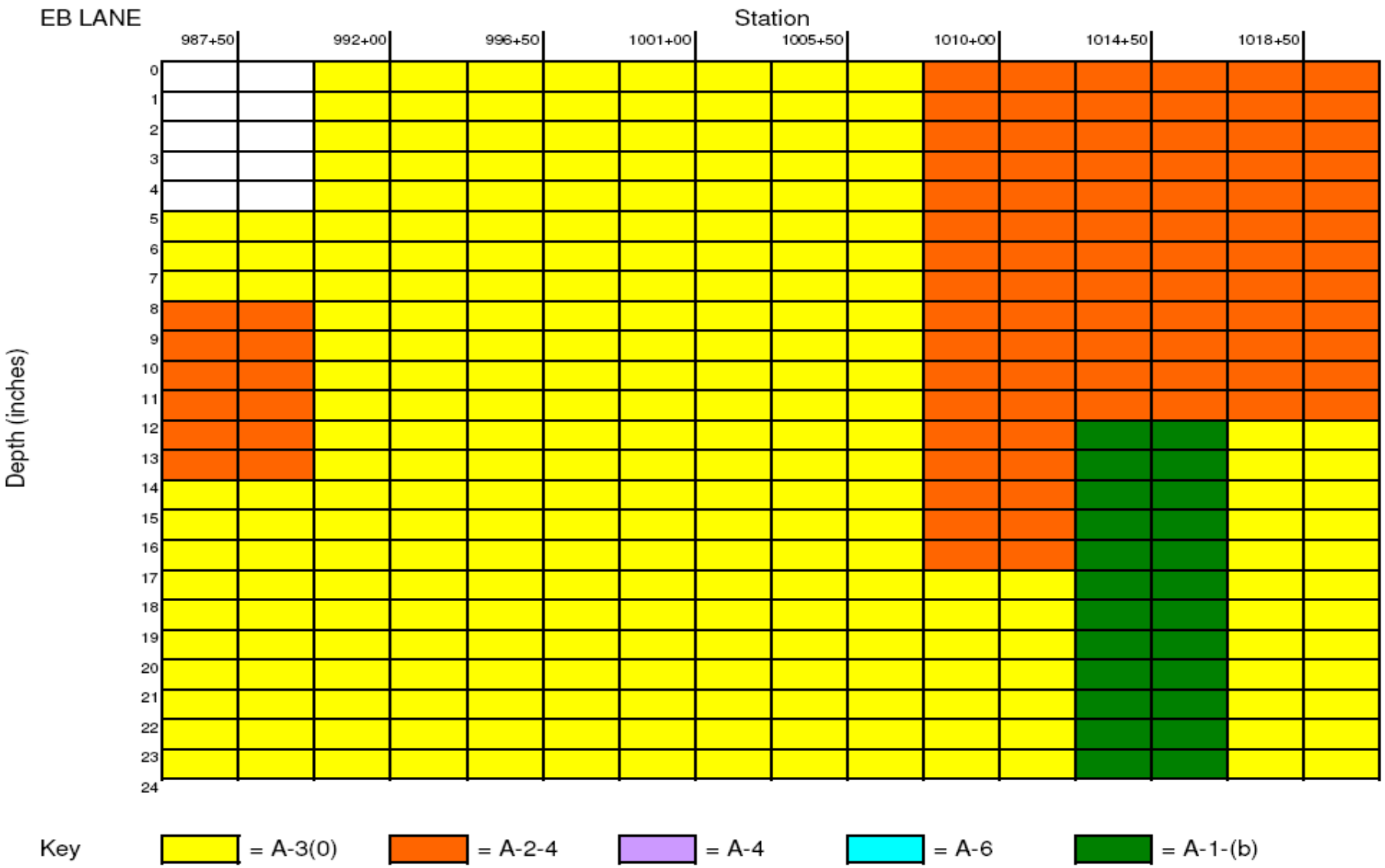
Recycled Concrete Material to Meet VDOT 21-A Specifications

Overview of Project During Grading

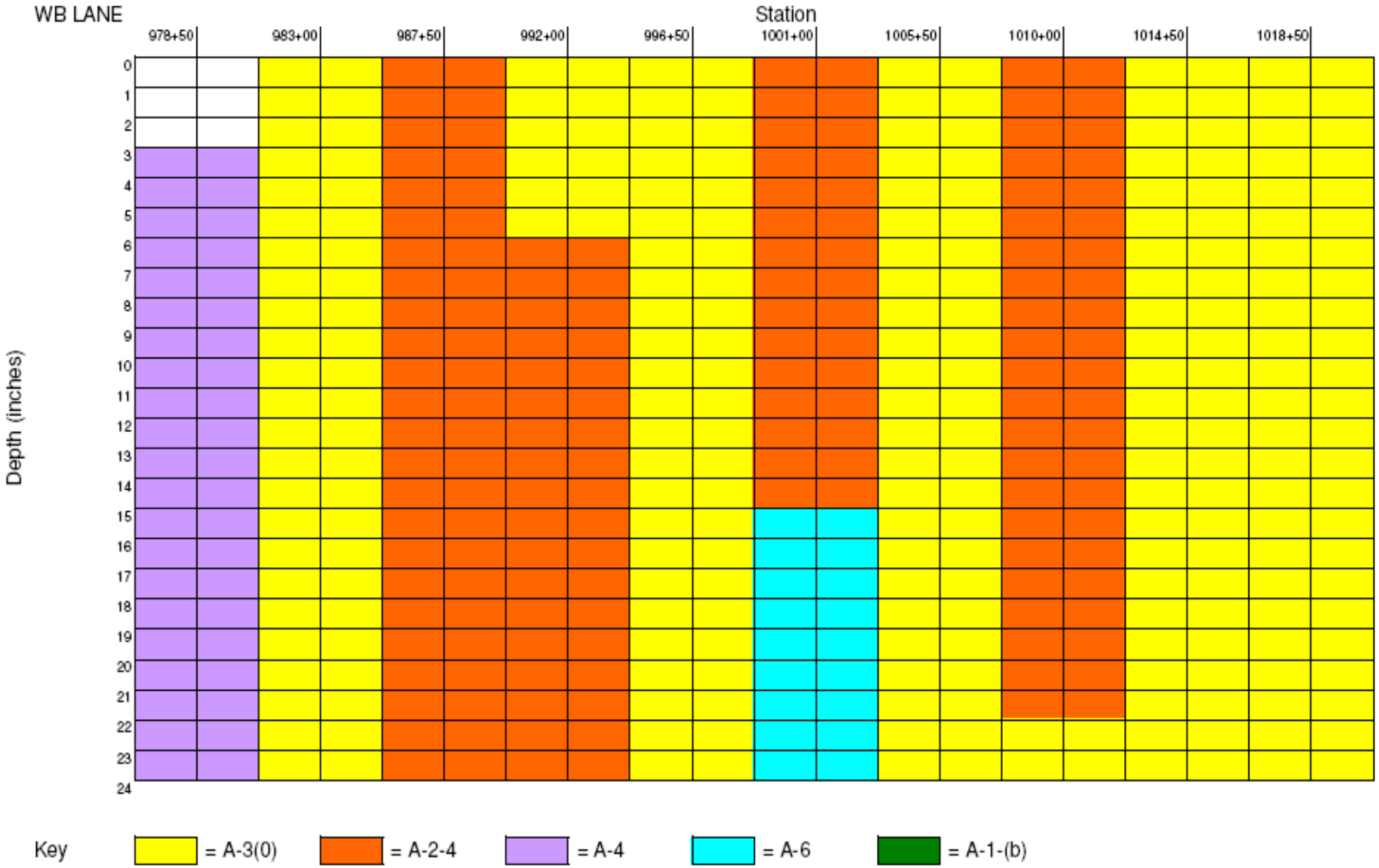
Project Overview During Grading

Soil Sampling at Station 1018+50

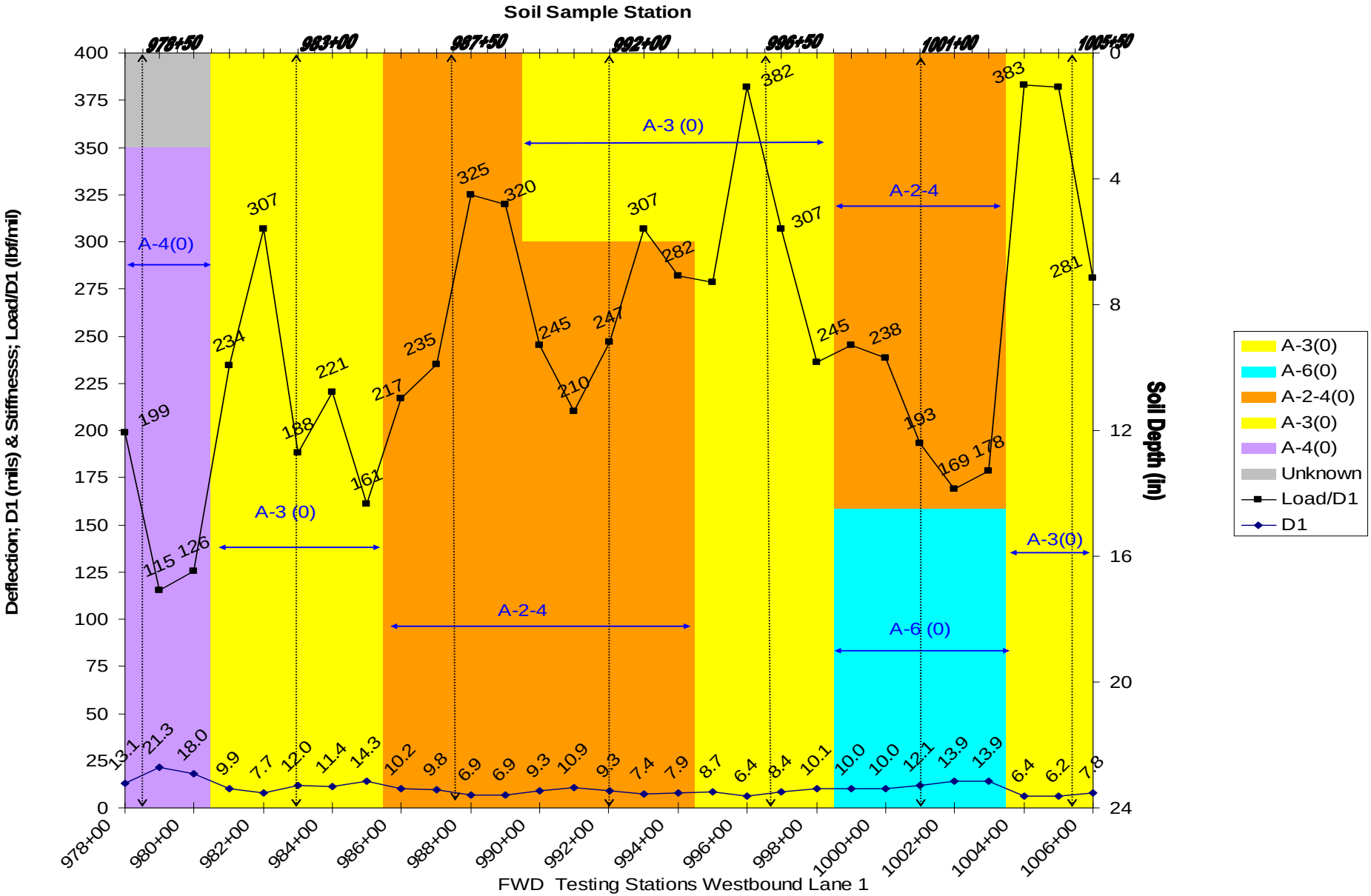
EB Lane Soil Classification



WB Lane Soil Classification



Deflection and Stiffness of subgrade (WB Lane 1)



Placement of Cement Treated Recycled Concrete (6 inches)

Compacting CTRC Using Steel Roller

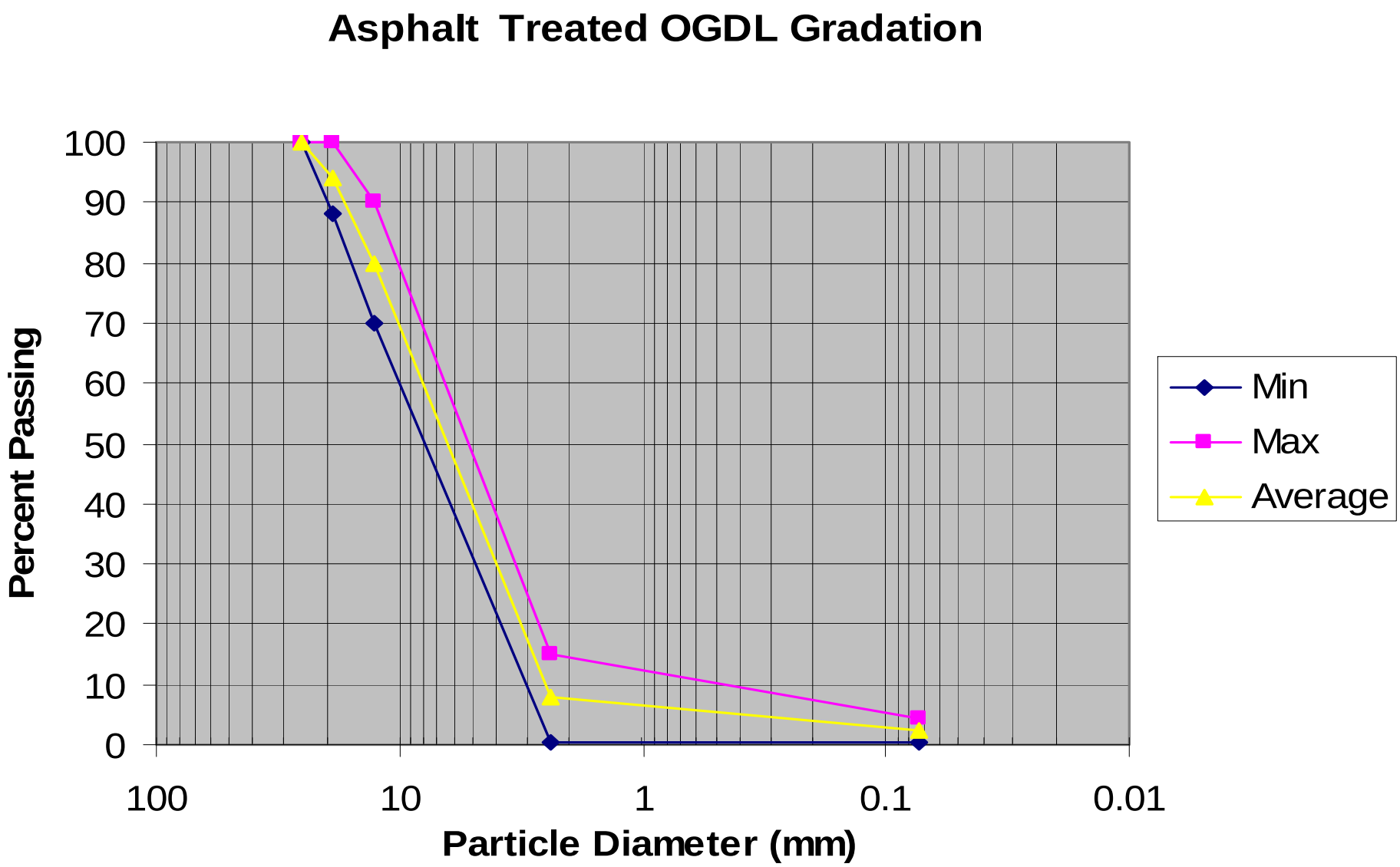
CTRC Core (WBL)

Sieve Analysis for Asphalt OGDL

Sieve Size, mm	Percent Passing		
	min	max	Average
25.4	100	100	100
19	88	100	94
12.5	70	90	80
2.36	0.5	15	7.75
0.074	0.5	4.5	2.5
A.C. pg 70-22 Content: 4.3 ± 0.3%			

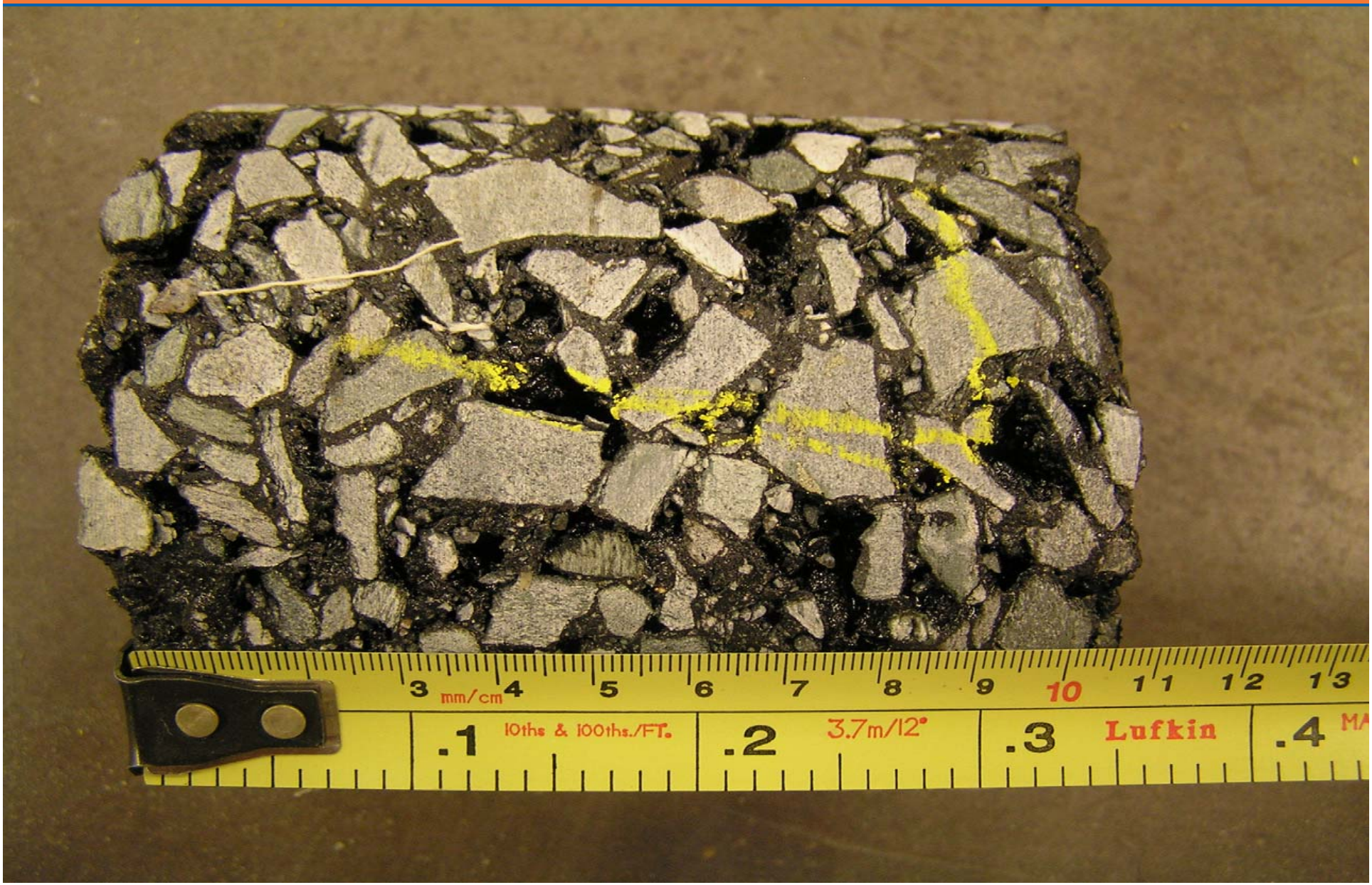
	Min	Max	Average
D60	10	6.3	8
D10	3	0.4	2.4
D30	4	2.1	3
Cu	3.33	15.75	3.33
Cc	0.53	1.75	0.47

Particle Size Distribution for Asphalt OGDL



Steel Chair Resting on Asphalt Treated ODGL

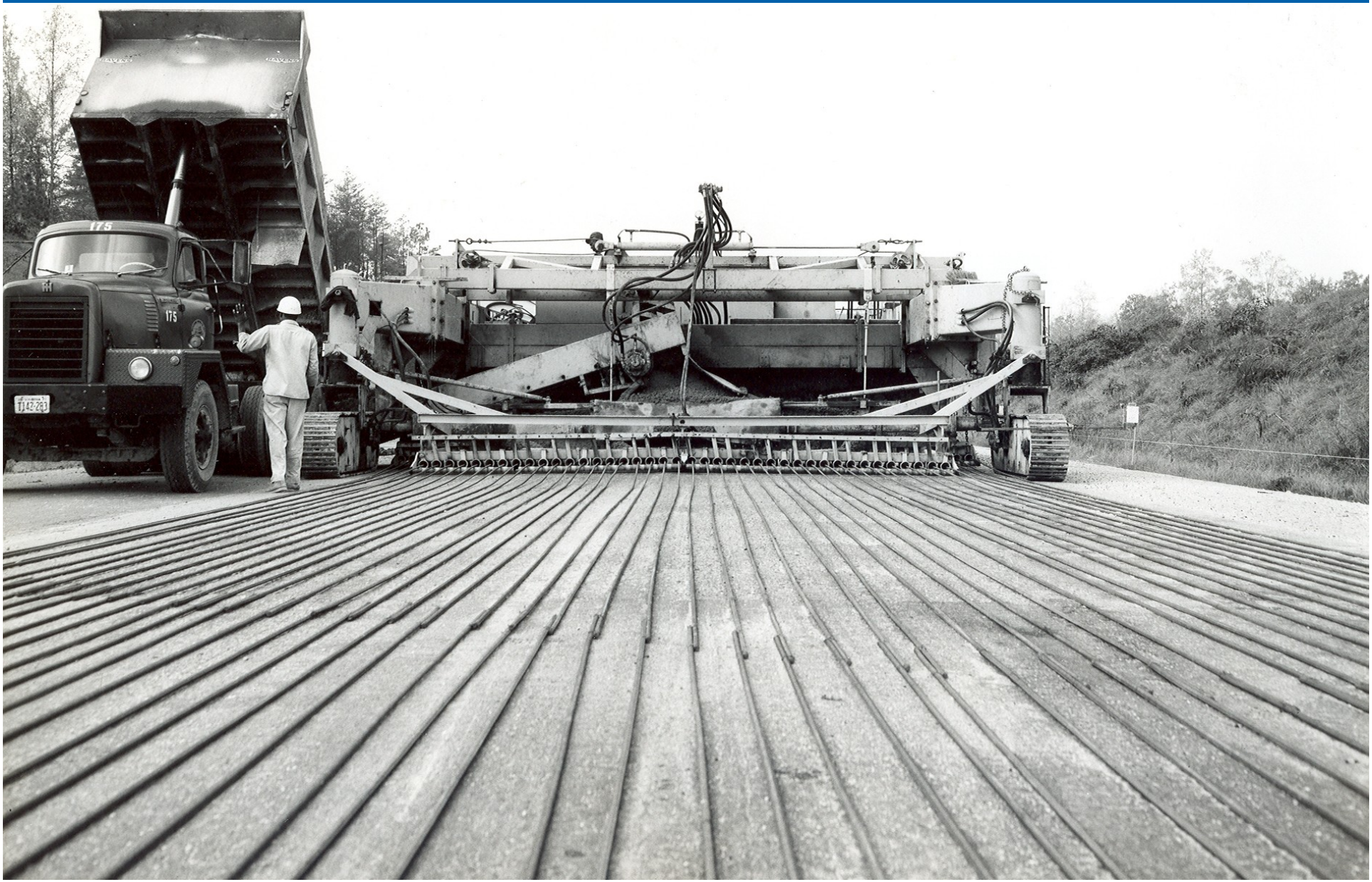
OGDL Core (3 inches thick) WBL



Locating Pavement Edgedrain on the Project

Edgedrain Connection to Drop Inlet

Longitudinal Steel Fed Through Tubes 1970's



Feed Tube System for Steel Placement

Feed Tube System

Feed Tube System

Finished CRCP

I-64 Battlefield Blvd. Reinforcement Steel in place

#7 Longitudinal Steel Bars (0.7% Steel)

Beginning of Paving Operation

Concrete Plant Set on the Project

Concrete Mix Components

Coarse Aggregate	1883	Lbs
Fine Aggregate	1222	Lbs
Cement Type I	282	Lbs
GGBF Slag	282	Lbs
Water	253.8	Lbs
Admixture (AE)	5	Oz
Admixture (Retarder)	17.6	Oz
Design W/C Ratio	0.45	

Preparing Concrete Cylinders

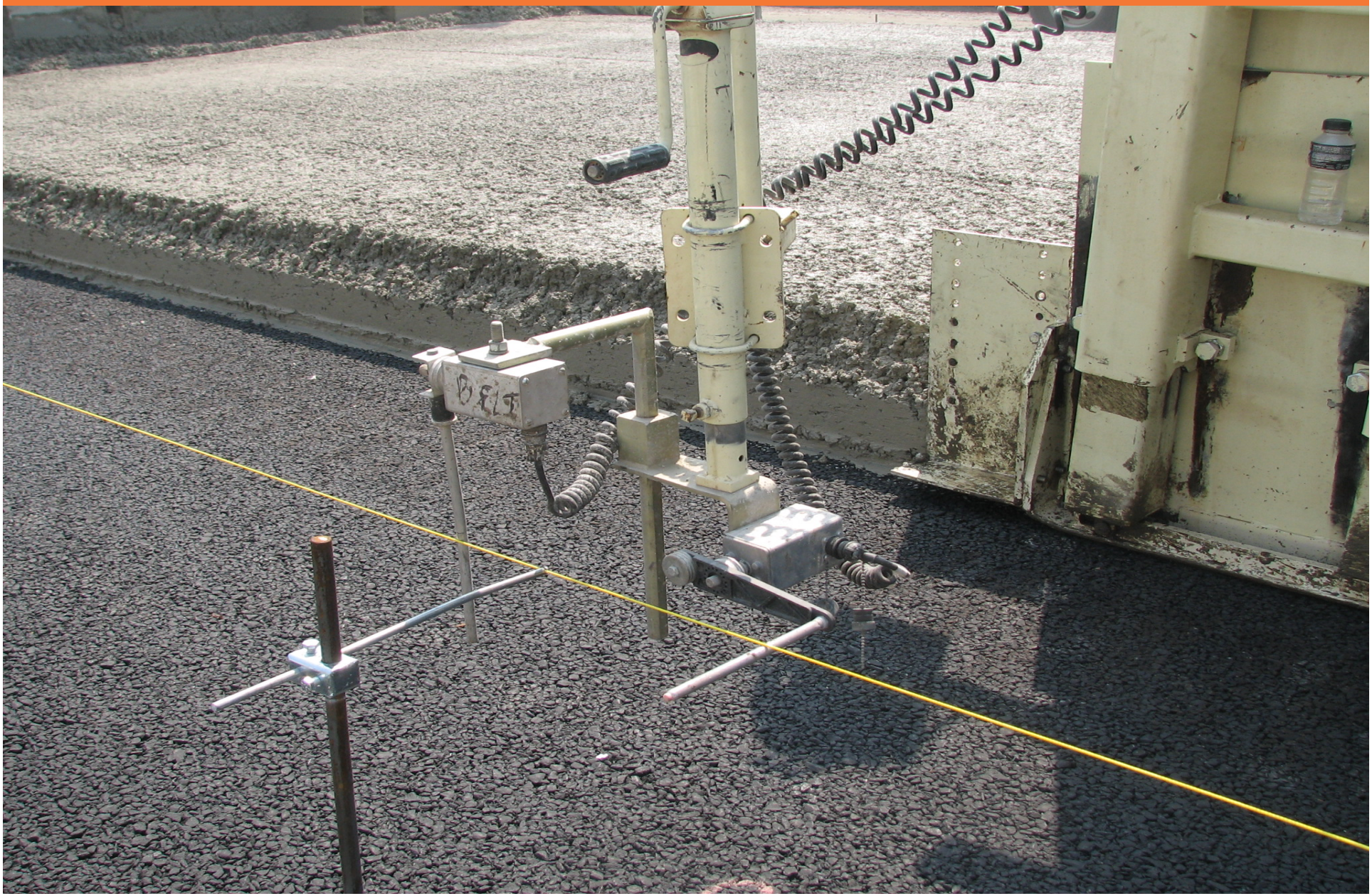
Making Beams for Modulus of Rupture

Delivering Concrete Using Side-belt

Delivering Concrete on the Grade

Paving in Progress

Slip Forming and String Line Control



Burlap Drag

Application of Curing Compound

More of Open House

Open House January 30, 2008

Placed CRCP 13 inches Thick

Activities by FHWA Concrete Mobile Laboratory

Personnel:

Gary Crawford, Jagan Gudimettla and Staff

Objectives:

- Collect Level I Data for MEPDG
- Maturity Data from Lab Cured Specimens for the First 28 Days
- Inputs for HIPERPAV Analysis to Predict Crack Spacing
- Comparison of Thermal Conductivity Test Results Using ASTM C177 and New Test Method By Arizona State University

FHWA Mobile Concrete Laboratory

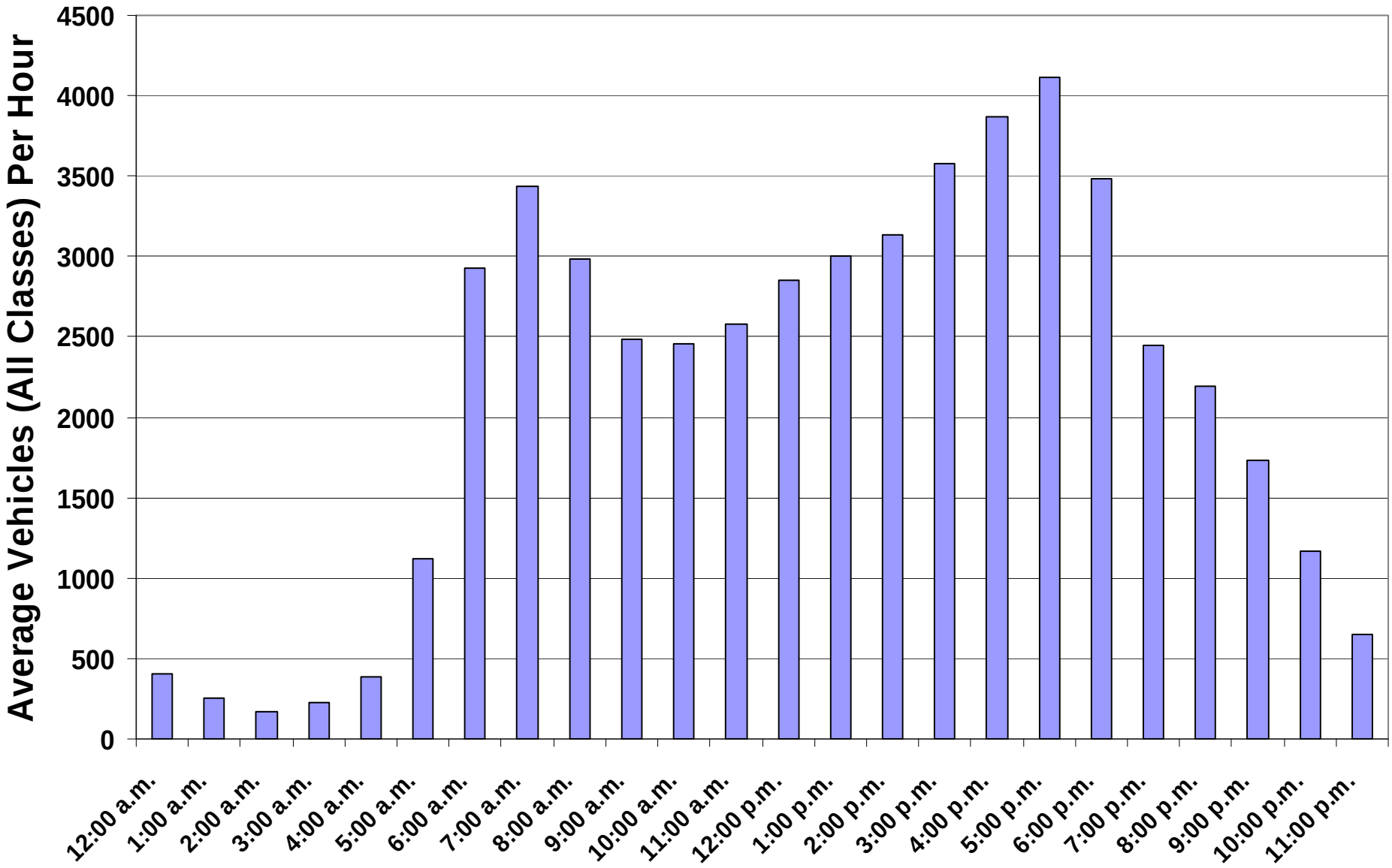
VDOT Traffic Counter Tubes (Axle Type and Count)

ESAL CALCULATION

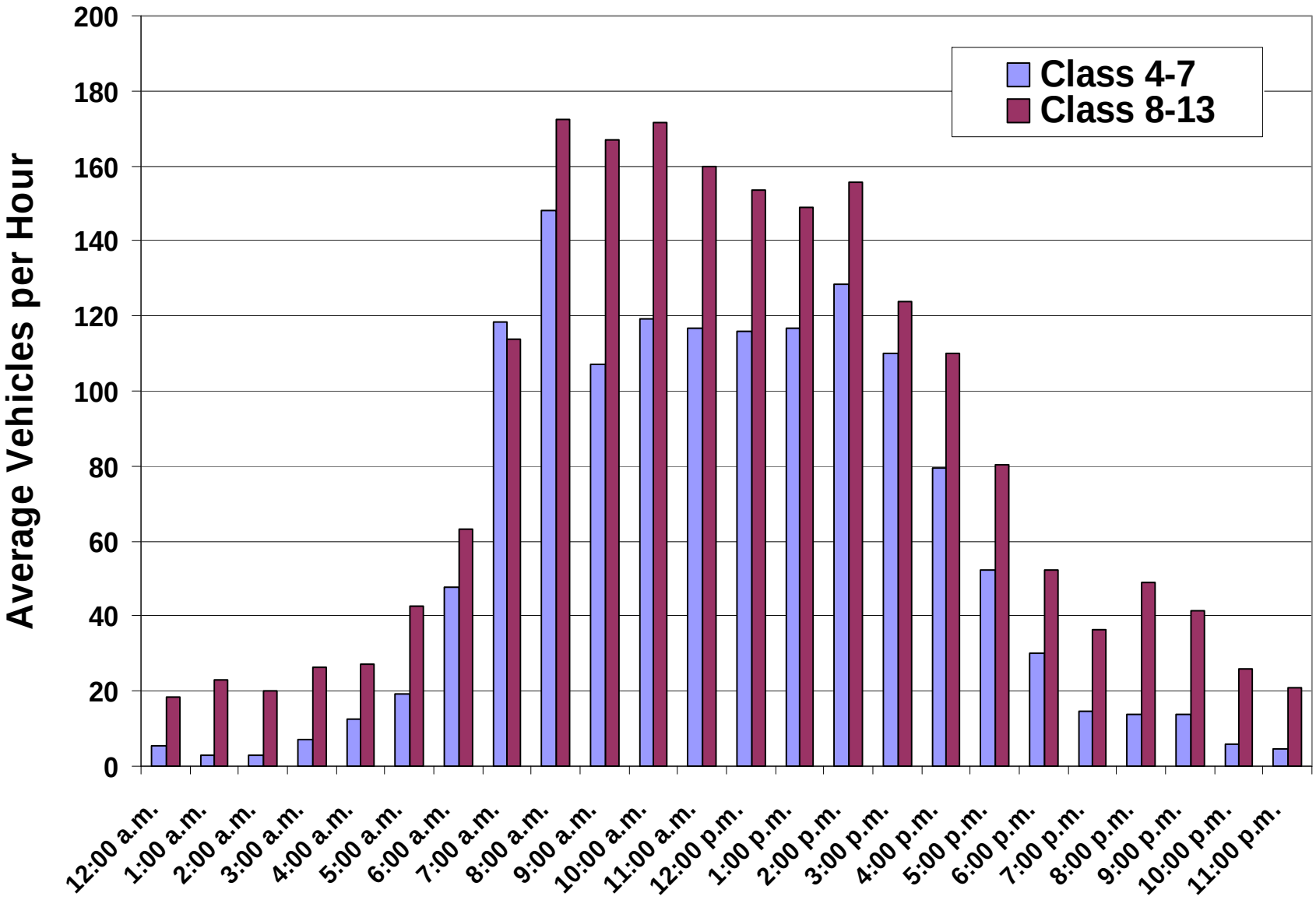
Class	Percent of ADT	Annual % Growth	Average initial Truck Factor (ESALs/truck)	Accumulated 18K ESALs Over Performance Period (30 Years)
1	1.229	4.5	0.0003	2,547
2	71.3	4.5	0.0003	147,748
3	20.95	4.5	0.0003	43,413
4	0.61	4.5	0.56	2,359,541
5	0.87	4.5	0.56	3,365,247
6	1.01	4.5	0.56	3,906,781
7	0.2	4.5	0.56	773,620
8	0.48	4.5	1.92	6,365,787
9	3.1	4.5	1.92	41,112,377
10	0.116	4.5	1.92	1,538,399
11	0.102	4.5	1.92	1,352,730
12	0.03	4.5	1.92	397,862
13	0.000019	4.5	1.92	252
Total	100			61,636,925

Percent of heavy vehicles (Class 4 and higher) = 7.5%

Hourly Volume of Vehicles (All Classes)

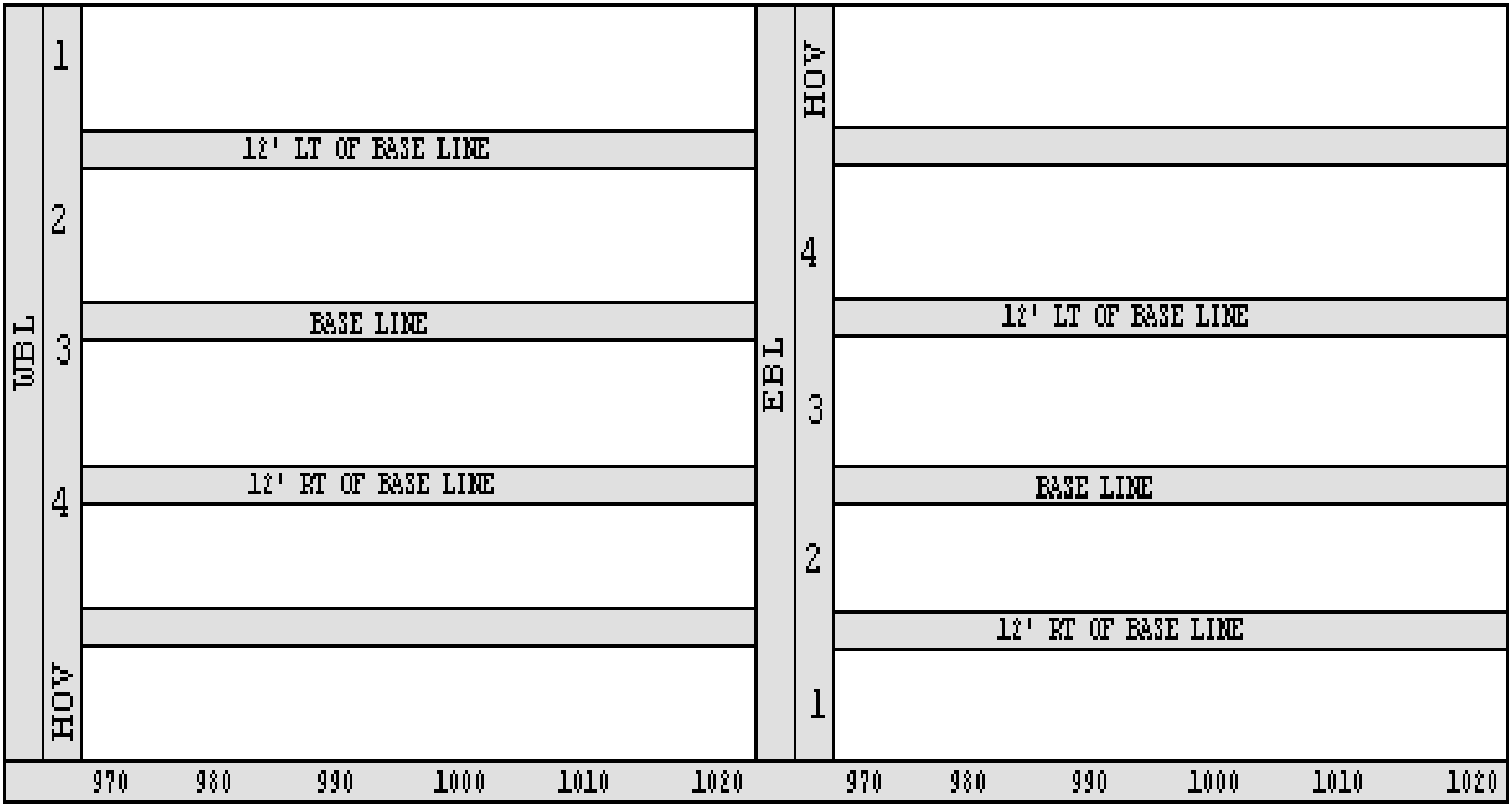


Hourly Volume of Vehicles



VDOT FWD Used in Testing the Completed Pavement

Schematic Plan View of lanes



= Masking Tape

36 Cores Assembled by Lane and Direction

36 Cores Assembled by Lane and Direction

Criteria for Selecting Areas of Concern due to the amount of Paste

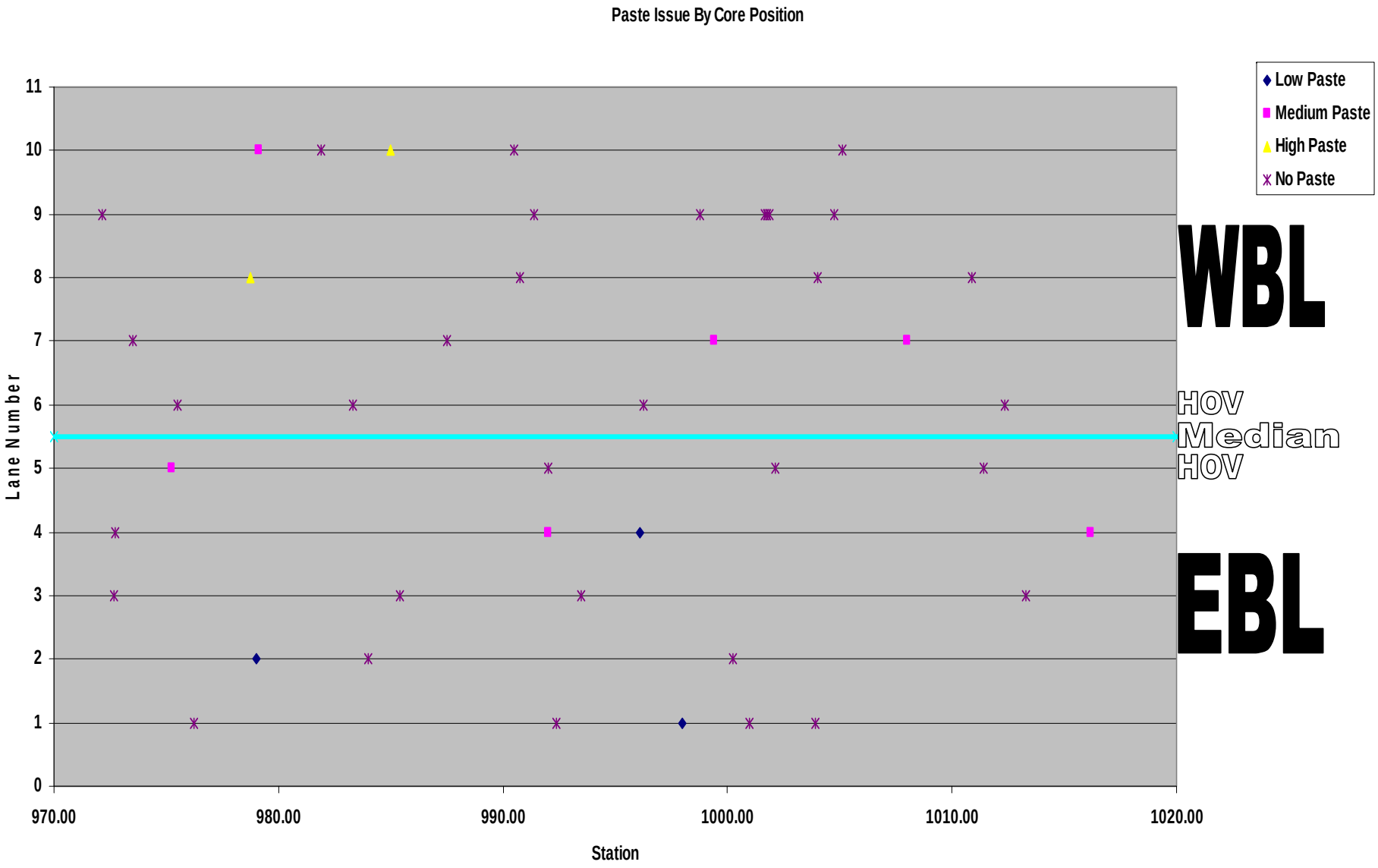
Severity	Amount of Paste
Low	0”-1”
Medium	1”-2”
High	2” or more

High Severity

Summary of All Core Results

Core #	Direction	Lane	Station	Height (in)	Adj Rebar Depth (in)	Paste depth (in)	Percent Steel (Area)
1	WBL	HOV	975.50	13.50			0.68
2	WBL	HOV	983.30	13.00	5.69		0.71
3	EBL	HOV	975.25	13.50	6.69	1.75	0.68
4	EBL	HOV	992.00	13.50	6.56		0.68
5	EBL	HOV	1002.15	13.75	6.69		0.67
6	EBL	HOV	1011.40	13.00	5.69		0.71
7	EBL	4	972.75	13.50	6.81		0.68
8	EBL	4	992.00	13.25	6.19	1.38	0.69
9	EBL	4	996.10	13.25	6.56	0.75	0.69
10	EBL	4	1016.20	13.00		1.50	0.71
11	EBL	3	972.65	13.75			0.67
12	EBL	3	985.40	13.75	6.69		0.67
13	EBL	3	993.50	13.50	7.06		0.68
14	EBL	3	1013.30	13.50			0.68
15	EBL	1	976.25	14.00	7.19		0.65
16	EBL	2	979.00	13.25	6.44	0.75	0.69
17	EBL	2	984.00	13.25	6.56		0.69
18	EBL	1	992.40	13.00			0.71
19	EBL	2	1000.25	13.00	5.94		0.71
20	EBL	1	1001.00	12.50	5.94		0.73
21	WBL	HOV	996.25	13.75	7.69		0.67
22	WBL	HOV	1012.35	13.50			0.68
23	WBL	4	973.50	13.25	6.94		0.69
24	WBL	3	978.75	13.00	5.94	2.88	0.71
25	WBL	4	987.50	13.50	6.81		0.68
26	WBL	3	990.75	13.75	7.19		0.67
27	WBL	4	999.40	14.00	7.06	1.75	0.65
28	WBL	3	1004.00	12.75	5.94		0.72
29	WBL	4	1008.00	13.50	7.06	1.25	0.68
30	WBL	3	1010.90	13.50			0.68
31	WBL	2	972.15	12.75			0.72
32	WBL	1	981.90	12.50			0.73
33	WBL	1	990.50	13.00	5.94		0.71
34	WBL	2	991.40	13.50	7.69		0.68
35	WBL	2	1001.75	11.75	4.94		0.78
36	WBL	1	1005.10	12.75	5.44		0.72
20A	EBL	1	998.00	13.00		0.75	0.71
20B	EBL	1	1003.90	13.00	6.19		0.71
32A	WBL	1	979.10	12.50		1.25	0.73
32B	WBL	1	985.00	12.50	5.44	2.75	0.73
35A	WBL	2	1001.85	12.00	4.94		0.76
35B	WBL	2	1001.65	12.00			0.76
35C	WBL	2	998.75	12.25	6.19		0.75
35D	WBL	2	1004.75	12.25			0.75
Average				13.11	6.39	1.52	0.70
Std Dev				0.55	0.71	0.73	0.03
Rel Std Dev				0.04	0.11	0.48	0.04

Paste Severity by Core Position



Areas of Improvements

1. Examine the true need for CRCP >12”
2. Using smaller bar size gives better bonding
3. Wider lane 14’ VS. 13’ for equal edge support
4. Use 2 inches OGDL rather than 3 inches
5. Raising the steel to within 4’’ from the top
6. Match concrete mix design and concrete mechanical properties
7. Use MEPDG level I to document materials characterization and the CRCP predicted performance.

103 Years of Excellence

Recycled Concrete
CTA
SOGM
Rebar
Batch Plant
Paving Operations

Thank You!