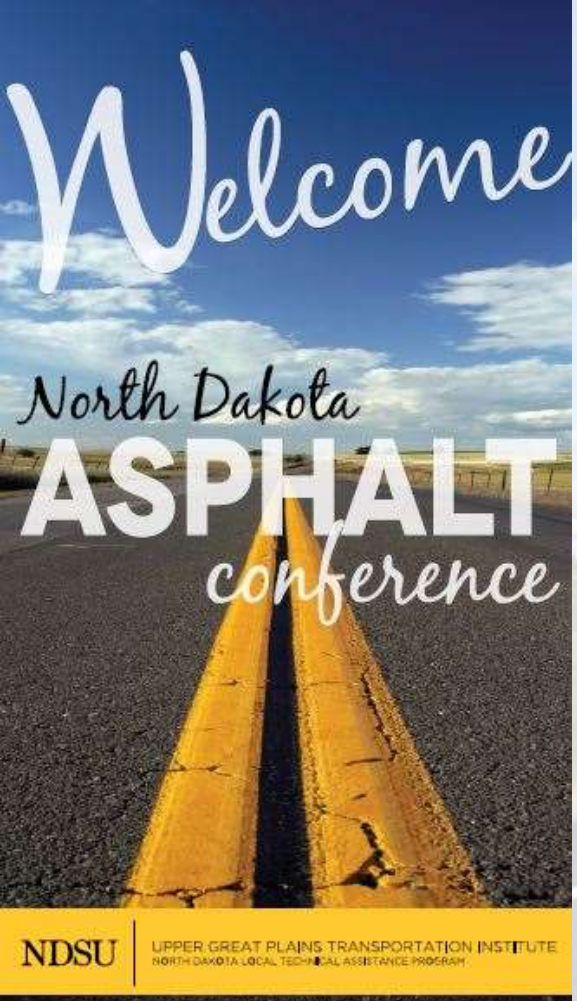


Intelligent Compaction
I-94 Project Highlights

Bernie Southam – NDDOT

Bryce Wuori – Northern Improvement

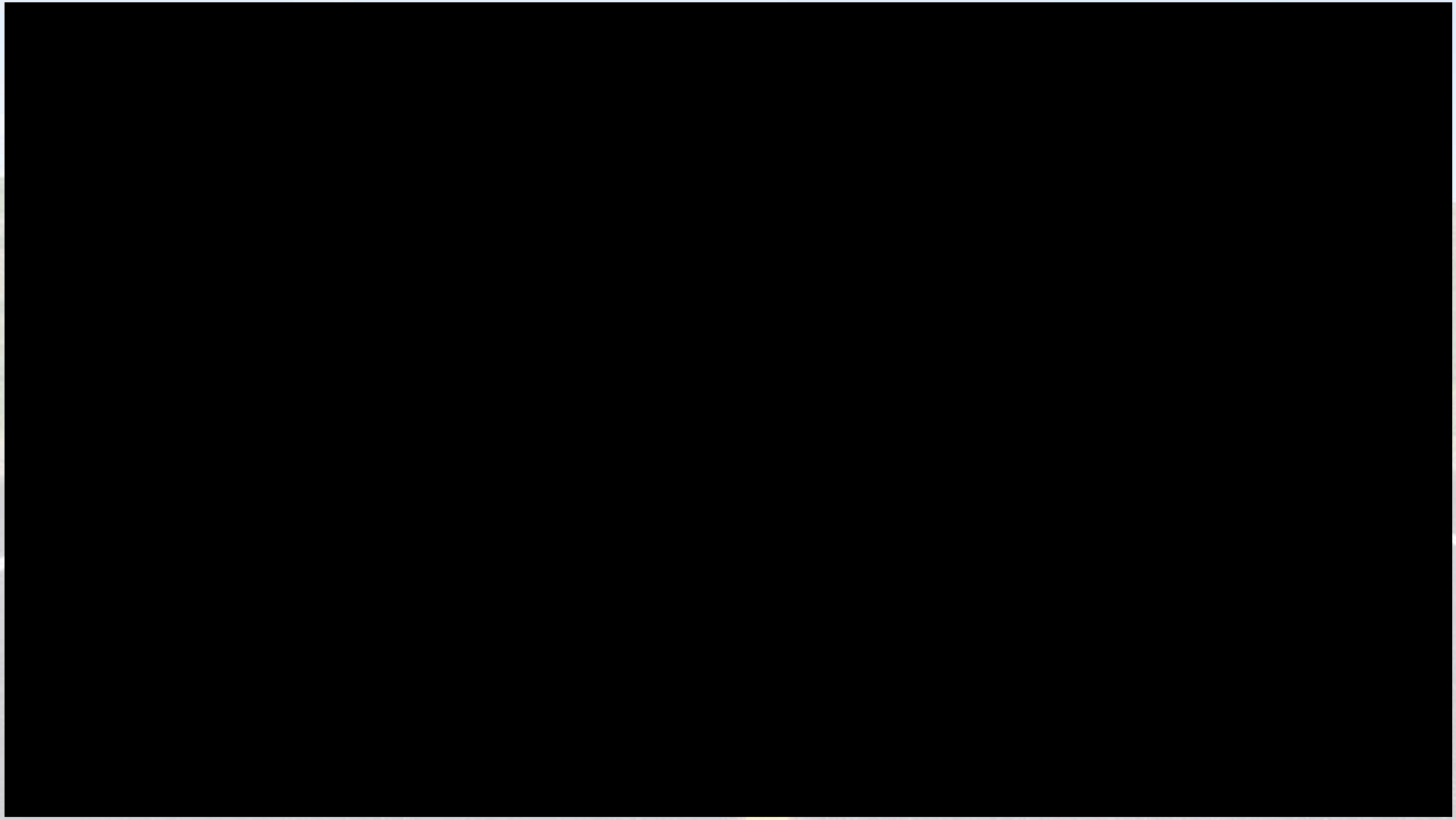
Northern Improvement Co.

NDDOT
North Dakota
Department of Transportation

North Dakota Asphalt Conference

Bismarck, ND - April 10-11-2018

I-94 Project Highlights



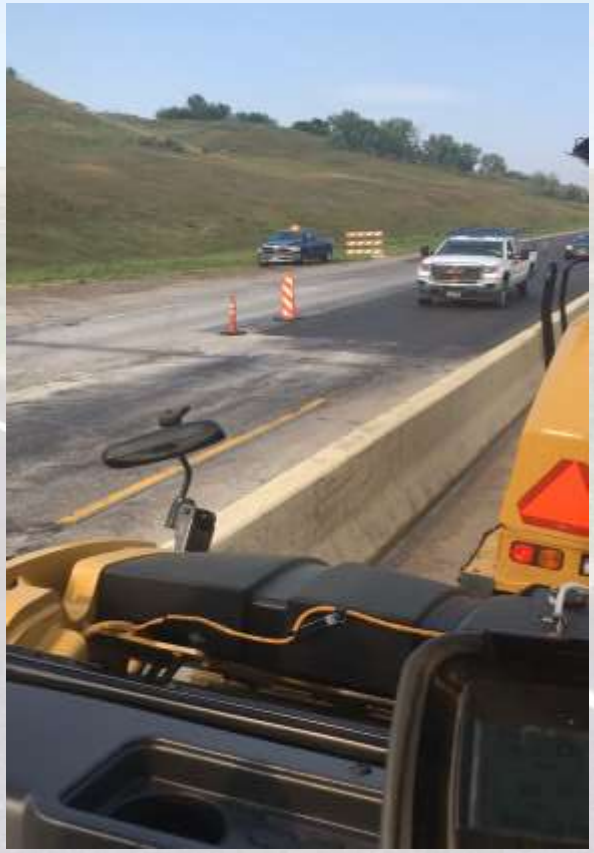
Presentation Overview

- Project Scope
- Project Requirements
- NDDOT & Intelligent Compaction
- Equipment Used on Project
- Project Results and Data
- IC Drawbacks
- Operator Benefits
- Contractor Benefits
- Owner Benefits

Project Scope

NDDOT JOB #10 (I-94 Concrete and Asphalt Repairs)

- 5.9 Miles Through Bismarck
- Grant Marsh Bridge to 1 Miles East of Exit 161 (Oasis Truck Stop)
- 13 On/Off Ramps
- Approximately 42,000 Tons of Super pave FAA 45 Asphalt
- Work to Take Place at Non-Peak Traveling Times
- Monday through Saturday (6:30 PM to 5:30 AM)
- Sunday (All Day)
- 90 % of Project Paved in Night Conditions
- 1.5” Leveling Course
- 1.5” Wear Course



Project Requirements

SP 348 (14) Intelligent Compaction for hot mix Asphalt (HMA)

- Rollers
- GPS
- Work Plan
- Training
- GPS Calibration
- Roller Operations
- Equipment Malfunctions
- Data Submittal
- Data Analysis Software
- GPS Rover

Project Requirements

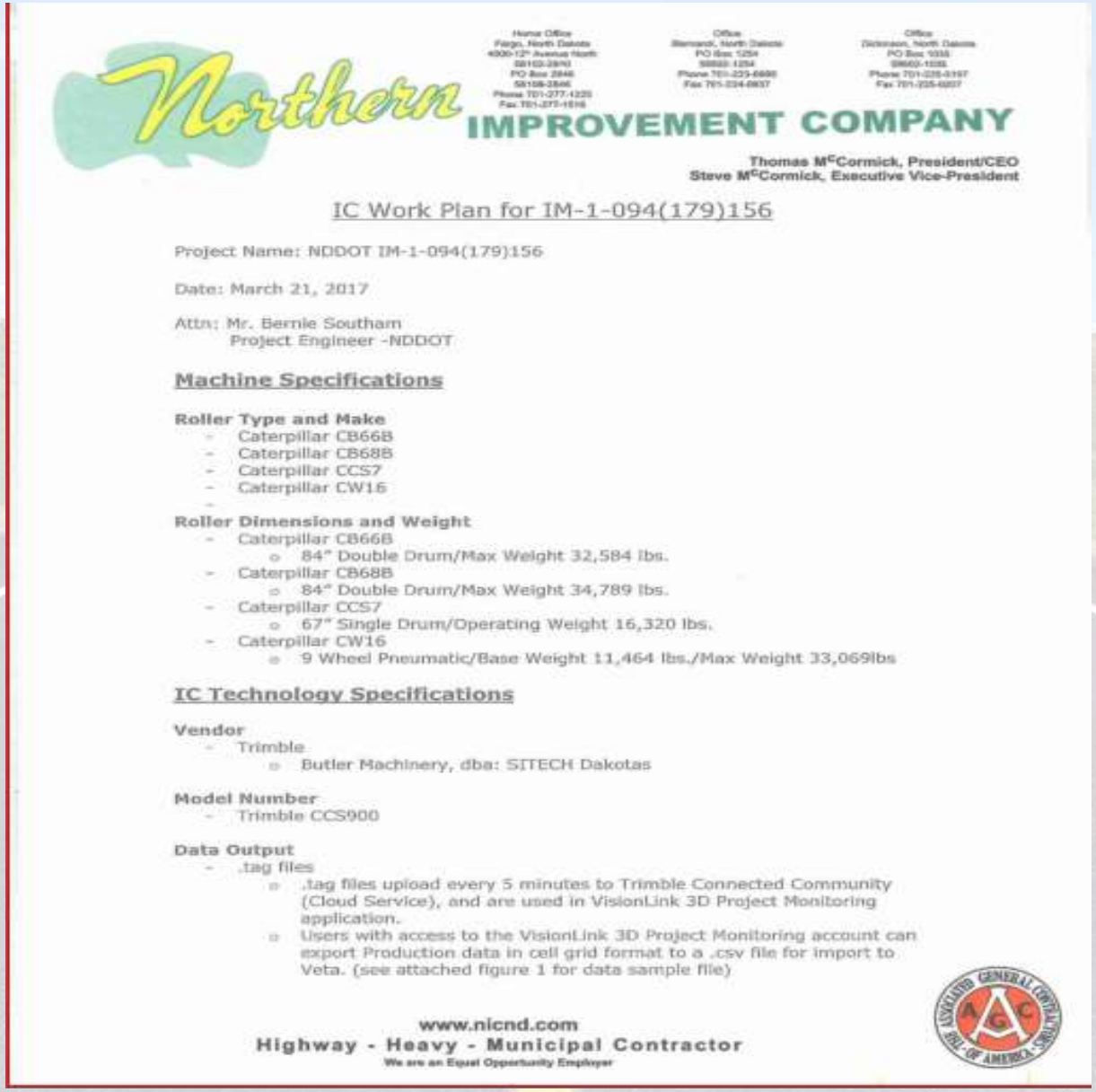
Super pave FAA 45 Asphalt

- Modified PG 64-28 AC Oil
- 2 cores per Sub lot
- Average of 2 cores

Required Density of 92%

- Both lifts of Asphalt

Project Requirements



Northern IMPROVEMENT COMPANY

Thomas M^cCormick, President/CEO
Steve M^cCormick, Executive Vice-President

IC Work Plan for IM-1-094(179)156

Project Name: NDDOT IM-1-094(179)156

Date: March 21, 2017

Attn: Mr. Bernie Southam
Project Engineer -NDDOT

Machine Specifications

Roller Type and Make
- Caterpillar CB66B
- Caterpillar CB68B
- Caterpillar CCS7
- Caterpillar CW16
-

Roller Dimensions and Weight
- Caterpillar CB66B
  - 84" Double Drum/Max Weight 32,584 lbs.
- Caterpillar CB68B
  - 84" Double Drum/Max Weight 34,789 lbs.
- Caterpillar CCS7
  - 67" Single Drum/Operating Weight 16,320 lbs.
- Caterpillar CW16
  - 9 Wheel Pneumatic/Base Weight 11,464 lbs./Max Weight 33,069lbs

IC Technology Specifications

Vendor
- Trimble
  - Butler Machinery, dba: SITECH Dakotas

Model Number
- Trimble CCS900

Data Output
- .tag files
  - .tag files upload every 5 minutes to Trimble Connected Community (Cloud Service), and are used in VisionLink 3D Project Monitoring application.
  - Users with access to the VisionLink 3D Project Monitoring account can export Production data in cell grid format to a .csv file for import to Veta. (see attached figure 1 for data sample file)

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Project Requirements

- Data File Types
  - .CSV (Comma Delimited Value)
  - .ttm (Trimble Triangulation Model) – Final Surface As – Built data

Temperature Measurement System
- Trimble IC Smart Technology

Number of IC rollers
- Total of 4 IC rollers can be in operation at same time
  - Caterpillar CB66B
  - Caterpillar CB68B
  - Caterpillar CCS7
  - Caterpillar CW16

Personnel Trained to work on IC System and Data Analysis
- Bryce Wuori (Northern Improvement Company, PM/Estimator MPM)
  - IC/GPS Manager and Data Analysis Design Manager
  - Will Design and be in charge of transfer data to NDDOT on daily basis or when requested
  - Review and submit IC Data and Maps to NDDOT representatives
  - Manage everyday IC operations in field and in office
  - Nuclear Density Technician for (CMV) Setup and Calibrations
- Nathan Sandberg (Northern Improvement Company, PM/Tech)
  - IC/Field Manager and Data Analysis Technician
  - Will be in field checking control, equipment operations and data collection processes in real time
  - Site Setup and Data Analysis
  - Nuclear Density Technician for (CMV) Setup and Calibrations
- Dustin Grant (Tech Specialist, SITETECH Dakotas/Butler Cat) (Bismarck, ND)
  - Machine and site setup
  - Compaction Meter Value(CMV) setup
  - SITETECH technology representative/specialist
- Kasey Erickson (Butler Cat, Equipment Sales/Specialist) (Bismarck, ND)
  - Machine setup and inspection
  - Machine Training and Technology Training
  - Butler Cat Equipment representative

NDDOT and Intelligent Compaction

Why the NDDOT is interested in Intelligent Compaction

- Get a uniformly compacted road
- Future Maintenance cost reductions (Less Patching)
- Smoother more dense roads from proper compaction methods
- CMV numbers and Data from IC is useful in locating areas that appear to have lower compactions values
- Does not eliminate use of nuclear gauge on project it is tool used by the contractor to determine their rolling patterns and timing for a better end product

NDDOT and Intelligent Compaction

NDDOT & Intelligent Compaction

- NDDOT does not use the CMV values to determine the pavement density pay factor
- Raw data files are very large and contain more than 100,000 rows of information
- As with any product the results are dependent on how well the contractor understands the information and how to use it
- Compaction still measured by field cores and compared to Maximum Theoretical Density
- Areas with poor cell phone coverage may not be able to use the VRS IC process to get needed data

Equipment Used on Project

IC Rollers

- Cat CB66B
- Cat CB68B
- Cat CW16
- Cat CCS7

GPS and IC Tools

- VRS
- Trimble IC Smart Technology
- Machine Sensors and Systems
- CB 460 Screen
- Vision Link
- Tsc3 Data Collector
- Nuclear Density Gauge

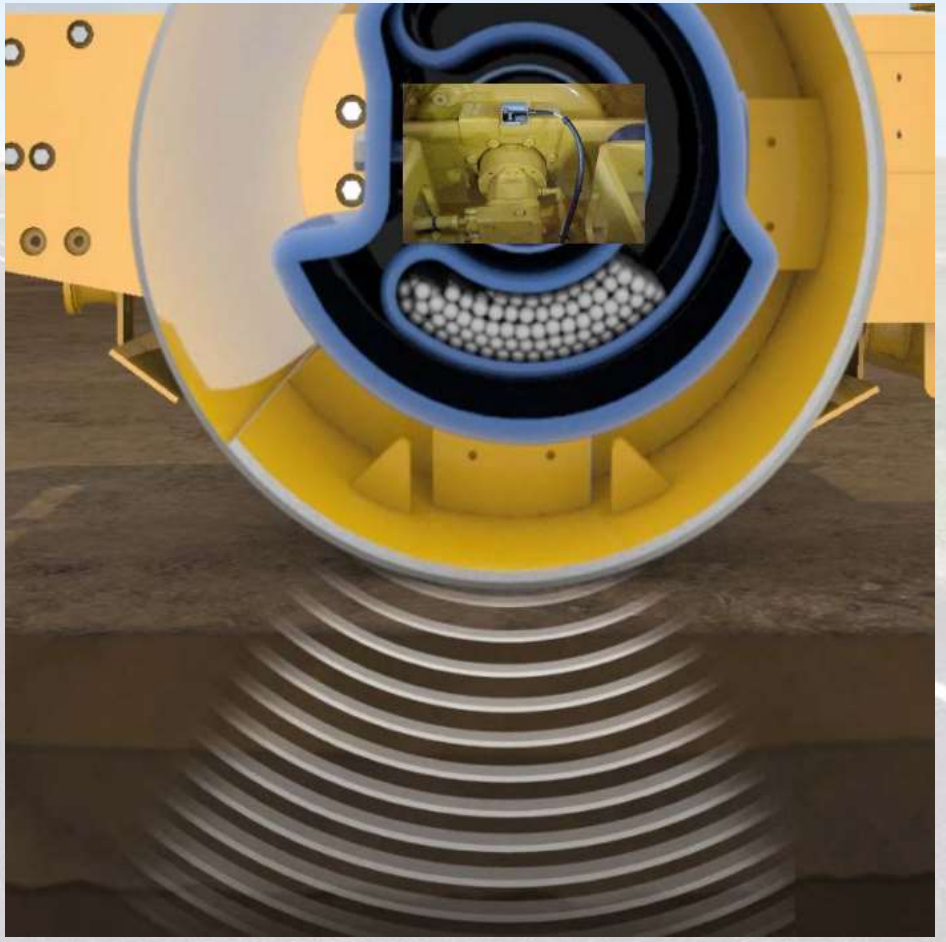
Project Results and Data

Time	CellN_FT	CellE_FT	Elevation_FT	Design Name	Machine	Speed_mph	LastGPS Mode	GPSAccTol_FT	TargPass Count	TotalPasses	Lift	LastCMV	TargCMV	LastRMV	LastFreq_Hz	LastAmp_mm	TargThickness_FT	Machine Gear	VibeState	LastTemp_c
2017-Aug-24 21:11:58.059	424849.1	1909212	1746.407	NDDOT Job #10	CB68BM024170	5.2	RTK Fixed	Medium (0.164FT)	6	7	1	47.1	50	1.7	63.7	0.38	0.656	Reverse	Off	67.9
2017-Aug-24 21:11:58.059	424850.2	1909212	1746.463	NDDOT Job #10	CB68BM024170	5.2	RTK Fixed	Medium (0.164FT)	6	10	1	37.1	50	1.4	63.7	0.41	0.656	Reverse	Off	67.9
2017-Aug-24 21:11:58.059	424851.3	1909212	1746.519	NDDOT Job #10	CB68BM024170	5.2	RTK Fixed	Medium (0.164FT)	6	9	1	47.1	50	1.4	63.7	0.41	0.656	Reverse	Off	67.9
2017-Aug-24 21:14:54.059	424852.5	1909212	1746.499	NDDOT Job #10	CB68BM024170	4.9	RTK Fixed	Medium (0.164FT)	6	8	1	42.5	50	3.6	63.7	0.39	0.656	Reverse	On	58.7
2017-Aug-24 21:14:54.059	424853.6	1909212	1746.512	NDDOT Job #10	CB68BM024170	4.9	RTK Fixed	Medium (0.164FT)	6	9	1	42.5	50	3.6	63.7	0.39	0.656	Reverse	On	58.7

Project Results and Data

What is CMV

- CMV is a Calculated Measured Value
- CMV is a dimensionless unit
- CMV is a stiffness measurement
- Look for consistency in this value
- CMV is NOT DENSITY!!!!
- Measures Frequency's and G forces
- How hard is that drum hitting the Material



Project Results and Data

Intelligent Compaction I-94 Project Data Overview

- Compared over 117 Core Density Tests to IC Data collected
- Used IC Data from core locations in field (Coordinates)
- CMV (Compaction Meter Value)
- CMV at set at 50 = 94-94.5% Density
- CMV average for project was 47.34 or 93.5-94% Density
- Project required a 92% Density

IC Data I-94 Complete Averages

Date	CMV Value	Core Value	Expected Core Result	Value Difference Core Vs Expected
3/25/2017	47.34	**93.42**	**93.86**	0.45

Project Results and Data

- Consistency = Smoothness
- 2 Grind Locations (Headers)
- Average Standard Deviation 7.0
- Average 56 Range

Profile Length	
5.9	Miles

Comments	Lots with bl

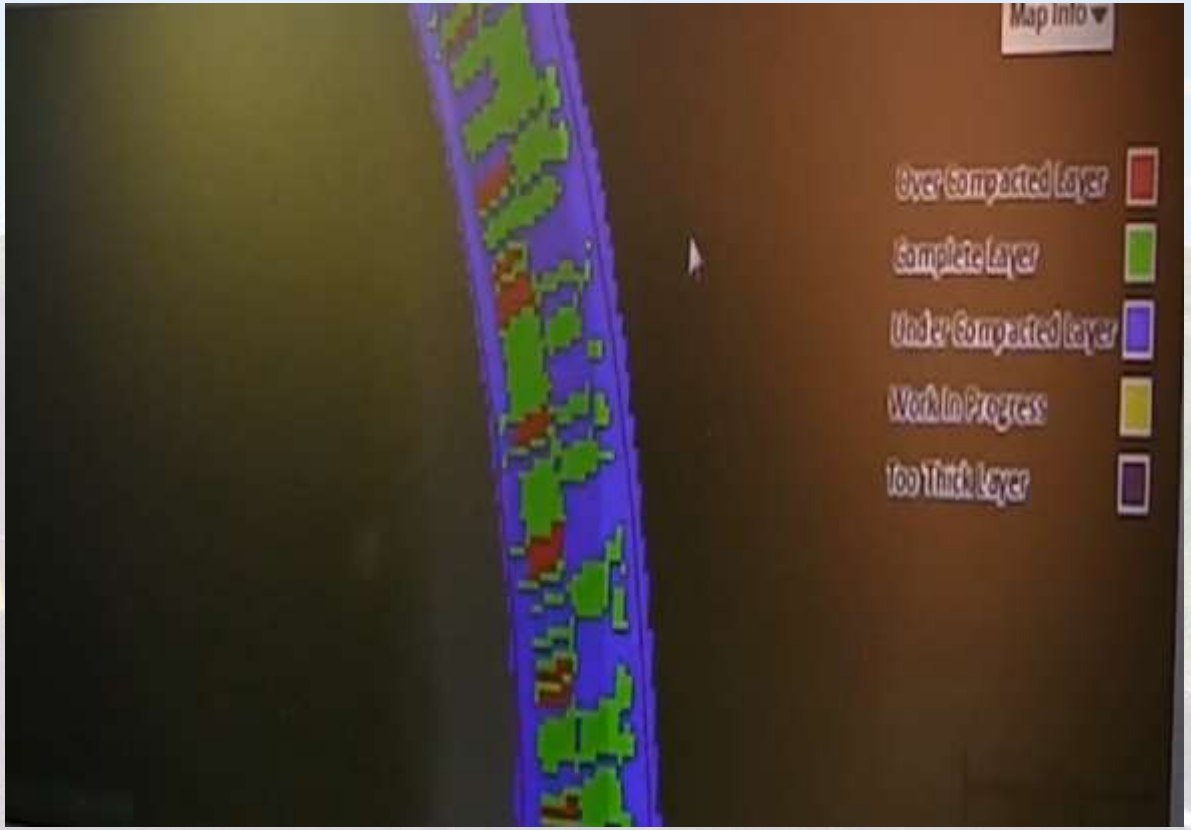
Range	Inc/CPA
<=34.0	$300.00
34.1 to 39.0	$225.00
39.1 to 44.0	$150.00
44.1 to 48.0	$75.00
48.1 to 56.0	$0.00
56.1 to 62.0	($100.00)
62.1 to 69.0	($200.00)
69.1 to 75.0	($400.00)
>=75.1	Corrective Action

Incentive/Contract Price Adjustment		
	Total Cost	Cost/Lane-Mile
EB Outside Lane	$ 950	$ 162
EB Inside Lane	$ (1,325)	$ (226)
WB Outside Lane	$ (4,600)	$ (785)
WB Inside Lane	$ (3,900)	$ (666)
Total		**$ (8,875)**

Statistical Information				
Statistic	EB Outside Lane	EB Inside Lane	WB Outside Lane	WB Inside Lane
	0.1 mile	0.1 mile	0.1 mile	0.1 mile
Average	50.1	56.4	59.6	58.6
Standard Deviation	5.2	6.9	12.5	7.3

IC Drawbacks

- Initial Investment Costs
- Training Time and Costs
- New Technology Glitches
- Collects Data up to 1.5 M in Ground
- Immense Amount of Data Collected
- Understanding and Evaluating the Data



Operator Benefits

- Operator Awareness
- Eliminates Operator Error (Paints a Picture)
- Temperature Mapping (Too Hot or To Cold)
- Pass Count Mapping

Contractor Benefits

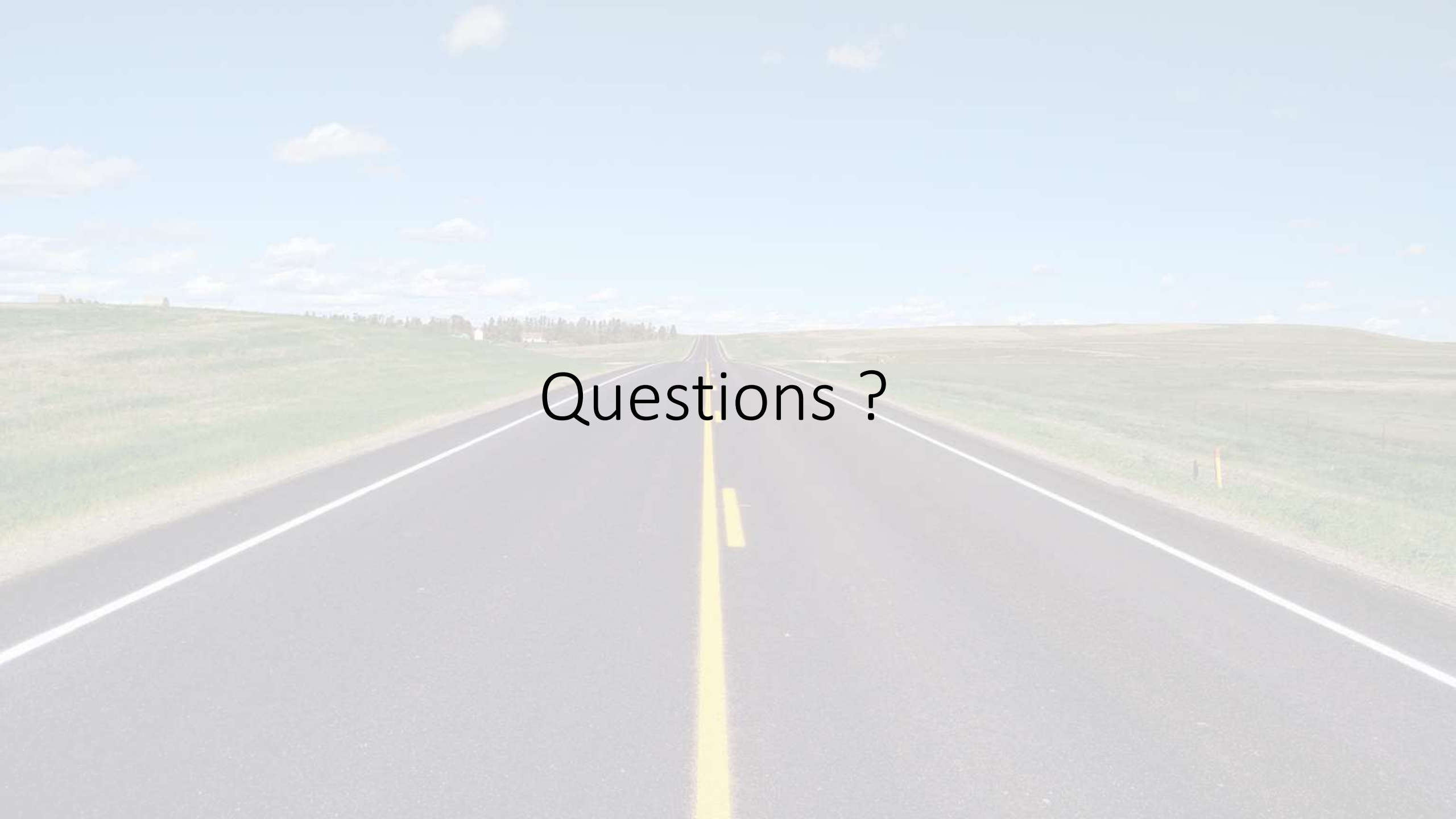
- Quality Control and Management
- Testing Costs
- Efficiency
- Consistency in Rolling Patterns
- Consistency = Smoothness
- Density Incentives
- Smoothness Incentives
- Can be Used in other Applications
  - ✓ Subgrade
  - ✓ Granular Base

Owner Benefits

- Quality Assurance and Management
- Better End Product
- Smoother Roads
- More Dense Asphalts
- Testing Costs (Less Cores)
- Data Collection
- Data Evaluation
- Complete Picture of Entire Project

Why IC and Technology is Important

- Competitive Edge
- Efficiency Tool
- Project Cost Reductions
- Flexibility/Diversity
- Quality Control Management
- Work Smarter and Not Harder
- Ahead of the Change Curve
- Technology is the key to success


Questions ?

Bernie Southam – NDDOT

Bryce Wuori – Northern Improvement

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