Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

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Training Module

Fundamental Concepts of IC Technology

- History of Continuous Compaction Control (CCC)
- Definition of Intelligent Compaction (IC)
- Components of Intelligent Compaction
- How the Intelligent Compaction works
- Benefits and implications of Intelligent Compaction

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History of Continuous Compaction Control (CCC)

1974 The first research on CCC was initiated in Swedish Highway Administration

1975 Geodynamik was founded to continue development of roller-mounted compaction meter

1978 Geodynamik and Dynapac introduced the Compaction Meter Value (CMV)

1980 A number of roller manufacturers began offering CMV systems

1982 Bomag introduced the Omega value (a measure of compaction energy and time) and Terrameter

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History of Continuous Compaction Control (CCC)

Introduction of mechanistic and performance related soil properties

1990 Bomag introduced Vibration Modulus (a measure of dynamic soil stiffness)

1999 Ammann introduced the Soil Stiffness Parameter

2004 Sakai introduced Compaction Control Value (CCV)

After 2004 Improvement of IC systems and data analysis algorithms

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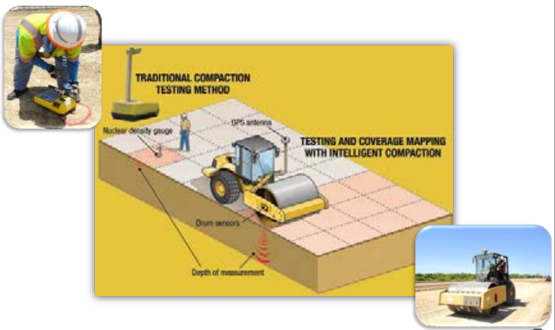
Definition of Intelligent Compaction (IC)



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Definition of Intelligent Compaction (IC)

IC is a fast-developing technology for quality control

Proof rolling using IC rollers can

- **Ensure appropriate coverage**
- **Identify weak spots**
- **Improve uniformity of compacted layers**

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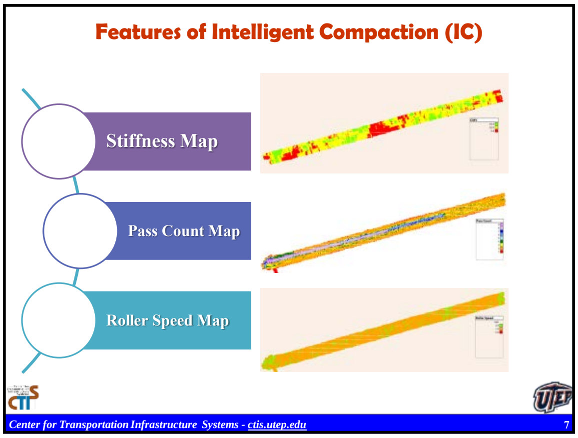
Features of Intelligent Compaction (IC)
Stiffness Map
Pass Count Map
Roller Speed Map
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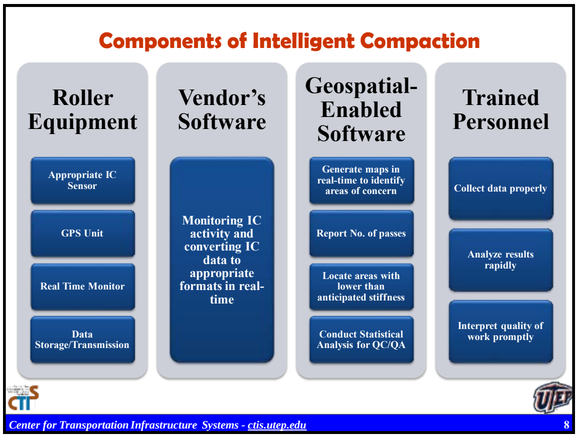
Components of Intelligent Compaction
Roller Equipment
Appropriate IC Sensor
GPS Unit
Real Time Monitor
Data Storage/Transmission
Vendor's Software
Monitoring IC activity and converting IC data to appropriate formats in real-time
Geospatial-Enabled Software
Generate maps in real-time to identify areas of concern
Report No. of passes
Locate areas with lower than anticipated stiffness
Conduct Statistical Analysis for QC/QA
Trained Personnel
Collect data properly
Analyze results rapidly
Interpret quality of work promptly
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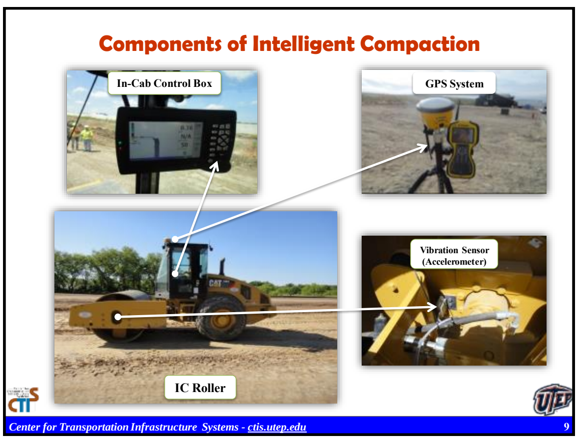
Components of Intelligent Compaction
In-Cab Control Box
GPS System
Vibration Sensor (Accelerometer)
IC Roller
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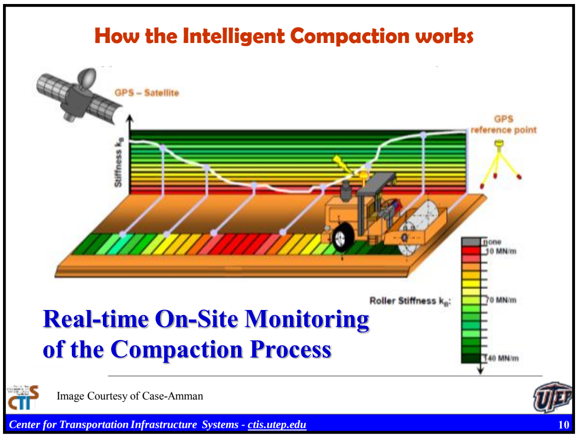
How the Intelligent Compaction works
GPS – Satellite
GPS reference point
Roller Stiffness
Real-time On-Site Monitoring of the Compaction Process
Image Courtesy of Case-Amman
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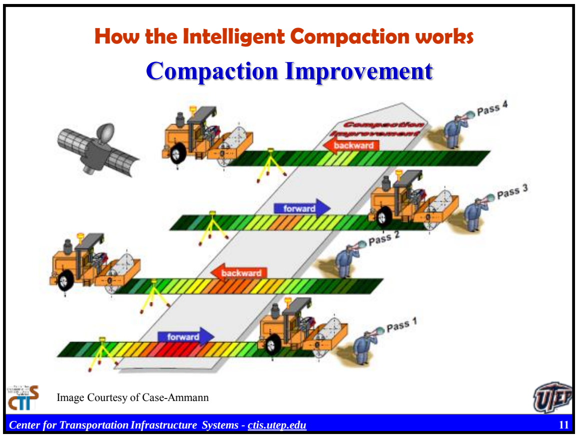
How the Intelligent Compaction works
Compaction Improvement
Pass 4
backward
Pass 3
forward
Pass 2
backward
Pass 1
forward
Image Courtesy of Case-Ammann
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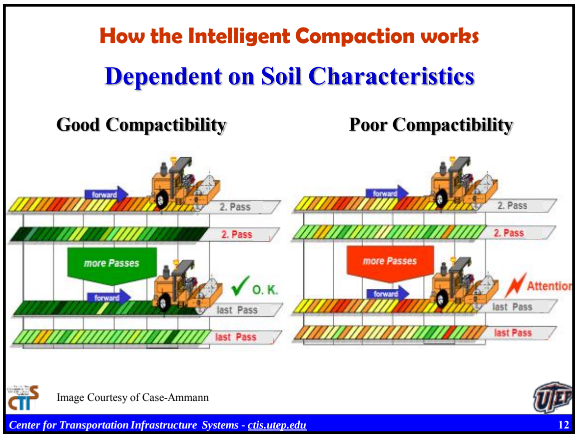
How the Intelligent Compaction works
Dependent on Soil Characteristics
Good Compactibility
Poor Compactibility
forward
2. Pass
2. Pass
more Passes
O. K.
Attention
last Pass
last Pass
Image Courtesy of Case-Ammann
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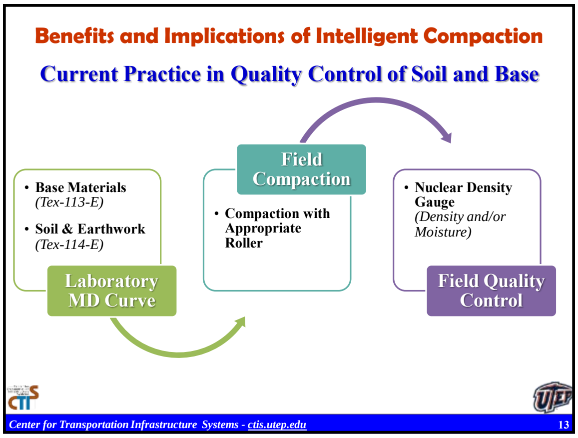
Benefits and Implications of Intelligent Compaction
Current Practice in Quality Control of Soil and Base
• Base Materials (Tex-113-E)
• Soil & Earthwork (Tex-114-E)
Laboratory MD Curve
Field Compaction
• Compaction with Appropriate Roller
• Nuclear Density Gauge (Density and/or Moisture)
Field Quality Control
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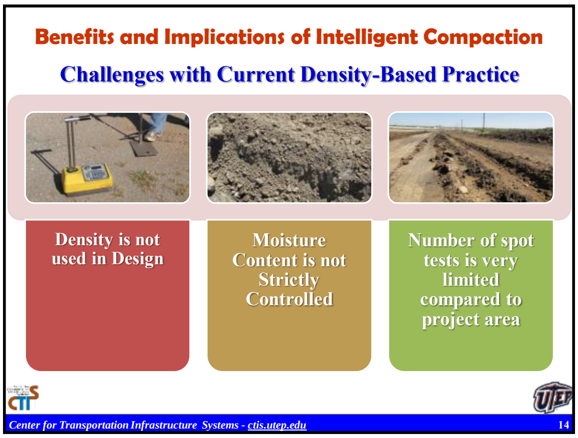
Benefits and Implications of Intelligent Compaction
Challenges with Current Density-Based Practice
Density is not used in Design
Moisture Content is not Strictly Controlled
Number of spot tests is very limited compared to project area
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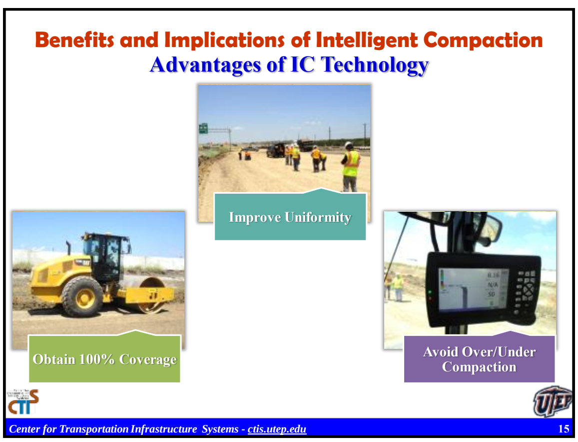
Benefits and Implications of Intelligent Compaction
Advantages of IC Technology
Improve Uniformity
Obtain 100% Coverage
Avoid Over/Under Compaction
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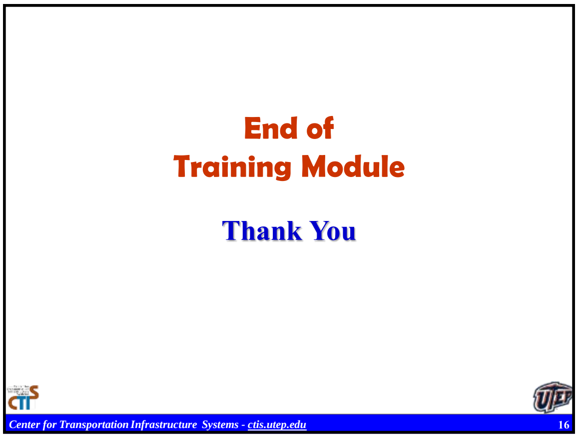
End of
Training Module
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Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

Training Module

IC Roller Retrofit Kit Installation and Calibration

- Introduction to the IC retrofit kit
- Components of IC roller kits
- How the IC retrofit kit works
- Features, benefits and limitations of IC retrofit kit
- Comparison of retrofitted with OEM IC rollers
- Operational steps for installation of retrofit kit
- Calibration of retrofitted IC roller

Introduction to IC retrofit kit

Two Types of IC Rollers

IC Retrofit Kit	Original Equipment Manufacturer (OEM) IC Roller
Retrofit IC components are installed on an existing roller	OEM roller is equipped with Factory-Installed IC components

Retrofit Kit vs OEM IC Roller

- **Performance of retrofitted IC-Rollers are dependent on following factors:**
  - ✓ **The roller model and make (physical configuration of drums)**
  - ✓ **Position of vibration sensor (accelerometer) on the roller**
  - ✓ **Accuracy of retrofit kit GPS system**
  - ✓ **Availability of local coordinate system**
  - ✓ **The units of Measurement Values (MVs) used by retrofit kit**

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Retrofit Kit vs OEM IC Roller

Retrofitted Sensor

OEM Sensor

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Retrofit Kit vs OEM IC Roller

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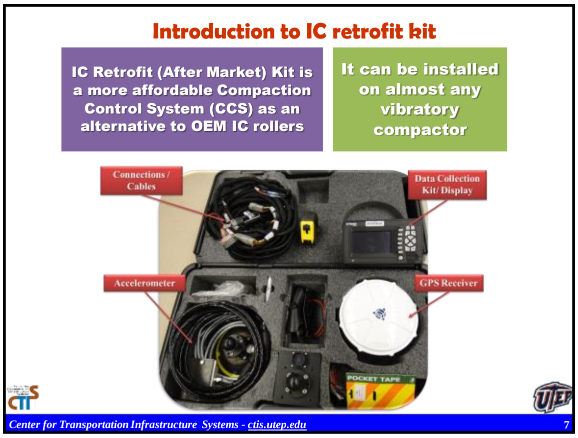
Introduction to IC retrofit kit
IC Retrofit (After Market) Kit is a more affordable Compaction Control System (CCS) as an alternative to OEM IC rollers
It can be installed on almost any vibratory compactor
Connections / Cables
Data Collection Kit/ Display
Accelerometer
GPS Receiver
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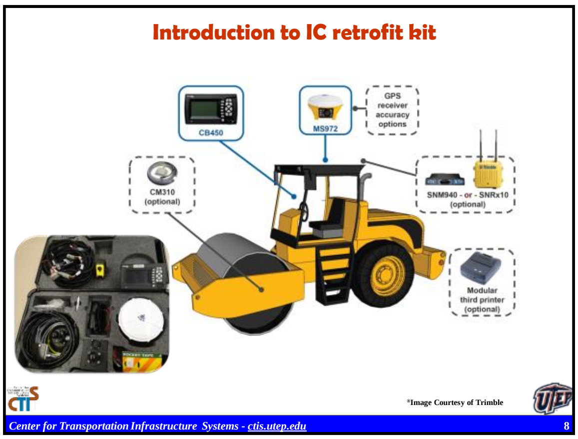
Introduction to IC retrofit kit
CB450
MS972
GPS receiver accuracy options
CM310 (optional)
SNM940 - or - SNRx10 (optional)
Modular third printer (optional)
*Image Courtesy of Trimble
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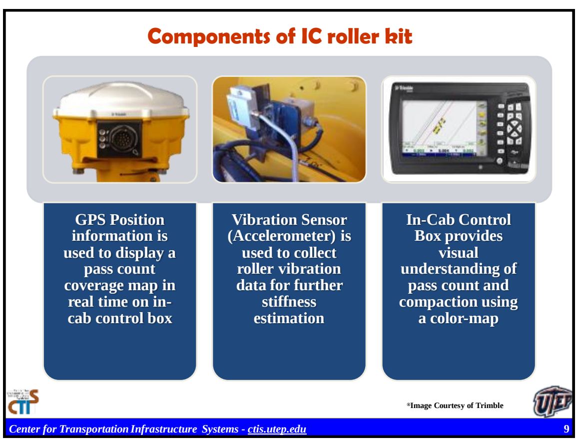
Components of IC roller kit
GPS Position information is used to display a pass count coverage map in real time on in-cab control box
Vibration Sensor (Accelerometer) is used to collect roller vibration data for further stiffness estimation
In-Cab Control Box provides visual understanding of pass count and compaction using a color-map
*Image Courtesy of Trimble
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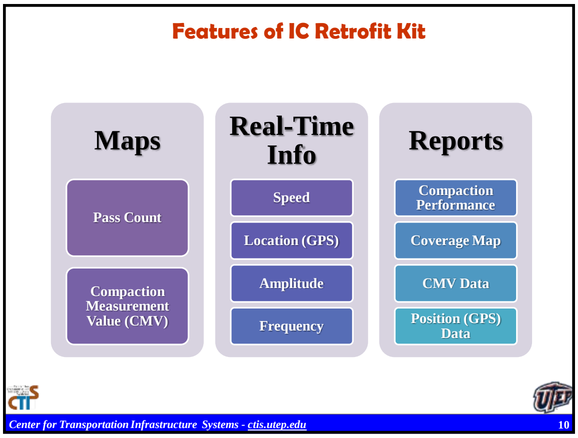
Features of IC Retrofit Kit
Maps
Pass Count
Compaction Measurement Value (CMV)
Real-Time Info
Speed
Location (GPS)
Amplitude
Frequency
Reports
Compaction Performance
Coverage Map
CMV Data
Position (GPS) Data
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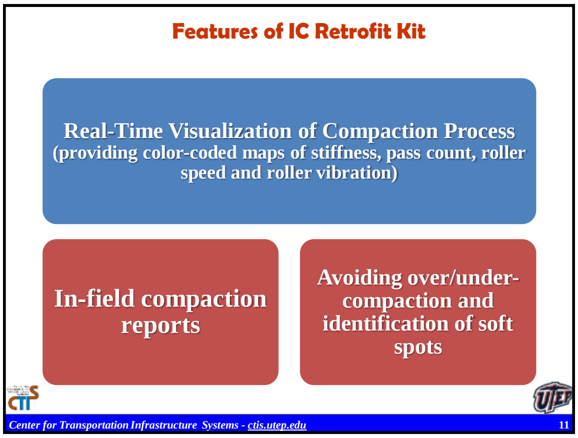
Features of IC Retrofit Kit
Real-Time Visualization of Compaction Process
(providing color-coded maps of stiffness, pass count, roller speed and roller vibration)
In-field compaction reports
Avoiding over/under-compaction and identification of soft spots
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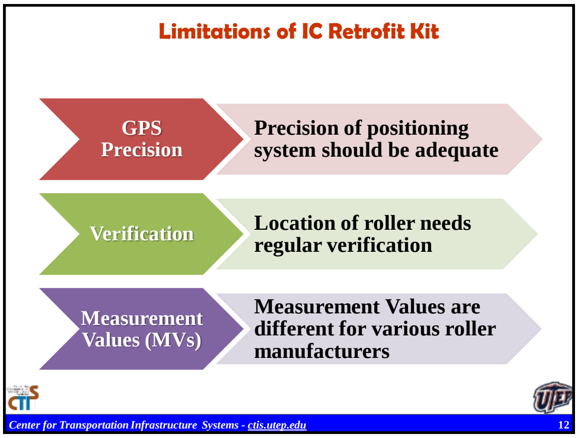
Limitations of IC Retrofit Kit
GPS Precision
Precision of positioning system should be adequate
Verification
Location of roller needs regular verification
Measurement Values (MVs)
Measurement Values are different for various roller manufacturers
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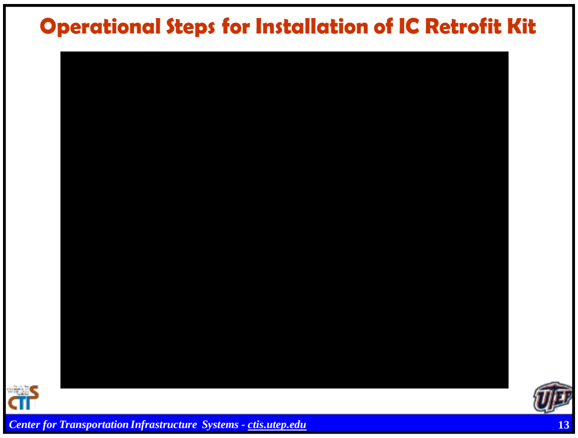
Operational Steps for Installation of IC Retrofit Kit
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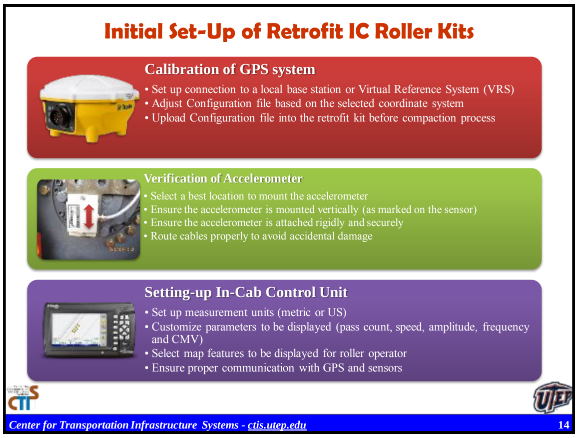
Initial Set-Up of Retrofit IC Roller Kits
Calibration of GPS system
• Set up connection to a local base station or Virtual Reference System (VRS)
• Adjust Configuration file based on the selected coordinate system
• Upload Configuration file into the retrofit kit before compaction process
Verification of Accelerometer
• Select a best location to mount the accelerometer
• Ensure the accelerometer is mounted vertically (as marked on the sensor)
• Ensure the accelerometer is attached rigidly and securely
• Route cables properly to avoid accidental damage
Setting-up In-Cab Control Unit
• Set up measurement units (metric or US)
• Customize parameters to be displayed (pass count, speed, amplitude, frequency and CMV)
• Select map features to be displayed for roller operator
• Ensure proper communication with GPS and sensors
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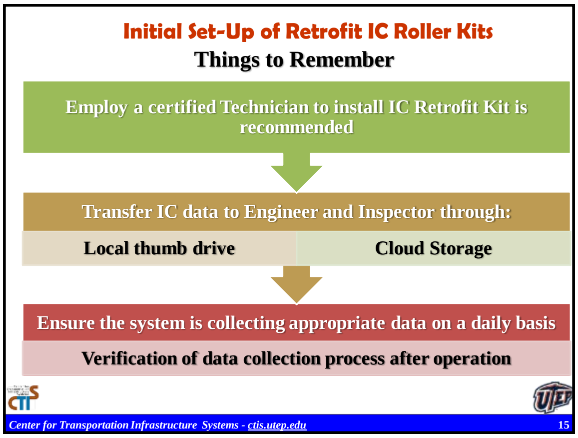
Initial Set-Up of Retrofit IC Roller Kits
Things to Remember
Employ a certified Technician to install IC Retrofit Kit is recommended
Transfer IC data to Engineer and Inspector through:
Local thumb drive
Cloud Storage
Ensure the system is collecting appropriate data on a daily basis
Verification of data collection process after operation
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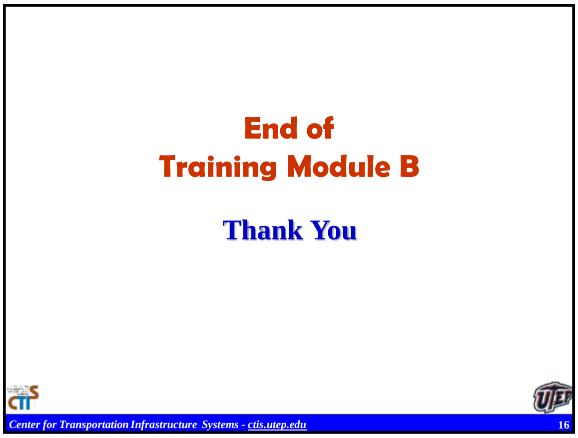
End of
Training Module B
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Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas
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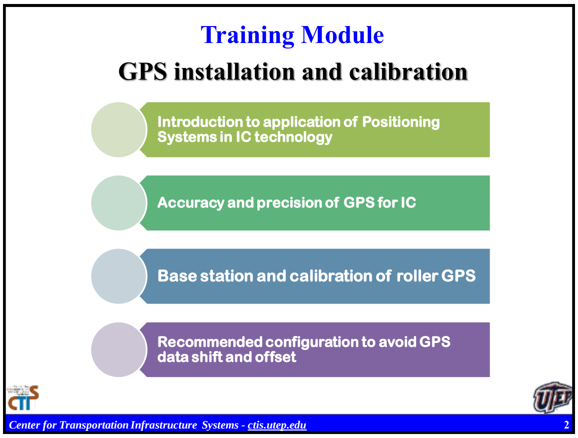
Training Module
GPS installation and calibration
Introduction to application of Positioning Systems in IC technology
Accuracy and precision of GPS for IC
Base station and calibration of roller GPS
Recommended configuration to avoid GPS data shift and offset
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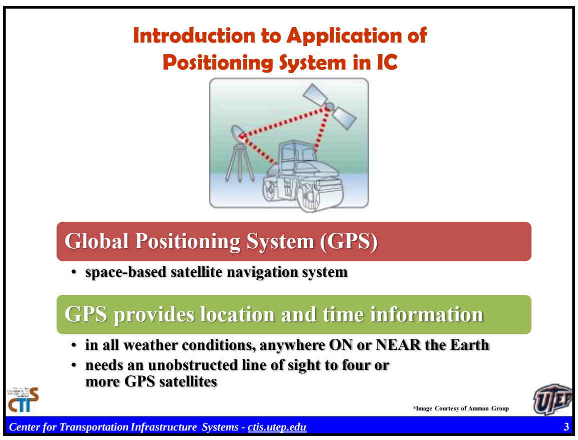
Introduction to Application of Positioning System in IC
Global Positioning System (GPS)
• space-based satellite navigation system
GPS provides location and time information
• in all weather conditions, anywhere ON or NEAR the Earth
• needs an unobstructed line of sight to four or more GPS satellites
*Image Courtesy of Ammann Group
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Application of GPS in IC

- Recording geographical location of roller
- Vibration data is tied with location through GPS
- Compaction values at different locations within job site

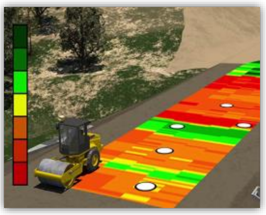

*Image Courtesy of Iowa State University

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Application of GPS in IC

- Provision of spatial distribution of stiffness
- Identification of soft areas (poorly compacted)
- Real-time compaction coverage map
- Availability of data for further Geostastistical analysis

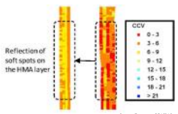

*Image Courtesy of SAKAI

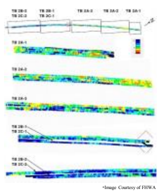

*Image Courtesy of FHWA

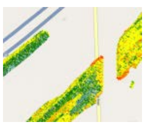

*Image Courtesy of VEDA

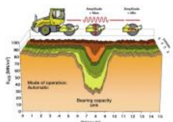

*Image Courtesy of BOMAG

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Accuracy and precision of GPS for IC

Accuracy	• Reporting IC data at 1 ft interval
Precision	• Sub-meter
GNSS	• Global Navigation Satellite System

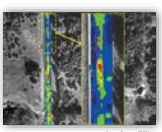

*Image Courtesy FHWA

*Image Courtesy of BOMAG

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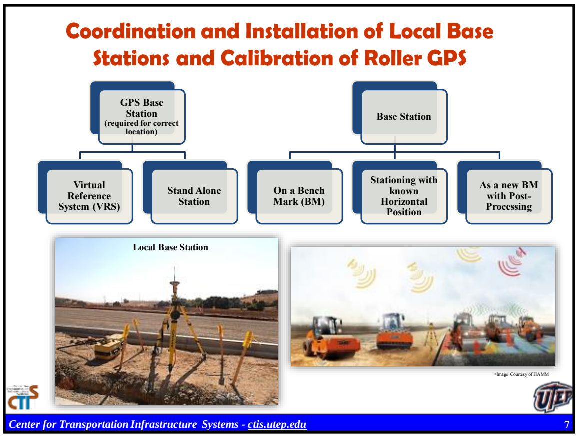
Coordination and Installation of Local Base Stations and Calibration of Roller GPS
GPS Base Station (required for correct location)
Base Station
Virtual Reference System (VRS)
Stand Alone Station
On a Bench Mark (BM)
Stationing with known Horizontal Position
As a new BM with Post-Processing
Local Base Station
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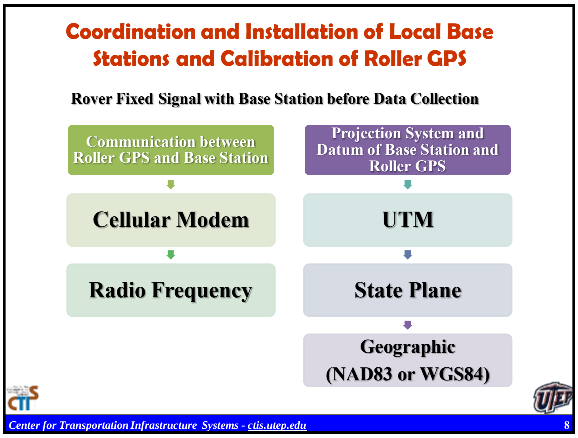
Coordination and Installation of Local Base Stations and Calibration of Roller GPS
Rover Fixed Signal with Base Station before Data Collection
Communication between Roller GPS and Base Station
Cellular Modem
Radio Frequency
Projection System and Datum of Base Station and Roller GPS
UTM
State Plane
Geographic (NAD83 or WGS84)
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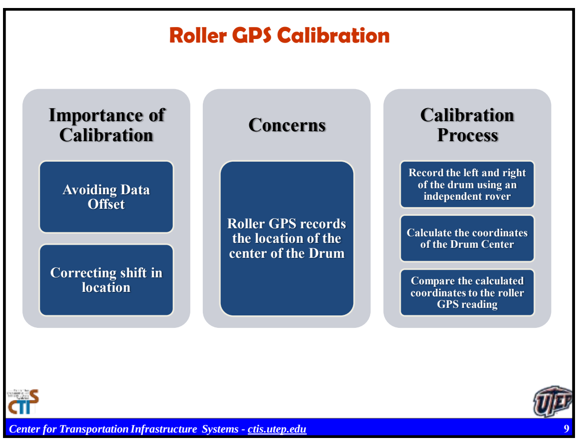
Roller GPS Calibration
Importance of Calibration
Avoiding Data Offset
Correcting shift in location
Concerns
Roller GPS records the location of the center of the Drum
Calibration Process
Record the left and right of the drum using an independent rover
Calculate the coordinates of the Drum Center
Compare the calculated coordinates to the roller GPS reading
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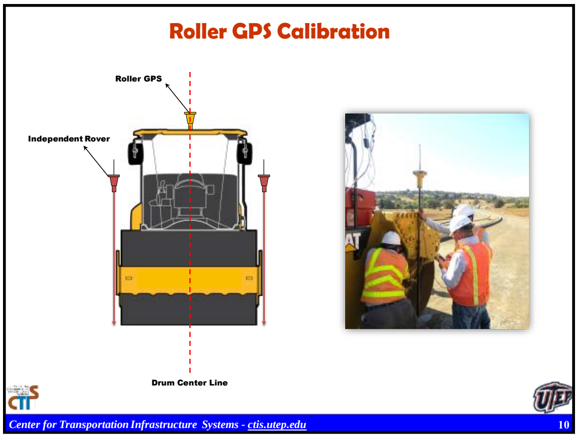
Roller GPS Calibration
Roller GPS
Independent Rover
Drum Center Line
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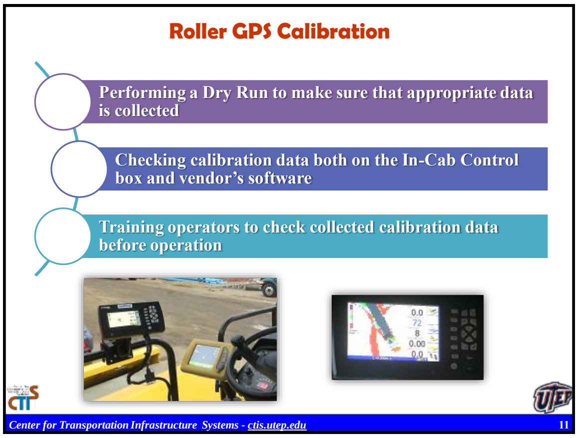
Roller GPS Calibration
Performing a Dry Run to make sure that appropriate data is collected
Checking calibration data both on the In-Cab Control box and vendor's software
Training operators to check collected calibration data before operation
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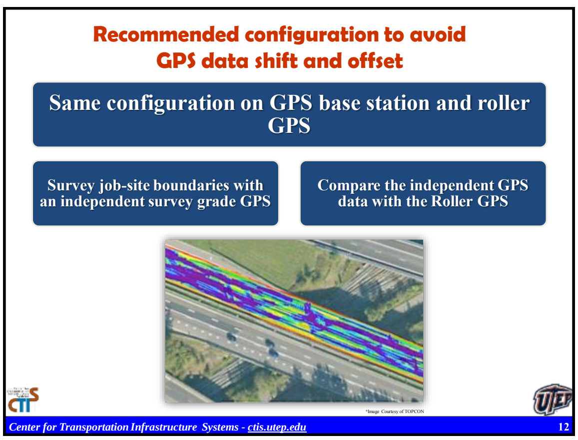
Recommended configuration to avoid GPS data shift and offset
Same configuration on GPS base station and roller GPS
Survey job-site boundaries with an independent survey grade GPS
Compare the independent GPS data with the Roller GPS
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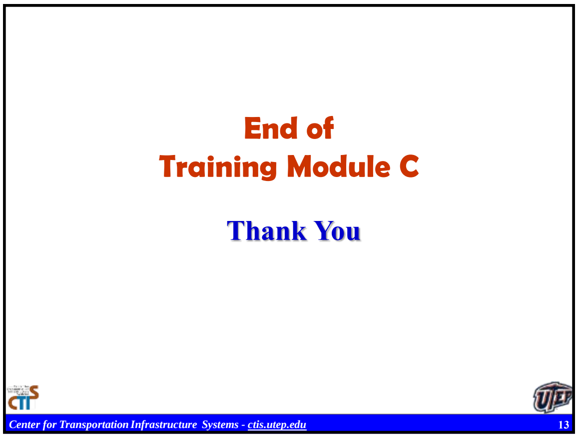
End of
Training Module C
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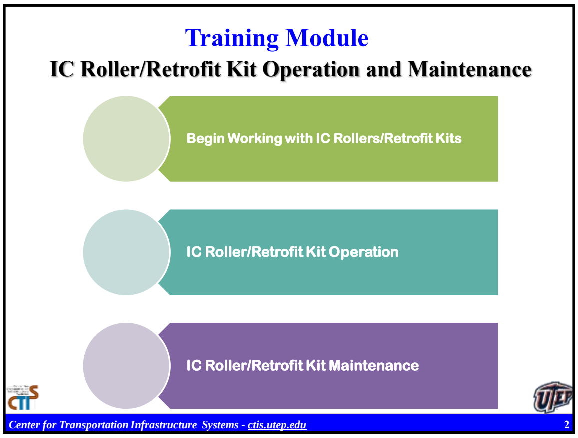
Training Module
IC Roller/Retrofit Kit Operation and Maintenance
Begin Working with IC Rollers/Retrofit Kits
IC Roller/Retrofit Kit Operation
IC Roller/Retrofit Kit Maintenance
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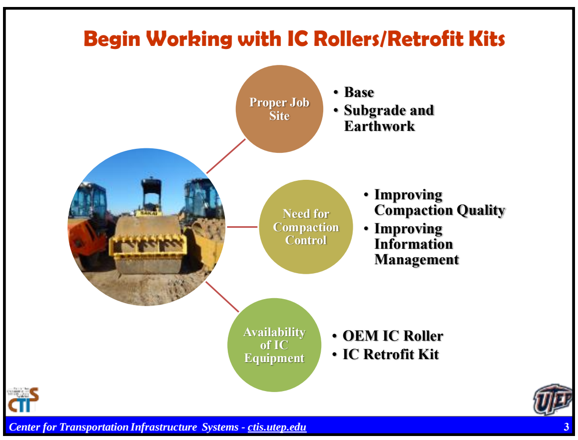
Begin Working with IC Rollers/Retrofit Kits
Proper Job Site
• Base
• Subgrade and Earthwork
Need for Compaction Control
• Improving Compaction Quality
• Improving Information Management
Availability of IC Equipment
• OEM IC Roller
• IC Retrofit Kit
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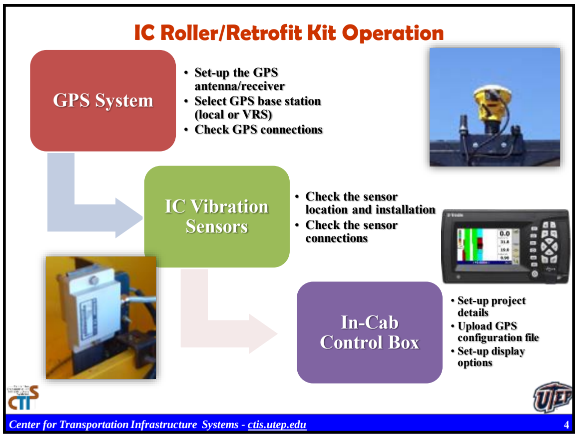
IC Roller/Retrofit Kit Operation
GPS System
• Set-up the GPS antenna/receiver
• Select GPS base station (local or VRS)
• Check GPS connections
IC Vibration Sensors
• Check the sensor location and installation
• Check the sensor connections
In-Cab Control Box
• Set-up project details
• Upload GPS configuration file
• Set-up display options
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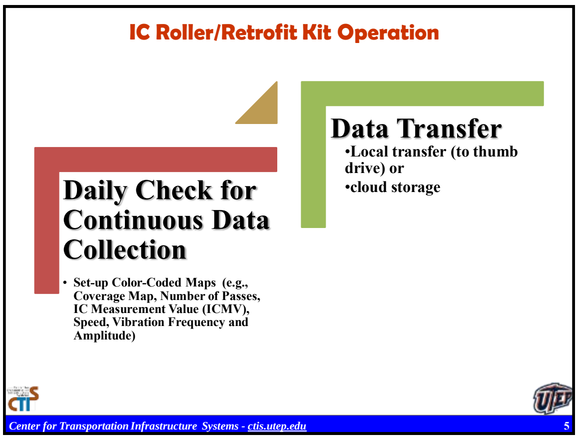
IC Roller/Retrofit Kit Operation
Data Transfer
•Local transfer (to thumb drive) or
•cloud storage
Daily Check for Continuous Data Collection
• Set-up Color-Coded Maps (e.g., Coverage Map, Number of Passes, IC Measurement Value (ICMV), Speed, Vibration Frequency and Amplitude)
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In-Cab Control Box Set-Up, Machine Settings
Trimble
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In-Cab Control Box Set-Up, Machine Settings
Trimble
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In-Cab Control Box Set-Up, Machine Settings
Trimble
Machine Settings
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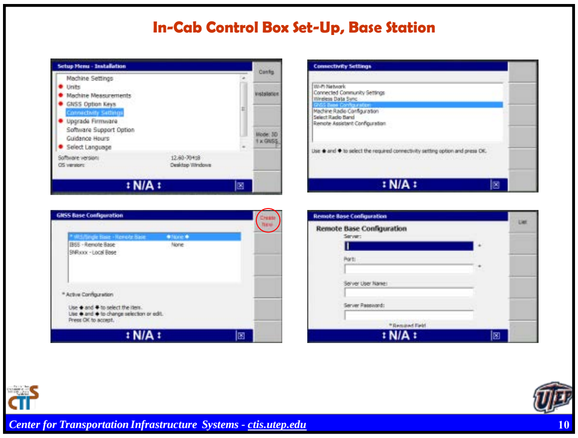
8


In-Cab Control Box Set-Up, Units
Trimble
Units
Speed
mph
Cross Slope
Station Format
1000.00
UTC Offset
N/A
Center for Transportation Infrastructure Systems - ctis.utep.edu
9


In-Cab Control Box Set-Up, Base Station
Setup Menu - Installation
Connectivity Settings
GNSS Base Configuration
Remote Base Configuration
N/A
Center for Transportation Infrastructure Systems - ctis.utep.edu
10


In-Cab Control Box Set-Up, GNSS Accuracy
Trimble
GNSS
GNSS accuracy mode:
Medium
GNSS error limit:
+/- 0.050 m
N/A
Center for Transportation Infrastructure Systems - ctis.utep.edu
11

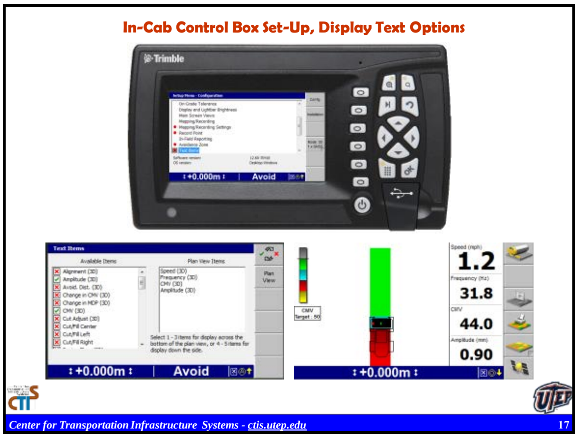

In-Cab Control Box Set-Up, Design Settings
Trimble
Select Design File
Setup Menu - Configuration
+0.000m
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
12


In-Cab Control Box Set-Up, Main Screen Views
Trimble
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
13

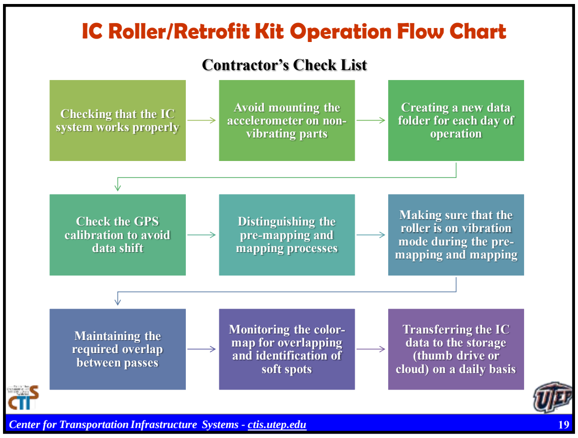

In-Cab Control Box Set-Up, Target Values
Trimble
Mapping/Recording
Required Passes
Target lift thickness
Target CMV
Status: Mapping
+0.000m
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
14

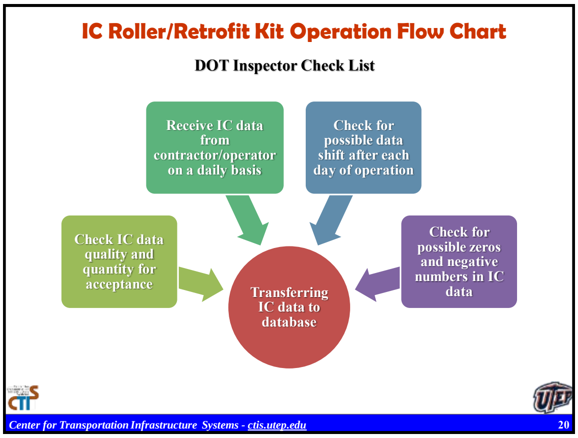

In-Cab Control Box Set-Up, Map Settings
Trimble
Mapping/Recording Settings
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
15

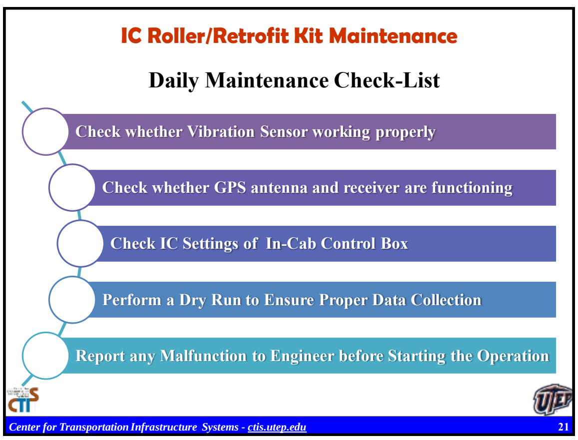

In-Cab Control Box Set-Up, In-Field Reporting
Trimble
+0.000m
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
16


In-Cab Control Box Set-Up, Display Text Options
Trimble
Avoid
1.2
31.8
44.0
0.90
+0.000m
Center for Transportation Infrastructure Systems - ctis.utep.edu
17

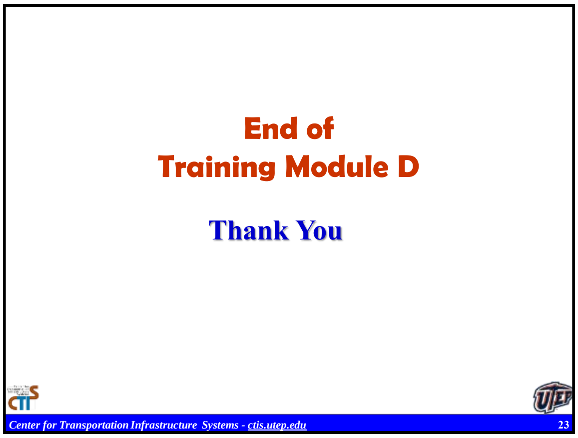

In-Cab Control Box Set-Up, Save Settings
Trimble
Save Settings
Save
Display Settings
Machine Settings
Saves the display settings only.
+0.000m
No Avoid
Center for Transportation Infrastructure Systems - ctis.utep.edu
18


IC Roller/Retrofit Kit Operation Flow Chart
Contractor's Check List
Checking that the IC system works properly
Avoid mounting the accelerometer on non-vibrating parts
Creating a new data folder for each day of operation
Check the GPS calibration to avoid data shift
Distinguishing the pre-mapping and mapping processes
Making sure that the roller is on vibration mode during the pre-mapping and mapping
Maintaining the required overlap between passes
Monitoring the color-map for overlapping and identification of soft spots
Transferring the IC data to the storage (thumb drive or cloud) on a daily basis
Center for Transportation Infrastructure Systems - ctis.utep.edu
19


IC Roller/Retrofit Kit Operation Flow Chart
DOT Inspector Check List
Receive IC data from contractor/operator on a daily basis
Check for possible data shift after each day of operation
Check IC data quality and quantity for acceptance
Transferring IC data to database
Check for possible zeros and negative numbers in IC data
Center for Transportation Infrastructure Systems - ctis.utep.edu
20


IC Roller/Retrofit Kit Maintenance
Daily Maintenance Check-List
Check whether Vibration Sensor working properly
Check whether GPS antenna and receiver are functioning
Check IC Settings of In-Cab Control Box
Perform a Dry Run to Ensure Proper Data Collection
Report any Malfunction to Engineer before Starting the Operation
Center for Transportation Infrastructure Systems - ctis.utep.edu
21


IC Roller/Retrofit Kit Maintenance
Trimble
Diagnostics
+0.000m
Center for Transportation Infrastructure Systems - ctis.utep.edu
22


End of
Training Module D
Thank You
Center for Transportation Infrastructure Systems - ctis.utep.edu
23

Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

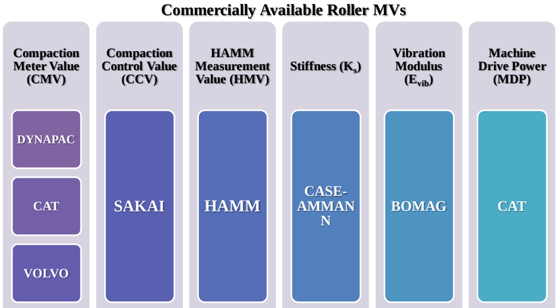
Training Module E

IC Data Analysis and Report

- Evaluating and interpreting different Measurement Values (MVs)
- Correlation between different Measurement Values
- Correlation analyses between MV and in-situ spot test data
- Geostatistical and geospatial applications in IC technology
- Introduction to IC data analysis, interpretation and reporting tools
- Using color-coded map to monitor compaction
- IC data formats and deployment options
- Quality Control (QC) with IC technology

Evaluating and interpreting different Measurement Values (MVs)

Commercially Available Roller MVs



Evaluating and interpreting different Measurement Values (MVs)

Parameters Affecting MV

Frequency → Amplitude → Speed → MV

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Evaluating and interpreting different Measurement Values (MVs)

Concept of Compaction Amplitude and Frequency

*Image courtesy of VOLVO

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Evaluating and interpreting different Measurement Values (MVs)

*Courtesy of VOLVO

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Evaluating and interpreting different Measurement Values (MVs)

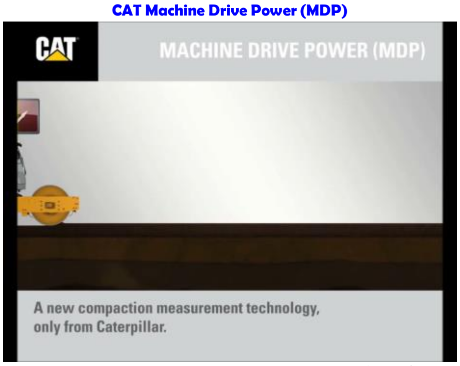
Machine Drive Power

*Courtesy of CAT

Center for Transportation Infrastructure Systems - ctis.utep.edu 7

Evaluating and interpreting different Measurement Values (MVs)

CAT Machine Drive Power (MDP)



*Courtesy of CAT

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Evaluating and interpreting different Measurement Values (MVs)

Interpretation of MDP

$$MDP = P_g - WV\left(Sin\,\theta + \frac{A'}{g}\right) - (\mathrm{mV+b})$$

P_g = Gross power needed to move the machine (kJ/s)

W = Roller Weight (kN)

A' = Machine Acceleration (m/s^2)

ɵ = Slope angle (roller pitch)

V = Roller Velocity (m/s)

m (kJ/m) and b (kJ/s) = Machine internal loss coefficients

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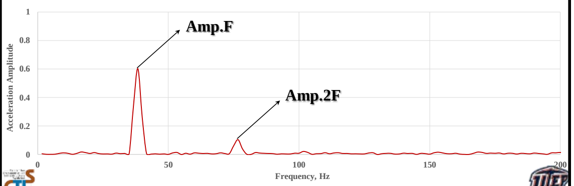
Evaluating and interpreting different Measurement Values (MVs)

Interpretation of CMV

$$CMV = 300 \times \frac{2F}{F}$$

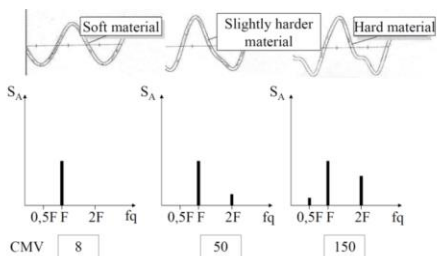
2F = Acceleration of the first harmonic of the vibration

F = Acceleration of the fundamental component of the vibration



Evaluating and interpreting different Measurement Values (MVs)

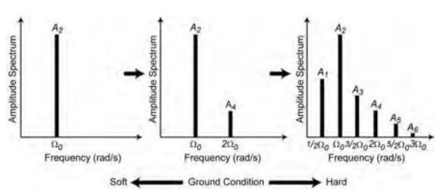
Interpretation of CMV



*Courtesy of DYNAPAC

Evaluating and interpreting different Measurement Values (MVs)

Interpretation of SAKAI CCV



$$CCV = 100 \times \left[\frac{A_1 + A_3 + A_4 + A_5 + A_6}{A_1 + A_2}\right]$$

Correlation analyses between MV and in-situ spot test data

Density/Moisture-Based Spot Tests

Nuclear Density Gauge (NDG)

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Geostatistical and geospatial applications in the IC technology

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Geostatistical and geospatial applications in IC technology

Geostatistics

- statistical techniques to analyze and predict spatially distributed values

Geostatistical Analyses

- tools for spatially distributed data
- identification of trends in spatial data
- evaluation of errors in spatial data modelling
- statistical analyses of spatial data
- Visualization of spatial data

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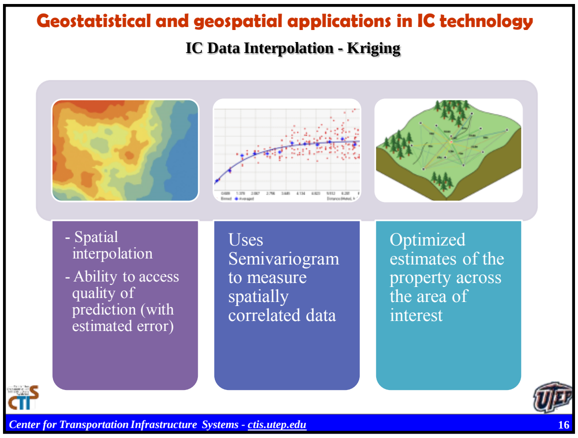
Geostatistical and geospatial applications in IC technology
IC Data Interpolation - Kriging
- Spatial interpolation
- Ability to access quality of prediction (with estimated error)
Uses Semivariogram to measure spatially correlated data
Optimized estimates of the property across the area of interest
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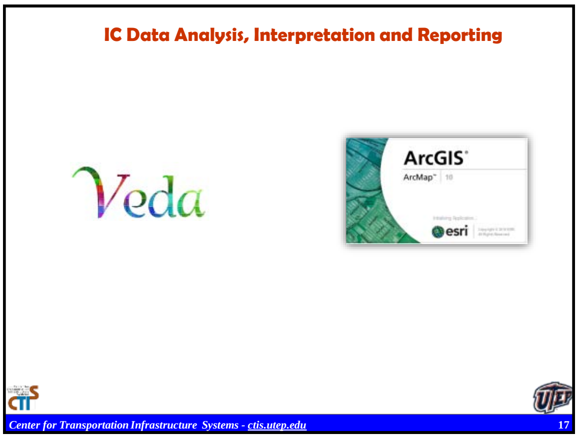
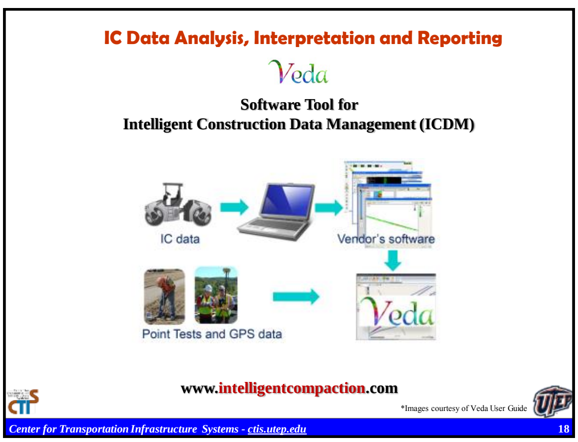
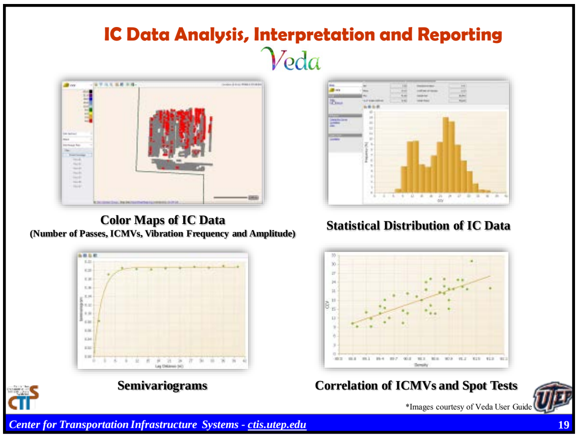
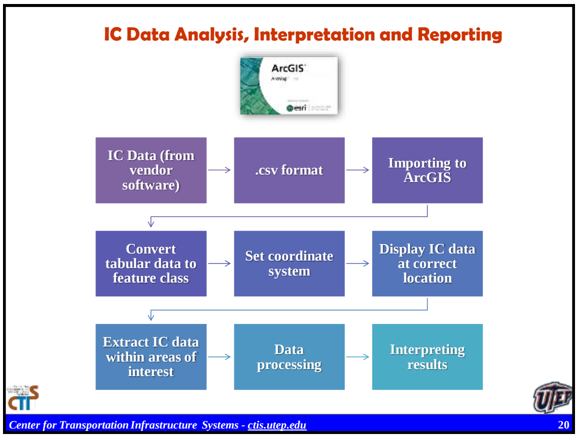
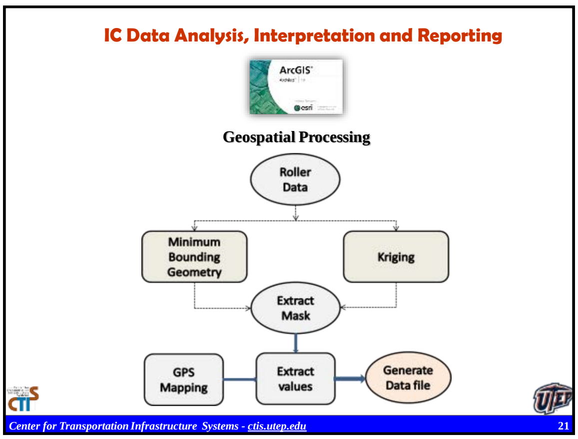
16

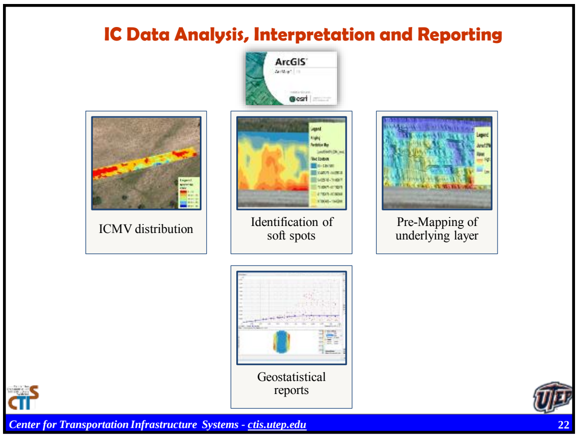

IC Data Analysis, Interpretation and Reporting
Veda
ArcGIS
ArcMap
esri
Center for Transportation Infrastructure Systems - ctis.utep.edu
17

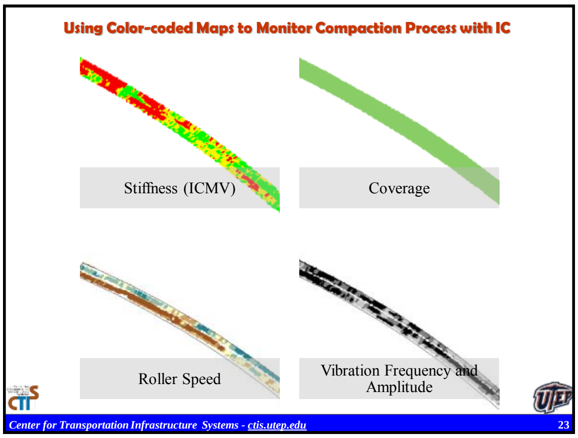

IC Data Analysis, Interpretation and Reporting
Veda
Software Tool for
Intelligent Construction Data Management (ICDM)
IC data
Vendor's software
Point Tests and GPS data
Veda
www.intelligentcompaction.com
*Images courtesy of Veda User Guide
Center for Transportation Infrastructure Systems - ctis.utep.edu
18

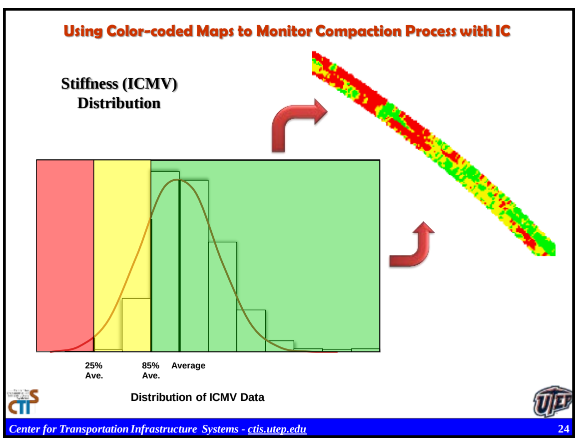

IC Data Analysis, Interpretation and Reporting
Veda
Color Maps of IC Data
(Number of Passes, ICMVs, Vibration Frequency and Amplitude)
Statistical Distribution of IC Data
Semivariograms
Correlation of ICMVs and Spot Tests
*Images courtesy of Veda User Guide
Center for Transportation Infrastructure Systems - ctis.utep.edu
19

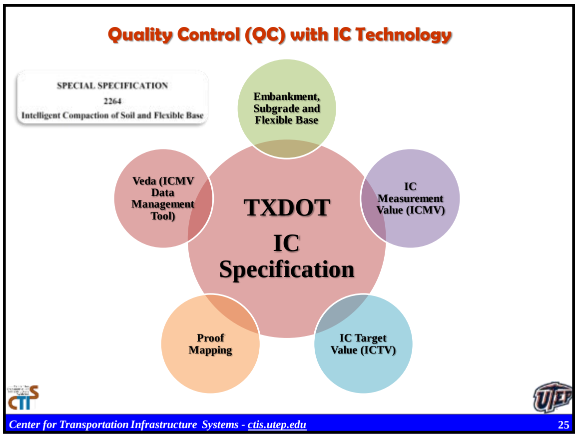

IC Data Analysis, Interpretation and Reporting
ArcGIS
IC Data (from vendor software)
.csv format
Importing to ArcGIS
Convert tabular data to feature class
Set coordinate system
Display IC data at correct location
Extract IC data within areas of interest
Data processing
Interpreting results
Center for Transportation Infrastructure Systems - ctis.utep.edu
20

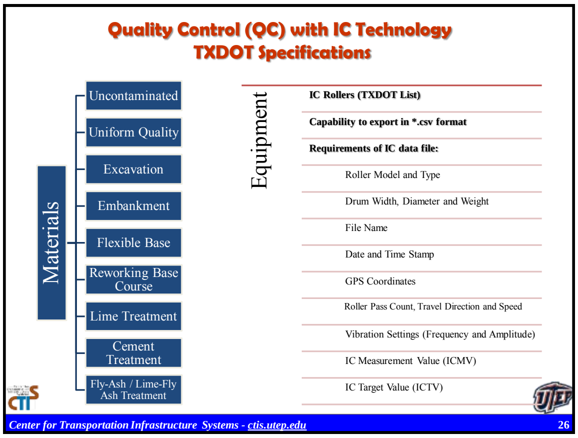

IC Data Analysis, Interpretation and Reporting
ArcGIS
Geospatial Processing
Roller Data
Minimum Bounding Geometry
Kriging
Extract Mask
GPS Mapping
Extract values
Generate Data file
Center for Transportation Infrastructure Systems - ctis.utep.edu
21


IC Data Analysis, Interpretation and Reporting
ArcGIS
ICMV distribution
Identification of soft spots
Pre-Mapping of underlying layer
Geostatistical reports
Center for Transportation Infrastructure Systems - ctis.utep.edu
22

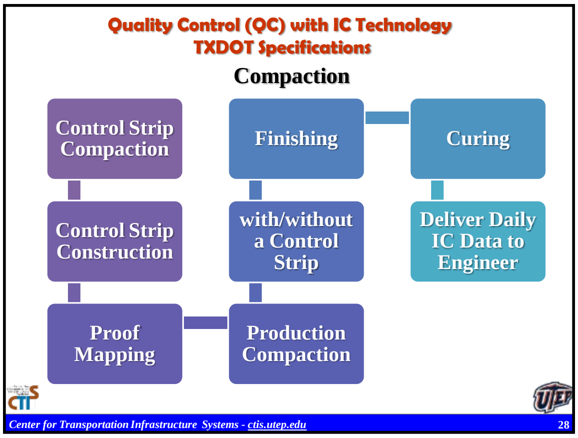

Using Color-coded Maps to Monitor Compaction Process with IC
Stiffness (ICMV)
Coverage
Roller Speed
Vibration Frequency and Amplitude
Center for Transportation Infrastructure Systems - ctis.utep.edu
23

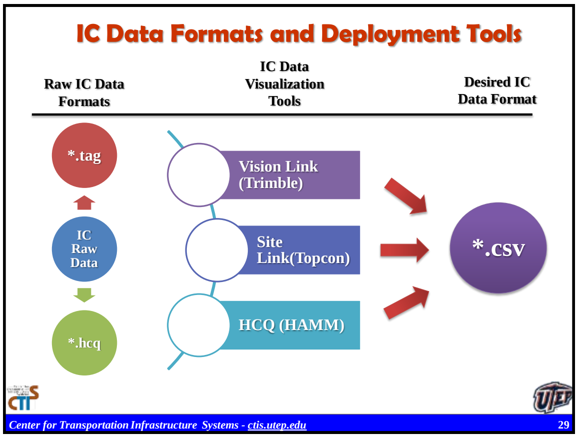

Using Color-coded Maps to Monitor Compaction Process with IC
Stiffness (ICMV) Distribution
25% Ave.
85% Ave.
Average
Distribution of ICMV Data
Center for Transportation Infrastructure Systems - ctis.utep.edu
24


Quality Control (QC) with IC Technology
SPECIAL SPECIFICATION
2264
Intelligent Compaction of Soil and Flexible Base
Embankment, Subgrade and Flexible Base
Veda (ICMV Data Management Tool)
TXDOT IC Specification
IC Measurement Value (ICMV)
Proof Mapping
IC Target Value (ICTV)
Center for Transportation Infrastructure Systems - ctis.utep.edu
25


Quality Control (QC) with IC Technology
TXDOT Specifications
Materials
Uncontaminated
Uniform Quality
Excavation
Embankment
Flexible Base
Reworking Base Course
Lime Treatment
Cement Treatment
Fly-Ash / Lime-Fly Ash Treatment
Equipment
IC Rollers (TXDOT List)
Capability to export in *.csv format
Requirements of IC data file:
Roller Model and Type
Drum Width, Diameter and Weight
File Name
Date and Time Stamp
GPS Coordinates
Roller Pass Count, Travel Direction and Speed
Vibration Settings (Frequency and Amplitude)
IC Measurement Value (ICMV)
IC Target Value (ICTV)
Center for Transportation Infrastructure Systems - ctis.utep.edu
26


Quality Control (QC) with IC Technology
TXDOT Specifications
Construction
Preparation of Subgrade or existing Base
Placing
Pulverization
Application of Additives
Mixing
Compaction
Center for Transportation Infrastructure Systems - ctis.utep.edu
27


Quality Control (QC) with IC Technology
TXDOT Specifications
Compaction
Control Strip Compaction
Finishing
Curing
Control Strip Construction
with/without a Control Strip
Deliver Daily IC Data to Engineer
Proof Mapping
Production Compaction
Center for Transportation Infrastructure Systems - ctis.utep.edu
28


IC Data Formats and Deployment Tools
Raw IC Data Formats
IC Data Visualization Tools
Desired IC Data Format
*.tag
IC Raw Data
*.hcq
Vision Link (Trimble)
Site Link(Topcon)
HCQ (HAMM)
*.csv
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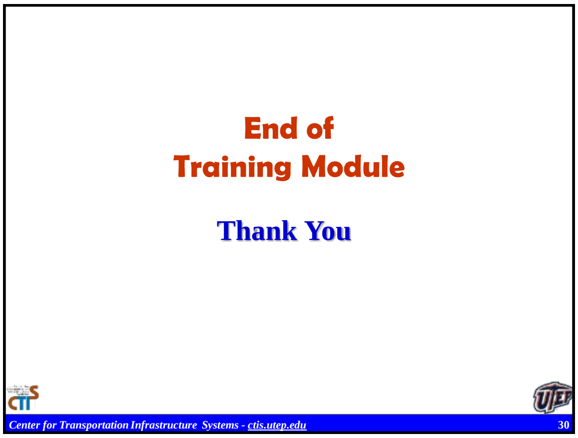
29


End of Training Module
Thank You
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30

Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas



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Training Module

IC Operator Certification Program

- Planning and preparing for IC operation
- Pre- and post-operational check list
- Start-up and shut down process
- GPS calibration and operation process
- Roller settings and data collection process
- Operator maintenance check list
- List of frequently asked questions (FAQ)

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Planning and Preparing for IC Operation

- Identification of job site
- Investigating the possibility of using Intelligent Compaction
- Availability of local GPS base stations
- Availability of IC rollers (OEM or Retrofitted)

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Pre-Operation Inspections

Pre-Run Checklist

- Check GPS Connections
- Check IC Box Connections
- Turn on the IC Box
- Input Project Details
- Input Layer Type
- Input GPS Coordinate System (UTM, state plane)
- Select Vibration Parameters

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Post-Operation Inspections

Check and Review Collected Data after Mapping

- Check CMV Color Map on Screen
- Check that speed, frequency and amplitude are reasonably uniform

Report any Errors or Missing Data to Engineer

- GPS Error (disconnected from base station, loss of satellite signal)
- Decoupling Error (stiff spots, high amplitude, high speed)

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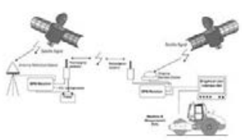
Field Operation Process

Turn on IC Kit and check if it is working → Enter Project Details → Perform Proof Mapping of the Compacted Area → Check Data Quality → Transfer Data to Inspector/ Engineer

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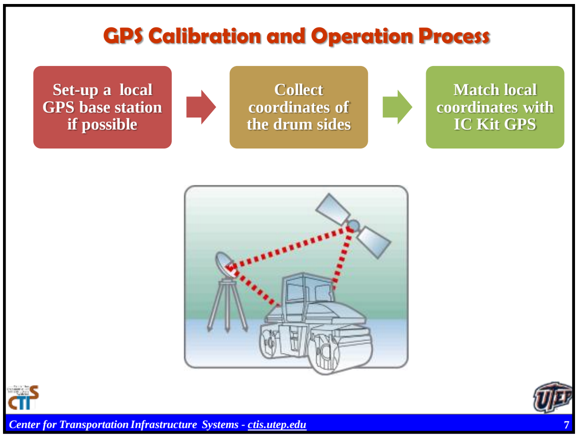
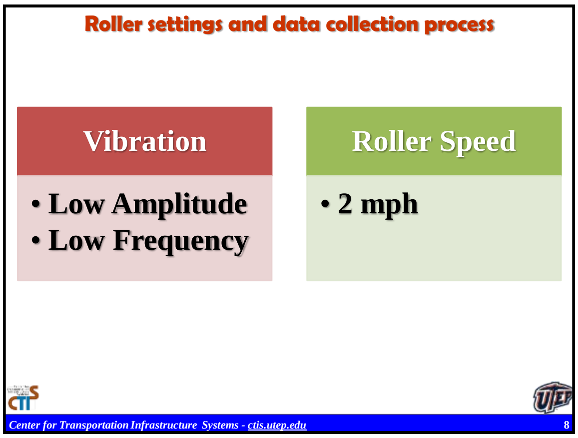
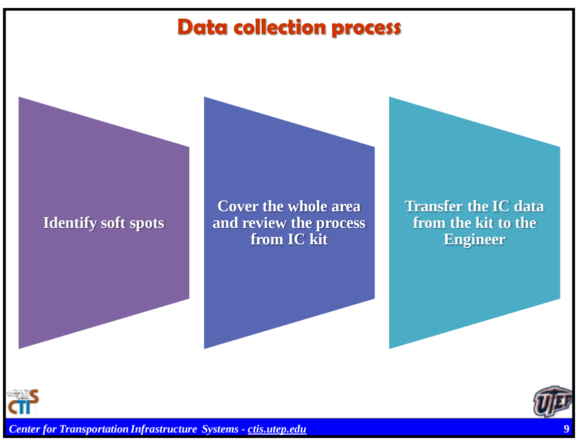

GPS Calibration and Operation Process
Set-up a local GPS base station if possible
Collect coordinates of the drum sides
Match local coordinates with IC Kit GPS
Center for Transportation Infrastructure Systems - ctis.utep.edu
7


Roller settings and data collection process
Vibration
• Low Amplitude
• Low Frequency
Roller Speed
• 2 mph
Center for Transportation Infrastructure Systems - ctis.utep.edu
8


Data collection process
Identify soft spots
Cover the whole area and review the process from IC kit
Transfer the IC data from the kit to the Engineer
Center for Transportation Infrastructure Systems - ctis.utep.edu
9

Operator maintenance check list

GPS Unit
- GPS antenna
- GPS receiver
- GPS connection

IC Display Unit
- Display unit connections
- Display unit settings

IC Sensors
- Position of accelerometer(s)
- Sensor connections

List of frequently asked questions (FAQ)

End of Training Module

Thank You

Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

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Training Module

Managing IC Data with VisionLink

- Introduction to VisionLink
- Options for Managing IC Data
- Exporting IC Data Files

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Introduction to VisionLink

Trimble® VisionLink is an online tool to view, manage, visualize and export the construction site data (including IC data).

To access VisionLink:

- Go to www.myvisionlink.com
- Enter your username and password and click "Login".

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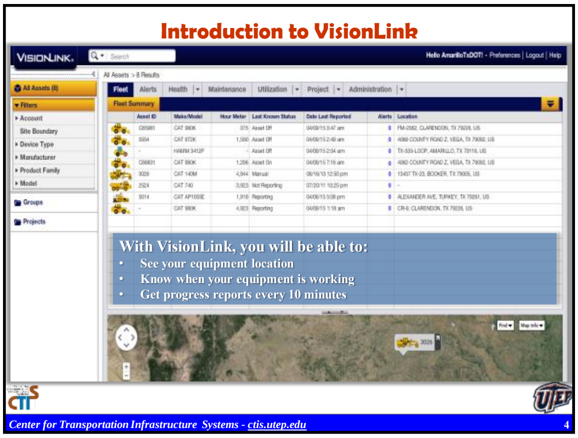
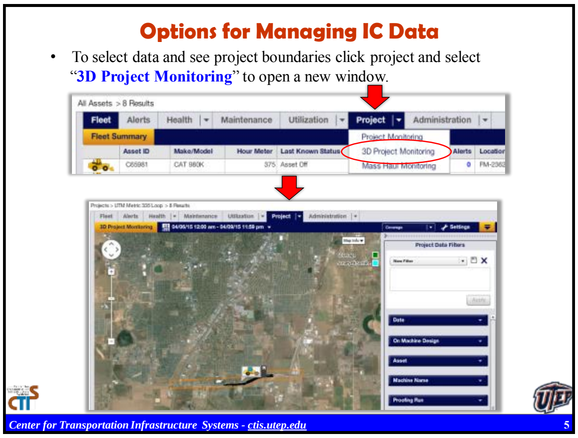
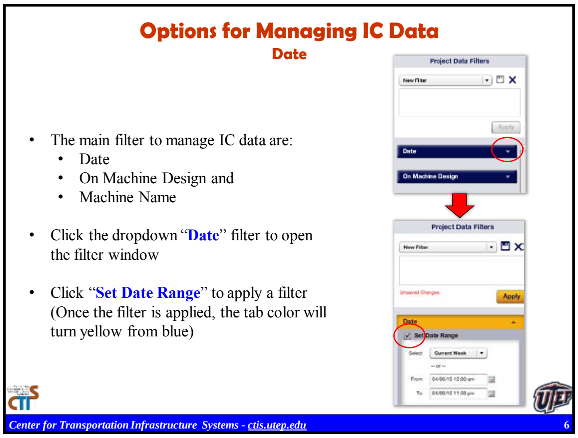

Introduction to VisionLink
VisionLink
All Assets > 8 Results
Fleet
Alerts
Health
Maintenance
Utilization
Project
Administration
Fleet Summary
With VisionLink, you will be able to:
• See your equipment location
• Know when your equipment is working
• Get progress reports every 10 minutes
Center for Transportation Infrastructure Systems - ctis.utep.edu
4

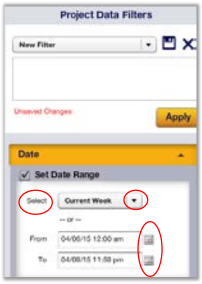

Options for Managing IC Data
• To select data and see project boundaries click project and select "3D Project Monitoring" to open a new window.
All Assets > 8 Results
Fleet
Alerts
Health
Maintenance
Utilization
Project
Administration
Fleet Summary
Project Monitoring
3D Project Monitoring
Mass Haul Monitoring
Center for Transportation Infrastructure Systems - ctis.utep.edu
5


Options for Managing IC Data
Date
• The main filter to manage IC data are:
• Date
• On Machine Design and
• Machine Name
• Click the dropdown "Date" filter to open the filter window
• Click "Set Date Range" to apply a filter (Once the filter is applied, the tab color will turn yellow from blue)
Project Data Filters
New Filter
Apply
Date
On Machine Design
Set Date Range
Current Week
Center for Transportation Infrastructure Systems - ctis.utep.edu
6

Options for Managing IC Data
Date

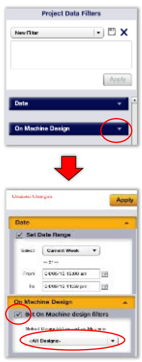
Select the desired date from the menu. There are two options to select the date:

1. **Select Day**: Click the "**Current Week**" dropdown menu to view different options (e.g., today, yesterday, current month, previous month, among others.
2. **Calendar**: Click on the **calendar icons** to select the desired dates.



Options for Managing IC Data
On Machine Design

- Click the "**On Machine Design**" dropdown filter to open the window.
- Select "**Set On Machine design filters**" to apply the filter. (Once the filter is on, the tab will turn yellow from blue)
- Click on "**All Designs**" to select an specific file (the selected file should be within the period of time of the Date filter selected previously).



Options for Managing IC Data
Machine Name

- Click the "**Machine Name**" dropdown menu to open the filter.
- Select "**Set Machine filters**" to apply the filter. (once the filter is selected, the tab will turn into yellow from blue)
- Select the desired machine name. When the machine is selected a green check mark will be displayed right next to it.
- Click "**Apply**" to apply the filters

Options for Managing IC Data
Project Data Filters

- Once you applied the filters, check whether you have any data within the project site boundary limits.
  - *Zoom-In for better identification of data*

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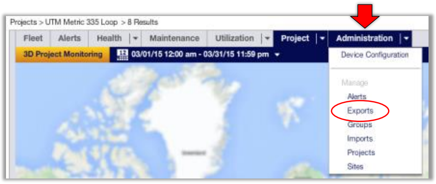
Exporting IC Data Files

- To export IC data,
  - Select "**Administration**" from the main menu, and
  - Click on "**Exports**"



A new window to "Manage Exports" will be displayed.

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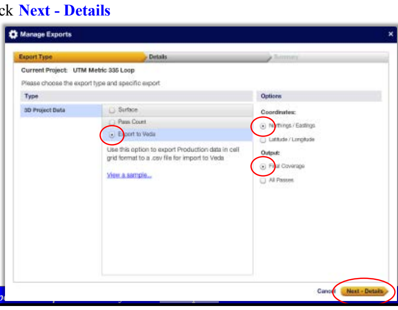
Exporting IC Data Files (cont.)

- Select "**Export to Veda**"
  - Make sure proper **Coordinate** setting (Northings/Eastings or Latitude/Longitude) is selected
  - Select **Output** data type (Final Coverage or All Passes)
- Click **Next - Details**



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Exporting IC Data Files (Cont.)

- Select same date that you used in Date Filter for "**Date Range**"
- Select default "**File Name**" or change file name as you see fit.
- Click **Next - Summary**

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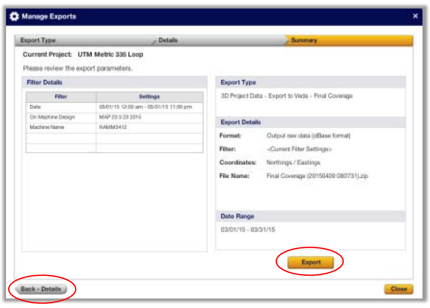
Exporting IC Data Files (cont.)

- Inspect the selected filters and settings in "**Summary**" screen
  - Click "**Back – Details,**" if the settings need to be modified
  - Click "**Export,**" if the filters and settings are correct



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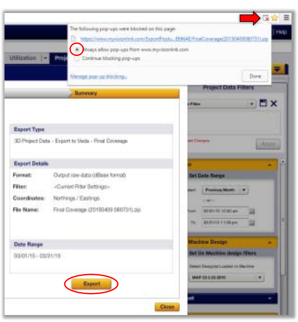
Exporting IC Data Files (cont.)

- Once you click "Export"
  - a new window will appear and
  - a ***.csv** file will be downloaded.
- If the download process does not start, you might have to unblock the **pop-ups** as shown here.



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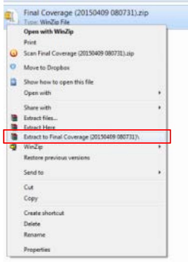
Exporting IC Data Files (cont.)

- The exported file will be in ***.zip** format
- The zip file could be found in **downloads** folder on your PC
- Extract the zip file to access the ***.csv** file



Overview of VisionLink
Instructional Video

End of Training Module

Thank You

Implementation of Intelligent Compaction Technology for Improving Compaction Quality of Soil and Base in Texas

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Training Module

IC Data Management with Veda

- Importing Data into Veda
- Customizing Color Maps
- User-Defined Sections
- IC Data Analysis
- Veda Instructional Video

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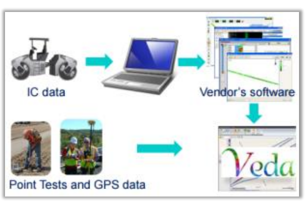
Introduction

Veda is a tool to import, manage, visualize, analysis and report Intelligent Compaction (IC) data.



Note: If Veda is not yet installed on your PC, download it from:
http://www.intelligentcompaction.com

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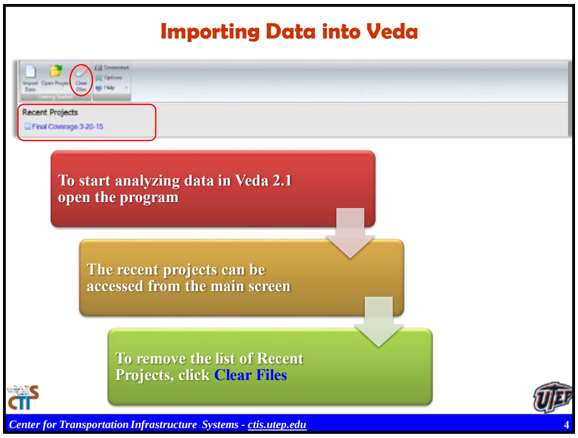
Importing Data into Veda
Recent Projects
To start analyzing data in Veda 2.1 open the program
The recent projects can be accessed from the main screen
To remove the list of Recent Projects, click Clear Files
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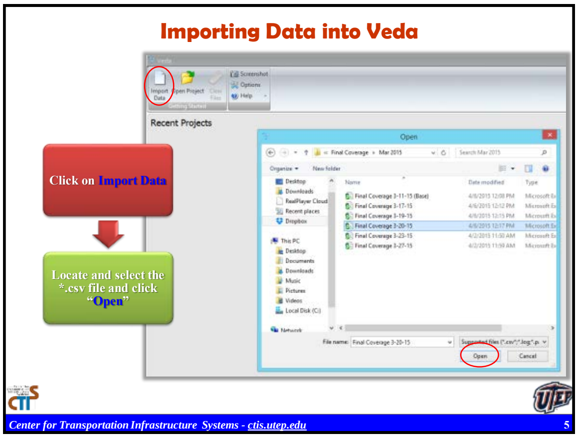
4


Importing Data into Veda
Recent Projects
Open
Click on Import Data
Locate and select the *.csv file and click "Open"
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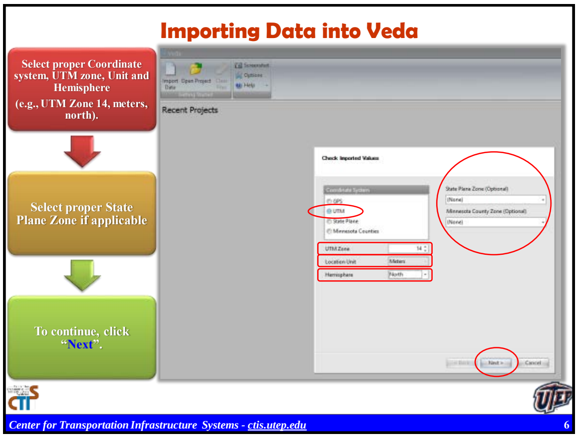
5


Importing Data into Veda
Select proper Coordinate system, UTM zone, Unit and Hemisphere
(e.g., UTM Zone 14, meters, north).
Select proper State Plane Zone if applicable
To continue, click "Next".
Recent Projects
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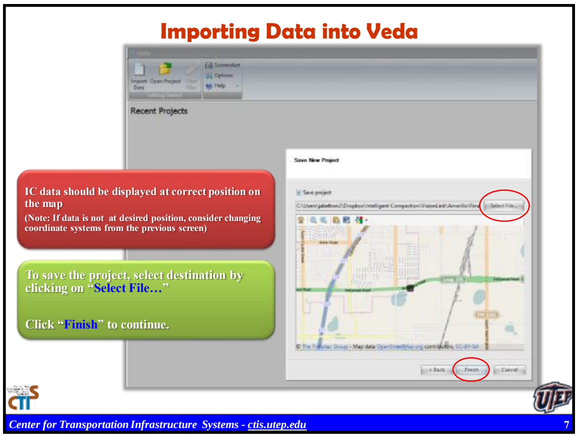
Importing Data into Veda
Recent Projects
Save New Project
IC data should be displayed at correct position on the map
(Note: If data is not at desired position, consider changing coordinate systems from the previous screen)
To save the project, select destination by clicking on "Select File…"
Click "Finish" to continue.
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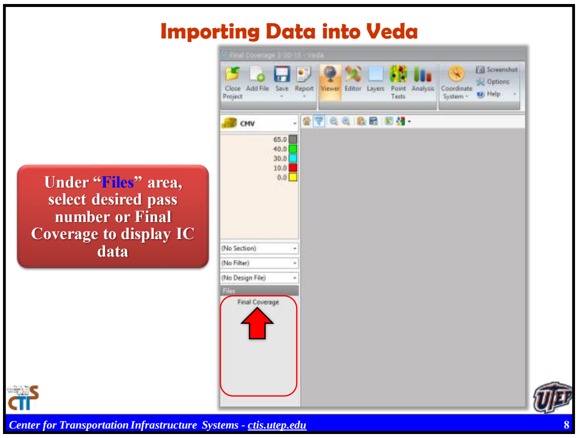
Importing Data into Veda
Under "Files" area, select desired pass number or Final Coverage to display IC data
Final Coverage
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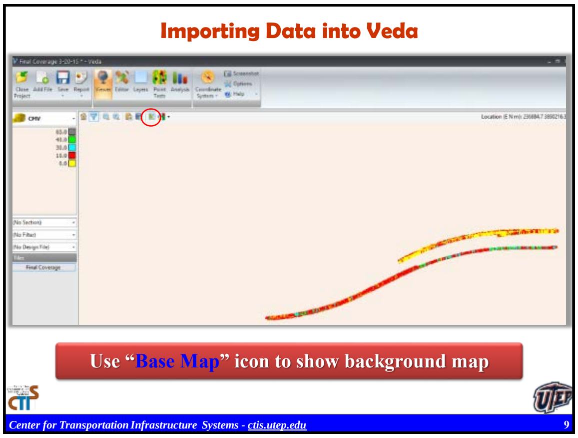
Importing Data into Veda
Use "Base Map" icon to show background map
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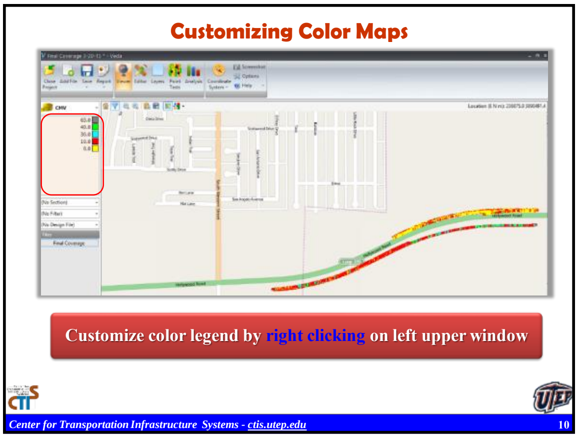
9


Customizing Color Maps
Customize color legend by right clicking on left upper window
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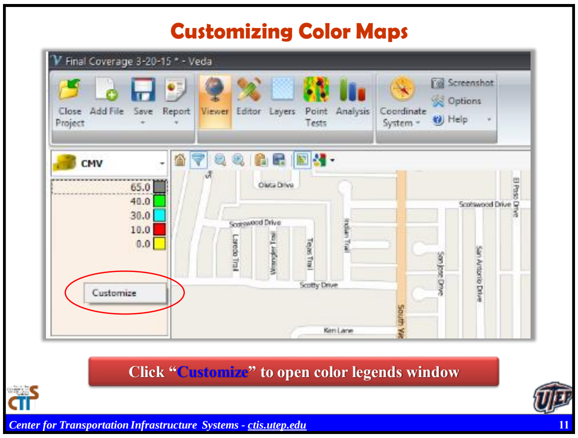
Customizing Color Maps
Final Coverage 3-20-15 * - Veda
Close Project
Add File
Save
Report
Viewer
Editor
Layers
Point Tests
Analysis
Coordinate System
Screenshot
Options
Help
CMV
65.0
40.0
30.0
10.0
0.0
Customize
Click "Customize" to open color legends window
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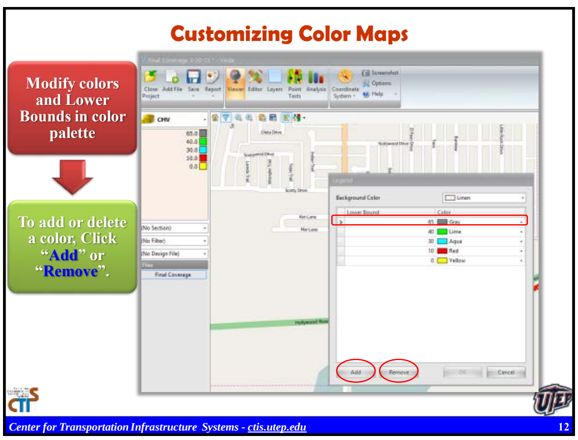
Customizing Color Maps
Modify colors and Lower Bounds in color palette
To add or delete a color, Click "Add" or "Remove".
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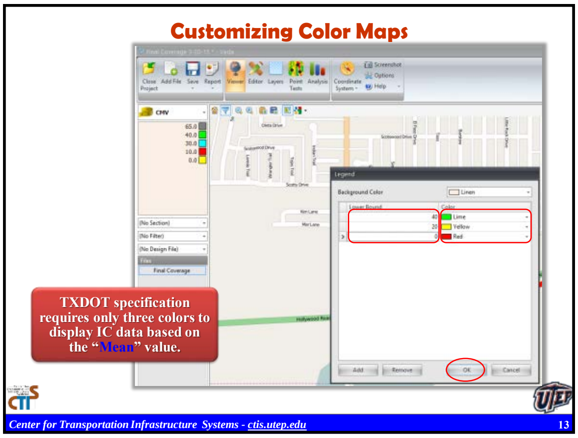
Customizing Color Maps
TXDOT specification requires only three colors to display IC data based on the "Mean" value.
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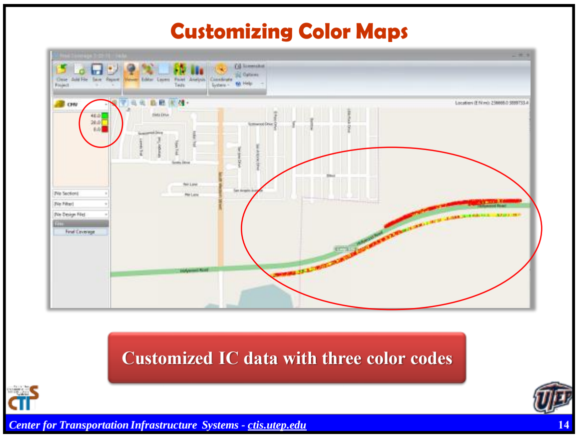
13


Customizing Color Maps
Customized IC data with three color codes
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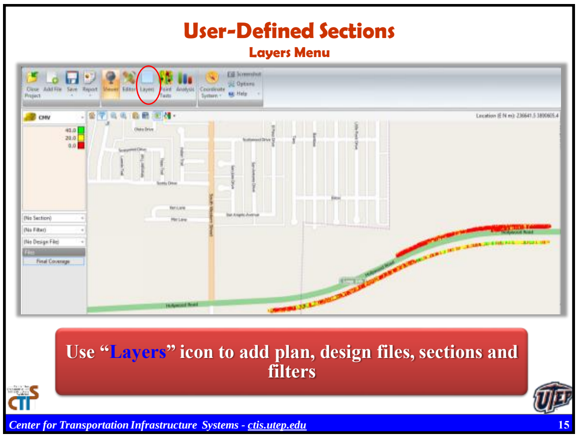
14


User-Defined Sections
Layers Menu
Use "Layers" icon to add plan, design files, sections and filters
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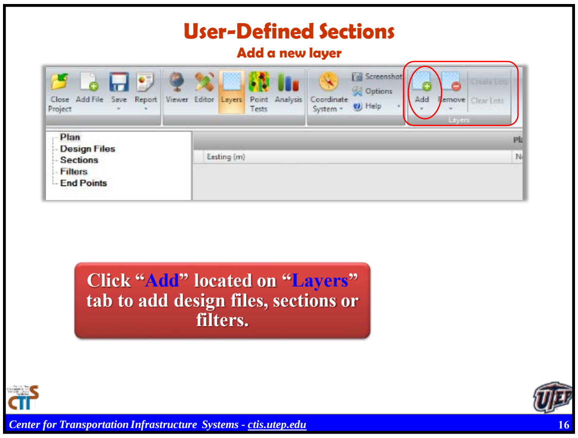
User-Defined Sections
Add a new layer
Plan
Design Files
Sections
Filters
End Points
Click "Add" located on "Layers" tab to add design files, sections or filters.
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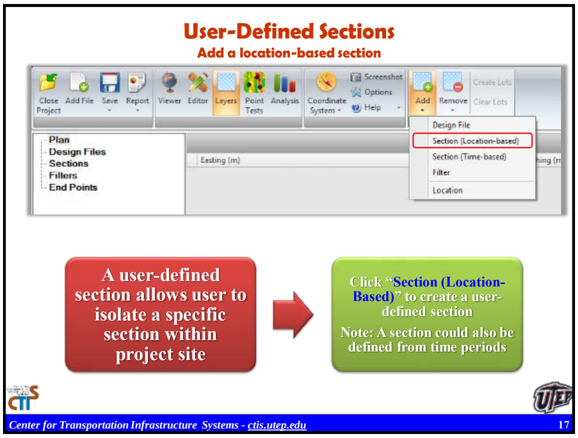
User-Defined Sections
Add a location-based section
Design File
Section (Location-based)
Section (Time-based)
Filter
Location
A user-defined section allows user to isolate a specific section within project site
Click "Section (Location-Based)" to create a user-defined section
Note: A section could also be defined from time periods
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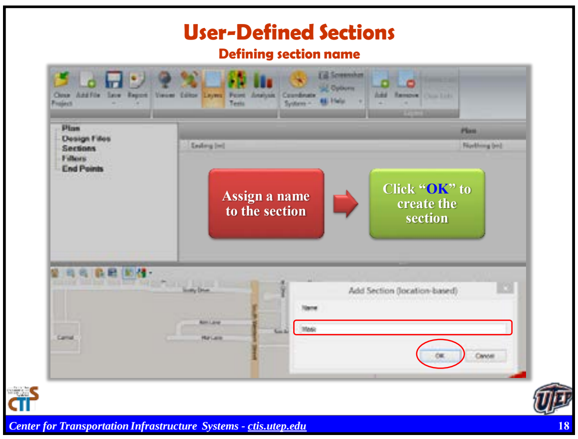
User-Defined Sections
Defining section name
Assign a name to the section
Click "OK" to create the section
Add Section (location-based)
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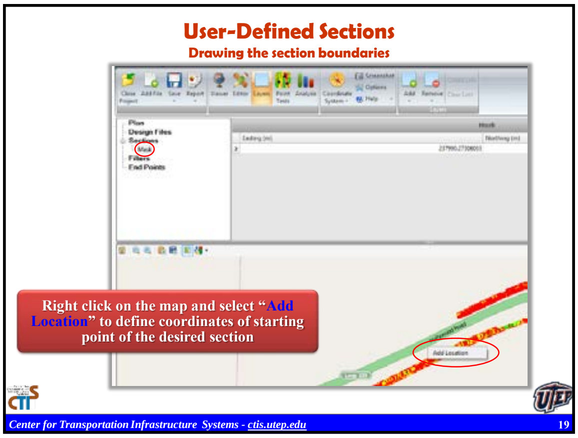
User-Defined Sections
Drawing the section boundaries
Right click on the map and select "Add Location" to define coordinates of starting point of the desired section
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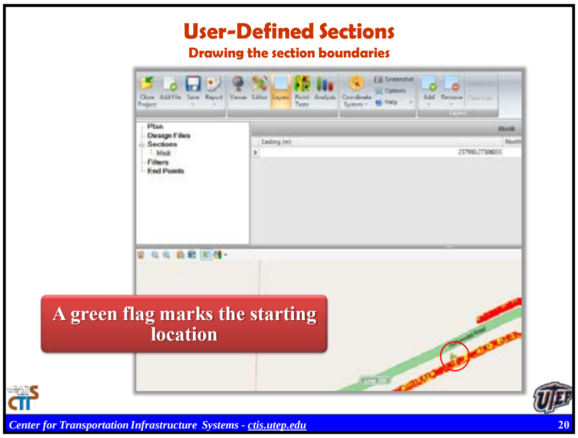
User-Defined Sections
Drawing the section boundaries
A green flag marks the starting location
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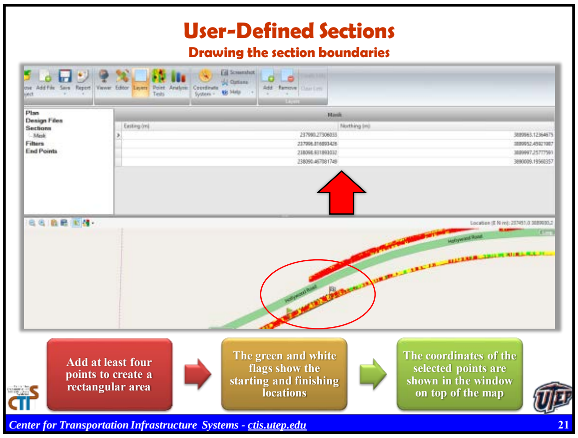
User-Defined Sections
Drawing the section boundaries
Add at least four points to create a rectangular area
The green and white flags show the starting and finishing locations
The coordinates of the selected points are shown in the window on top of the map
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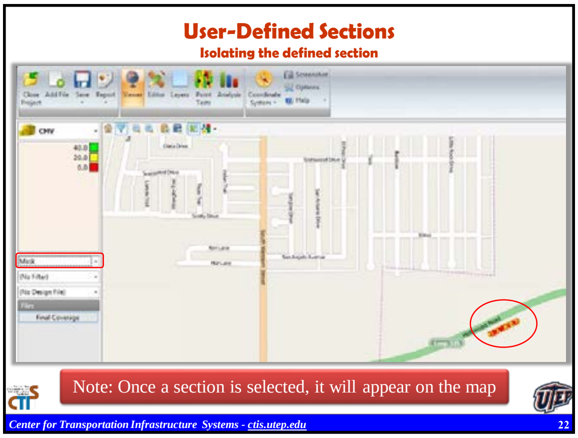
User-Defined Sections
Isolating the defined section
Note: Once a section is selected, it will appear on the map
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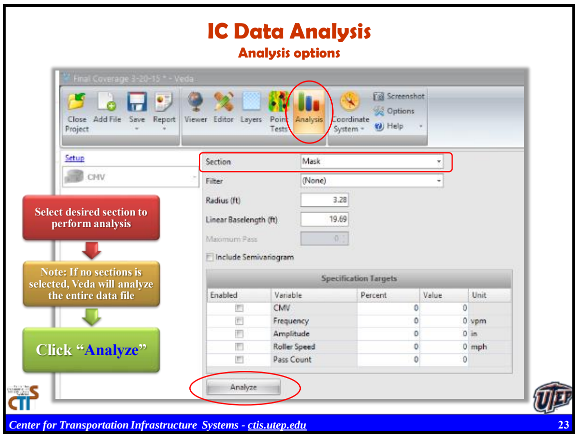
IC Data Analysis
Analysis options
Select desired section to perform analysis
Note: If no sections is selected, Veda will analyze the entire data file
Click "Analyze"
Section
Mask
Filter
(None)
Radius (ft)
3.28
Linear Baselength (ft)
19.69
Include Semivariogram
Specification Targets
Analyze
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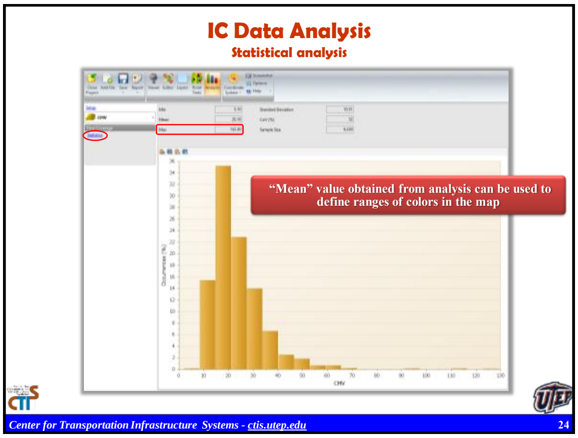
IC Data Analysis
Statistical analysis
"Mean" value obtained from analysis can be used to define ranges of colors in the map
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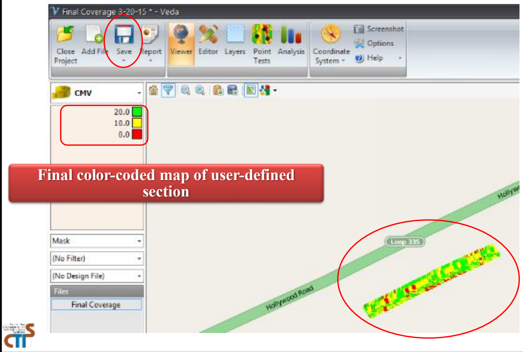
IC Data Analysis

Color-coding the defined section



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Veda Instructional Video

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End of Training Module

Thank You

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