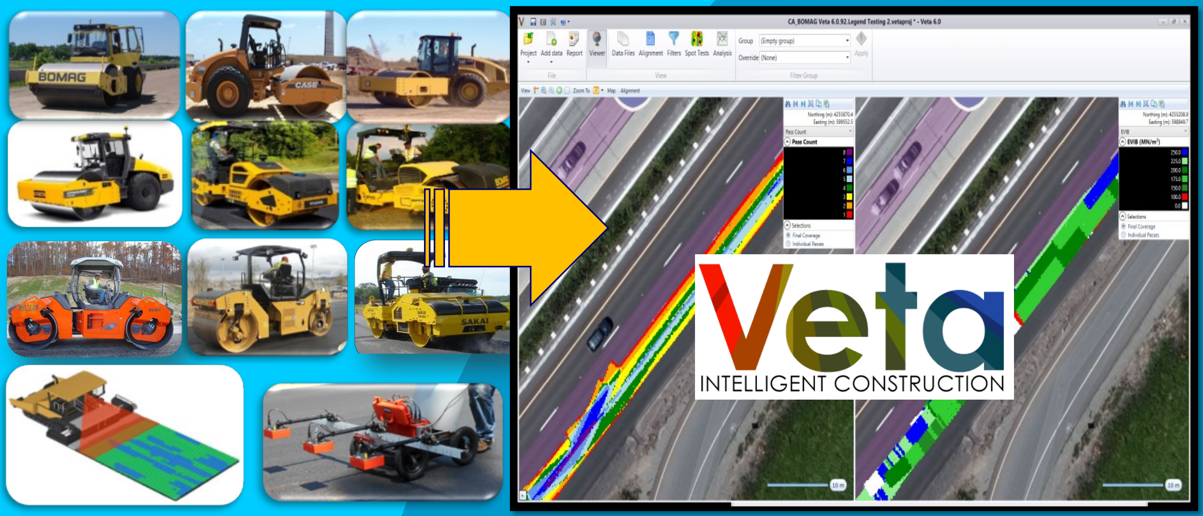
Intelligent Construction Data Management (ICDM) Guidelines

For use with Veta 8.0+

Many Systems ONE SOFTWARE



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Intelligent construction technologies (ICT) are a combination of modern science and innovative construction technologies. The ICT applications cover the life cycle of infrastructure, from the survey, design, construction, operation, and maintenance/rehabilitation by adapting to changes of environments and minimizing risks. The goals are to improve the quality of construction, cost-saving, and safety. ICT data are often massive and new to DOTs and industries. Thus, it requires practical guidelines and protocols to assist DOTs and industries in adequately managing the IC data to support decision-making, quality control (QC), and acceptance. Therefore, there is an immediate need to develop ICT Data Guidelines to fulfill these needs and on a local level, to assist with Minnesota's current IC implementation efforts. This document also includes intelligent compaction (IC), paver-mounted thermal profiles (PMTP), and Dielectric Profiling System (DPS). It will include other emerging ICT once their data are compatible with Veta.

This document provides guidelines for ICT data viewing, setting up Data Lot Names, data export/direct download, etc. to use Veta for ICT data management. This document is compatible with Veta 8.0+.</td></tr>
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

Intelligent Construction Data Management Guidelines

For Use with Veta 8.0+

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For

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Acknowledgment

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Introduction

This document provides a guideline for Intelligent Construction Data Management (ICDM) such as intelligent compaction (IC), paver-mounted thermal profiling (PMTP), Dielectric Profiling System (DPS). Specific steps for setting up data lot names, viewing data, and exporting from various ICT vendors to Veta-compatible formats are included.

This document aims to assist end users in exporting ICT data files from a vendor-specific program. Therefore, these exported files can be imported to Veta-compatible formats. Veta can import data from various ICT data to perform viewing, filtering, spot tests, analysis, and report. Veta displays ICT information in easy-to-read formats, including graphs and maps. Veta is required AASHTO standards: R 110, R 111, MP 39, PP 114. Veta is also increasingly adopted by US Department of Transportation. Veta has been sponsored by MNDOT and Transportation Pooled Fund Study TPF-5(334) "Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation" and TPF-5(466) "National Road Research Alliance – NRRA (Phase-II).

Further information regarding Veta is available at https://www.intelligentconstruction.com/veta/

Terminology

Terms

All passes data	Gridded IC data that contain measurements from all passes
Drum passes	Pass count based on drums
Final coverage data	Gridded IC data that contain the last pass measurements
Gridded data	Processed data after mesh refinement
Machine passes	Pass count based on machines
Pass Count	Number of roller passes for a given gridded data mesh
Raw data	Ungridded data

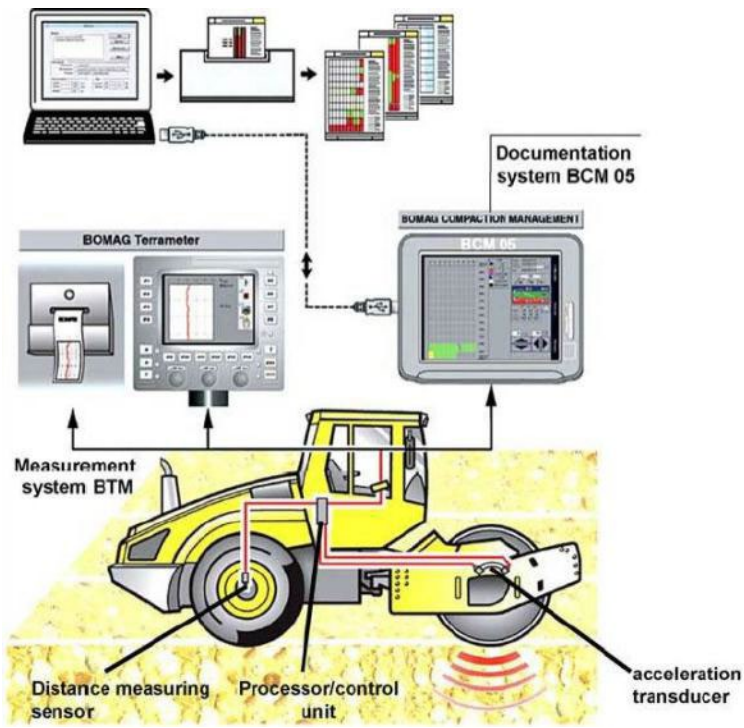
Acronym

BCM	BOMAG Compaction Manager software
CCV	Compaction Control Value from the Sakai IC system
CIS	Sakai Compaction Information System
CMV	Compaction Meter Value from the Caterpillar and Dynapac IC system
DCA	Dynapac Dynamic Compaction Analyzer software
EDV	Estimated density values from VOLVO
Evib	Vibration modulus from the BOMAG IC system
HCQ	HAMM Compaction Quality software
HMV	HAMM Measurement Value (similar to CMV).
ICMV	Generic term for Intelligent Compaction Measurement Value
MCI	MOBA compaction index
MDP	Machine Drive Power value from the Caterpillar IC system
PPM	MOBA Pave-IR pave project manager software
VL	Trimble VisionLink web solution

Intelligent Compaction (IC) Data

Systems

Intelligent Compaction refers to the compaction of road materials, such as soils, aggregate bases, or asphalt pavement materials, using modern vibratory rollers equipped with an in-situ measurement system and feedback control. Global Positioning System (GPS) based mapping is included as software that automates the documentation of the results. By integrating measurement, documentation, and control systems, the IC rollers allow for real-time monitoring and correction of the compaction process. IC rollers also maintain a continuous record of (nominally) color-coded plots that indicate the number of roller passes, roller-generated material stiffness measurements, and the precise location of the roller. The sampling frequency is generally between 5 to 10 Hz, i.e., once every second or 2 seconds. An example of such an IC roller system is illustrated in Figure 1.

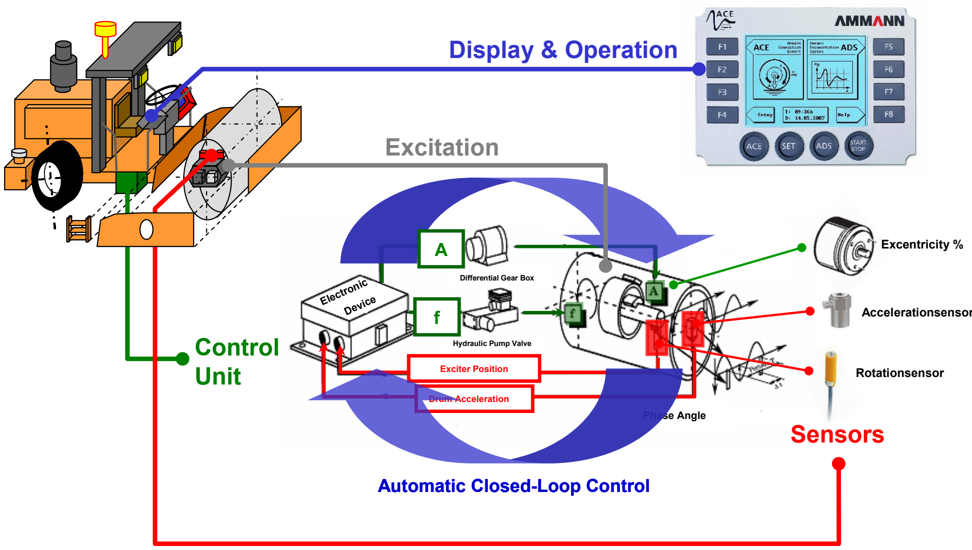


(Courtesy of BOMAG)

Figure 1. BOMAG VarioControl System

To understand IC data, it is essential to understand how IC rollers work first.

IC rollers utilize the framework of a vibratory roller to provide monitoring of IC measurements as a real-time "visual feedback" to roller operators. If outfitted with "auto-feedback systems", IC rollers would automatically adjust roller vibration amplitudes and/or frequencies to optimize compaction. An example of such IC auto-feedback systems is illustrated in Figure 2.



(Courtesy of Case/Ammann)

Figure 2. Case/Ammann auto-feedback system.

The precise location of the roller, speed, and number of passes over a given location are mapped using GPS. These systems are commonly used to establish grades and control other equipment pieces.

Compaction meters or accelerometers are mounted in or about the drum to monitor applied compaction effort, frequency, and response from the material being compacted. The readings from this instrumentation determine the effectiveness of the compaction process. The methodology to calculate the material response to compaction is often proprietary, resulting in various intelligent compaction measurement values (ICMV).

A calibration procedure often correlates the ICMV to a material modulus or density measured by other (in-situ) test devices. Compaction curves from ICMVs and in-situ test results can be established to indicate the target ICMV, and optimum roller passes (see an example in Figure 3).

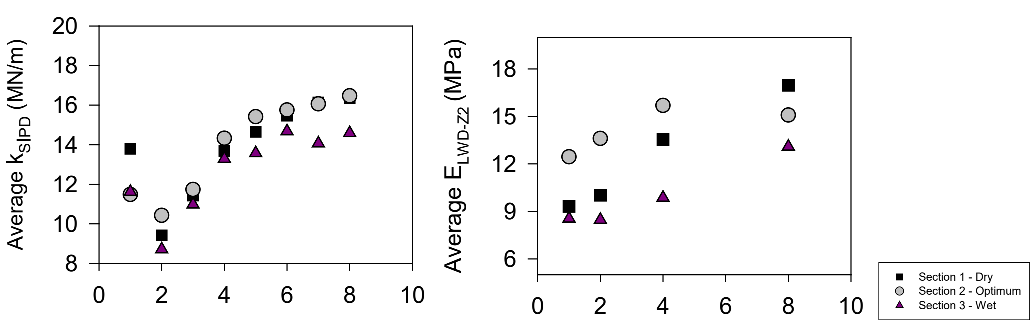


Figure 3. Calibration test – with compaction growth curves vs. pass count for Case/Ammann ICMV (k_{SIPD}) and in-situ point measurements (ICPF TXDOT demo).

For asphalt IC rollers, additional temperature instrumentation is used to monitor the surface temperature of the asphalt pavement material. This is critical as vibratory compaction within specific temperature ranges (such as too-cold-to-compact temperatures or tender zones for Superpave mixtures) can have adverse effects. An example of IC temperature instrumentation is illustrated in Figure 4 to measure asphalt surface temperatures using an infrared sensor.

Figure 4. Infrared temperature sensor on a Sakai IC roller.

Check on the IC website for the available IC rollers (https://www.intelligentconstruction.com/resources/equipment/)

High precision positioning data collection is the most critical element in IC implementation. To ensure accurate and consistent data collection, the following capabilities for the roller positioning systems are required:

- RTK-GPS (Real-Time Kinematic-GPS) systems or equivalent on IC rollers with either ground-based GPS base station or network type of reference system.
- Recommended positioning system reports and records values in Northing/Easting or longitude/latitude in UTM coordinates or state plane coordinates for the project site.
- If an offset is necessary between GPS antenna and the ICMV measuring drum(s), it must be input and validated.
- Hand-held rovers are required for both validation tests and point measurements at locations where in-situ tests are performed using conventional methods.

Figure 5. Base Station for Ground-based RTK GPS.

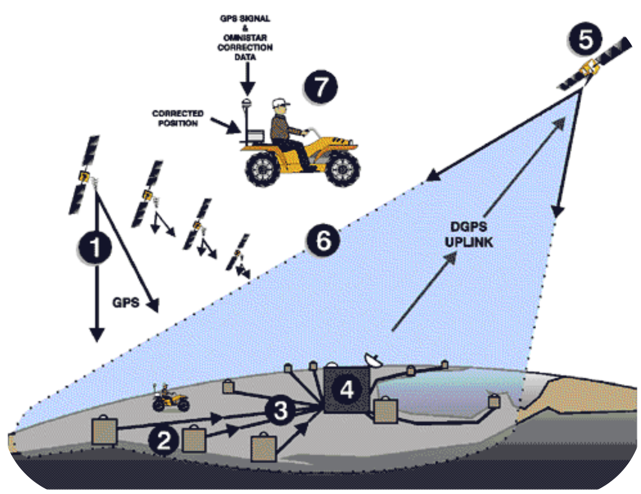


Figure 6. Network Type of RTK GPS.

Figure 7. RTK GPS receiver and antenna on a Sakai roller (ICPF MnDOT demo).

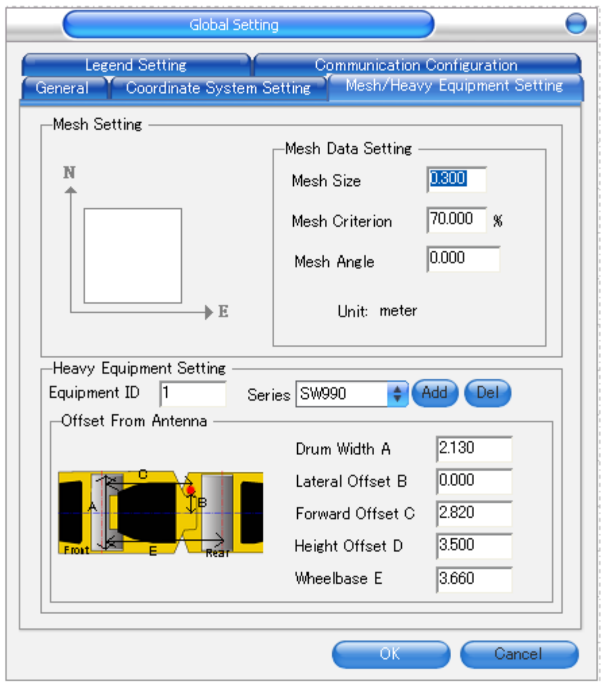


Figure 8. Offsets from antenna for a Sakai roller.

Figure 9. An example of network type RTK GPS - OmniSTAR.

The UTM (Universal Transverse Mercator) coordinate system zone is designated when the UTM grids are produced based on the geodetic GPS data, longitudes, and latitudes. The conversion is based on The World Geodetic System 84 (WGS84). US State plane is also allowable which is based on North American Datum of 1983 (NAD83). See Figure 10 for the UTM zones in the US and Figure 11 in the world. Users can typically select the desired UTM zone in vendor's IC field software program settings.

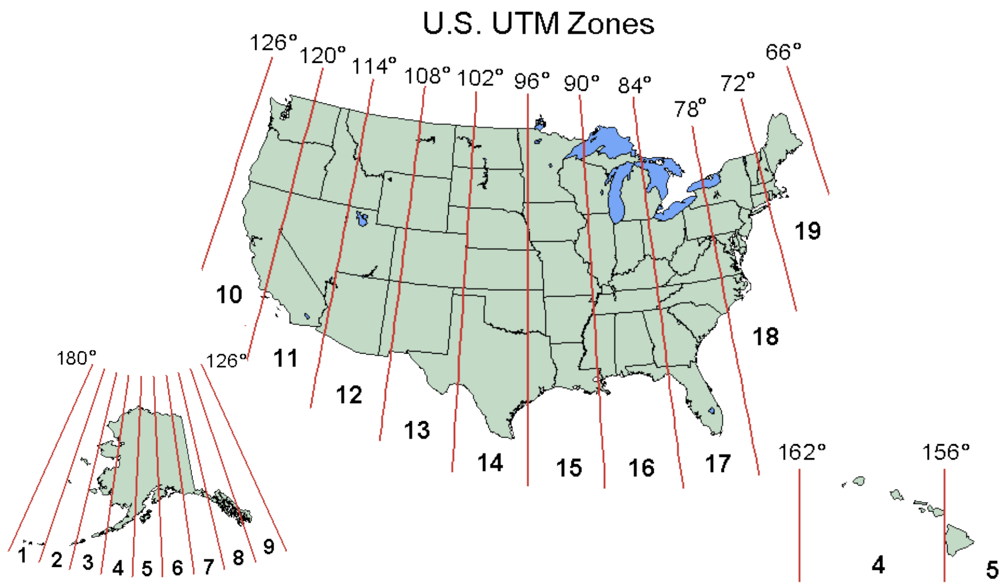


Figure 10. UTM Zones in the US.

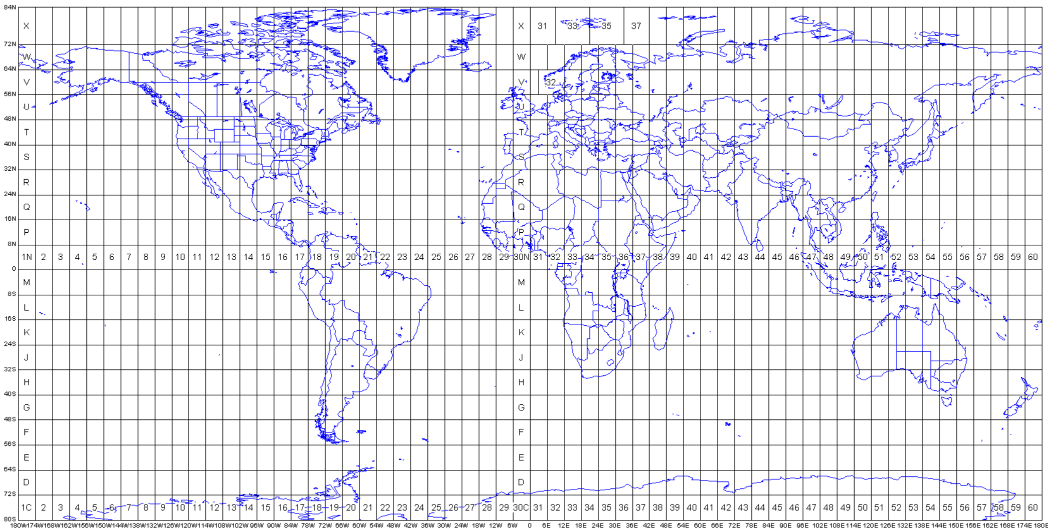


Figure 11. UTM Zones in the World.

Figure 12. US State Plane Coordinate (SPC) Zones.

Other coordinate systems are compatible with the Veta software, such as MNDOT CORS, Oregon CORS, Map grids of Australia (MGA), and New Zealand map projection.

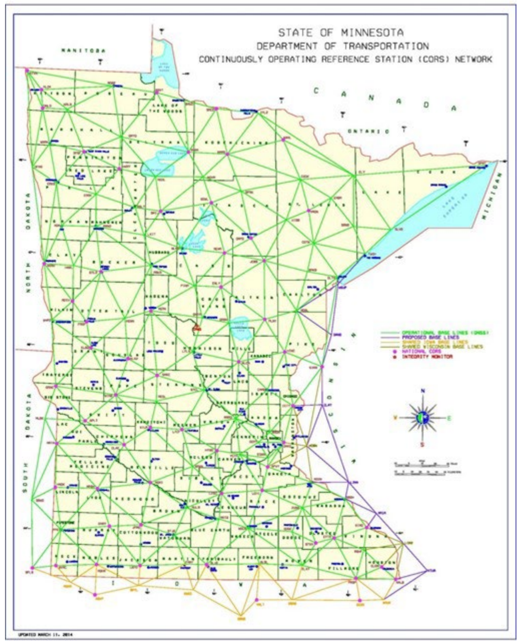


Figure 13. US MNDOT CORS.

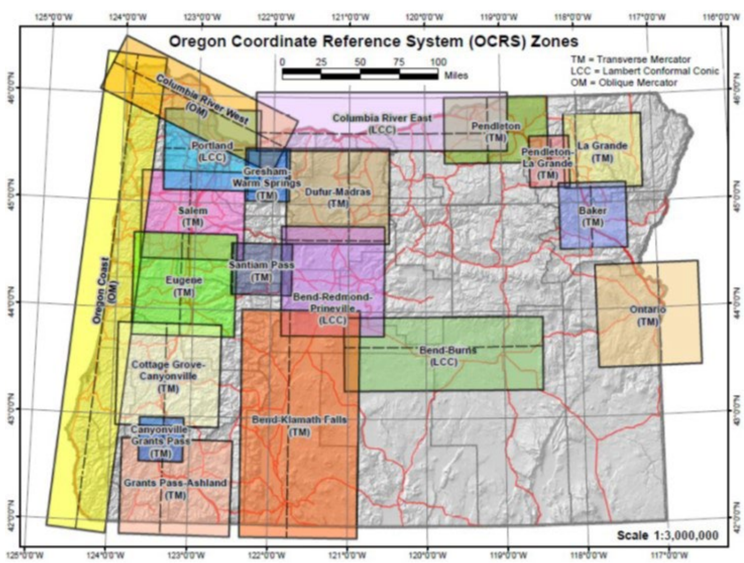


Figure 14. US Oregon CORS.

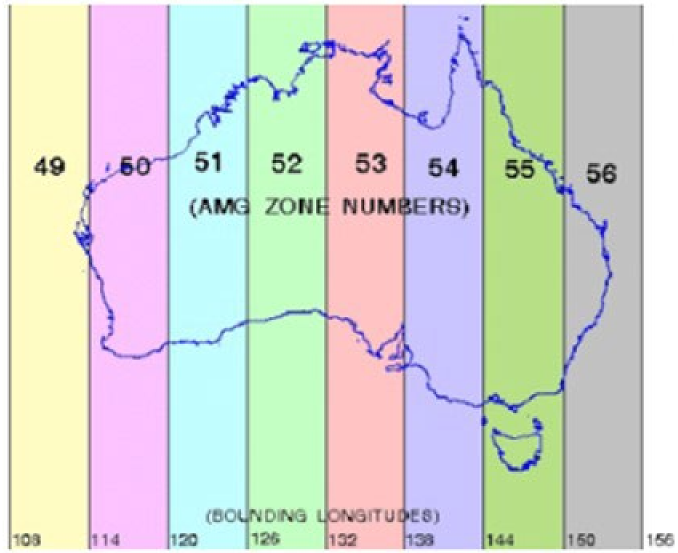


Figure 15. Map grids of Australia (MGA).

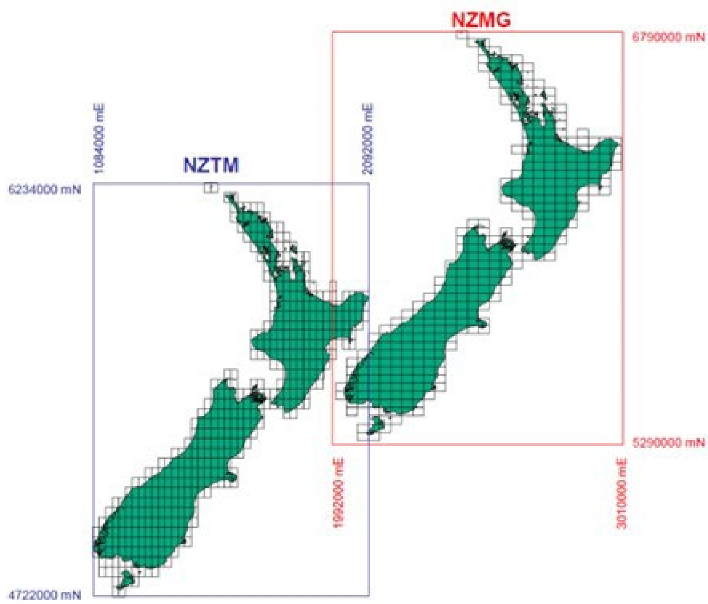


Figure 16. New Zealand map projection.

Technical assistance by roller vendors or GPS equipment manufacturers is often recommended:

- On-site staff with sufficient technical knowledge to set up roller-mounted GPS equipment and provide input for equipment operation during the first day of the field operation.
- Contact information for personnel with sufficient technical knowledge to assist the authors with technical questions during field testing when on-site technical assistance is not available.

Use of a GPS base station radio operating at 900MHz or higher is recommended (see Figure 17). Many GPS vendors offer Trimble, TOPCON, Leica, etc. In addition to setting up GPS base stations, there can also be other options, such as virtual reference stations (VRS) and internet-based correction signals. Before the beginning of IC data collection during the compaction operation, the GPS setup must be validated using a survey-grade hand-held GPS "rover"unit to ensure that the roller-mounted GPS provides accurate positioning data. (Figure 18).

Figure 17. A Trimble GPS base station (ICPF MnDOT demo).

(Courtesy of MnDOT)

Figure 18. Validation of roller mounted GPS with a hand-held rover at a marked location on the ground.

The GPS setup and verification can be summarized in the following steps:

1. Select a Coordinate System
2. Select Location(s) for GPS Base Station
3. Set up a GPS Base Station (Initialization takes 30 to 60 seconds, and re-initialization when the machine first powers up and loss-of-lock)
4. Set up Hand-held GPS Receiver (rover)
5. Set up GPS Receiver on IC Roller
6. Verify GPS Measurements
   - Move the IC roller around until the GPS header computation is initialized.
   - Move the IC roller and park at a selected location. Record the GPS measurements from the IC roller ensuring the distance offsets are applied so that the GPS coordinate is at the center or at left/right edges of the front drum.
   - Mark two locations on the ground adjacent to the right and left edges of the front drum contact patch. Move the IC roller from the marked locations.
   - Use a hand-held rover to measure at the marked locations.
   - Average the rover GPS measurements if the roller GPS measurement is at the center of the front drum.
   - The differences between the roller GPS and rover measurements shall be within ±12 inches (±300 mm) for northing and easting.

Data Types

IC data are generally in two forms: *Raw Data* and *Gridded Data*.

- **Raw Data**: Raw data are recorded during compaction operations before the gridding process. Raw data consists of one data point for a roller drum at approximately 10 Hz or 1 ft. interval. Therefore, the data mesh or data footprint is about the drum width by 1 ft. Both vibratory and non-vibratory data are normally recorded.
- **Gridded Data**: Gridded data are processed from raw data by refining the data mesh. Raw measurement data are duplicated over the meshes for the entire drum width (i.e., multiple data points cover the drum width). The refined data mesh size is generally 1 ft. by 1 ft. horizontally. One of the purposes of this process is to track partial drum overlaps among passes. It is anticipated that the gridding rule will be included in a future standard.

The raw data and gridded data are illustrated in Figure 19.

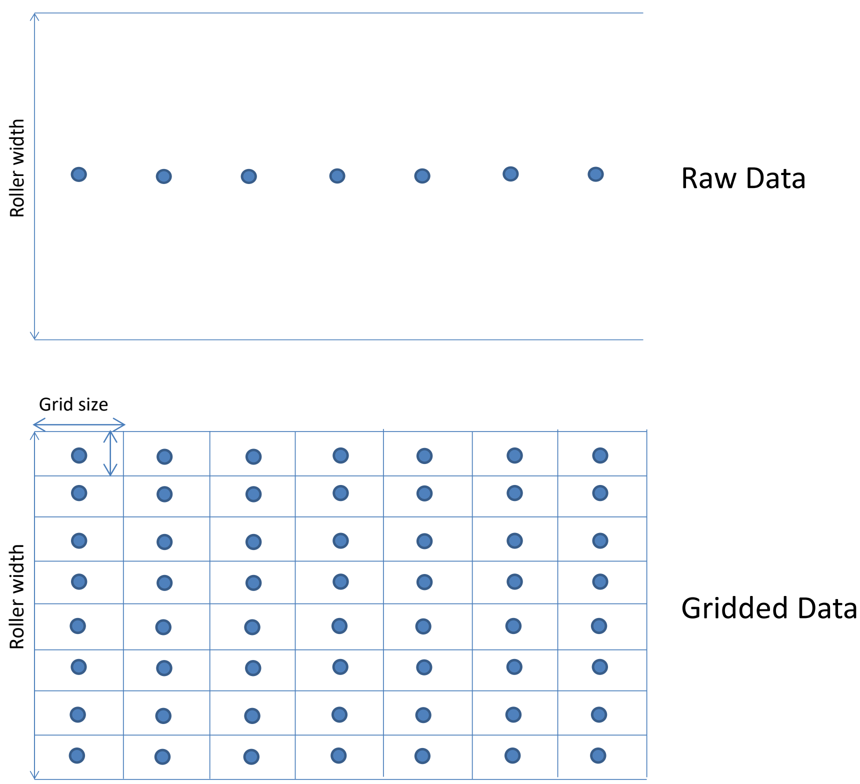


Figure 19. Raw data vs. gridded data.

The **gridded data** are in two sub-forms:

- **All-Passes Data**: All-passes data include all measurements within a given mesh. All passes are generally used to build compaction curves in order to establish rolling patterns.
- **Final Coverage Data**: Final coverage data contain measurements from the last passes within a given mesh. Final coverage data can be used to assess the results of compaction.

Gridded all-passes data and final coverage data are illustrated in Figure 20.

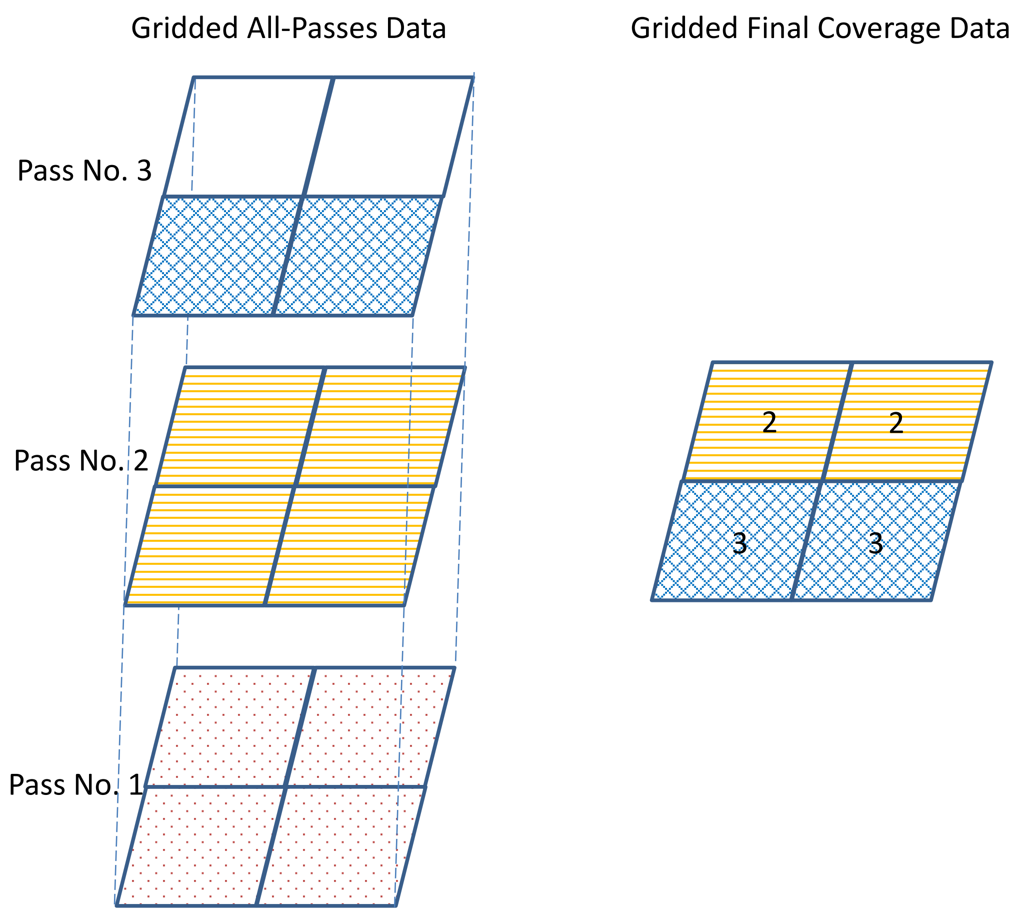


Figure 20. All passes data vs. final coverage data.

<u>Starting Veta 4.0+, only All-Passes Data is required to import to Veta</u> as the Final Coverage Data will be automatically generated based on the All-Passes Data.

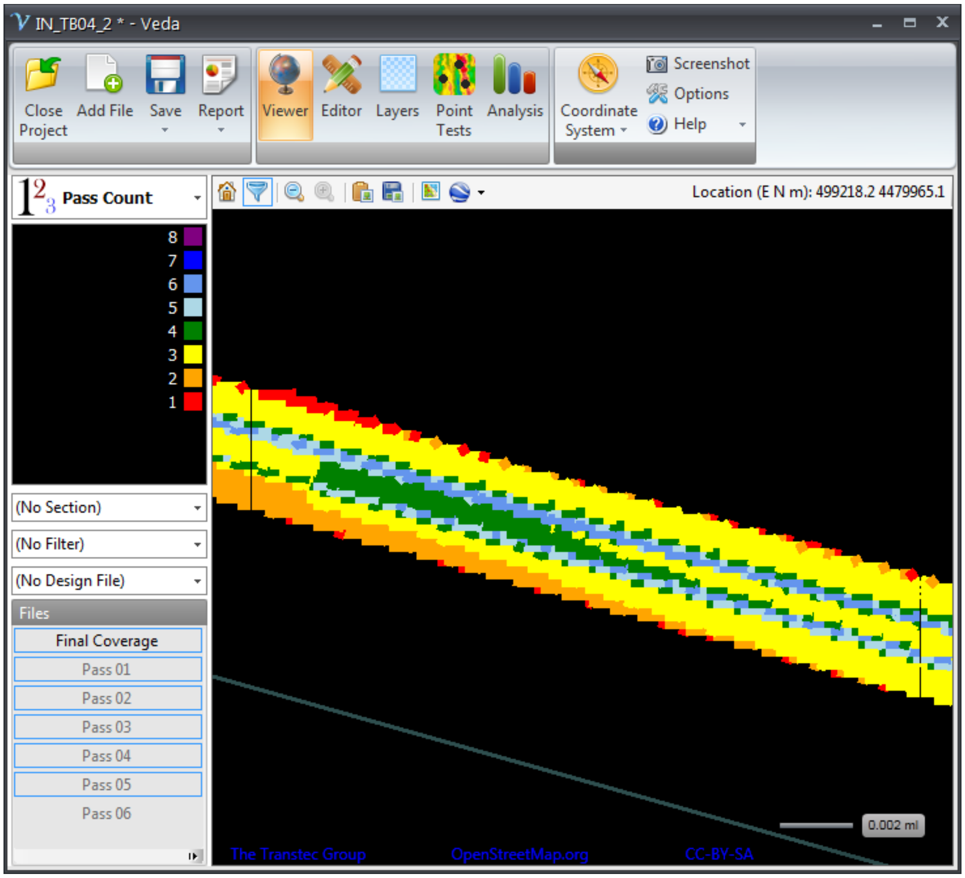


Figure 21. An example of pass count map of final coverage data.

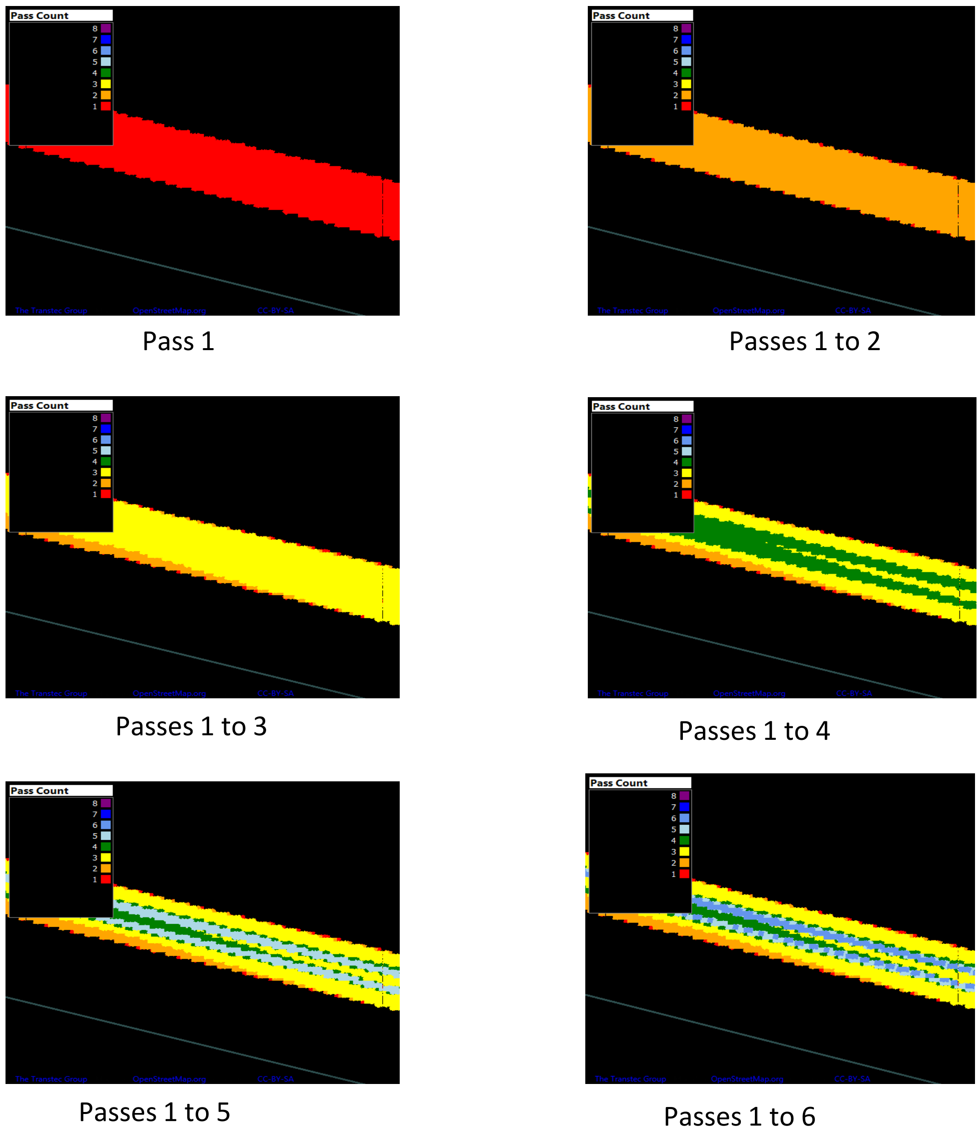


Figure 22. An example of progress of pass count maps of all-passes data.

Data Contents

The following requirements are consistent with those in the AASHTO R 111 Standard Practice for Intelligent Compaction Technology for Embankment and Asphalt Pavement Applications.

The IC data files need to include an essential IC data header and essential data blocks for effective data exchange. Data header consists of information regarding the measurement data in the data blocks (Table 1). Data blocks consist of all measurement data, while each measurement point or block includes all essential elements (Table 2).

Table 1. Essential IC Data Header

No.	Field Name/Definition/Unit	Examples
1	Section title	I-95 NB S1
2	Layer number	1
3	Machine trade name	My Brand
4	Machine ID (serial number)	Machine1234
5	Drum configuration (1: single drum; 2: double-drum)	2
6	Drum width (m)	2.007
7	Drum diameter (m)	1.2
8	Machine weight (metric ton)	14.0
9	Data reporting interval in the direction 90 degrees to the roller moving direction (mm)	30
10	Data reporting interval in the roller moving direction (mm)	30
11	EPSG coordinate system code (0 for non-EPSG coordinate system)	3745
12	Non-EPSG coordinate system zone name	NA
13	Name index of ICMV (1: Kb, 2: Evib, 3: CMV, 4: HMV, 5: CCV, 6: MDP, 7: Other)	1
14	IC Data type (1: Raw data, 2: Gridded all–passes data, 3: Gridded final coverage data)	3
15	Number of IC data points	100000

Notes:

- Item 2: A layer is a construction layer that may consist of one or more lifts.
- Item 3: The machine trade name is for the host roller regardless whether it is a retrofit system or not.
- Item 4: Machine ID is required to filter data if a project file consists of data from multiple machines.
- Items 6 to 8: Machine weight, drum width, and drum diameter are used to compute the Nijboer number to assess the risk of ground or asphalt buckling or cracking during compaction.
- Items 9 and 10: Data reporting intervals are applied to both raw and gridded IC data.
- Item 11: The European Petroleum Survey Group (EPSG) geodetic parameter dataset is a structured dataset of coordinate reference systems and coordinate transformations. EPSG code covers GPS, UTM, State plane NAD 1983, and others. For example, EPSG 3745 represents UTM 15N.
- Item 12: An example of non-EPSG is Minnesota Dodge county coordinate system that can be parsed and recognized by Veta.
- Item 13: ICMV can be either from OEM or a retrofit system. ICMV for a retrofit system can be from a different manufacturer than the one for the machine.

Table 2. Essential Elements for Each IC Data Block.

No.	Data Field Name/Definition/Unit	Examples
1	Date Stamp (YYYYMMDD)	20080701
2	Time Stamp (HHMMSS.SSS)	090504.001
3	Longitude (decimal degrees) or Easting (m)	94.85920403
4	Latitude (decimal degrees) or Northing (m)	45.22777335
5	Height of ground above WGS84 geoid (m)	339.945
6	GPS flag (1: valid, 2: invalid)	1
7	Construction lift number	1
8	Current compaction mode (1: steel vibration drum; 2: steel oscillation drum, 3: static drum; 4: pneumatic tire)	1
9	Current pass number	5
10	Direction index (1: forward, 2: reverse)	1
11	Roller speed (km/h)	4.0
12	Vibration frequency (vpm)	3500.0
13	Vibration amplitude (mm)	0.6
14	Temperature flag (1: valid, 2: invalid)	1
15	Temperature (ºC)	120.0
16	ICMV flag (1: valid, 2: invalid)	1
17	ICMV for the last vibratory pass	20.0

Notes:

- Items 1 and 2: The date/time need to be recorded as local time.
- Item 2: The resolution of 0.001 seconds is required to differentiate data points during post-processing for viewing and analysis.
- Items 3 to 4: The storage can be either GPS or coordinates, but the numbers need to be precise within 1cm. For example, at least 8 decimal places are needed for GPS.
- Item 6: GPS flag is invalid when the status is at non-RTK mode caused by losing GPS correction signals or others.
- Item 7: Construction lift number is required even when there is only one lift for a specific layer. Both layer and lift numbers are counted in consecutive sequence from the bottom up.
- Item 9: Current roller pass number is the counts of roller machine passes, instead of individual drum passes, within a given mesh for a construction lift. It is an accumulated value of passes of all compaction modes. For example, a total passes of 5 consists of 3 vibratory passes and 2 static passes.
- Item 11: Direction index is referenced to machine configuration/movement instead of traffic directions.
- Item 16: Temperature flag is invalid when temperature sensors or recording is faulty.
- Item 17: ICMV flag is invalid when starting/stopping a machine or when sensors are faulty or absent.
- Item 18: The unit of ICMV should be either unitless or in SI. That is Kb [MN/m] and Evib [MN/m²].
- Accumulated vibratory passes will be needed in the future for using all passes data to produce a compaction curve (i.e., ICMV vs. pass counts) and for using final coverage data to access the end results of ICMV.

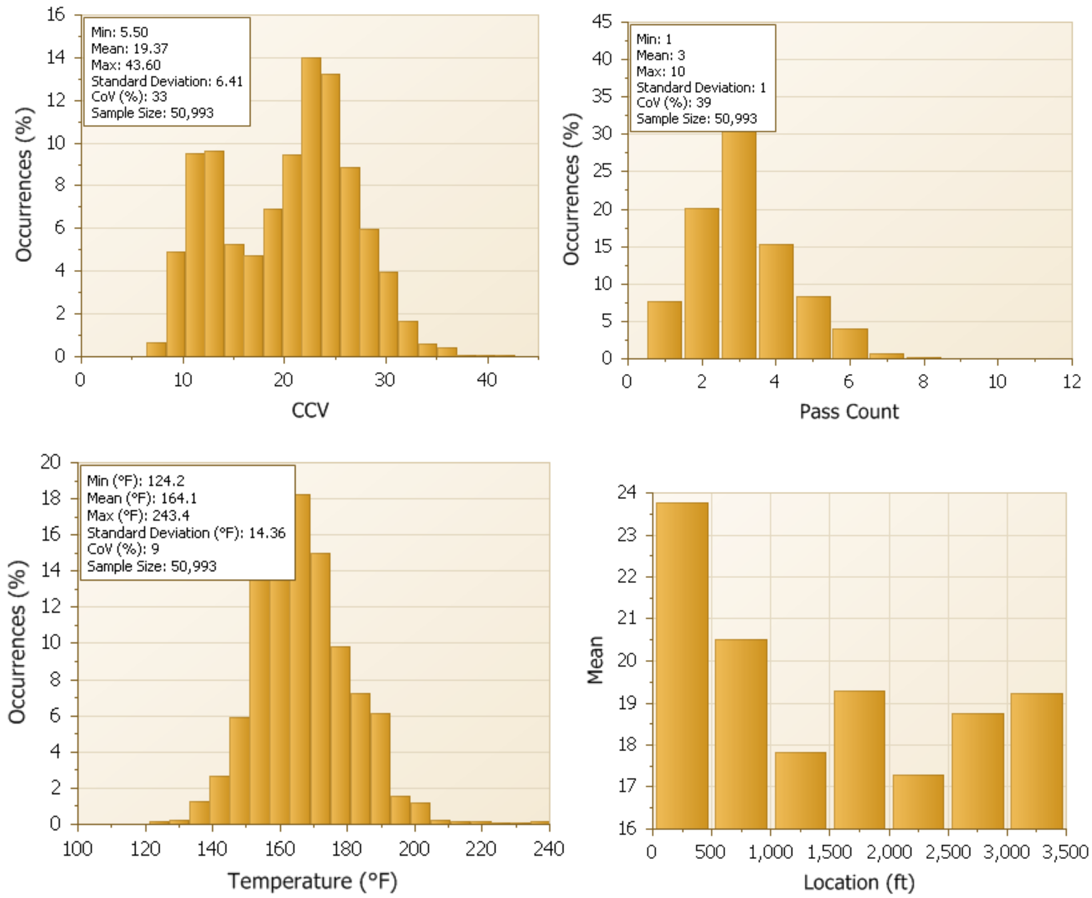


Figure 23. An example of statistics of final coverage data.

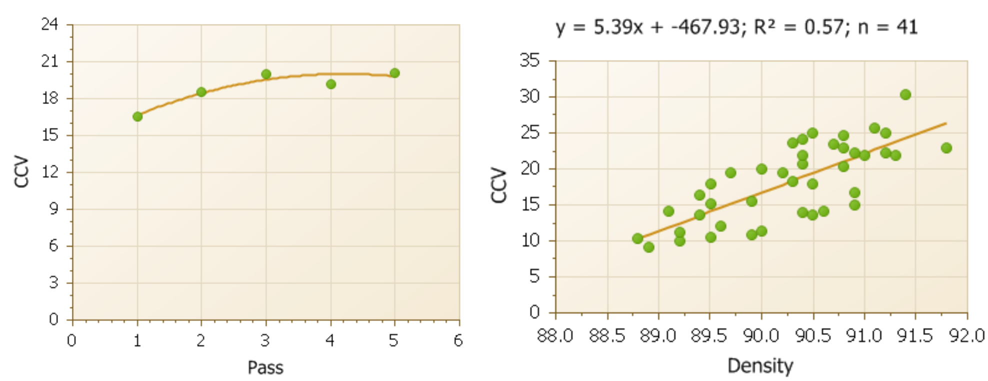


Figure 24. An example of compaction curves and correlation based on all passes data.

Vendor's IC Data

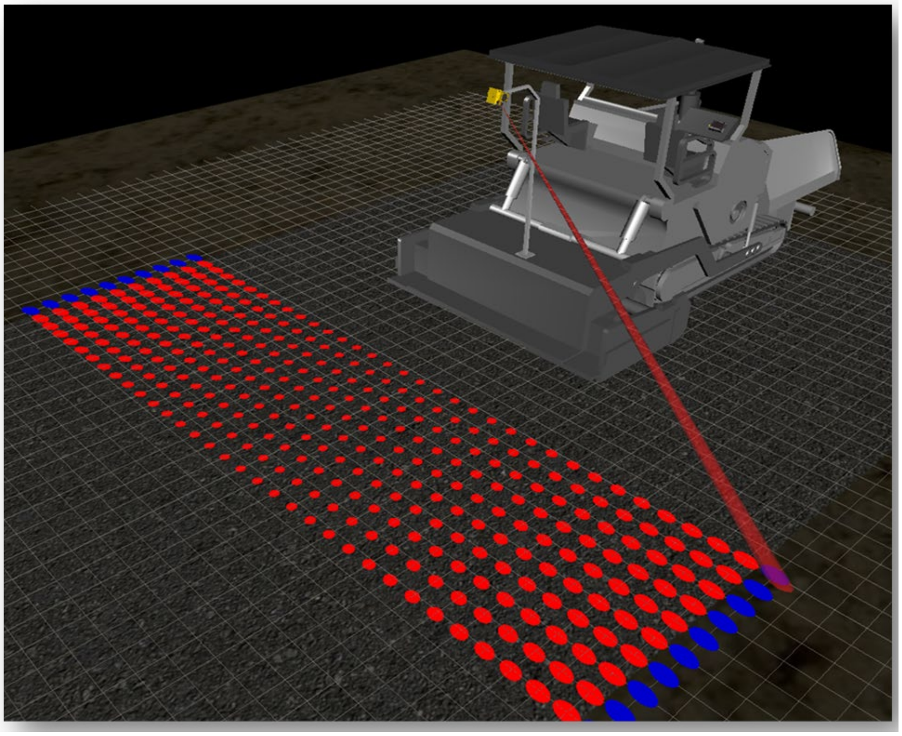
Table 3. Veta-compatible IC data formats

Vendor	Extension	Source	Format	Gridding	Available ICMV	Multiple ICMV
Bomag	csva	file	text	gridded	EVIB	no
Bomag	csvr	file	text	ungridded	EVIB	no
Bomag	tds	file	binary	ungridded	EVIB, ECONOMIZER	yes
Dynapac	txt	file	text	gridded	Dynapac CMV, Dynapac E-VIB1, Dynapac E-VIB2	no
Hamm	vexp	file	text	gridded	HMV	no
Leica	cgt	file	text	ungridded	Leica CMV	no
Moba	csv	file	text	gridded	EVIB, CMV, HMV, CCV, MDP, MCI	no
Moba	tds	download	binary	ungridded	EVIB, CMV, HMV, CCV, MDP, MCI	no
Propeller	tds	download	binary	ungridded	-	-
Sakai	pln	file	text	gridded	CCV	no
Topcon	pln	file	text	gridded	CCV, Topcon CMV	no
Topcon	tds	download	binary	ungridded	CCV, Topcon CMV	yes
Trimble/CAT	csv	file	text	gridded	Caterpillar CMV, Trimble CMV, Dynapac CMV, Dynapac E-VIB1, Dynapac E-VIB2, CCV, MDP	yes
Trimble/CAT	tds	download	binary	ungridded	Caterpillar CMV, Trimble CMV, Dynapac CMV, Dynapac E-VIB1, Dynapac E-VIB2, CCV, MDP	yes
Völkel	tds	file	binary	ungridded	?	yes
Volvo	csv	file	text	gridded	EDV, Volvo CMV	yes
Volvo	tds	?	binary	ungridded	EDV, Volvo CMV	yes

Paver-Mounted Thermal Profile (PMTP) Data

Systems

The PMTP systems in the market use either thermal scanner or camera to measure continuous thermal profiles behind the paver screed.



Source: MOBA

Figure 25. An illustration of a PMTP System

Data Types

PMTP records thermal profiles, GPS, paver speeds and paver stops.

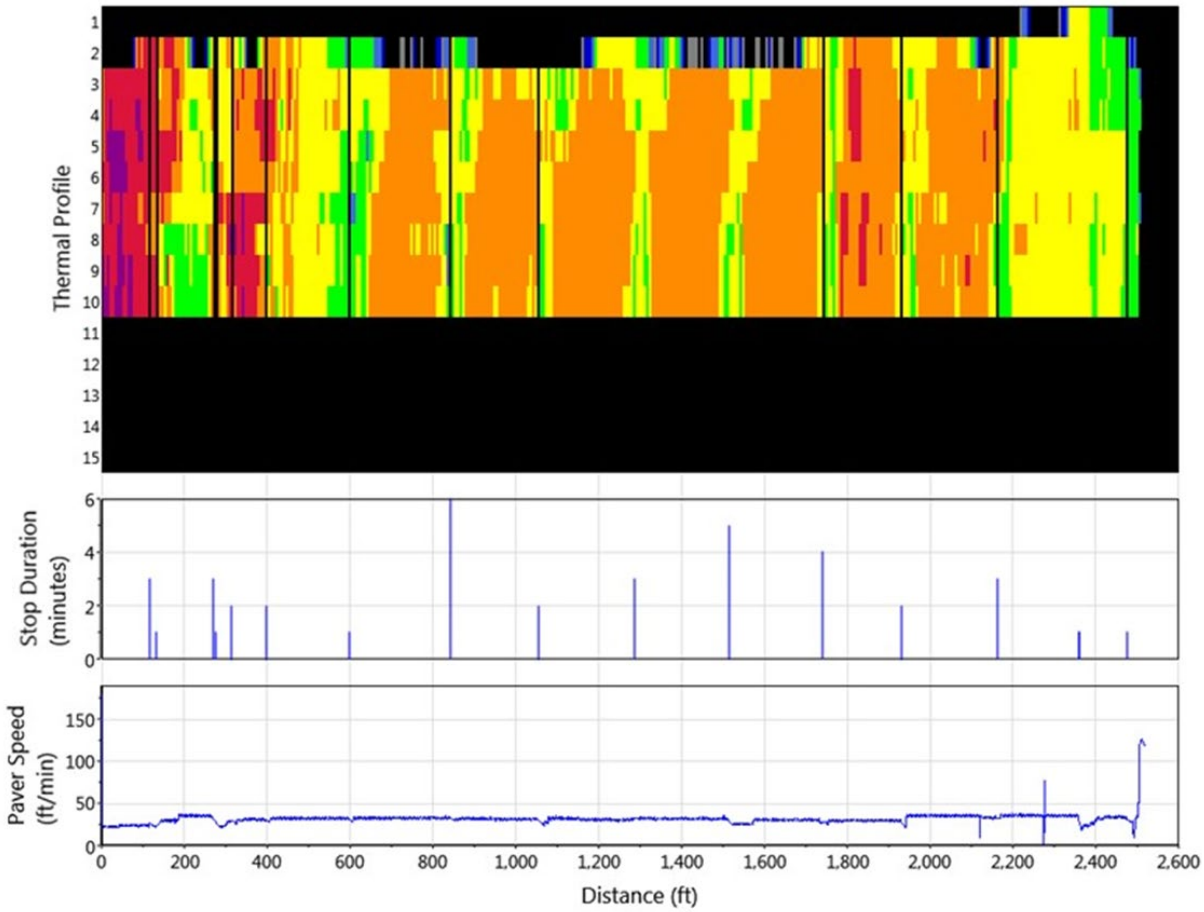


Figure 26. An Example of PMTP Data Types in the Veta PMTP Thermal Profile report

Data Contents

The following requirements are consistent with those in the AASHTO PP 110 Standard Practice for Continuous Thermal Profile of Asphalt Mixture Construction.

Table 4. Required Information in Data Header – AASHTO PP80 PMTP Data

Description	Example Data
Agency project number, highway and/or section title	Highway 77
Machine trade name	ABC Company
Machine ID	Temp Bar
Lateral spacing between surface temperature measurements, mm [in.]	305 [12]
Longitudinal spacing between surface temperature measurements, mm [in.]	305 [12]
Vertical distance between temperature sensor(s) and mat, mm [in.]	305 [120]
Reporting resolution for independent surface temperature data—in the paver moving direction, mm [in.]	305 [12]
Number of lateral surface temperature measurements/sensors	10

Number of surface temperature measurement data blocks	5000

Table 5. Required Information in Each Data Block – AASHTO PP80 PMTP Data

Data Field Name	Example Data
Date stamp	20130607 (YYYYMMDD)
Time stamp	090504.0 (9 hr 5 min 4.0 s) HHMMSS.S (military format)
Longitude, decimal degrees, with at least 8 significant digits	94.85920403
Latitude, decimal degrees, with at least 8 significant digits	45.22777335
Distance, m [ft]	0.3 [1]
Direction heading, degree angle, clockwise from the north; or calculated value, in Veta, using values from the other data blocks, m/min [ft/min]	[45]
Speed	9.1 [30]
Surface temperature reading/Location 1, °C [°F][a]	143 [290]
…	…
Surface temperature reading/Location N, °C [°F][a]	149 [300]

[a] Surface temperature readings/locations are numbered from 1 to N, left to right, in the direction of paving.

Vendor's PMTP Data

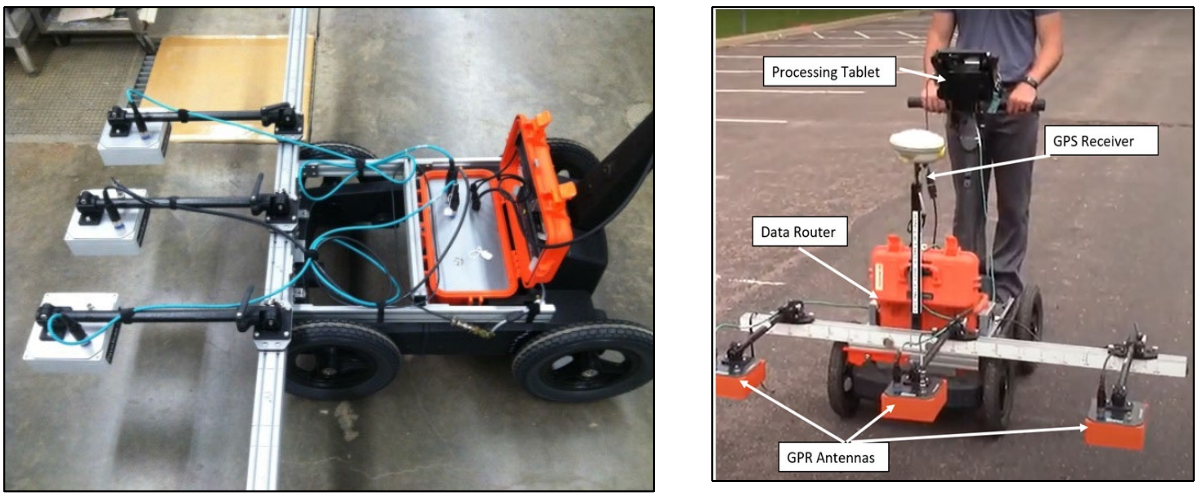
Table 6. Vendors' PMTP data format and Veta-compatibility

Vendor	Extension	Source	Format	SRS	Veta SRS detection
Moba	paveproj	file download	binary	WGS84	yes
Trimble/CAT	tds	download	binary	Any	yes
Topcon	tds	download	binary	Any	yes
Vögele	csv	file download	text	WGS84	yes

Dielectric Profiling System (DPS) Data

Systems

DPS is a ground-penetrating radar (GPR)-based system that measures the dielectric constant of asphalt pavements to evaluate the uniformity and density. The dielectric constant is the relative permittivity that quantifies the material's polarization under electrical fields. Because pavements are constructed in layers and are assumed non-conductive and non-magnetic, the dielectric constant differences between materials contribute to the GPR signal reflections from layer interfaces. The DPS measurements can be correlated to limited asphalt core or "puck" density data to predict the asphalt in-place density for the measured surfaces. Veta currently allows the linear correlation equation.



Source: MnDOT, 2020

Figure 27. An Example of a DPS and its components

Data Types

DPS records geo-referenced dielectric constant profile, dielectric quality, sensor heights, speed.

Figure 28. An Example of DPS Data Types in the Veta Viewer Screen

Data Contents

The following data contents are compatible with the AASHTO PP 98 "Standard Practice for Asphalt Surface Dielectric Profiling System using Ground Penetrating Radar".

Mata data:

- Dielectric value
- Project Name
- Road ID
- Travel Direction
- Lift Designation
- Lane Designation
- Date-time
- Distance (ft)
- Station (ft)
- Lateral Offset (ft)
- Longitude (°)
- Latitude (°)
- Elevation (ft)
- Moving Average Distance (ft)
- Output Interval Distance (ft)

- Date
- FileName

Vendor's DPS Data

The following is the summary of vendors' DPS data.

Table 7. Vendors' DPS data format and Veta-compatibility

Vendor	Extension	Source	Format	GPS Quality
ESS	tds	file	binary	no
GSSI	tds	file	binary	no

AASHTO Data Standards

AASHTO ICT Data Standard

The purpose of the AASHTO MP 39 Standard Specification for File Format of Intelligent Construction Data is to facilitate ICT data exchange.

The summary of the AASHTO IC data is as follows:

- Binary format for data
    - Performance
    - Space conservation
    - Protection against casual modification
- Text format for Metadata (data descriptions)
    - Easier for parsing and interpretation
- File name extension
    - "TDS" (Tagged Data Storage)

The file structure is summarized as:

- Blocks – Sections
- Sections
    - [file-headers]
    - [lookup-tables]
    - [data-headers]
    - [data-source]
    - [log-data]
- Self-describing (all org data preserved)

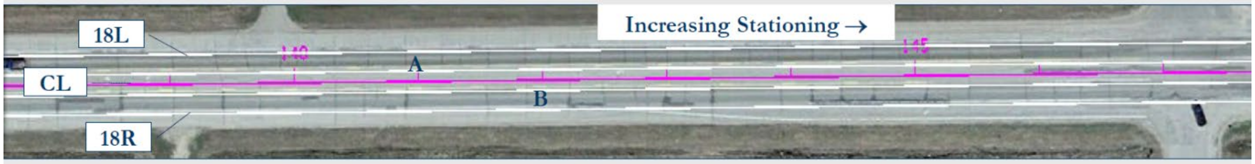
- One set coordinates per timestamp
- One machine per file
- Allow multiple sensors
- Allow coordnate offsets for sensors
- Store measured data, not calculated values

Data Storage Options include:

- Sensor Section: After all measurements are done. **Best Computing Performance**
- Log Data Section: During measurement. **Most Compact for Data Transmission**

AASHTO ICT Data Lot Names Standard

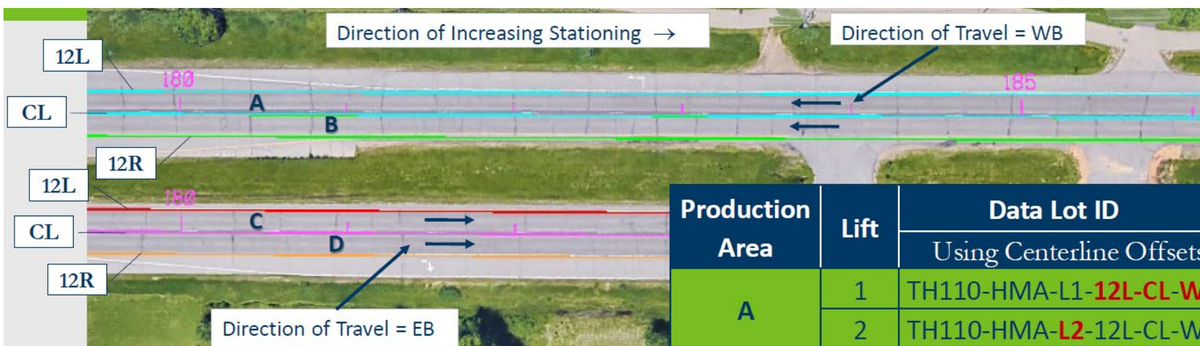
The AASHTO PP 114 Standard Practice for Data Lot Names for Use with Intelligent Construction Technologies is to facilitate ICT data filtering automation and management.



Production Area	Lift	Data Lot ID Using Centerline Offsets
A	1	TH12-HMA-L1-**18L-CL**
	2	TH12-HMA-**L2**-18L-CL
B	1	TH12-HMA-L1-**CL-18R**
	2	TH12-HMA-**L2**-CL-18R

Source: Embacher, MnDOT

Figure 29. An Example of the AASHTO Data Lot Names for Undivided Highways



Production Area	Lift	Data Lot ID Using Centerline Offsets
A	1	TH110-HMA-L1-**12L-CL-WB**
	2	TH110-HMA-**L2**-12L-CL-WB
B	1	TH110-HMA-L1-**CL-12R**-WB
	2	TH110-HMA-**L2**-CL-12R-WB
C	1	TH110-HMA-L1-**12L-CL-EB**
	2	TH110-HMA-**L2**-12L-CL-EB
D	1	TH110-HMA-L1-**CL-12R-EB**
	2	TH110-HMA-**L2**-CL-12R-EB

Source: Embacher, MnDOT

Figure 30. An Example of the AASHTO Data Lot Names for Divided Highways

Venders IC Data

BOMAG IC Data

System Summary

The BOMAG IC system is summarized in Figure 31.

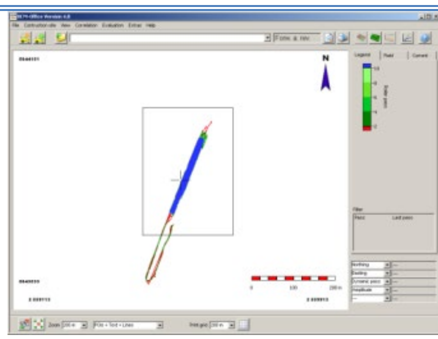
Roller

double drum

single smooth drum

Control Panel

Documentation



BCM-05 Office 4

Figure 31. BOMAG IC system.

Data Management

The BOMAG IC data are organized in a hierarchical data structure: project, lot, layer, and field. The data management structure needs to be setup before the compaction and data collection. An example of the hierarchical data structure is shown on the BCM Open dialogue in Figure 33.

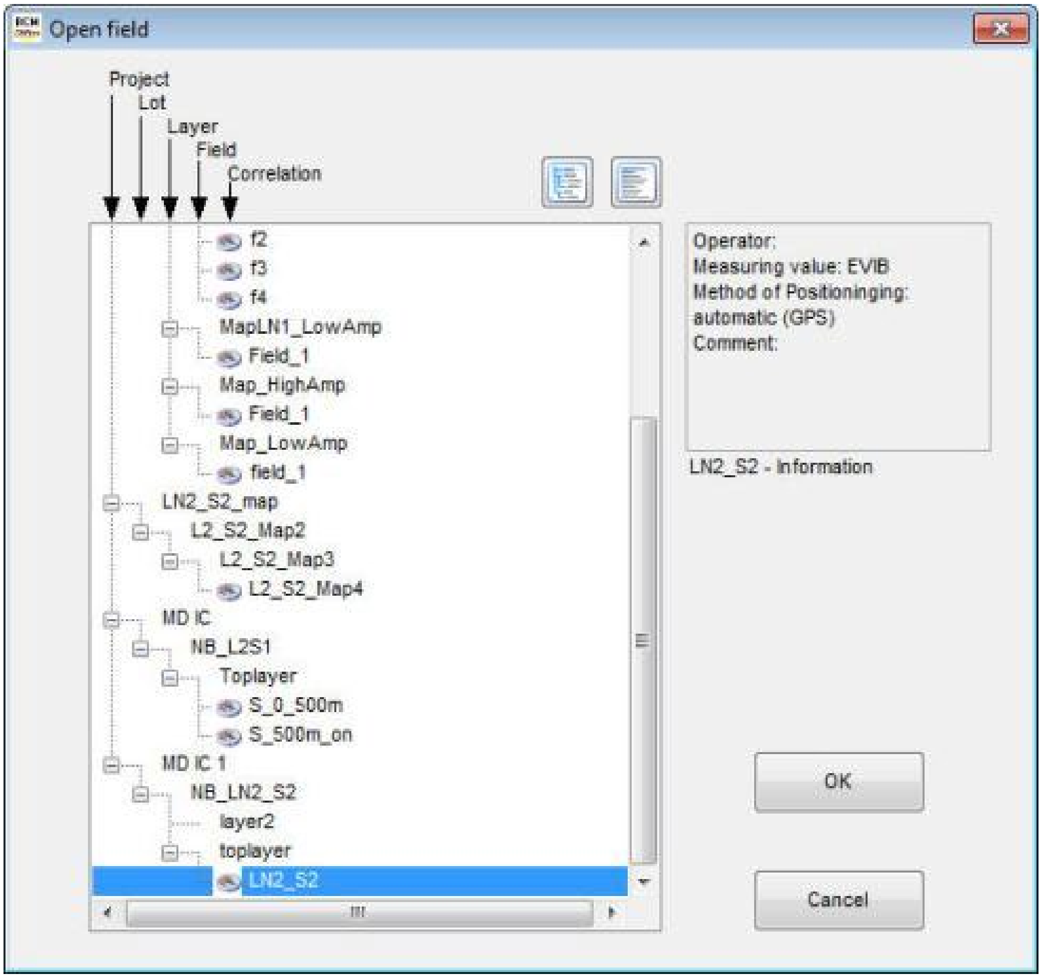


Figure 32. Hierarchical structure of BOMAG IC data.

Data Lot Names

NA

Data Export Procedures

BOMAG IC data can be downloaded from the onboard display unit using a USB flash drive. Users should be cautious about setting up BCM prior to data collection during compaction following a hierarchical project structure: Project/Lot/Layer/Field. The downloaded files need to be restored to a computer by using the BCM Office software before the export process. Consult the BCM Office users' manual for further details.

View the restored data using the BCM Office software:

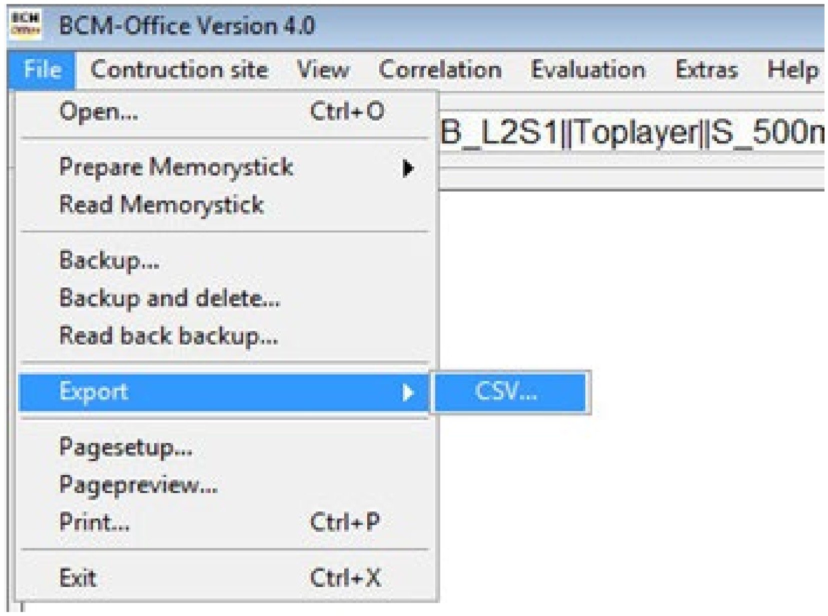
1. Use File/Open, and select a specific Project/Lot/Layer/Field.
2. Inspect the data by using various viewing options.

Direct Download from Cloud to Veta

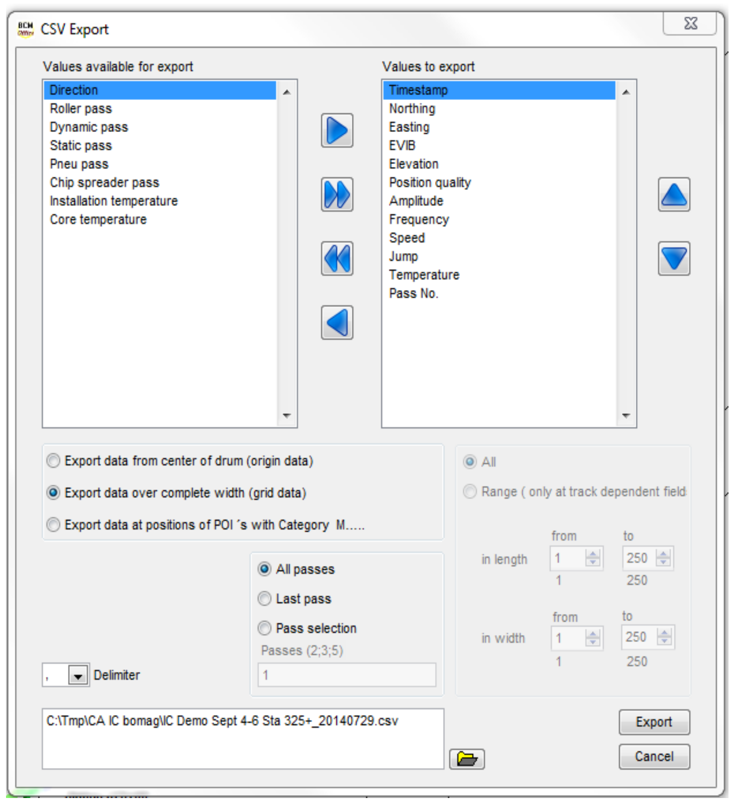
NA

Export BOMAG IC data to CSV files using the BCM Office software:

1. Select File/Export/CSV from the software menu.



2. Under the "Values available for export", select all items and click the double-arrow button pointing to the right.
3. Select "Export data over complete width (grid data)".
4. Select the default "," as Delimiter.
5. Select "All passes".
6. Click the folder icon and rename the export file as "*.csva" (CSV files for all passes data).
7. Click Export to export to the csva file.
8. Select Last Pass and repeat the process to export final coverage data and save as *.csvp file.
9. Both the *.csva and *.csvp files can be readily imported to Veda 4.0+.



Caterpillar-Trimble IC Data

System Summary

<table>
<tr><td>Hardware</td><td>

Caterpillar IC rollers

Single smooth drum

Single drum pad foot

Double drum

Trimble IC Retrofit

for double drum rollers

for single drum rollers

</td></tr>
<tr><td>Onboard Display</td><td>

</td></tr>
</table>

Documentation	 VisionLink

Figure 33. Caterpillar-Trimble IC System.

Data Management

The Caterpillar-Trimble IC data are managed with VisionLink.

A specific " On-Machine Design " needs to set before any compaction for a given lift of a section, a specific “On-Machine Design” needs to set. Then, select the desired “Design” under the Project Data Filters before the data export. This would bypass current issues with time stamps and layers/lifts. Note that Veta current analyzes one lift at a time.

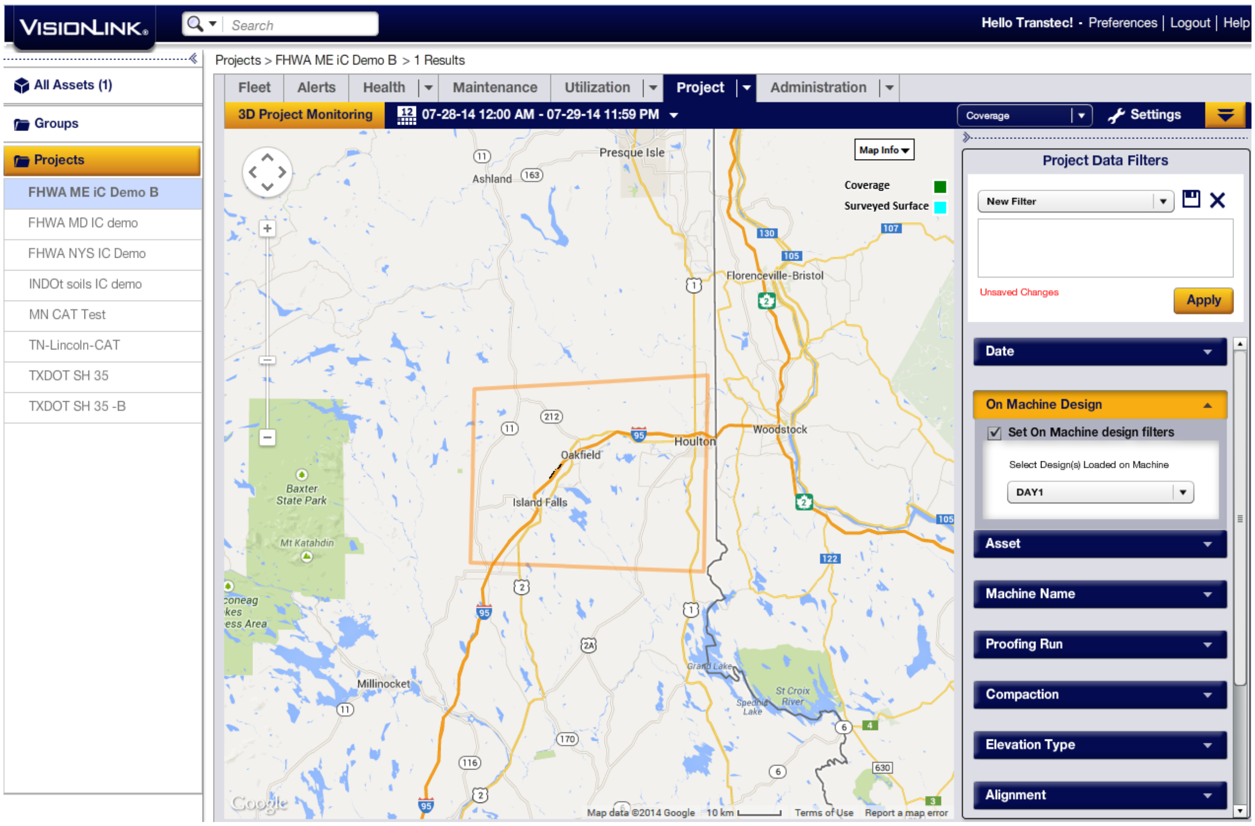
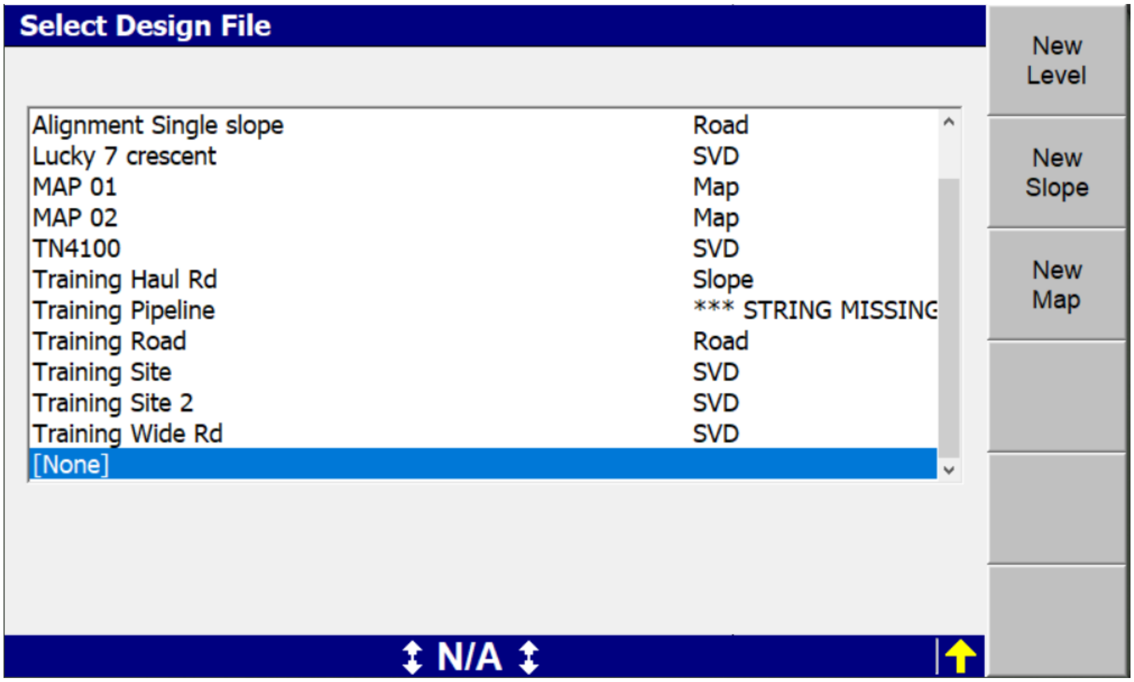


Figure 34. View data in VisionLink.

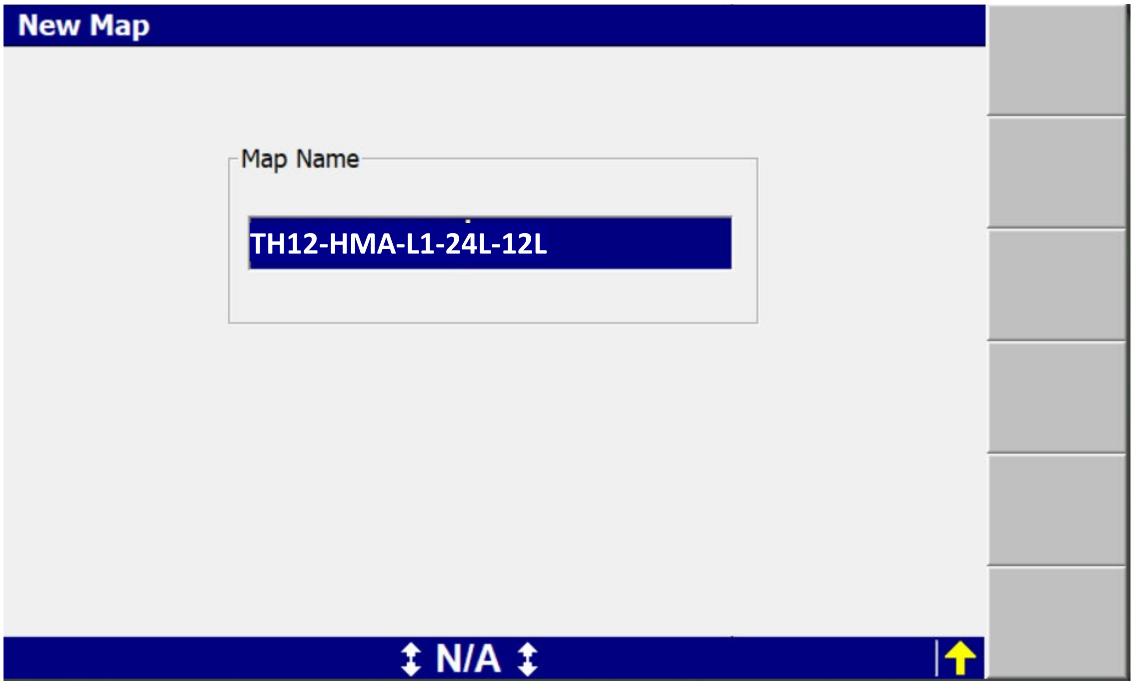
Data Lot Names
Use either the "Design" field or "Measured Data" field for the Data Lot Names.

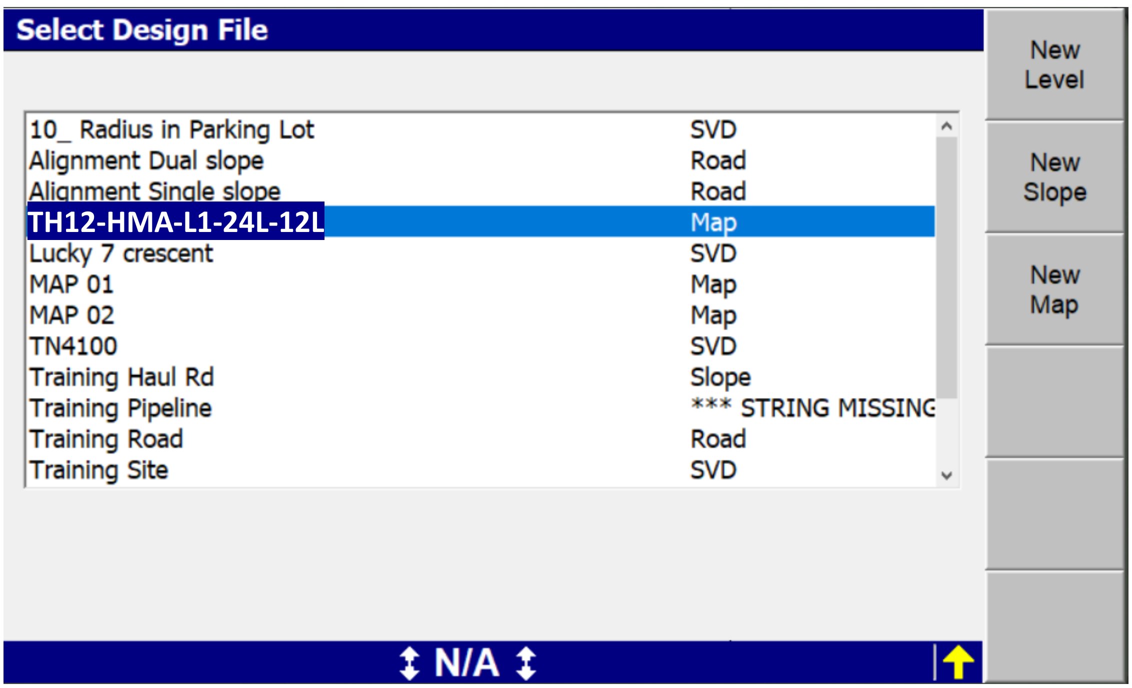
<u>Option 1</u>

If a 3D design or 3D linework created from Trimble Business Center will be used, then that "design" can be selected in the following menu once loaded to the control box. These can be project specific if each machine is using the same "design":



"Maps" can also be created in the field if no pre-generated 3D design or linework are used. In this case, a "Map" is considered a "design" from the software's perspective. These new "maps" can be created using a desired (pre-loaded) coordinate system or auto-created on design load based on GPS positioning. The "Map" can be named anything and selected in the same menu path. These are machine specific - not necessarily project specific if each machine is creating a differently named Map:



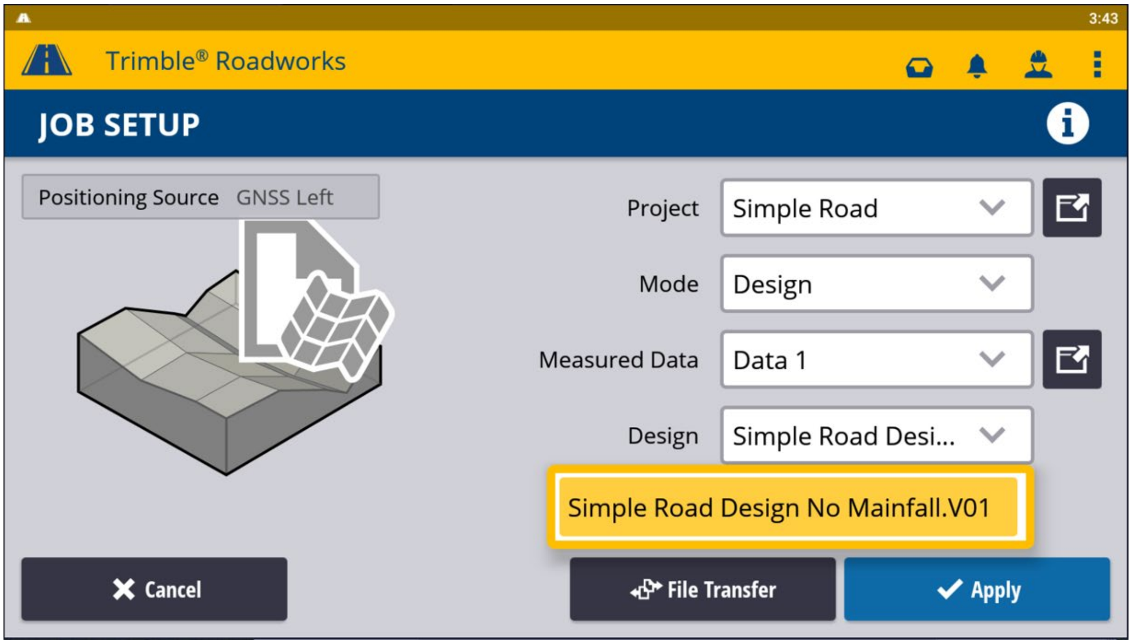


It is the same process for GNSS based CCS900 systems and GNSS based PCS900 thermal mapping systems. Users can either use designs or linework created from Trimble Business Center or use the "New Map" functionality to create an in-field design that is then referenced from all collected mapping data in office software analytics.

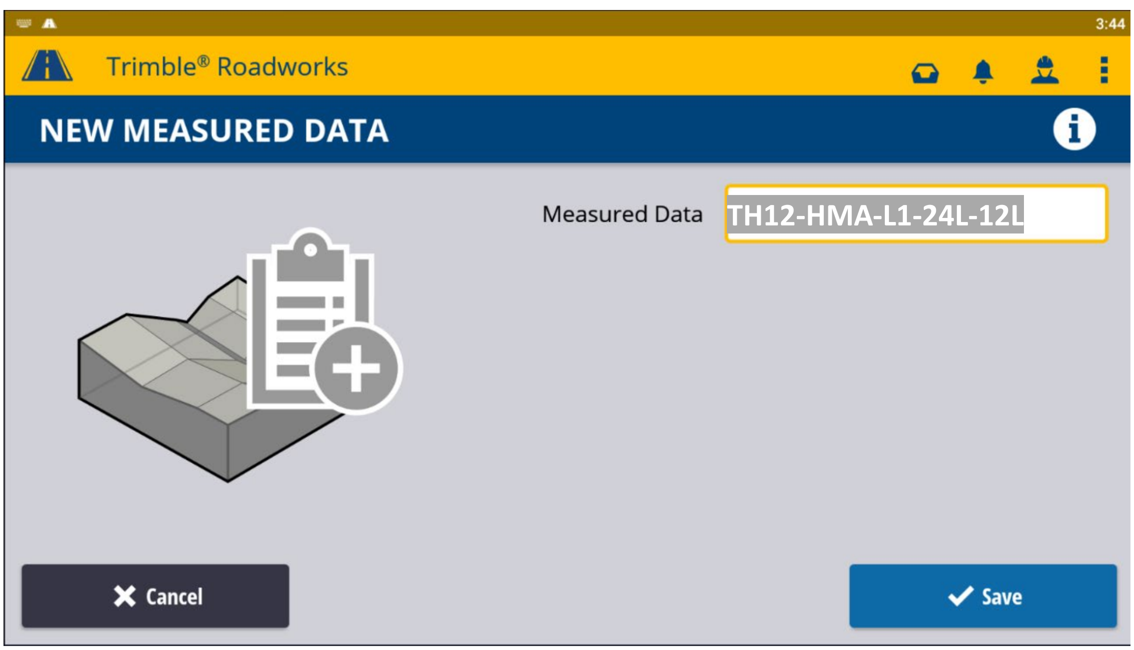
Option 2

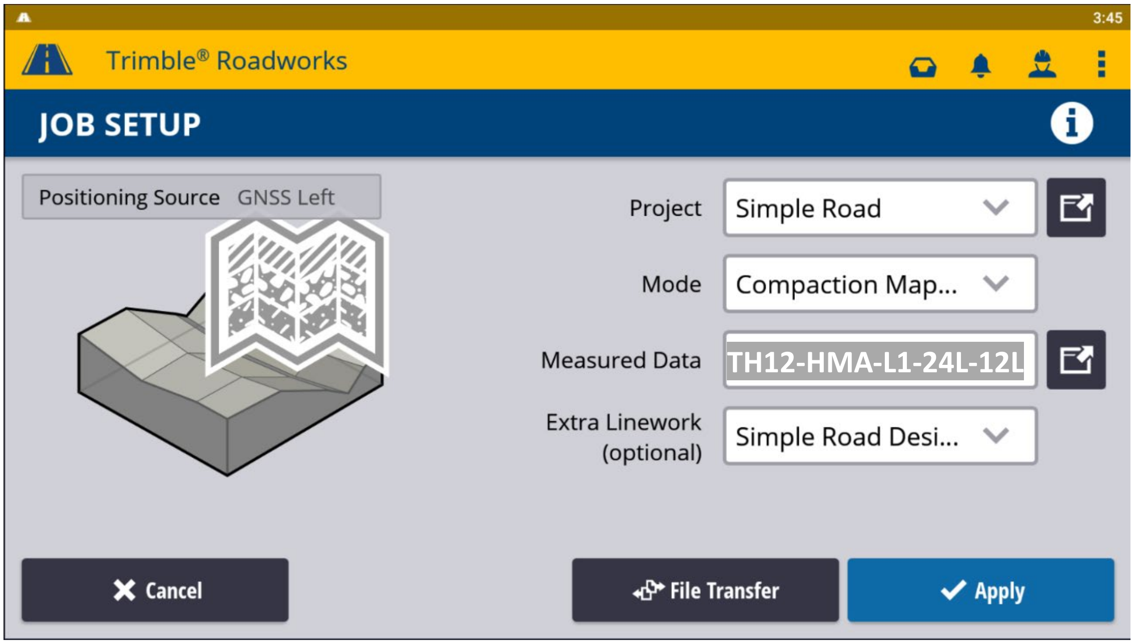
The new Trimble Earthworks and Roadworks compaction systems can also utilize 3D designs from the office, but users don't have to use them. The terminology with the new systems are "Measured Data" containers (instead of new "maps").

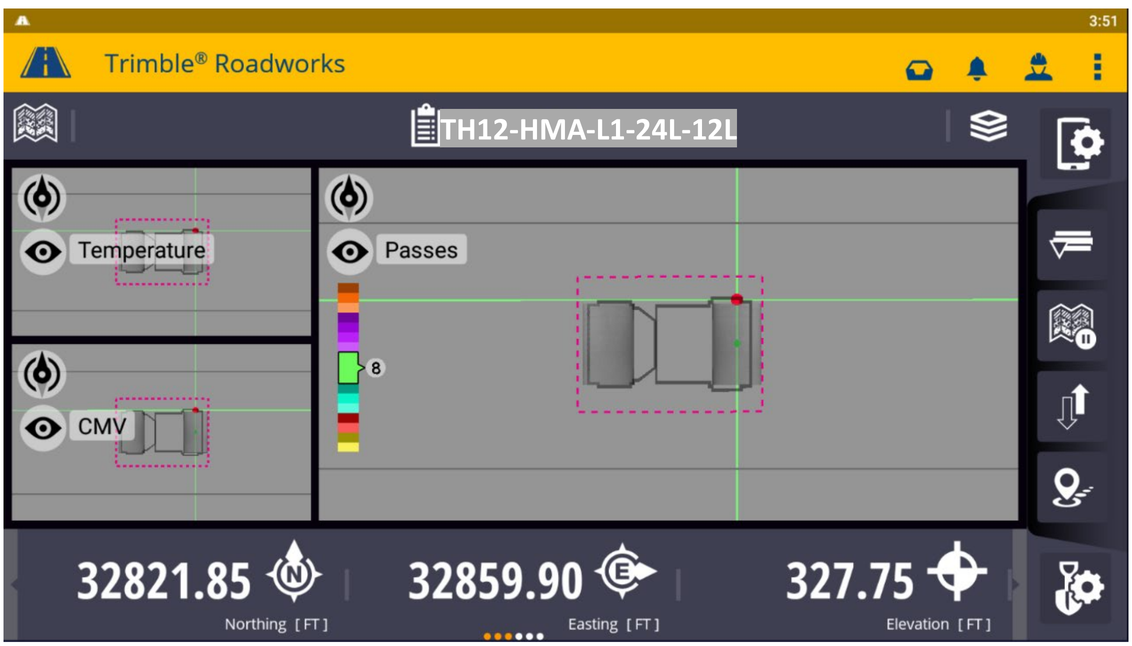
Using a design:



New "Measured Data" store for mapping data:

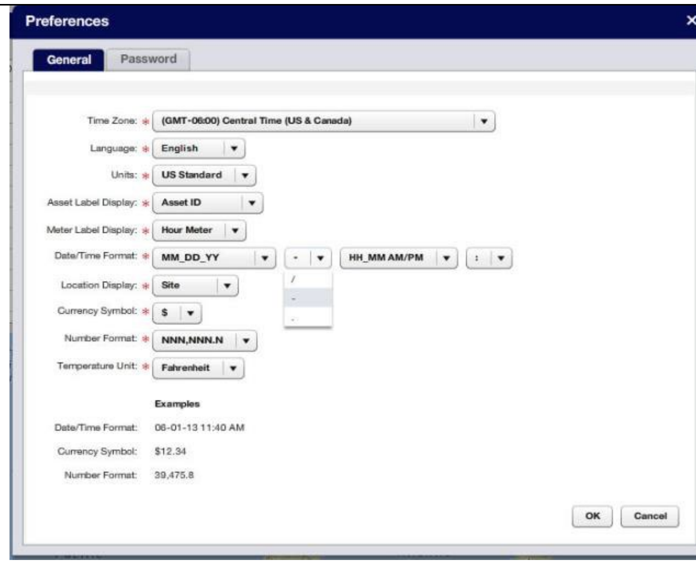



3:45
Trimble® Roadworks
JOB SETUP
Positioning Source GNSS Left
Project
Simple Road
Mode
Compaction Map...
Measured Data
TH12-HMA-L1-24L-12L
Extra Linework
(optional)
Simple Road Desi...
Cancel
File Transfer
Apply

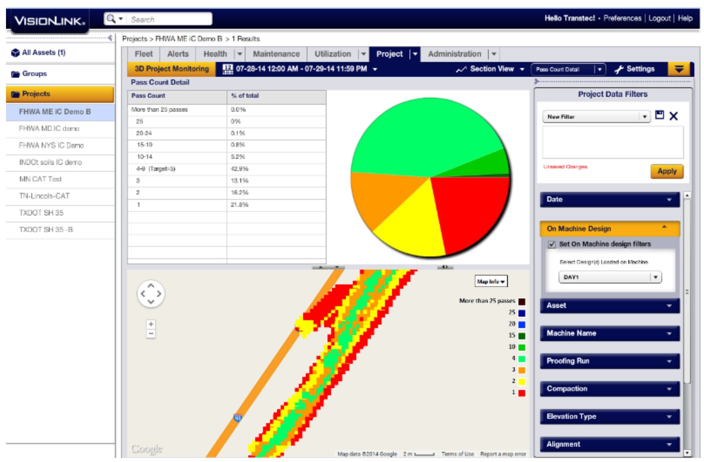

3:51
Trimble® Roadworks
TH12-HMA-L1-24L-12L
Temperature
CMV
Passes
8
32821.85
Northing [FT]
32859.90
Easting [FT]
327.75
Elevation [FT]

Data Export Procedures

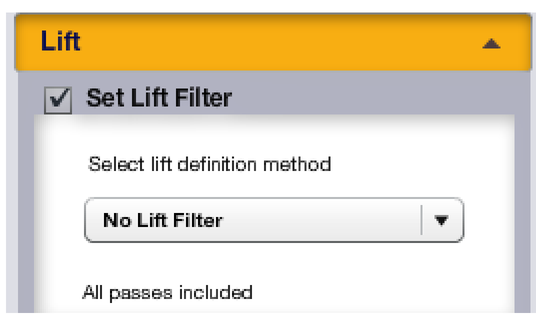
1. Make sure the “Preference” settings are compatible with Veta. Date Format: MM_DD_YY., Units: US Standard, Temperature Unit: Fahrenheit.



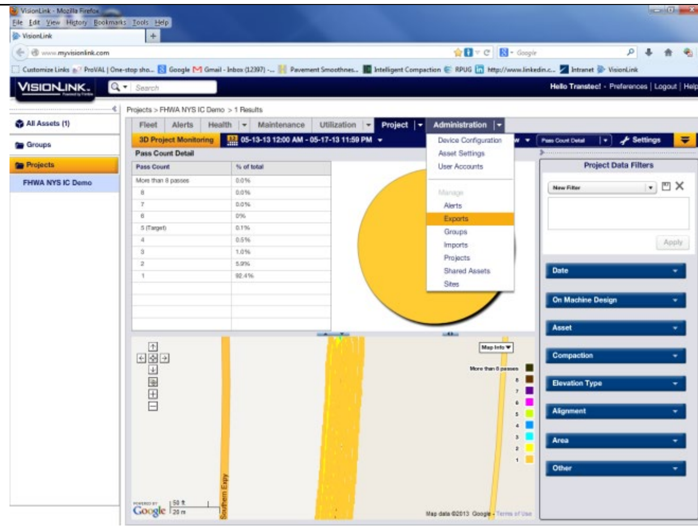
2. Make sure the desired “Design” under the Project Data Filters is selected prior to the data export.



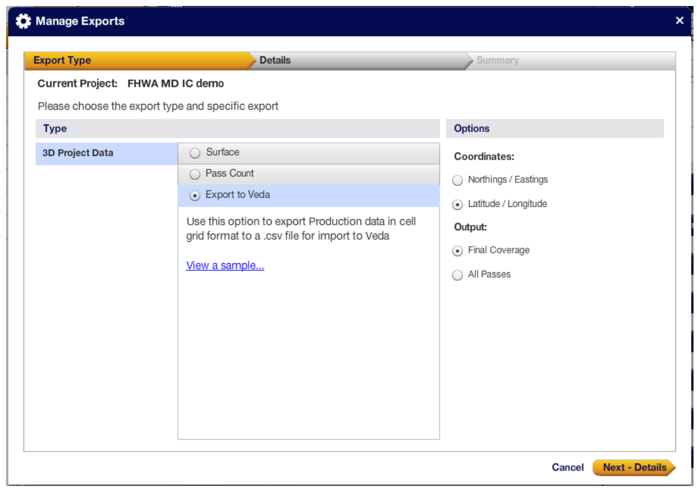
3. Ensure the No Lift Filter is selected.



4. Select Administration/Export from the menu.

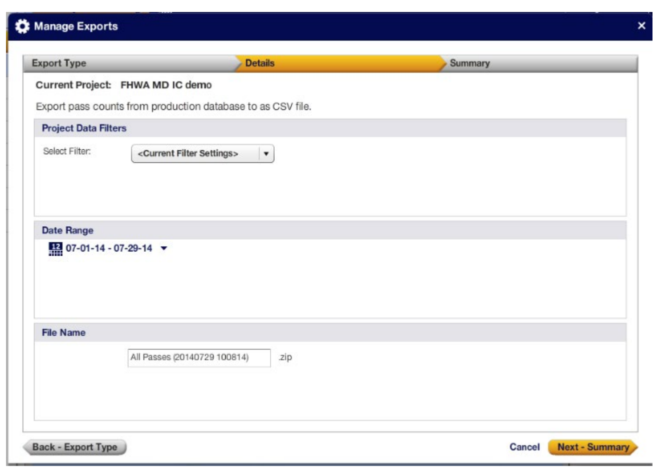


5. Within the “Management Exports/Export Type” dialog, select the Export to Veta, Coordinates (Latitude/Longitude), and Output (All Passes) to export the all passes data. Click “Next – Details”

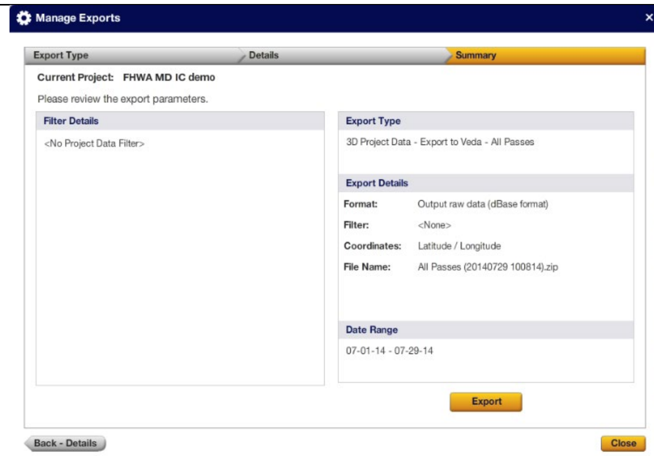


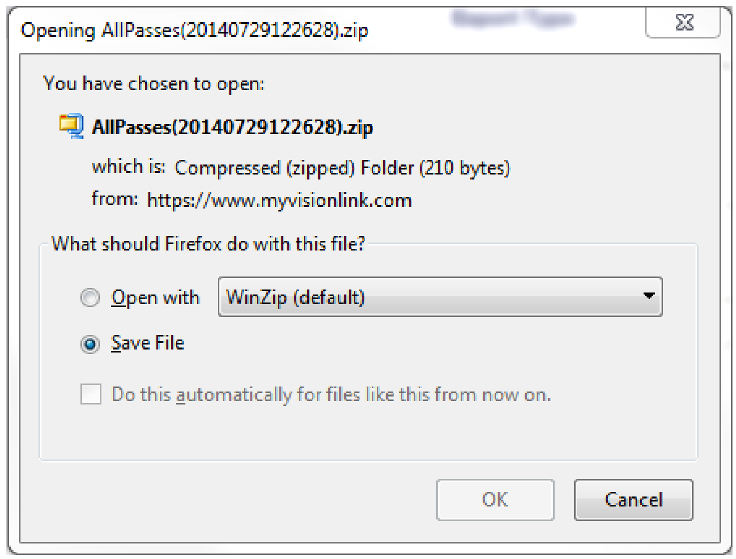
6. Within the “Management Exports/Details” dialogue, click “Next – Summary”

7. Within the “Management Exports/Summary” dialog, click “Export”



8. Select a target folder to save the exported zip file.





9. Click "Back – Details", then "Back – Export Type" and Repeat the above steps for "Final Coverage"

10. Unzip both the last pass and all passes files to csv files. These csv files are ready to be imported to Veta.

Direct Download from Cloud to Veta

The Caterpillar-Trimble IC data (ungridded *.tds) can be imported directly from the Cloud to Veta.

The user needs to have a login credential and set up in Veta. Then, select the account, site, and time frame to download data.

Dynapac IC Data

System Summary

The Dynapac IC system is summarized in Figure 36.

Rollers

Double drum

Single smooth drum

Onboard display

Documentation **Dyn@lzser**

Figure 35. Dynapac IC system.

Data Management

The Dyn@lzser IC data is stored in a database under Project/Object/Layer. The original file can be exported to text files.

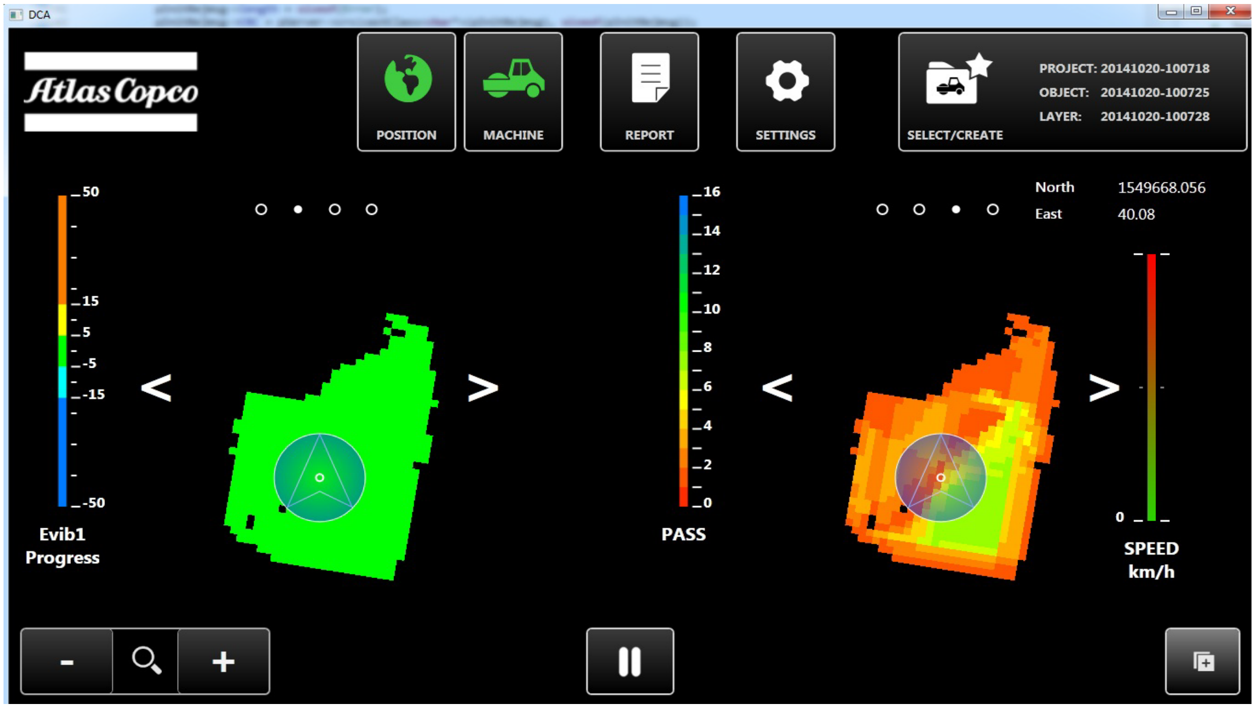


Figure 36. Dynapac Dyn@lzser IC Display

The Dyn@lzser IC system allows users to prepare a new project with different objects, layers, and sections prior to the fieldwork. A grid system can be selected to be used for positioning including UTM coordinates. Other grid systems can also be used based on transformation from WGS 84 to the desired local grid systems.

The Dyn@lzser documentation structure can be transferred to the roller computer using a USB memory stick after the data are recorded. Further objects, layers, and sections can be added to the roller on-board computer if needed.

Data Lot Names

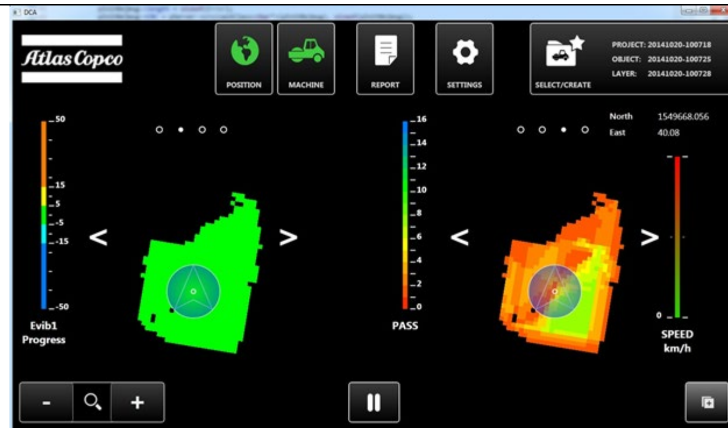
NA

Data Export Procedures

Once the data is recorded, it can be viewed and analyzed on the roller on-board computer. Users are strongly recommended to transfer the data to the office computer using a USB memory stick.

To export from database to text files:

1. Open a project in Dyn@lyzer software and select a desired Project/Object/Layer.



2. Connect USB-stick

3. Click "Export Text File"

The exported text data can be imported to Veta for further analysis.

Direct Download from Cloud to Veta

NA

Hamm IC Data

System Summary

The Hamm/Wirtgen IC system is summarized in Figure 38.

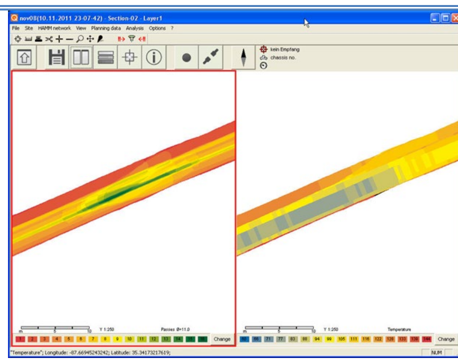
Rollers	 Double drum  Single smooth drum
Onboard Display	
Documentation	 HCQ

Figure 37. Hamm IC system.

Data Management

HAMM IC data need to transferred and stored locally under the following folder.

"C:\Users\Public\HammHcqData\Project"

HAMM IC data are stored in a folder that contains 7 sub-folders: Calibration, Dictionary, ErrorData, Export, PlanningData, Project, and Settings. The raw IC data are under the "Project" folder. The export files, once done, are in the Export subfolder.

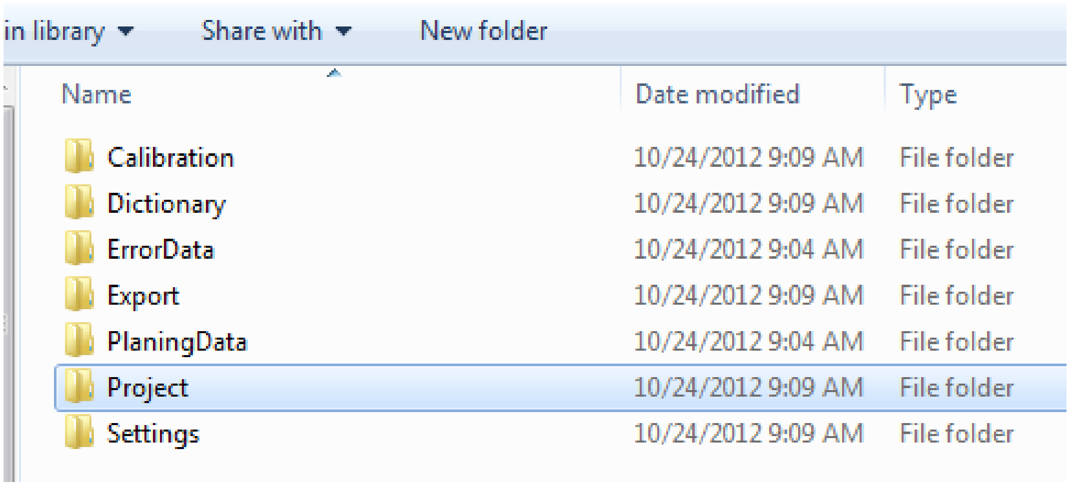


Figure 38. HAMM HCQ software – Folder structure.

Data Lot Names

NA

Data Export Procedures

Using a usb flash drive, HAMM IC data can be downloaded from the onboard display unit. Native HAMM IC data are organized in folders for any given project. The raw IC data are stored in binary files with the “hcq” extension under the “Project” subfolder. No naming convention is required.

*View HAMM *.hcq data using the HCQ software*:

1. Select File/Open Project from the menu.
2. Under the “Open project” dialogue, select the Project and Section and load the data.
3. Adjust the view setting to view desired IC maps. Note that HCQ allows split screens to view two types of data maps at the same time.
4. Use the Analysis/Filter setup to filter and view desired data.

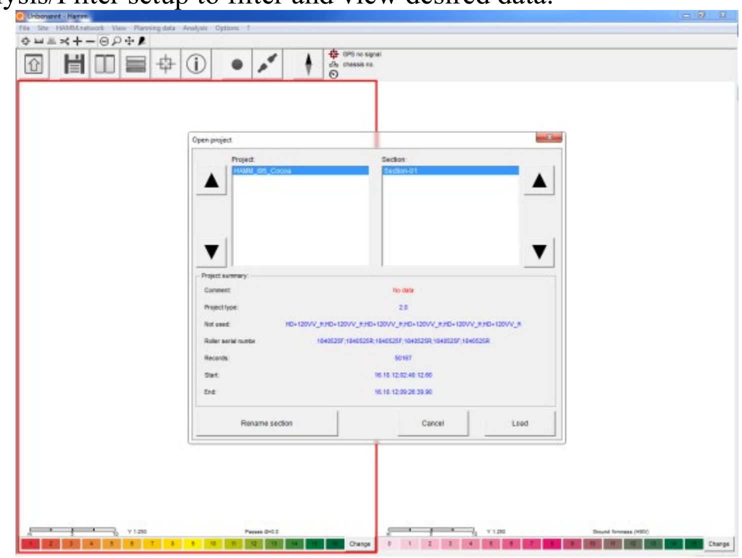


Figure 39. HAMM HCQ software – Open project dialogue.

*Export HAMM *.hcq data to text files using the HCQ software*:

1. Select File/IC Export All Data to export all-passes data.
2. A “File > IC Export Dialogue would appear and show progress bars. Click the OK button once the Export is finished.
3. Use Windows’ filer explorer to navigate to "C:\Users\Public\HammHcqData\Project" and select the current project name and its Export subfolder.
4. The exported data will be saved under the Export subfolder with *_amd.vexp as filename extension. Use only the front drum data to import to Veta. Normally the file name would consist of date stamp and “F” instead of “R” (e.g. Mainline Surface_IC_2070045F(2)_1_amd.vexp).

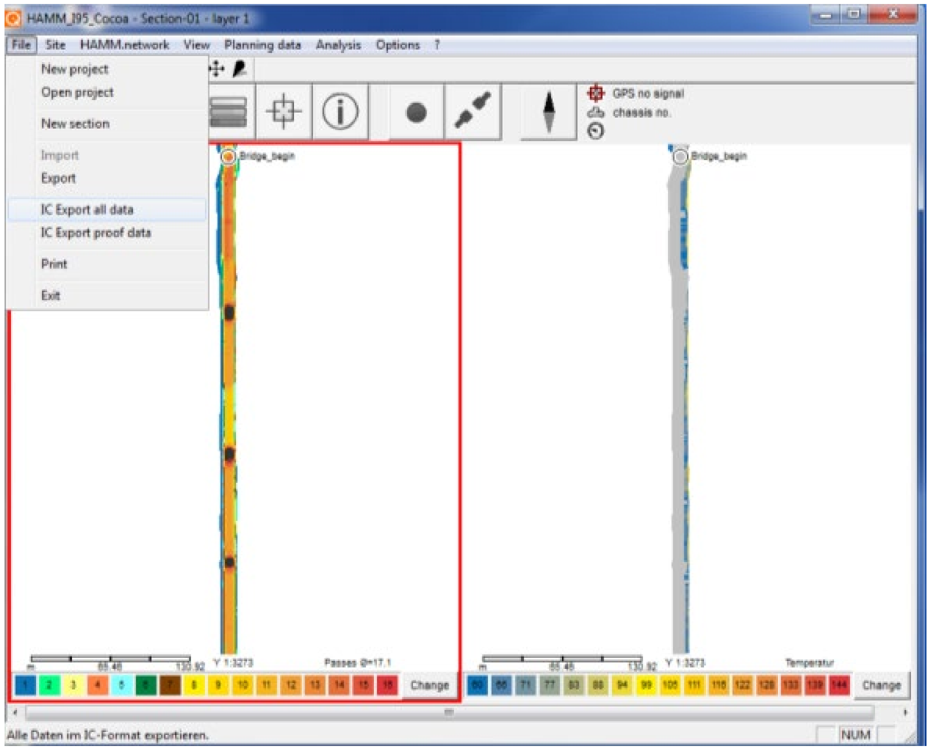


Figure 40. HAMM HCQ software – Export menu.

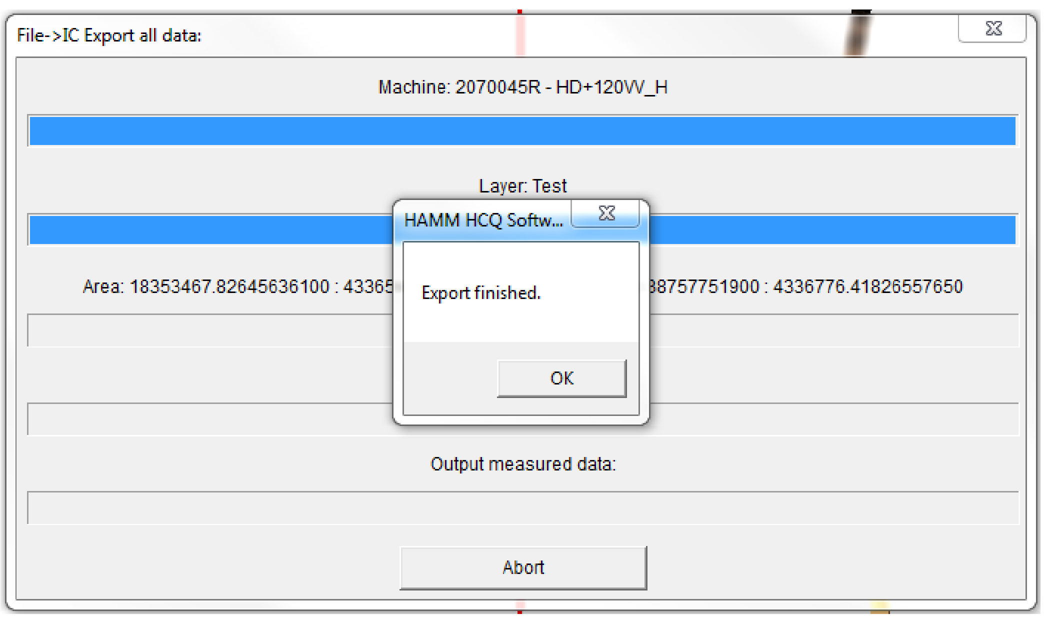


Figure 41. HAMM HCQ software – IC Export all data.

Direct Download from Cloud to Veta

NA

LEICA IC Data

System Summary

The LEICA GEOSYSTEMS IC retrofit system.

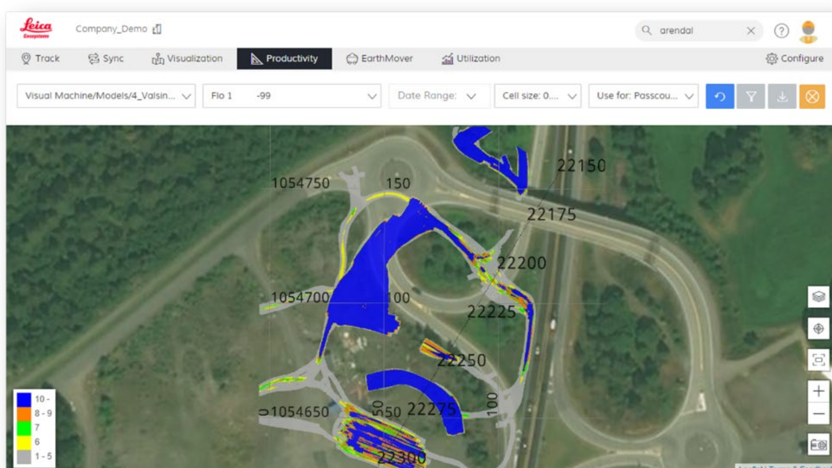
Roller Components	IC retrofit can be mounted on a selected Soil Compactor for Pass count and CMV (Compactor Meter Value) readings. 
Documentation System ConX.	

Figure 42. Leica IC system.

Data Management

The Leica Geosystems IC documentation system is Leica ConX web service with the ability to export files to Veta.

Open the internet browser and select your Leica Geosystems ConX start page.

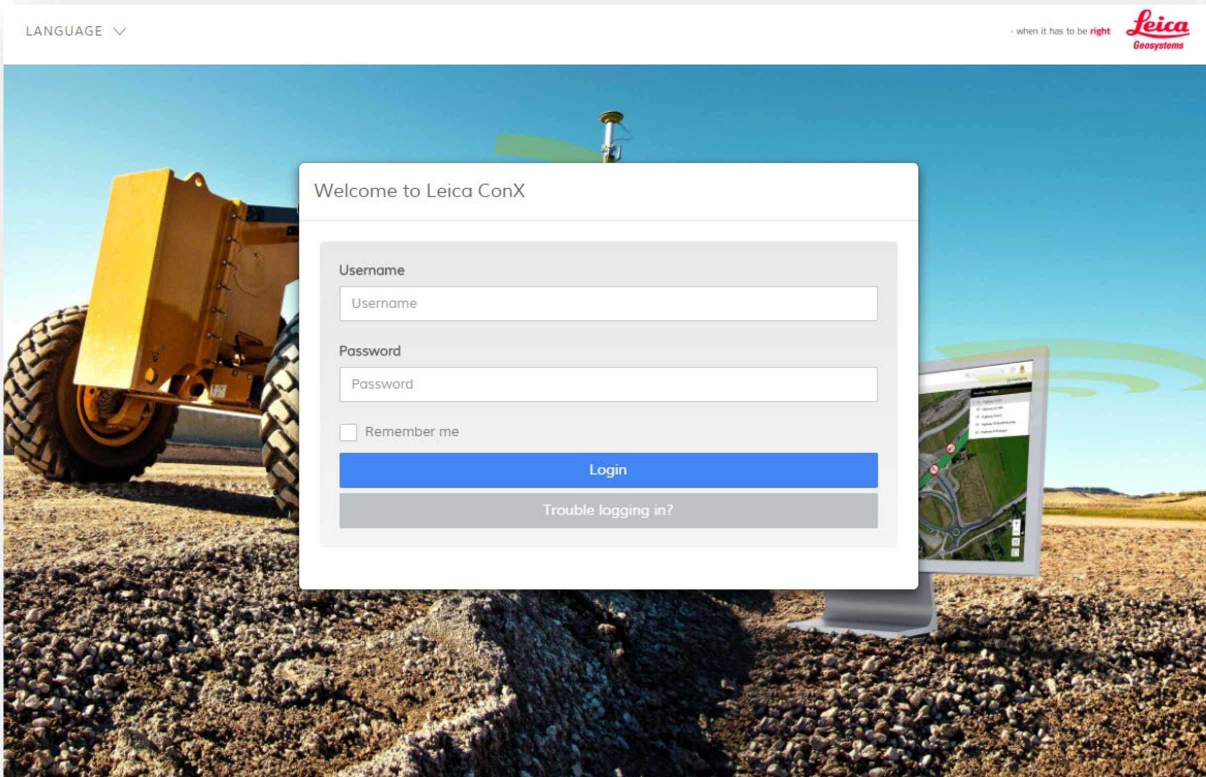
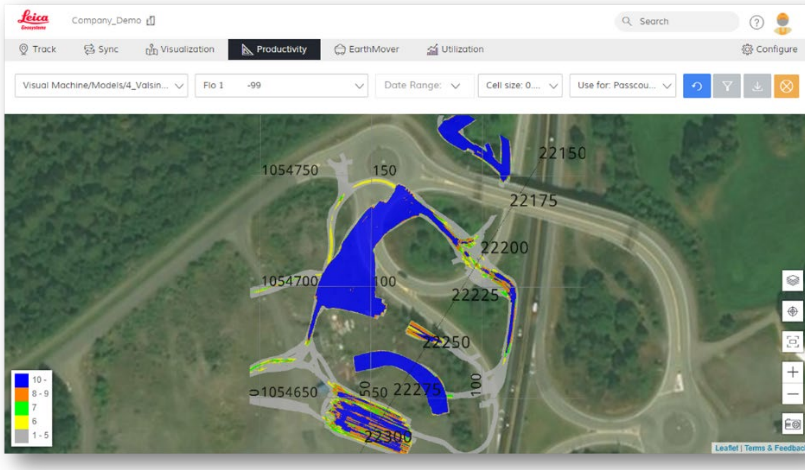
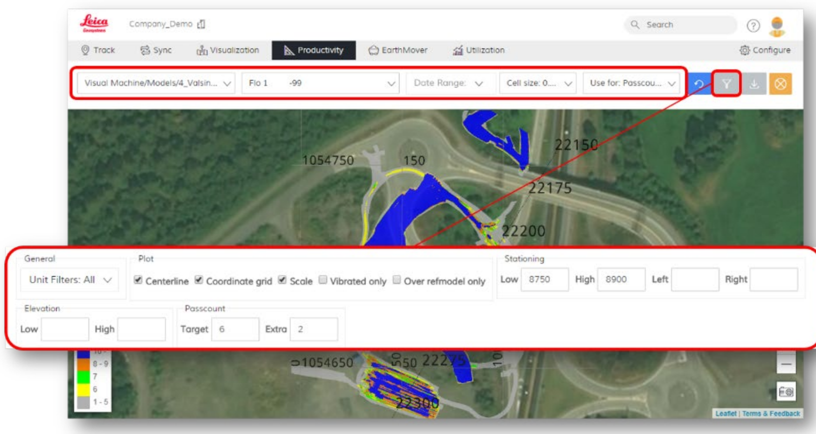
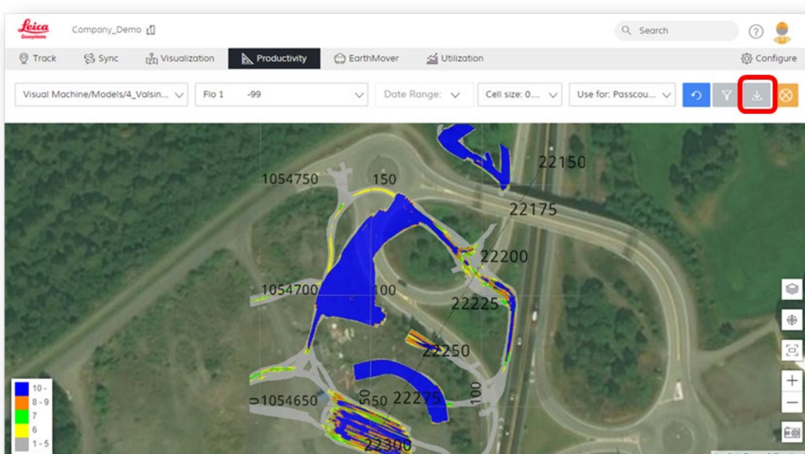


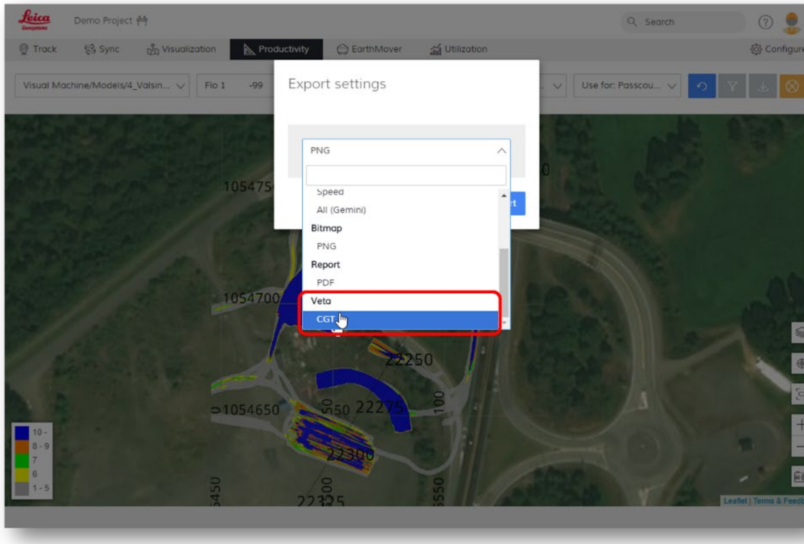
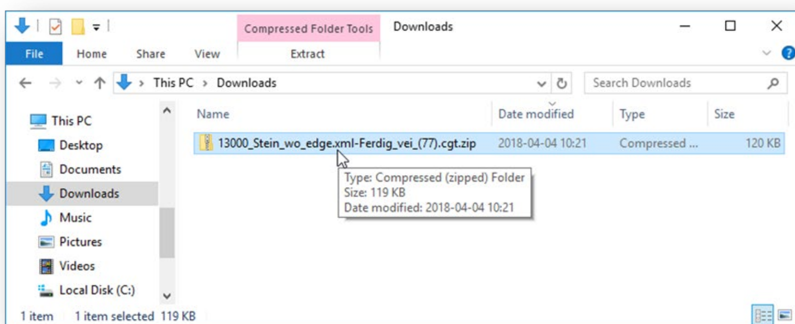
Figure 43. Leica IC Viewer Program.

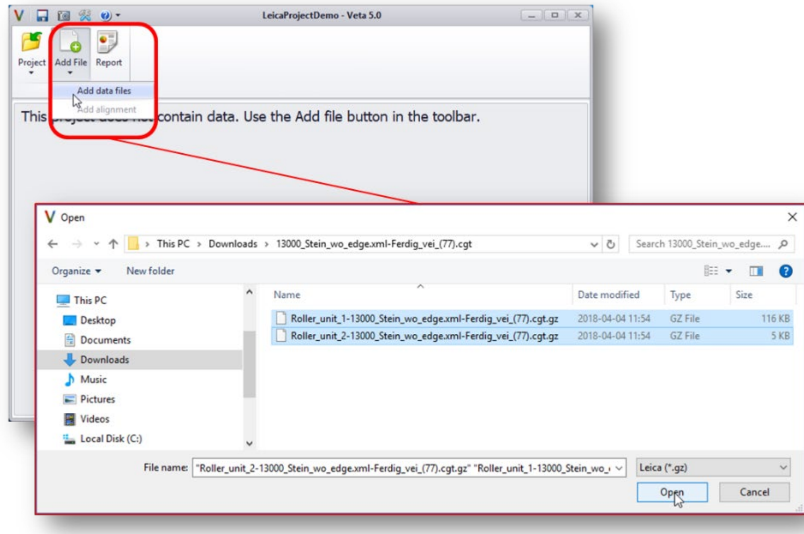
Data Lot Names

NA

Data Export Procedures

1. Navigate to the Productivity tab.	
2. Use the filters (and advanced filters if necessary) to find the data needed.	
3. Click the Export button.	

<table>
<tr>
<td>4. Select “Veta - CGT” and click the Export button.</td>
<td>
</td>
</tr>
<tr>
<td>5. Download the report.cgt.zip file and unzip it to your local computer.</td>
<td>
</td>
</tr>
</table>

6. The CGT.GZ files can then be imported to Veta 5.2+	

Open Veta 5.2+ and create a new project.
When done add files from your folder with ConX exports.
Optionally, users can import the zip files from ConX (*.gz) directly to Veta.

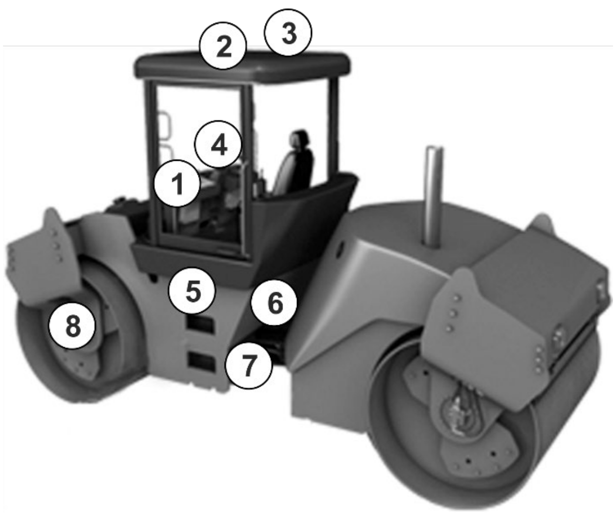
Direct Download from Cloud to Veta
NA

MOBA IC Data

System Summary

The summary of the MOBA Compaction Assistant (MCA-3000) system is shown in the table below.

Roller



1 Touch screen display

2 GNSS antenna

3 WIFI antenna (optional)

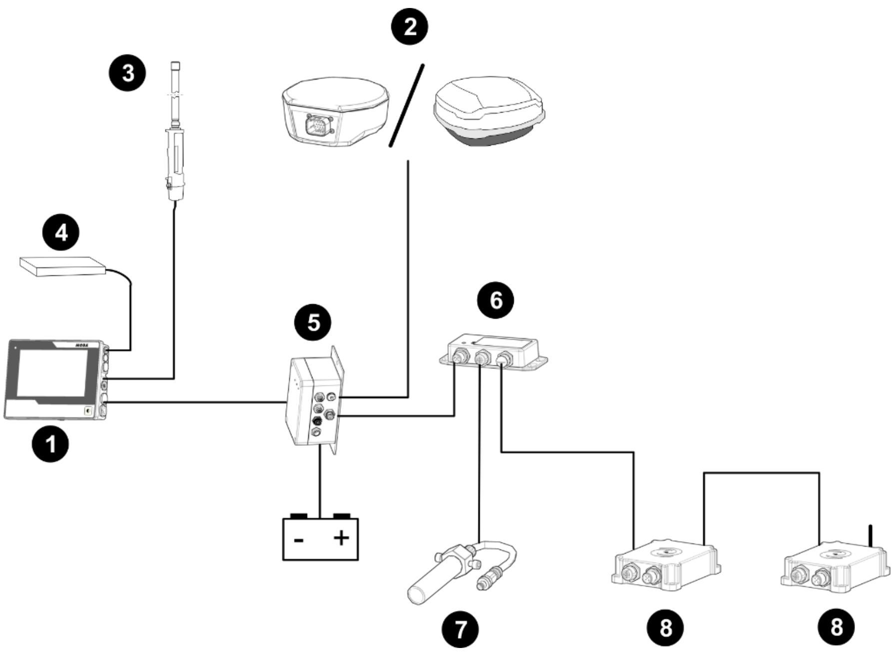
4 GSM antenna (optional)

5 Uninterruptible power supply

6 T-connector (optional)

7 IR temperature sensor (optional)

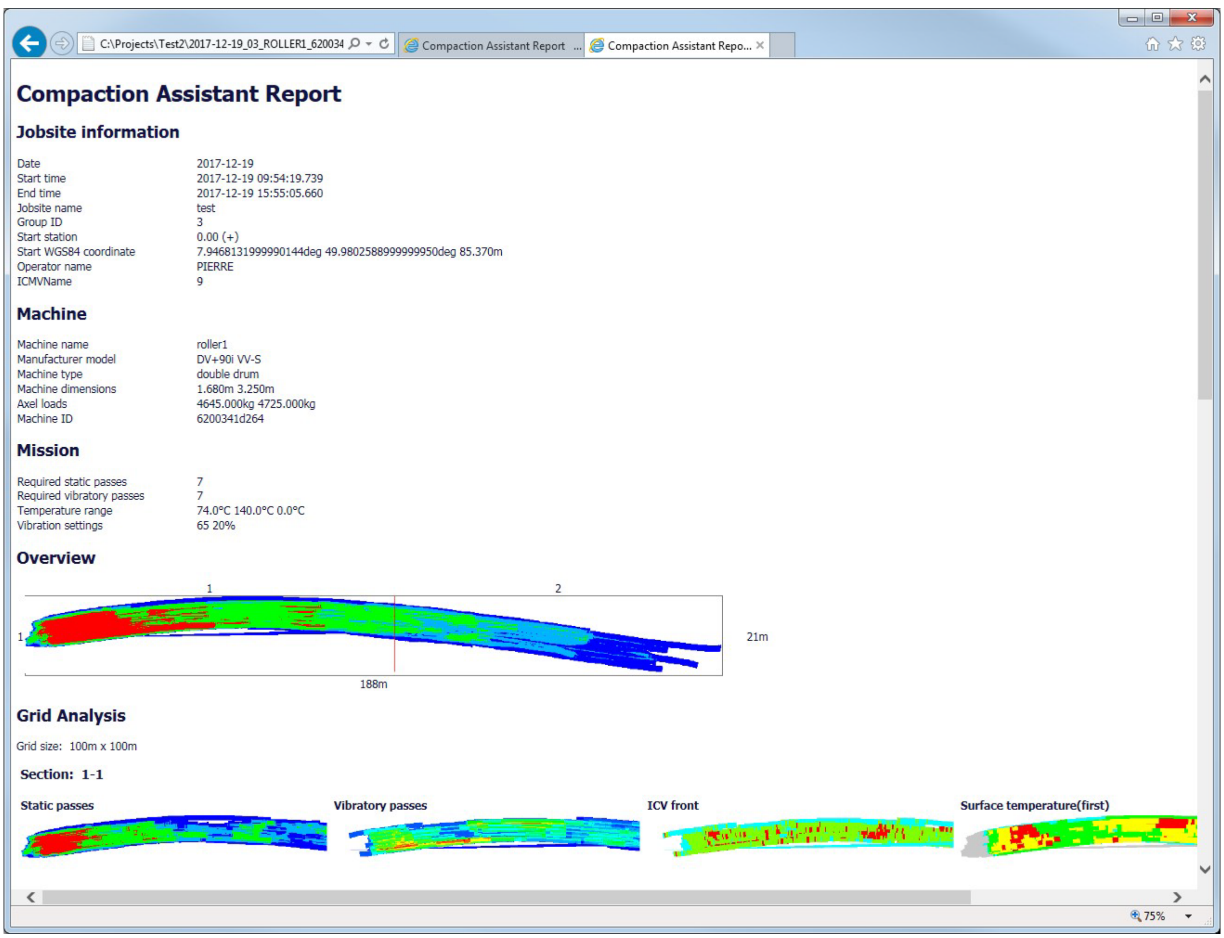
8 Acceleration sensor (optional)



On-board display

Documentation

Xml Report



C:\Projects\Test2\2017-12-19_03_ROLLER1_620034
Compaction Assistant Report
Compaction Assistant Repo...

Compaction Assistant Report

Jobsite information

Date	2017-12-19
Start time	2017-12-19 09:54:19.739
End time	2017-12-19 15:55:05.660
Jobsite name	test
Group ID	3
Start station	0.00 (+)
Start WGS84 coordinate	7.946813199999990144deg 49.98025889999999950deg 85.370m
Operator name	PIERRE
ICMVName	9

Machine

Machine name	roller1
Manufacturer model	DV+90i VV-S
Machine type	double drum
Machine dimensions	1.680m 3.250m
Axel loads	4645.000kg 4725.000kg
Machine ID	6200341d264

Mission

Required static passes	7
Required vibratory passes	7
Temperature range	74.0°C 140.0°C 0.0°C
Vibration settings	65 20%

Overview

Grid Analysis

Grid size: 100m x 100m

Section: 1-1

CEval desktop application

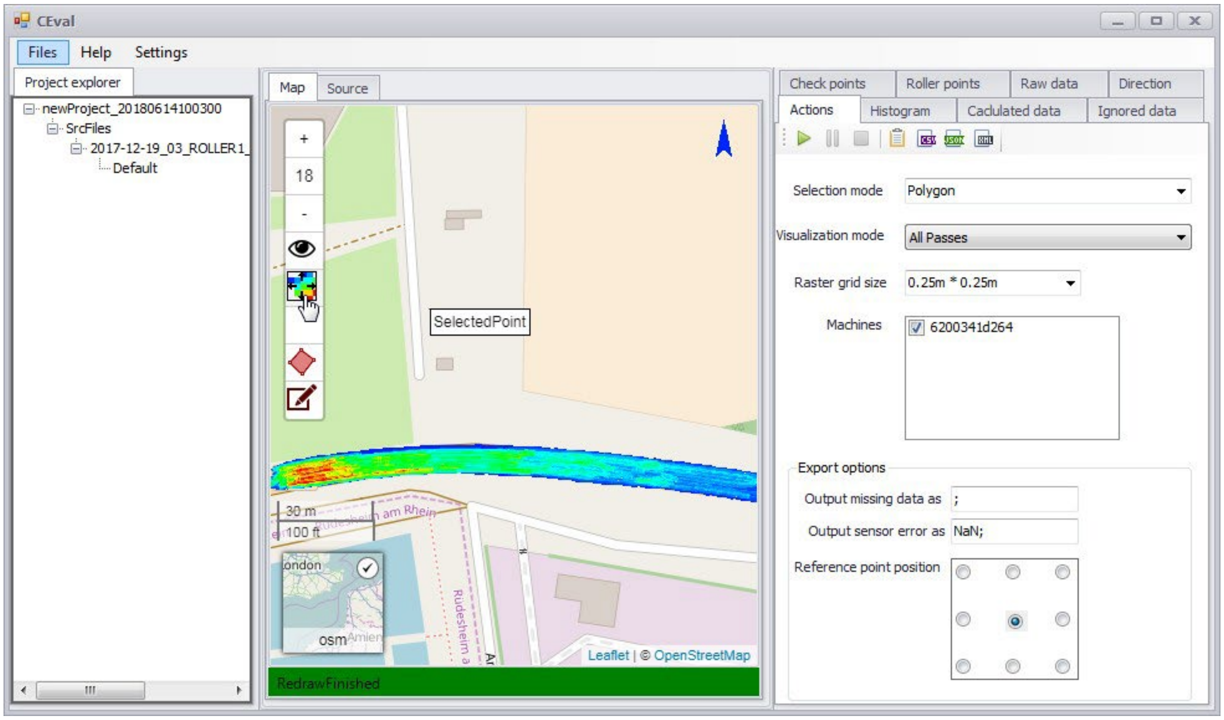


Figure 44. MOBA IC system.

Viewing Program

MOBA Compaction Assistant (MCA-3000) - consisting of a GNSS antenna, an on-board computer, a touch screen, a temperature sensor (optional), and an acceleration sensor (optional) - supports the operator by displaying the number of roller passes, surface temperature, and compaction values of the whole project.

Depending on the GNSS antenna, the position of the roller is recorded with a decimeter-to-centimeter-level accuracy. The Compaction Assistant enables the operator to achieve the preset compaction by evenly compacting the entire working area. It results in a homogenous compacted material preventing later damages to the road surface.

The fleet configuration enables the operator to see all the rollers' static and vibratory passes on the same project. Therefore, the operators have a whole picture of the project and improve compaction by working in collaboration.

Data Management

After finishing the work, a work report of the whole project can be generated for post-processing, which is either saved on a USB stick or transferred to the cloud server.

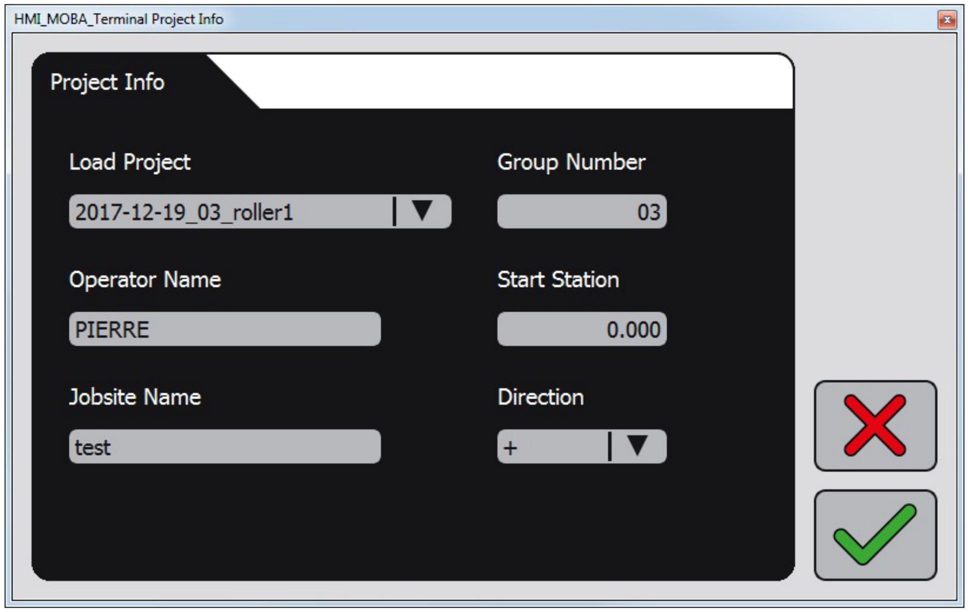
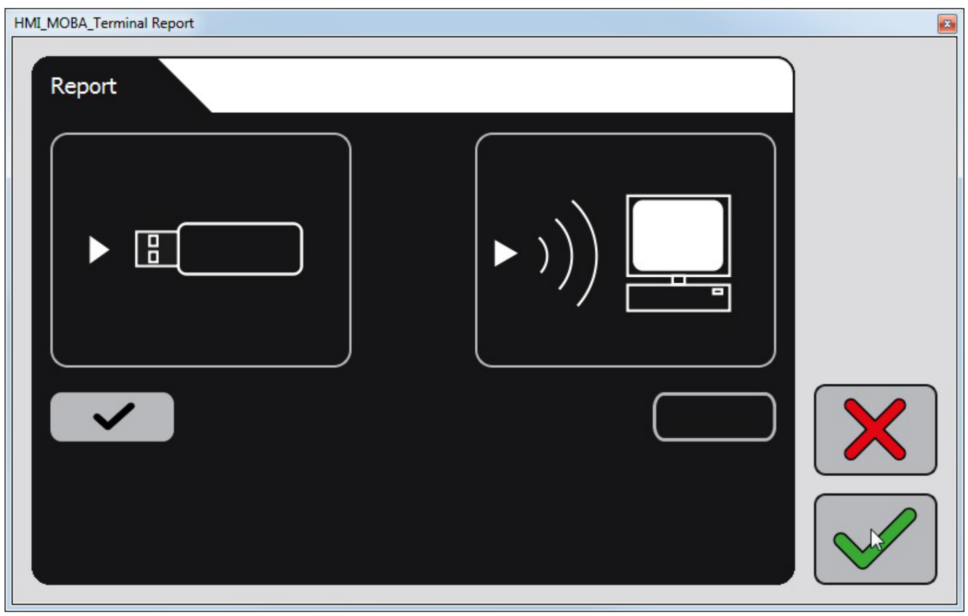
The file naming convention can be taken from the MCA-3000 user manual.

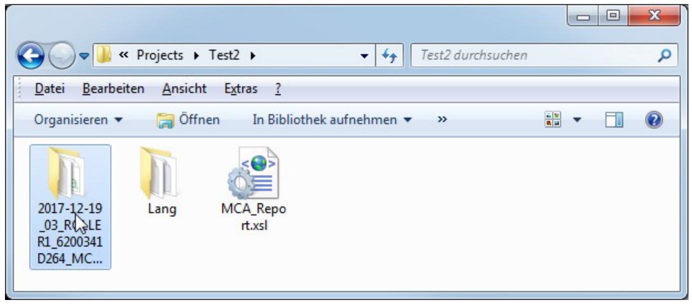
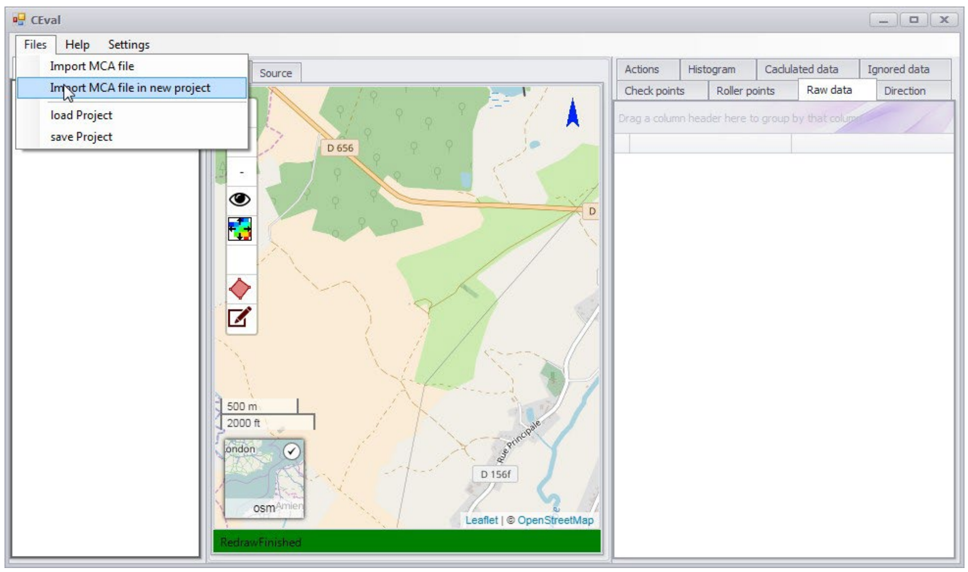
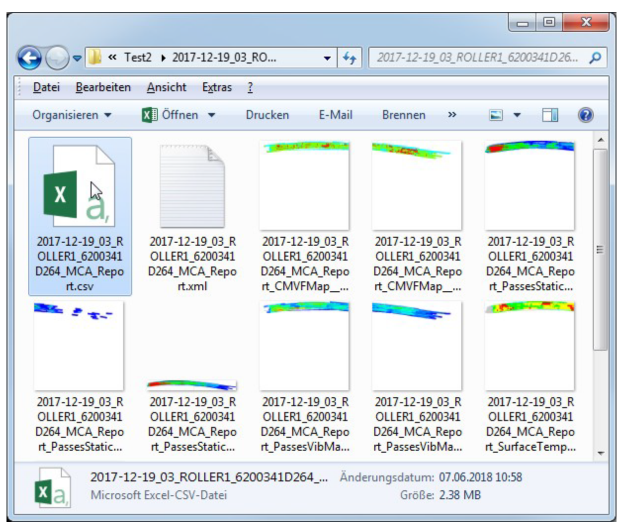
The report can be viewed directly in Internet Explorer or in the PC desktop application ***CEval***.

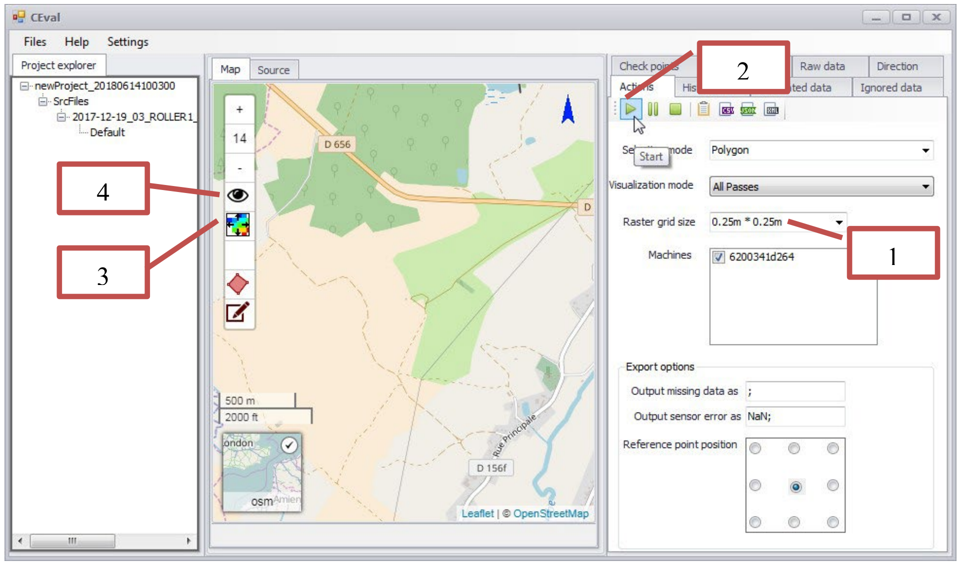
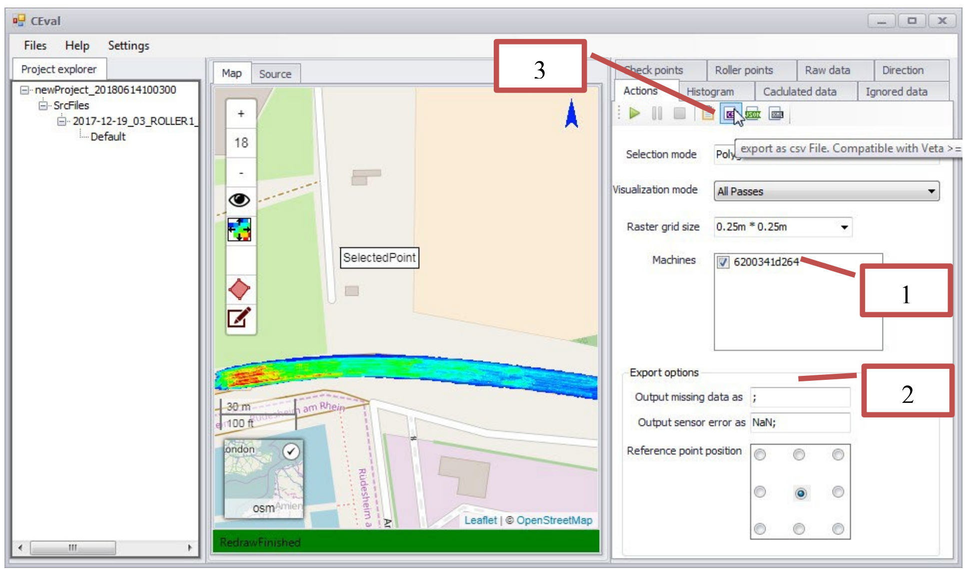
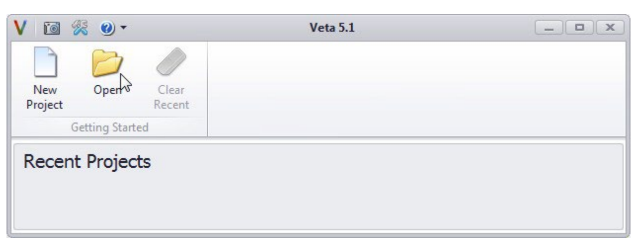
Data Lot Names

NA

Data Export Procedure

<table>
<tr>
<td>Select the project on the on-board display</td>
<td>
</td>
</tr>
<tr>
<td>Generate the report on the on-board display</td>
<td>
</td>
</tr>
</table>

Unzip the report to a local directory on the PC. The data are contained in the csv file.	
Start CEval.exe and load MCA report (csv) from the above location.	 

<table>
<tr>
<td>Load and view the data.
1. Choose raster size: 0.25x0.25cm.
2. Import the data.
3. Center the map to the worksite.
4. Show the map.</td>
<td>
</td>
</tr>
<tr>
<td>Generate the Veta export file.
1. Select the machine(s). For each selected machine a separate export file will be generated.
2. Set “Export options” as shown on the screenshot.
3. Click the “Csv” export button.
4. You will be asked to enter the location and the name for the exported file.</td>
<td>
</td>
</tr>
<tr>
<td>Load the exported file(s) to Veta using the “Open” button. The type of the import file will be recognized as “MOBA Compactor”.</td>
<td>
</td>
</tr>
</table>

Direct Download from Cloud to Veta

The MOBA IC data (ungridded *.tds) can be imported directly from the Cloud to Veta.

The user needs to have a login credential and set up in Veta. Then, select the account, site, and time frame to download data.

Sakai IC Data

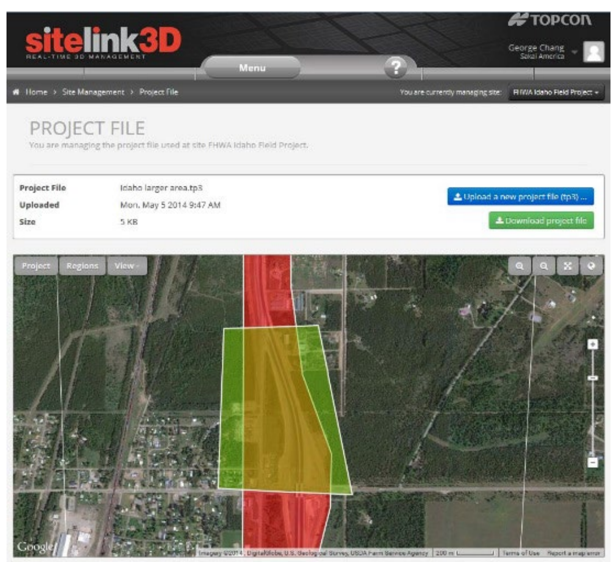
System Summary

Roller

double drum | single drum pad foot

Control Panel

Documentation



TOPCON SiteLink web service with the ability to export files to Veta

Figure 45. Sakai IC system.

Data Management

The Sakai IC documentation system is TOPCON SiteLink web service with the ability to export files to Veta.

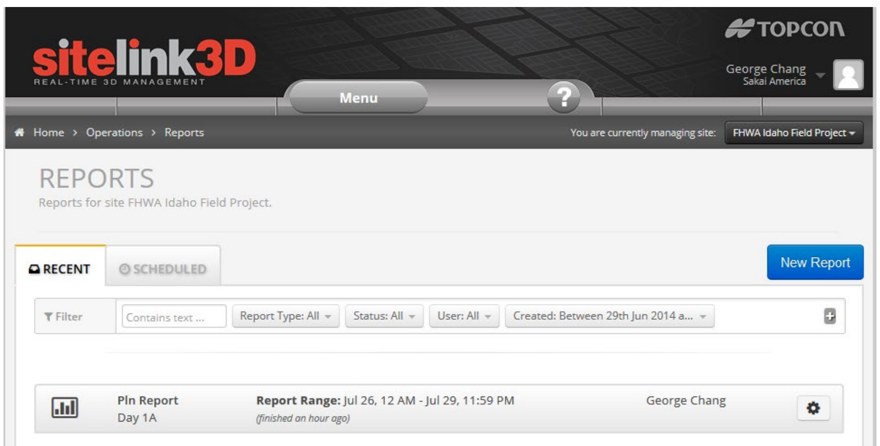
Figure 46. Sakai Uses TOPCON sitelink3D.

Data Lot Names

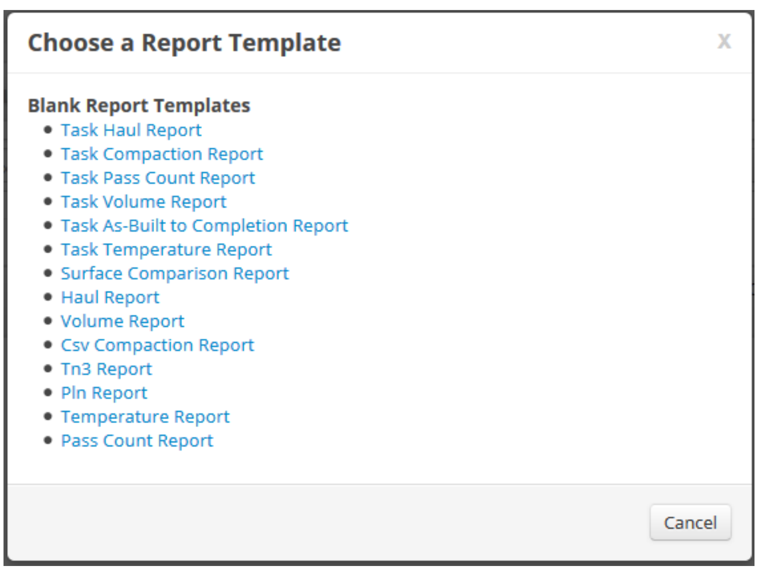
NA

1. Select "Reports" from the Menu.

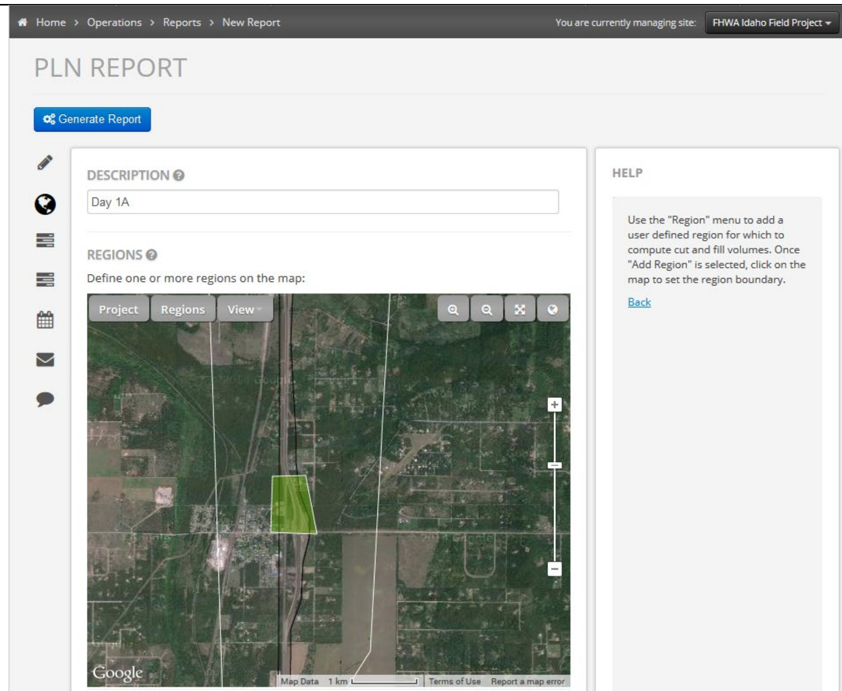
2. Click "New Report" on the REPORTS screen.

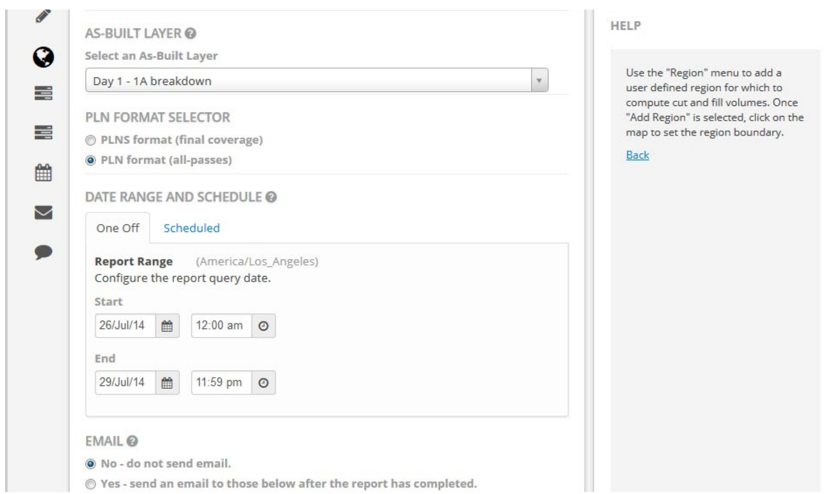


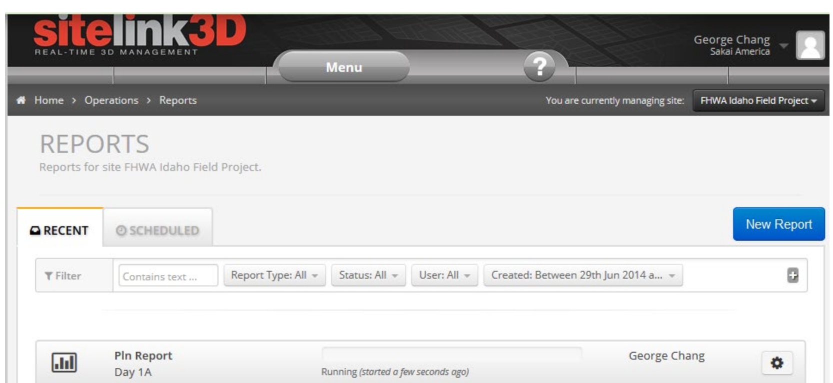
3. Select "Pln Report"



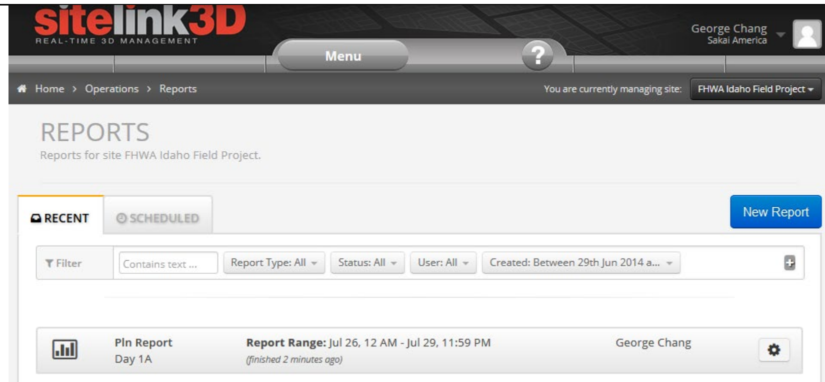
4. Provide report Description, select a region, select As Build Layer, select PLN format (all-passes), Set start/end Date/time, then click Generate Report.





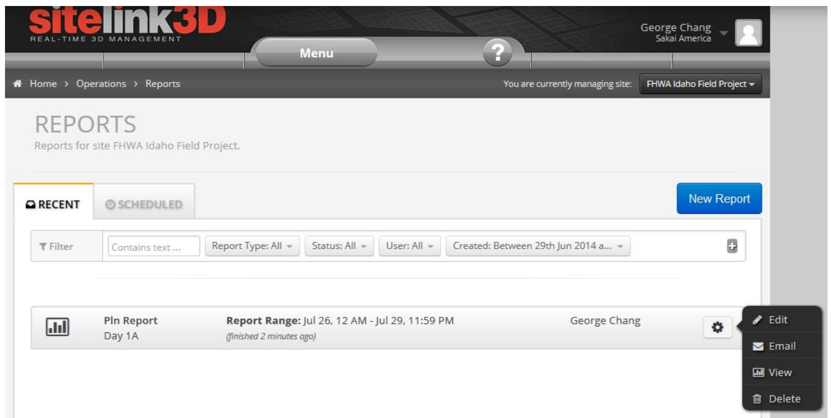


5. The Report Generation is under progress with notes "Running (started a few seconds ago)"

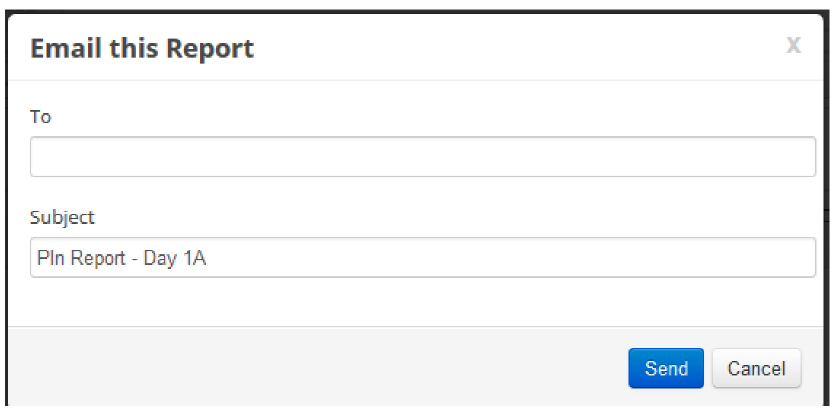


6. Once it is complete, a report range would appear.

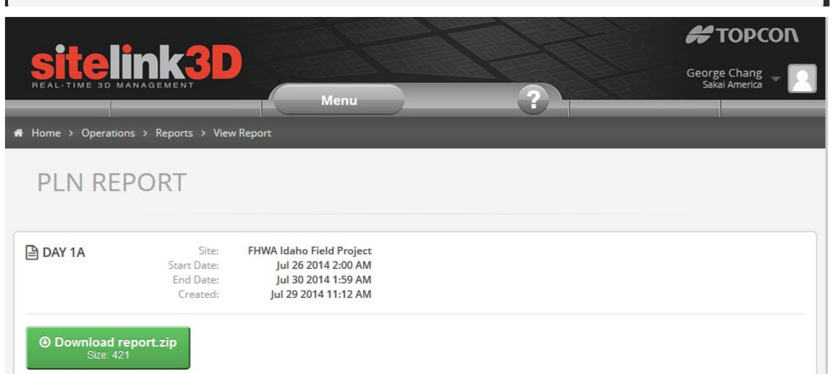
7. Click the gear wheel symbol and select Email.



8. Enter the email address for receiving a download link for the PLN report.



9. Download the report.zip and unzip the PLN file to your local computer. Rename the report.pln file to a more descriptive file name. The PLN file can then be readily imported to Veta.



Direct Download from Cloud to Veta

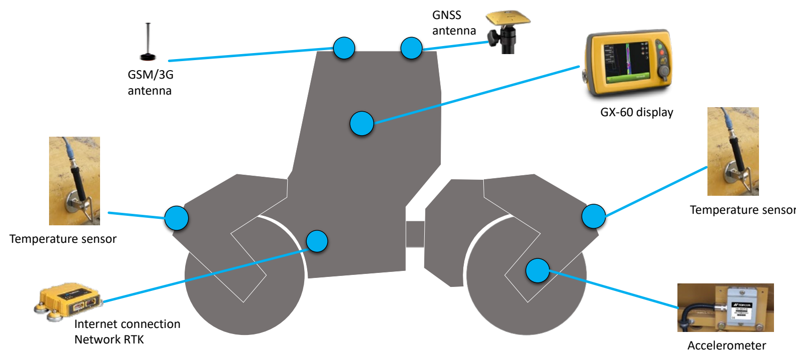
NA

TOPCON IC Data

System Summary

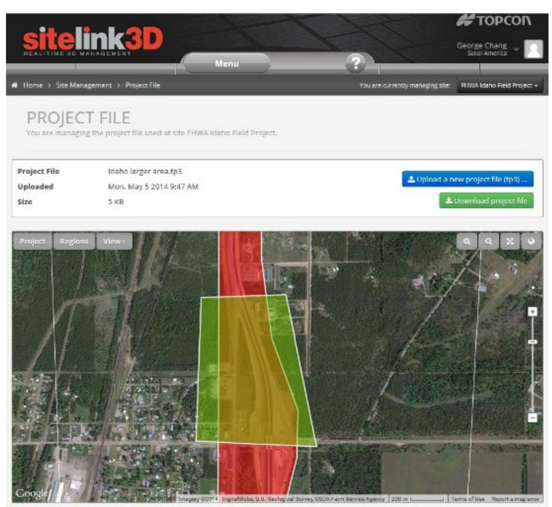
Hardware

IC retrofit can be mounted on selected roller models.



Onboard Display

Documentation



TOPCON SiteLink

Figure 47. TOPCON IC system.

Data Management

The TOPCON IC documentation system is SiteLink3D web service with the ability to export files to Veta.

Figure 48. TOPCON sitelink3D.

Data Lot Names

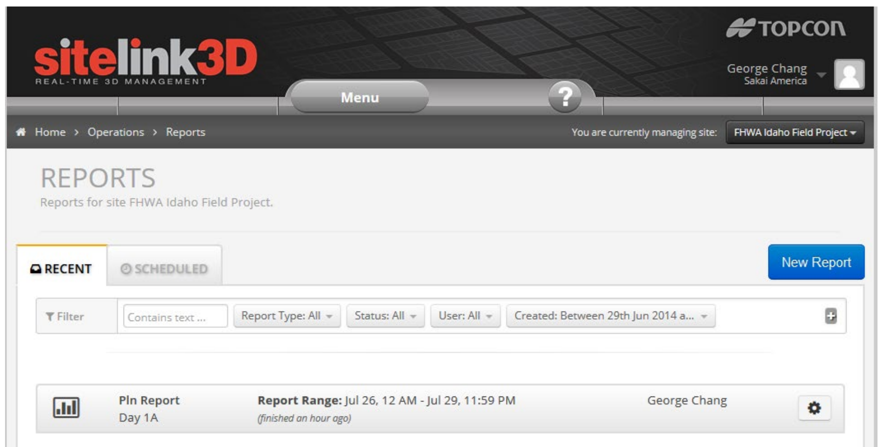
Topcon (IC)

- When using a PLN file, the data lot name comes from the Name item under [Construction Area].
- When downloading from SiteLink, the name comes from the layer associated with a given task.

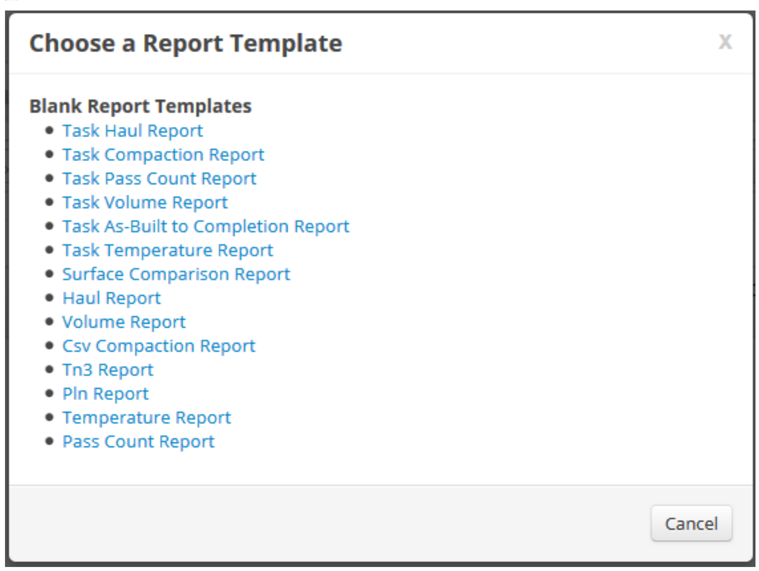
Data Export Procedures

1. Select "Reports" from the Menu.

2. Click "New Report" on the REPORTS screen.

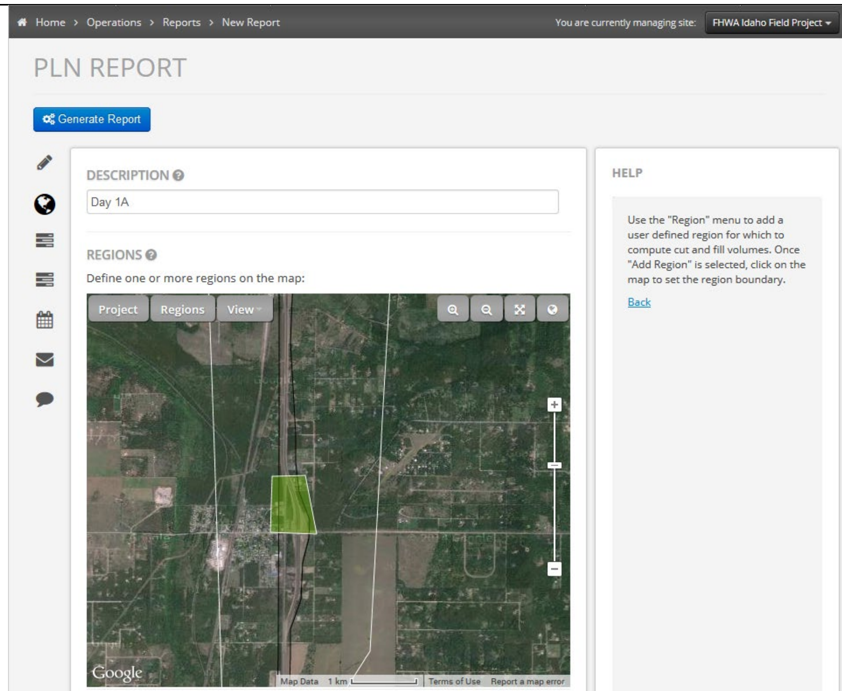


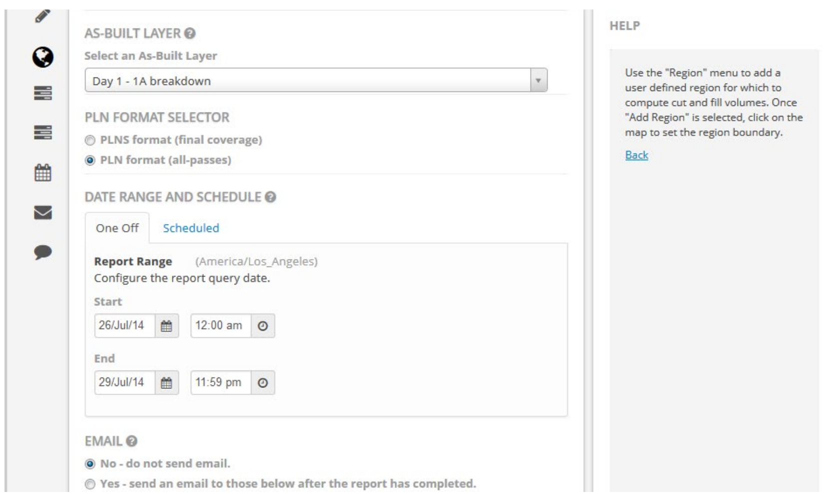
3. Select "Pln Report"

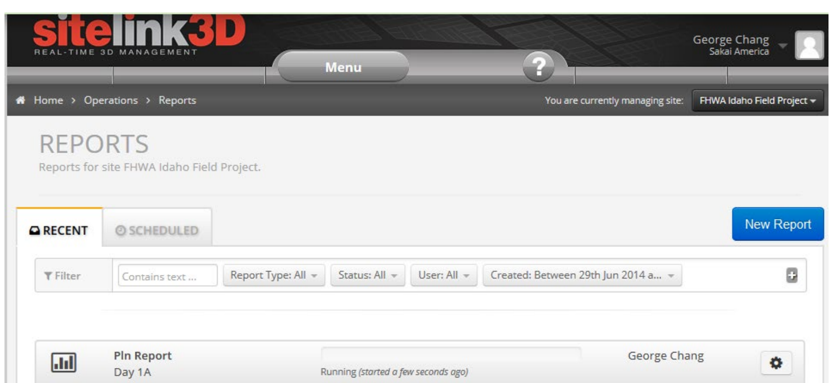


4. Provide report

Description, select a region, select As Build Layer, select PLN format (all-passes), Set start/end Date/time, then click Generate Report.

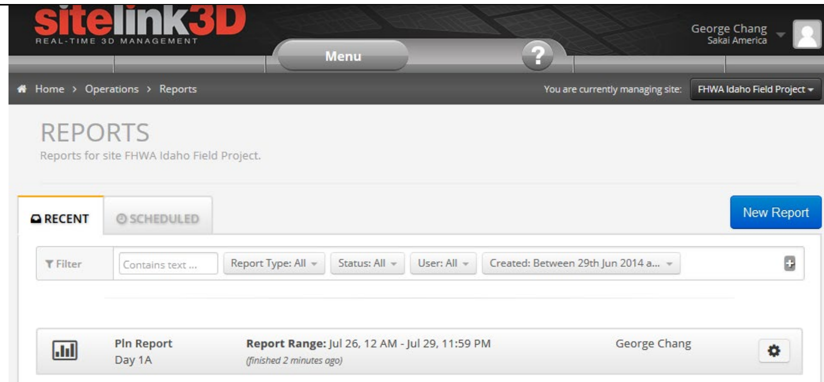




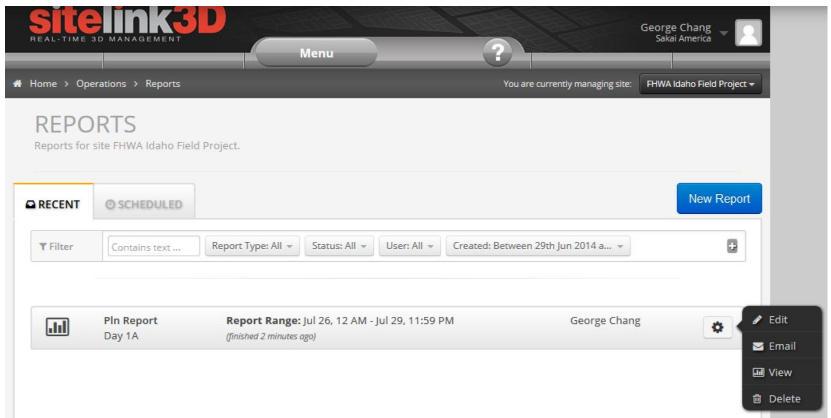


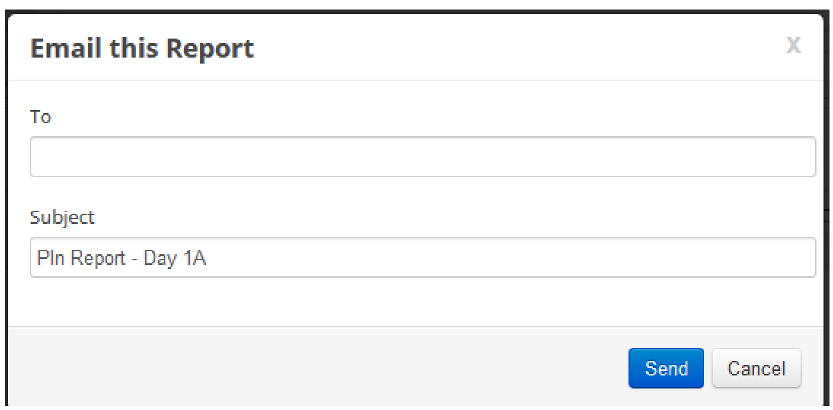
5. The Report

Generation is under progress with notes “Running (started a few seconds ago)”

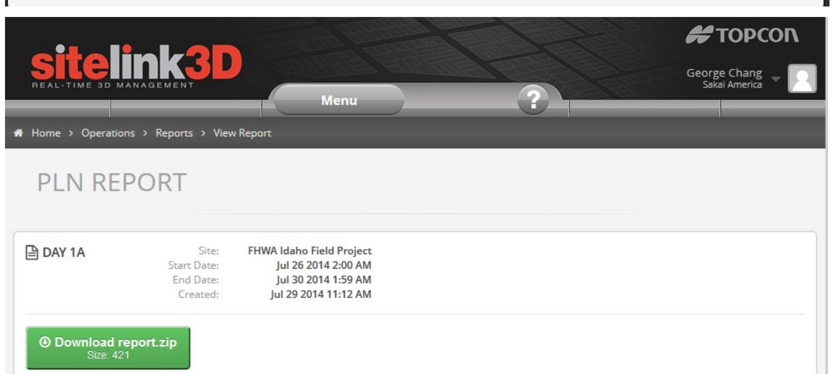


6. Once it is complete, a report range would appear.





7. Click the gear wheel symbol and select Email.



8. Enter the email address for receiving a download link for the PLN report.

9. Download the report.zip and unzip the PLN file to your local computer. Rename the report.pln file to a more descriptive file name. The PLN file can then be readily imported to Veta.	

Direct Download from Cloud to Veta

TheTOPCON IC data (ungridded *.tds) can be imported directly from the Cloud to Veta.

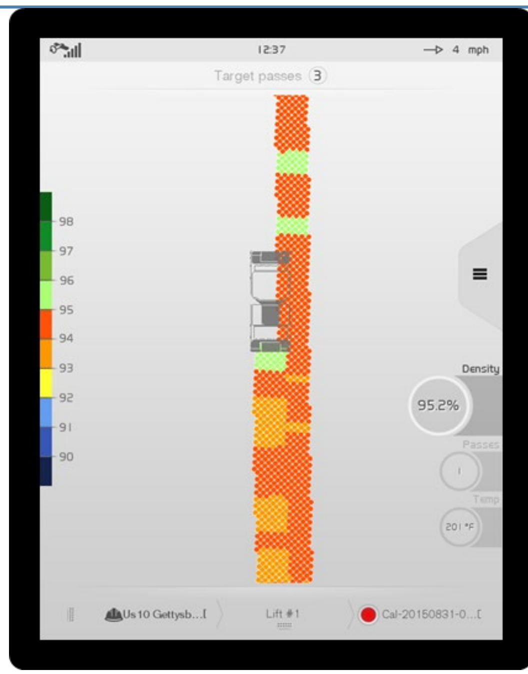
The user needs to have a login credential and set up in Veta. Then, select the account, site, and time frame to download data.

VOLVO IC Data

System Summary

Roller

Onboard Display



Documentation

Volvo proprietary IC software

Figure 49. VOLVO IC Retrofit system.

Data Management

The VOLVO IC system makes use of Android –based tablets. The system can display the pass count map, temperature map, and estimated density map as follows.

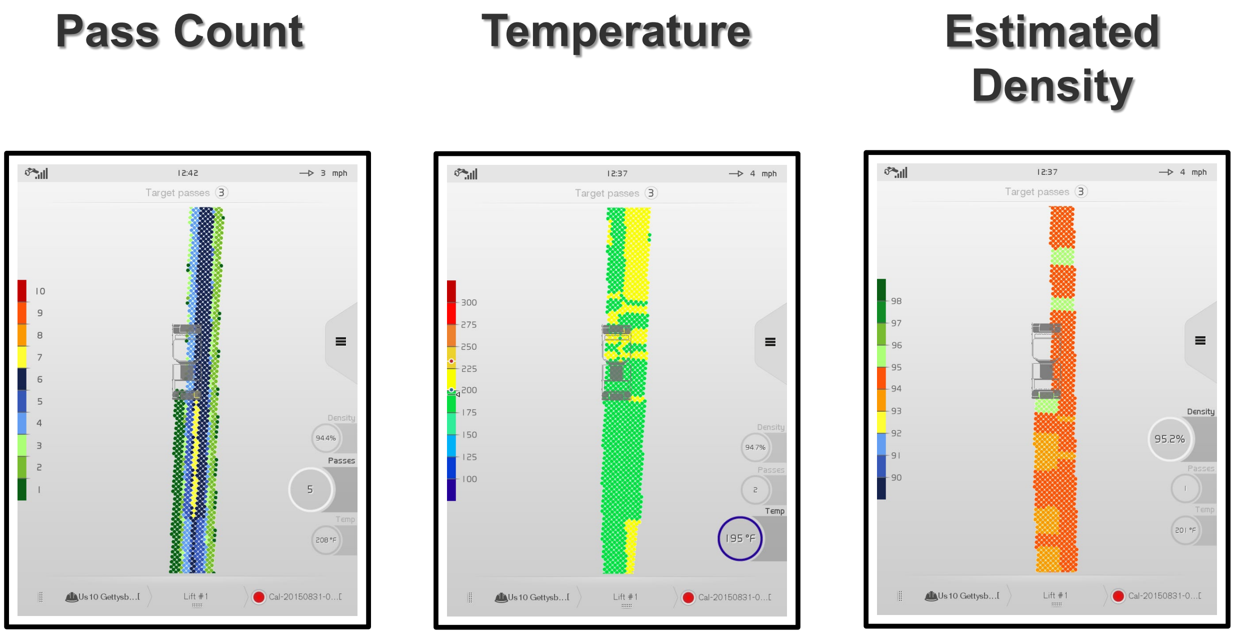
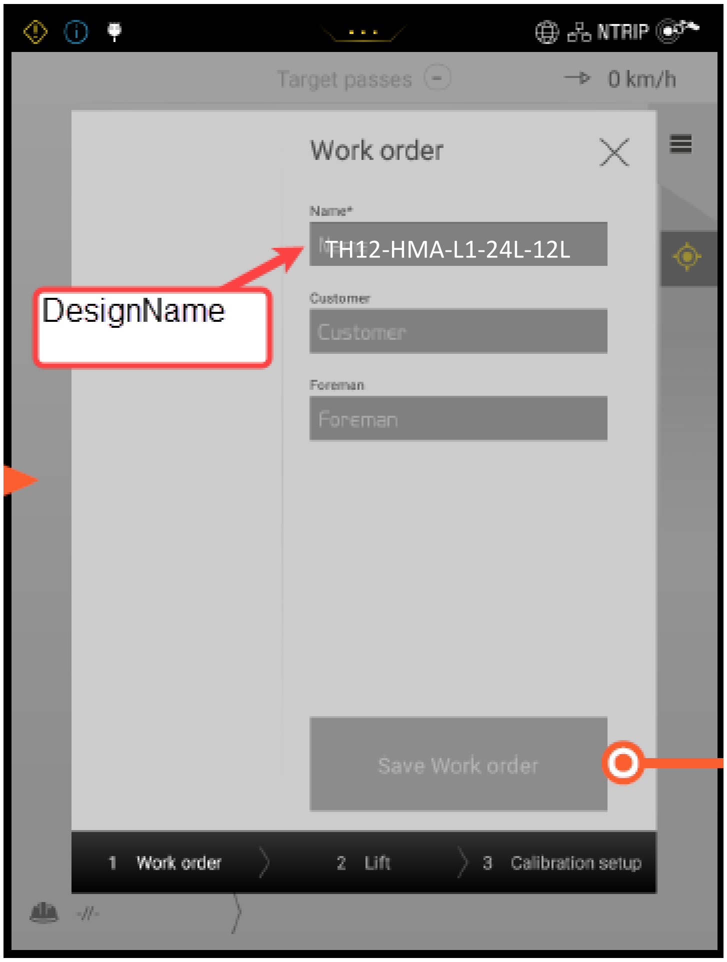


Figure 50. VOLVO IC Display.

Data Lot Names

When starting a Work order, use the Name field to enter the AASHTO “Data Lot Name”. This will store the data lot names under the “DesignName” column of the data.

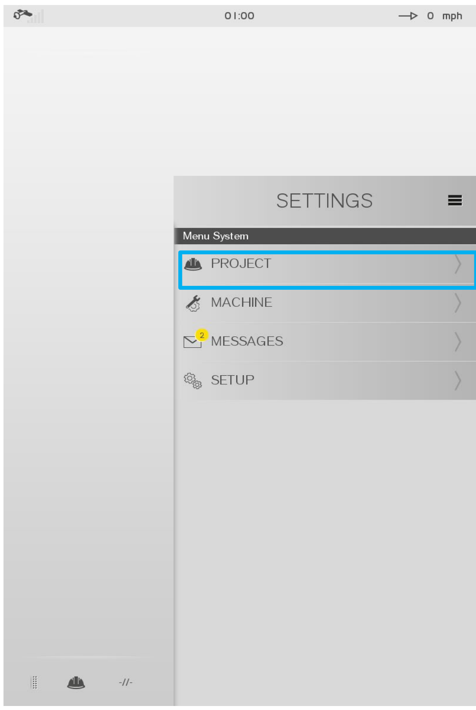
Note that a new calibration will be needed after starting a Work order.



Data Export Procedures

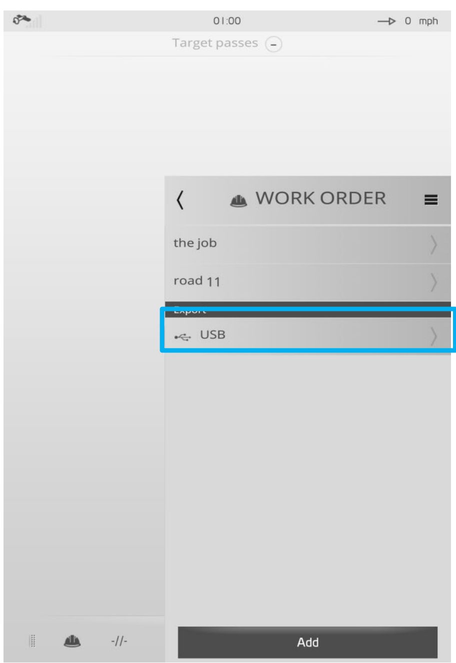
The VOLVO IC tablets can export IC data in csv format directly to an USB drive. The csv files can then be imported to Veta.

1.



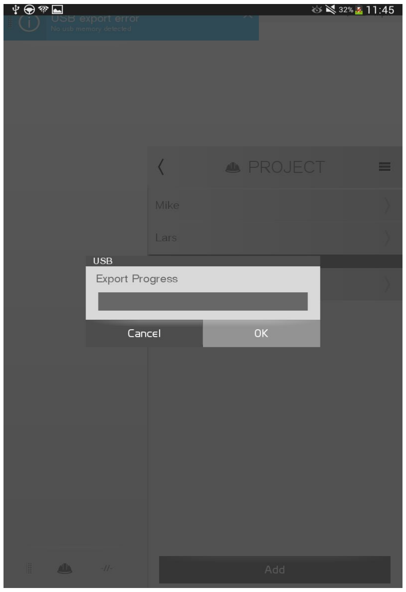
Select
Project

2.



Select
USB

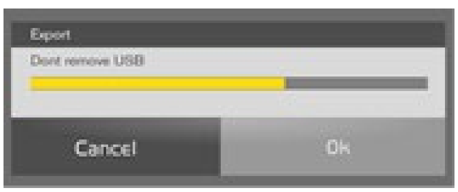
3.



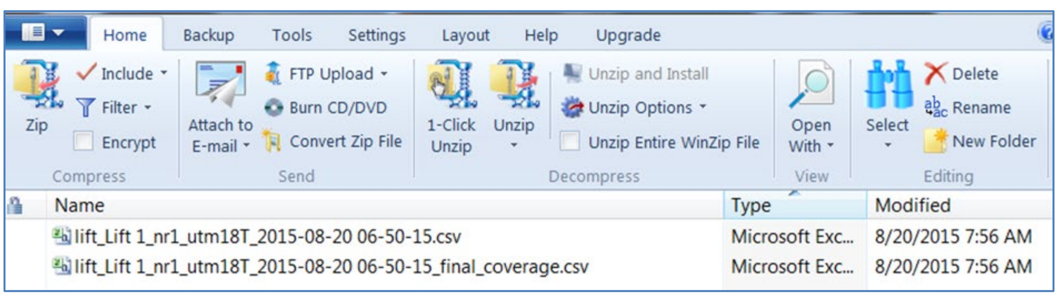
Make sure USB stick is inserted in back of display.

Select OK

4.



5.



Remove USB and download to PC.

There are two data files in each zipped project file: all-passes data and final coverage data.

The file name convention is: Lift number + UTM zone + Date + Time.

"_final_coverage" denotes the final coverage data.

Direct Download from Cloud to Veta

NA

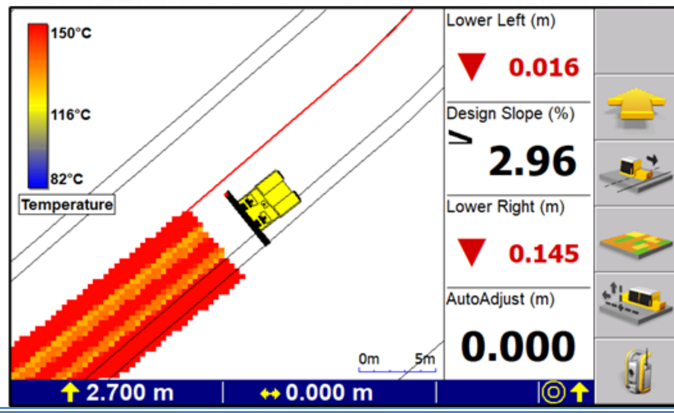
Venders PMTP Data

Caterpillar-Trimble PMTP Data

System Summary

Hardware	 

Onboard Display



Documentation

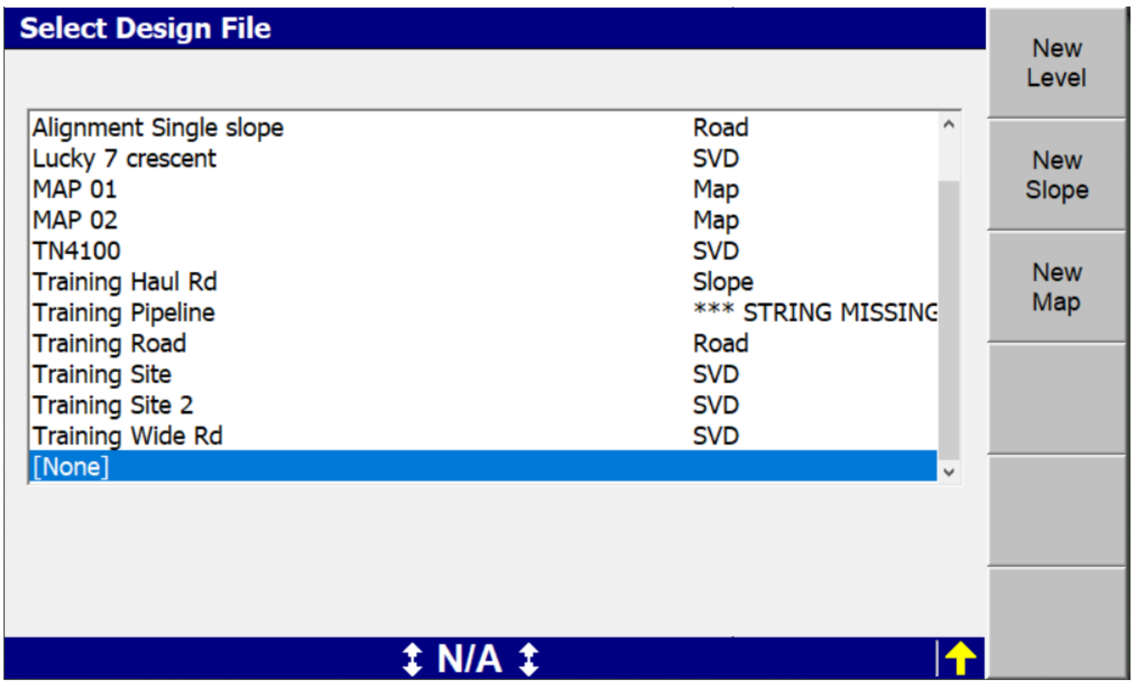
Figure 51. Caterpillar Thermal Camera system.

Data Management
(TBA – VisionLink?)

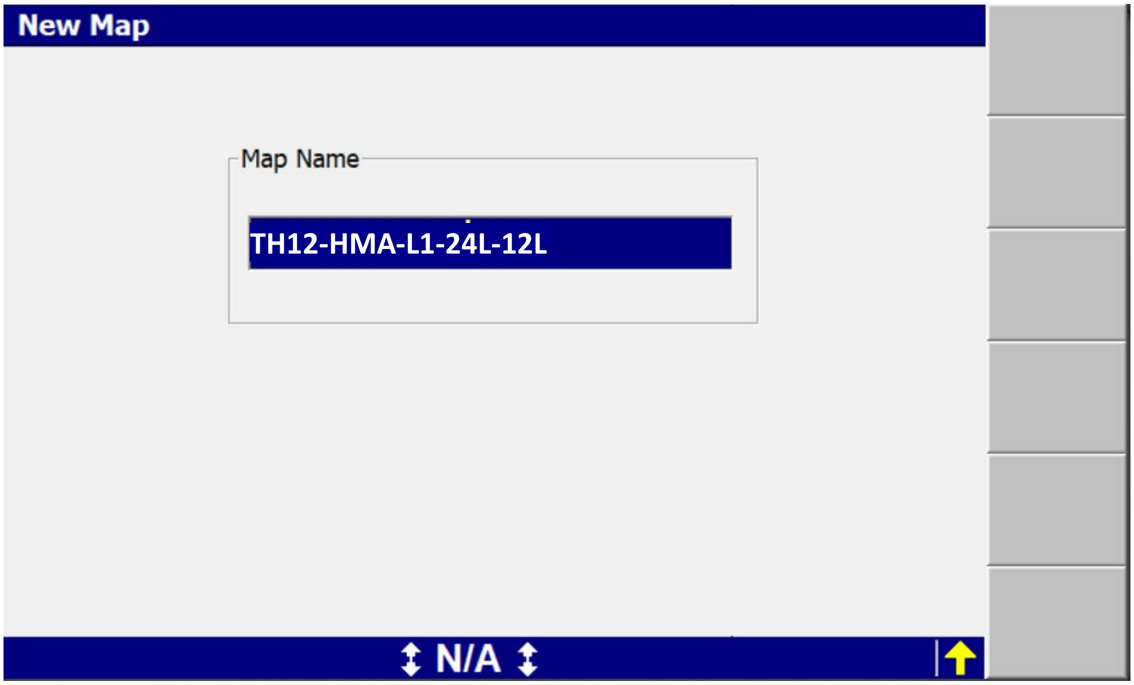
Data Lot Names
Use either the "Design" field or "Measured Data" field for the Data Lot Names.

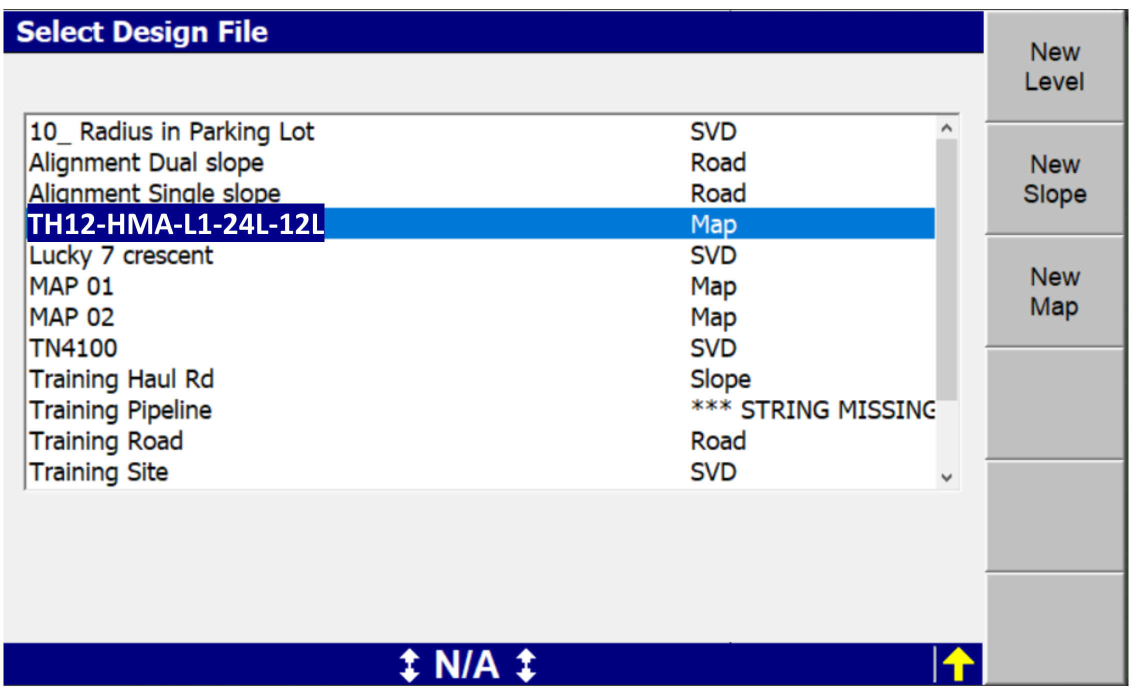
<u>Option 1</u>

If a 3D design or 3D linework created from Trimble Business Center will be used, then that "design" can be selected in the following menu once loaded to the control box. These can be project specific if each machine is using the same "design":



"Maps" can also be created in the field if no pre-generated 3D design or linework are used. In this case, a "Map" is considered a "design" from the software's perspective. These new "maps" can be created using a desired (pre-loaded) coordinate system or auto-created on design load based on GPS positioning. The "Map" can be named anything and selected in the same menu path. These are machine specific - not [redacted]



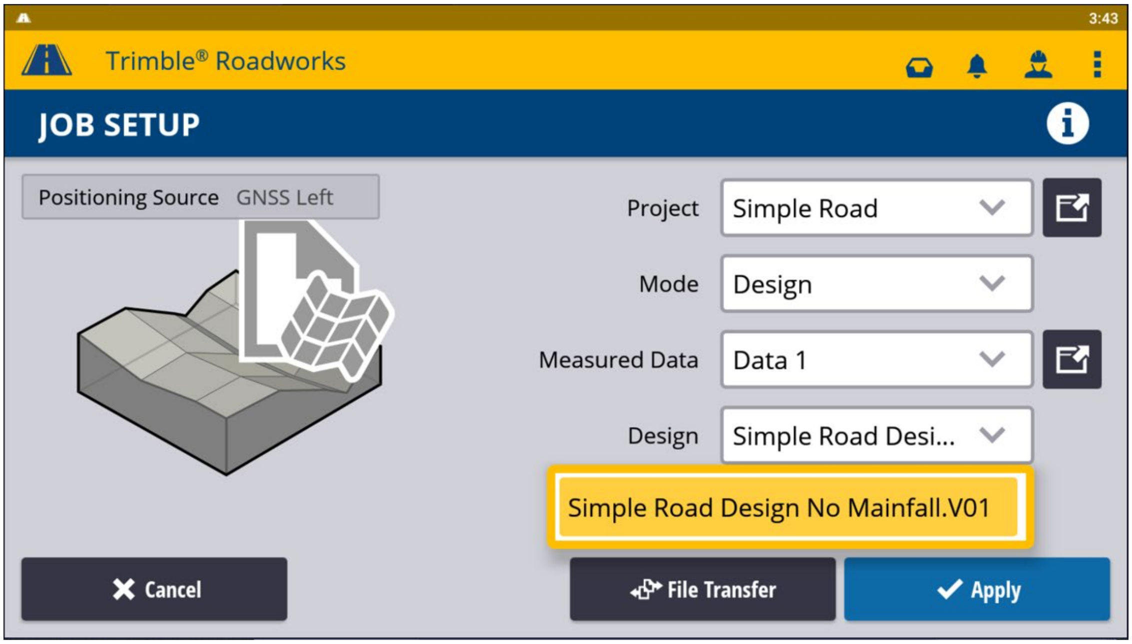


It is the same process for GNSS based CCS900 systems and GNSS based PCS900 thermal mapping systems. Users can either use designs or linework created from Trimble Business Center or use the "New Map" functionality to create an in-field design that is then referenced from all collected mapping data in office software analytics.

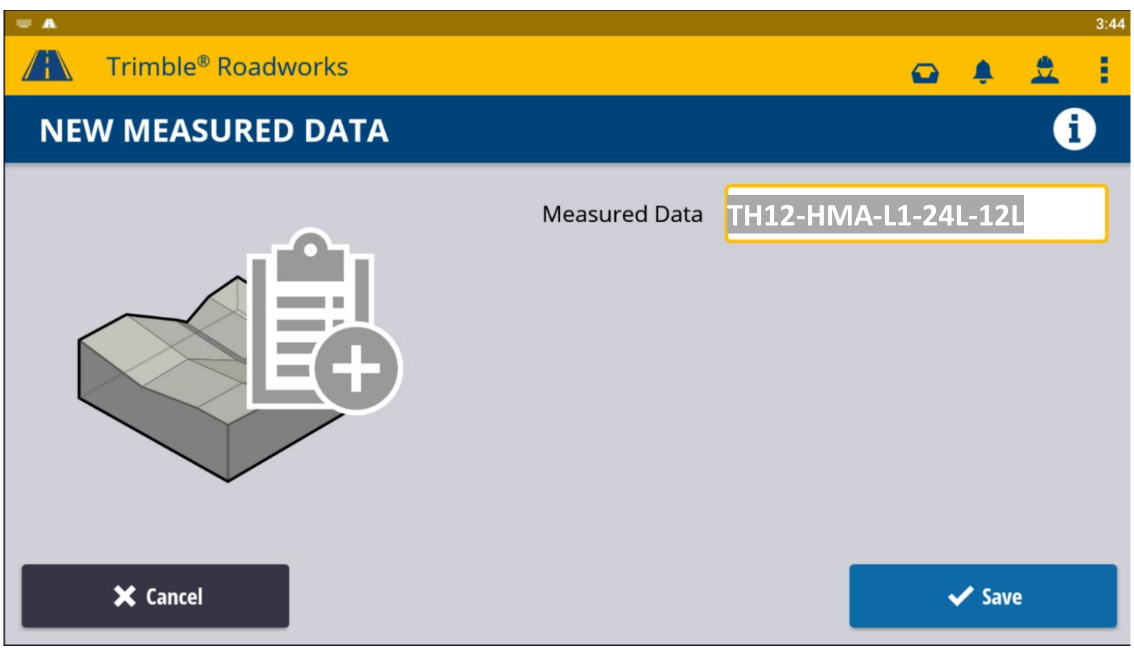
Option 2

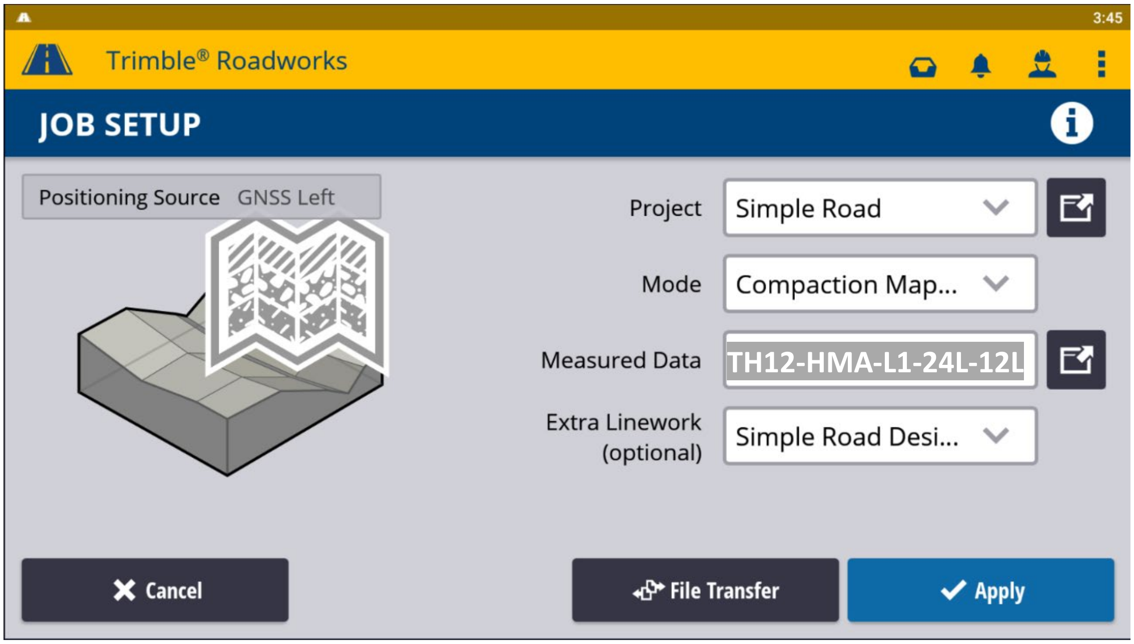
The new Trimble Earthworks and Roadworks compaction systems can also utilize 3D designs from the office, but users don't have to use them. The terminology with the new systems are "Measured Data" containers (instead of new "maps").

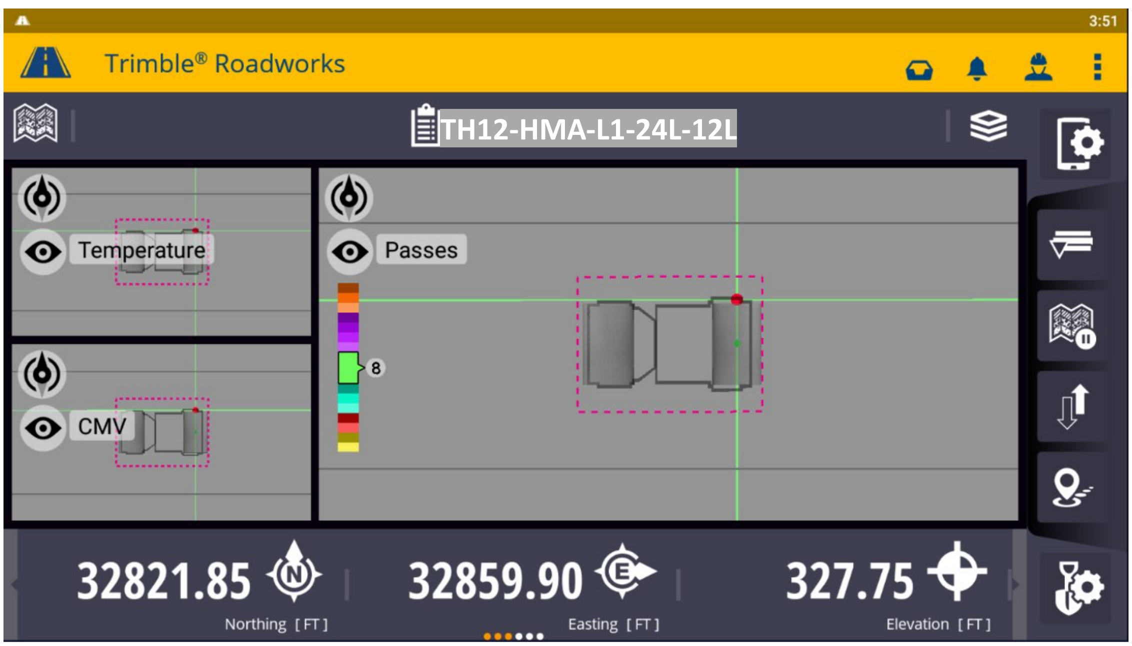
Using a design:



New "Measured Data" store for mapping data:




3:45
Trimble® Roadworks
JOB SETUP
Positioning Source GNSS Left
Project
Simple Road
Mode
Compaction Map...
Measured Data
TH12-HMA-L1-24L-12L
Extra Linework
(optional)
Simple Road Desi...
Cancel
File Transfer
Apply


3:51
Trimble® Roadworks
TH12-HMA-L1-24L-12L
Temperature
CMV
Passes
8
32821.85
Northing [FT]
32859.90
Easting [FT]
327.75
Elevation [FT]

Data Export Procedures

There is no need for data export since the data can be downloaded directly from the Cloud to Veta.

Direct Download from Cloud to Veta

The Caterpillar-Trimble PMTP data (*.tds) can be imported directly from the Cloud to Veta.

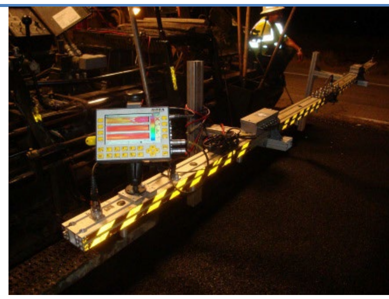
The user needs to have a login credential and set up in Veta. Then, select the account, site, and time frame to download data.

MOBA PMTP Data

System Summary

The summary of the MOBA PAVE-IR paver-mounted thermal profile system is presented as follows.

Hardware



Onboard Display

Documentation

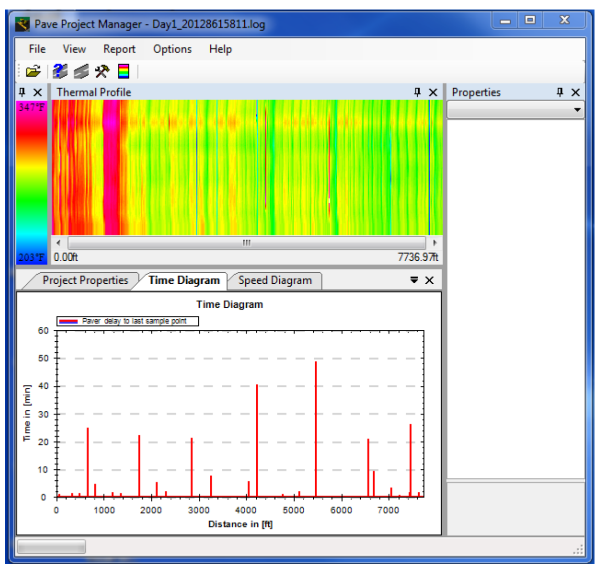


Figure 52. MOBA PMTP system.

Data Management

The data management program is called MOBA Pave-IR PPM (Pave Project Manager). Thermal profile is displayed a color-coded maps vs. distance. Other charts include: Time (paver stops) and Speed.

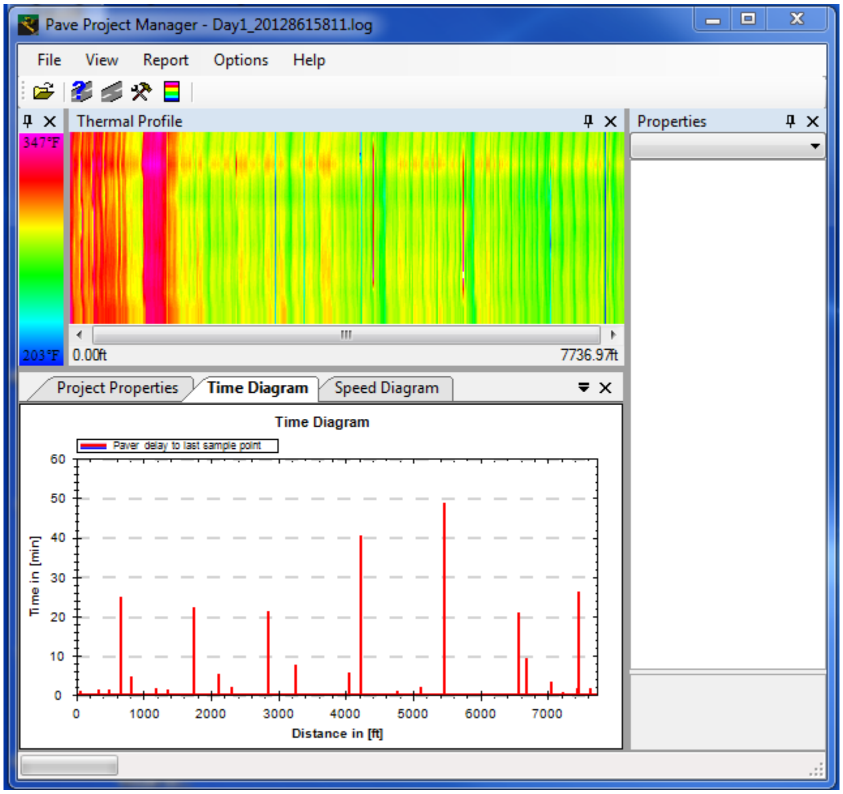


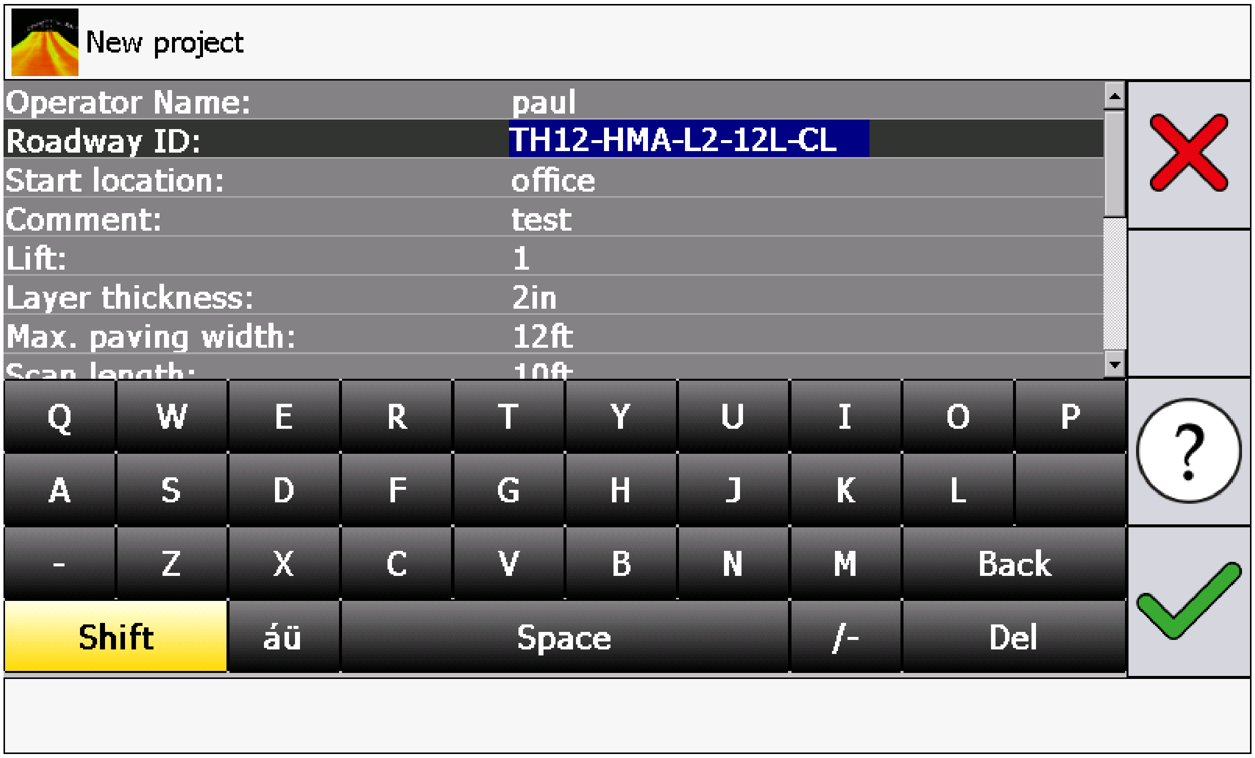
Figure 53. MOBA PPM Program.

The thermal profile data are stored in either *.log (older format) or *.paveproj formats.

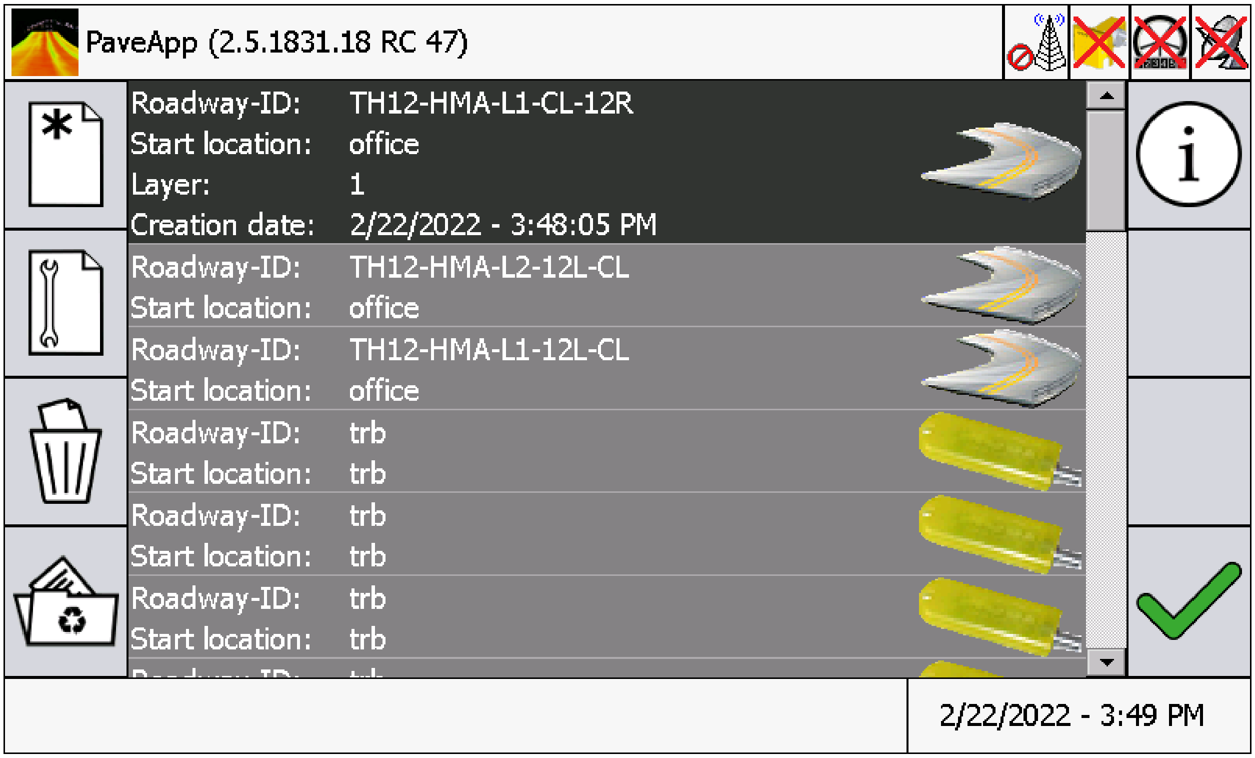
Data Lot Names

When “Creating new Project”, use the “Roadway ID” field to enter the AASHTO “Data Lot Name”. This will store the data lot name in the “Roadway ID” field of the data.

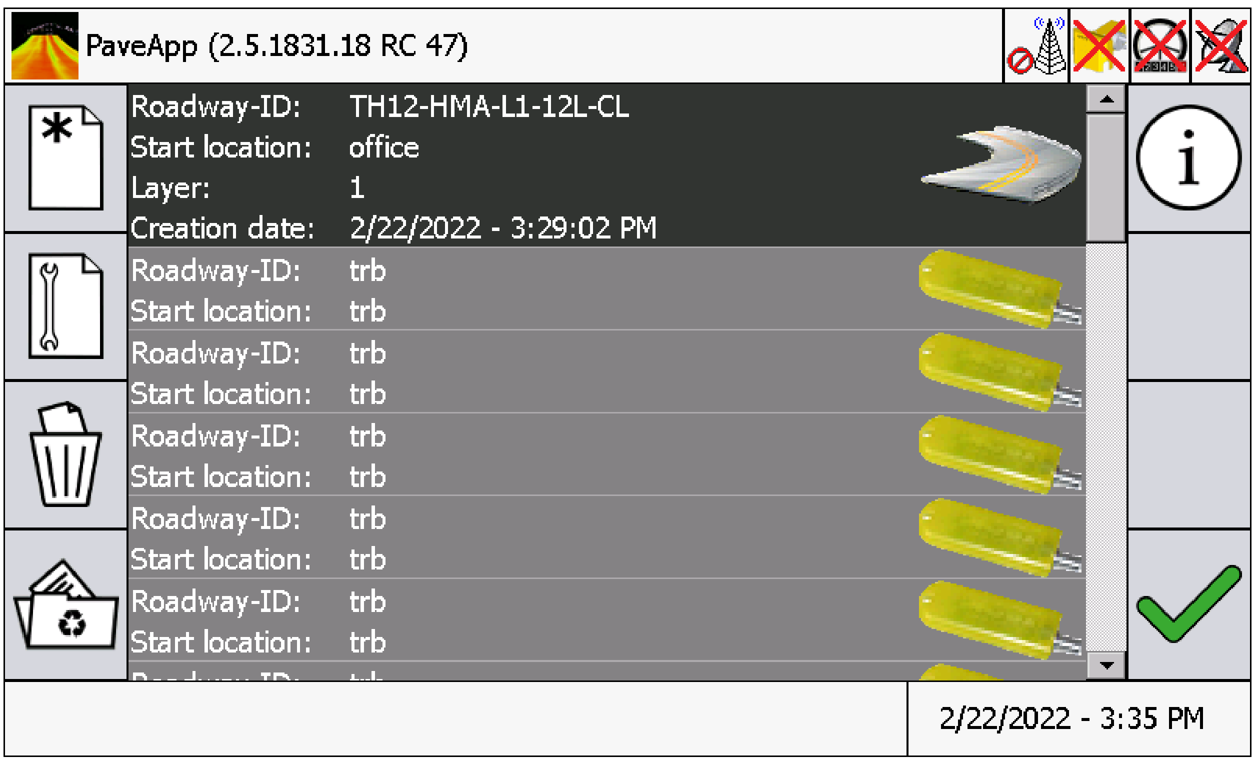
Users may pre-create the Roadway ID before the construction.



Multiple Roadway IDs can be pre-created.



Then, users can select one of the pre-created Roadway ID for the daily production.



Data Export Procedures

There is no need for data export since the data can be downloaded directly from the Cloud to Veta.

Direct Download from Cloud to Veta

The MOBA PMTP data (*.paveproj files) can be downloaded directly from the Cloud to Veta.

The user needs to have a login credential and set up in Veta. Then, select the account, site, and time frame to download data.

TOPCON PMTP Data

System Summary

Hardware	 

<table>
<tr><td>Onboard
Display</td><td>
</td></tr>
<tr><td>Documentation</td><td>
SiteLink3D</td></tr>
</table>

Figure 54. TOPCON PMTP system.

Data Management

(TBA – Sitelink3D?)

The thermal profile data are stored in the AASHTO M 39 *.tds formats.

Data Lot Names

(TO DO: how to set up the AASHTO PP 114-compatible data lot names)

Topcon (PMTP????)

- ~~When using a PLN file, the data lot name comes from the Name item under [Construction Area].~~
- When downloading from SiteLink, the name comes from the layer associated with a given task.

Data Export Procedures

There is no need for data export since the data can be downloaded directly from the Cloud to Veta.

Direct Download from Cloud to Veta

The TOPCON thermal profile data (*.tds) can be imported directly from the Cloud to Veta. There is no need for data export.

The user needs to have a login credential and setup in Veta. Then, select the account, site, and time frame to download data.

Vogele PMTP Data

System Summary

The summary of the Vogele RoadScan PMTP system is presented as follows.

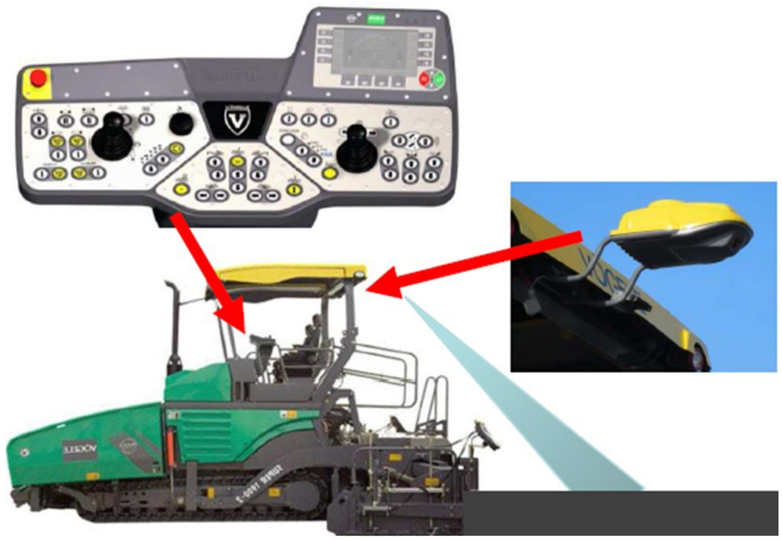
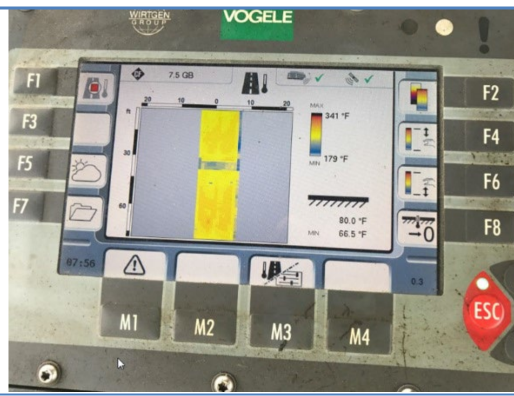
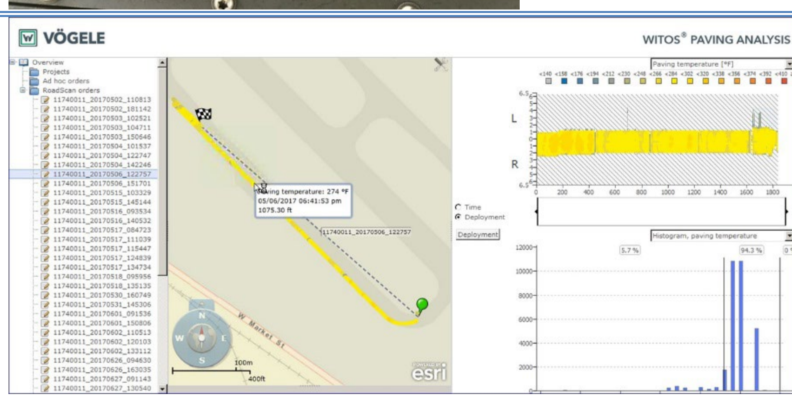
Vogele RoadScan PMTP system	
Hardware	
Onboard Display	
Documentation	

Figure 55. Vogele PMTP system.

Data Management

The viewing program is called WITOS Paving Analysis. Thermal profile is displayed a color-coded maps vs. time/distance. Other charts include: Time (paver stops) and Speed.

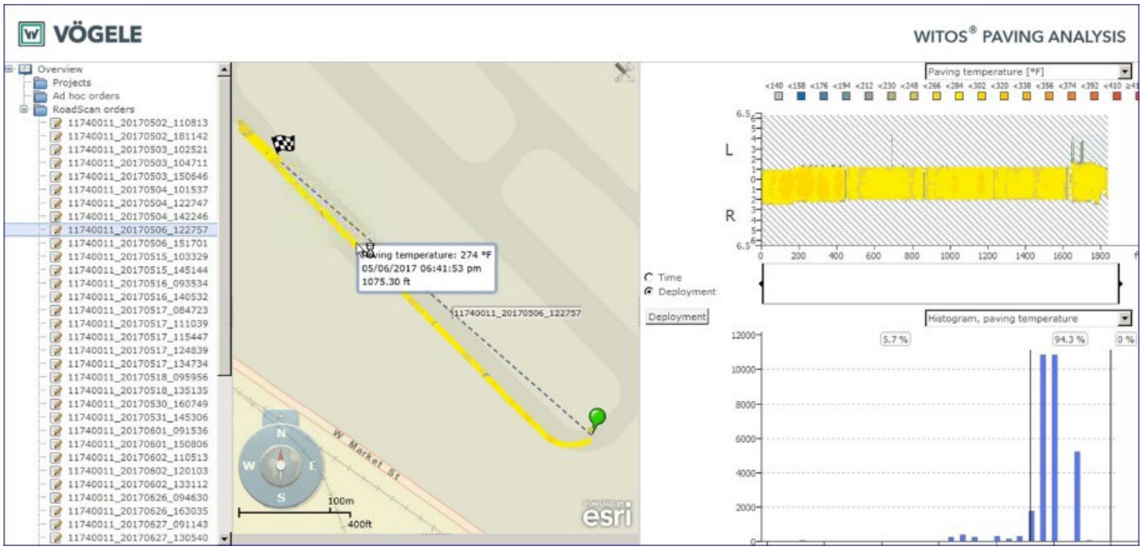


Figure 56. WITOS Paving Analysis Software.

To export data from the RoadScan sensor from WITOS Paving Analysis, the following preconditions apply:

- The thermal data were uploaded from the USB stick to WITOS
- The user has valid access credentials to the WITOS portal.
- The "WITOS Paving Analysis" application is activated in the portal.
- The computer used has the necessary Citrix Client installed and can start and display "WITOS Paving Analysis".

Data Lot Names

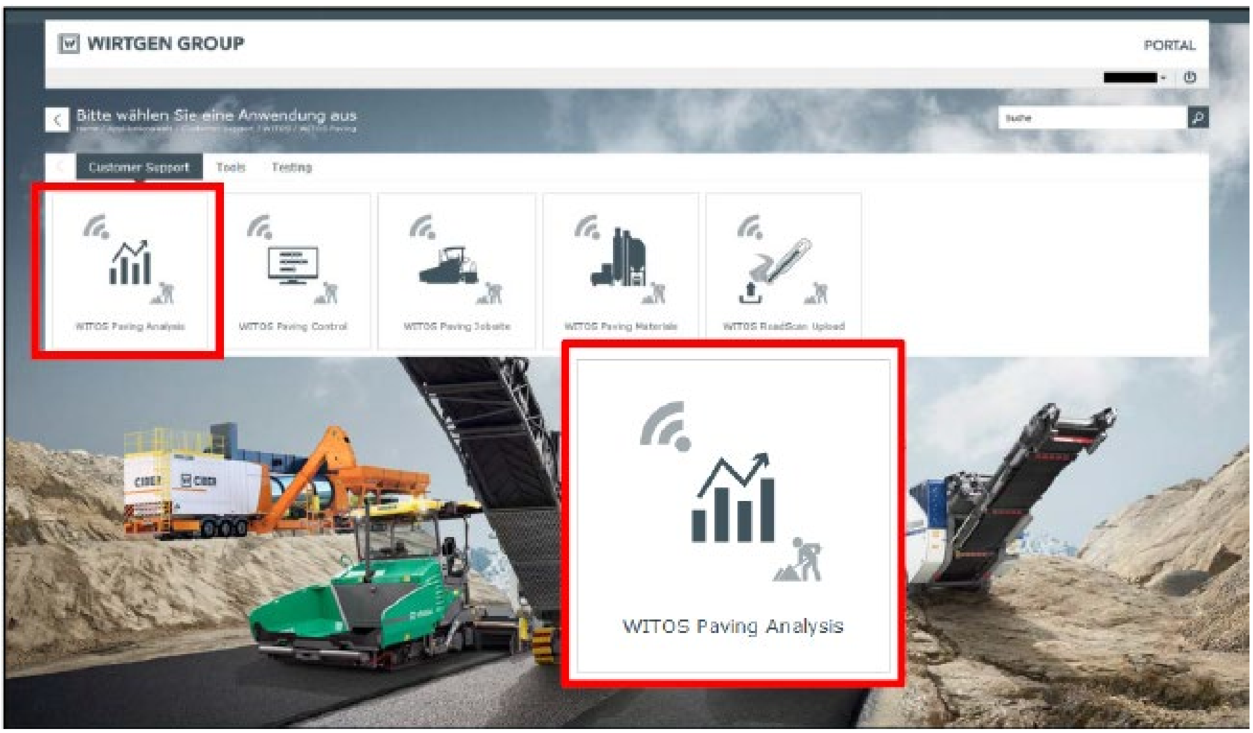
NA

Data Export Procedures

Vogele RoadScan PMTP data can be exported to Veta-compatible format (*.csv).

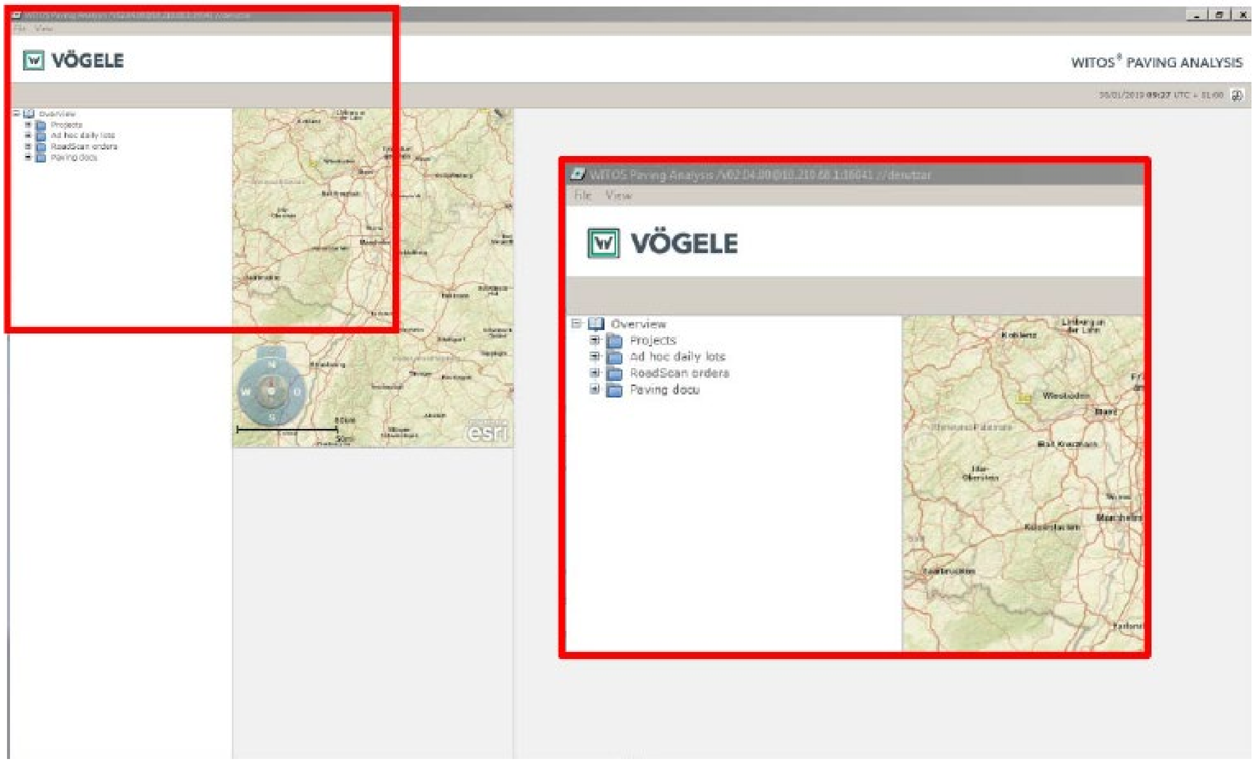
__Step 1__

The user logs on to the WITOS portal and starts WITOS Paving Analysis by clicking on the corresponding tile:



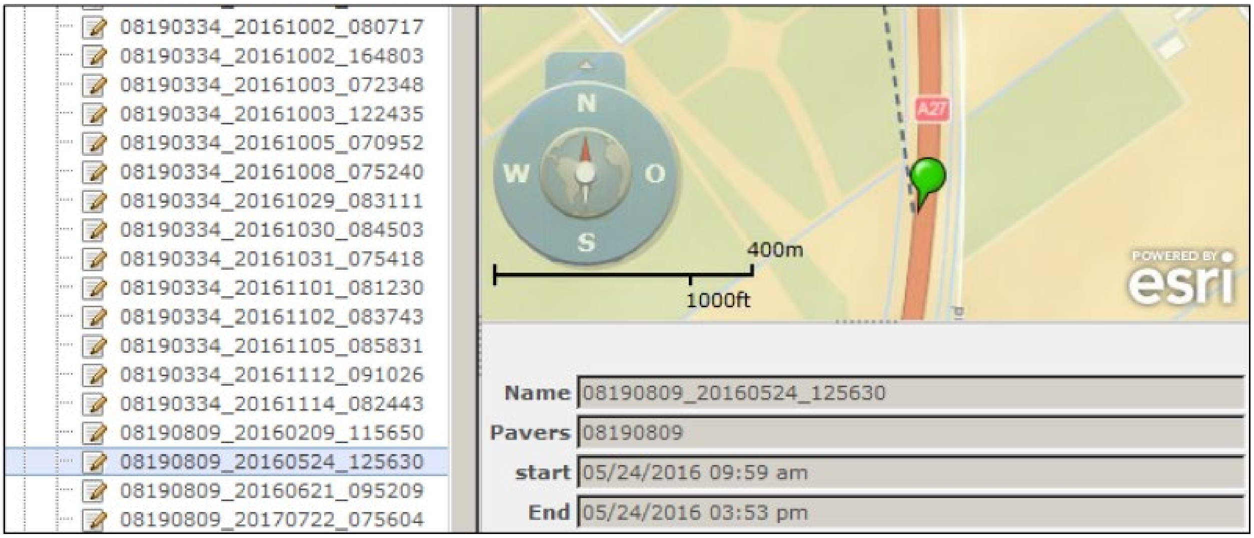
Step 2

Selecting the thermal data to be exported.



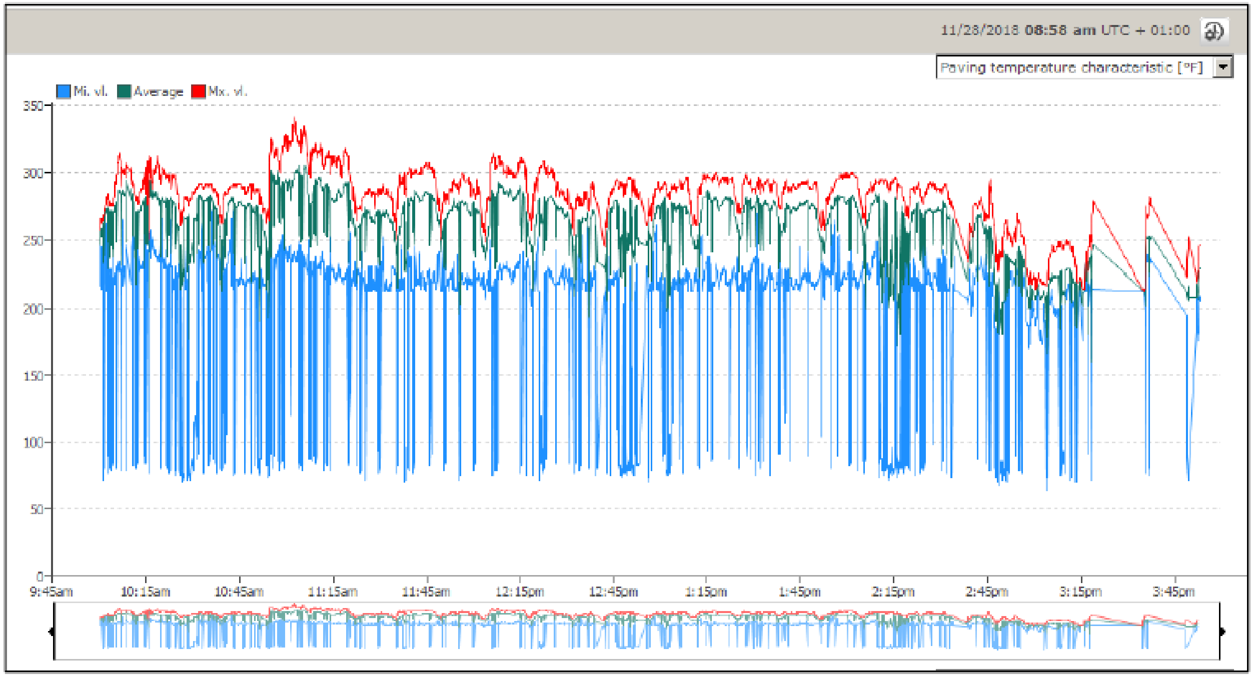
Step 3

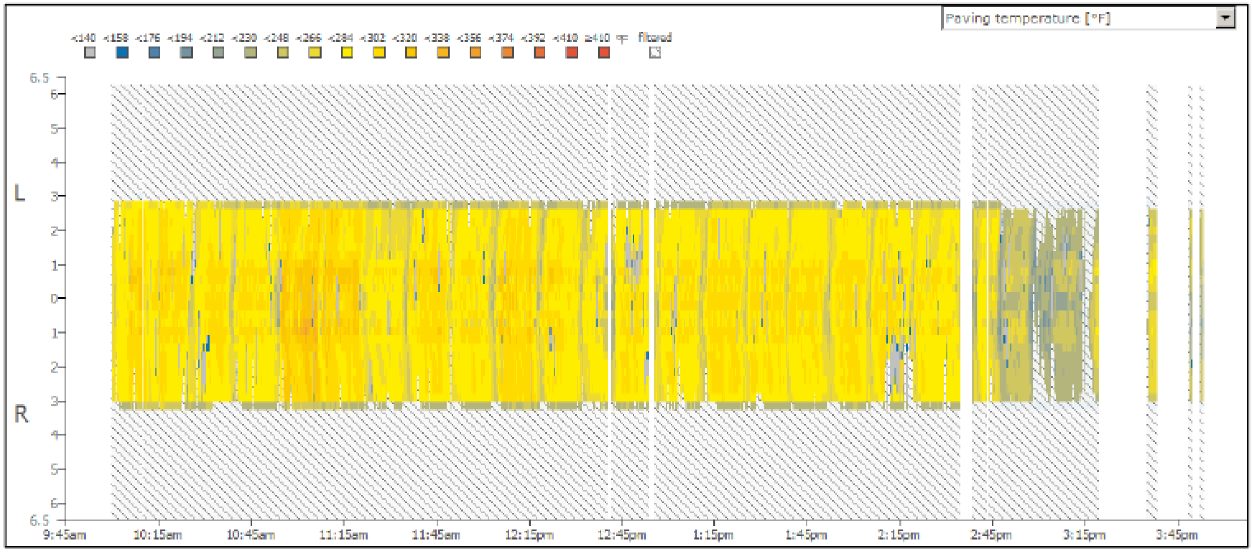
- In the project tree on the left side open the folder "RoadScan Orders" by clicking on the plus sign and select the desired order by clicking on it. The orders are sorted by machine serial number, current date and time.
- After selecting an order, it is display in the map view. The corresponding data can be found in the diagrams to the right.



Step 4

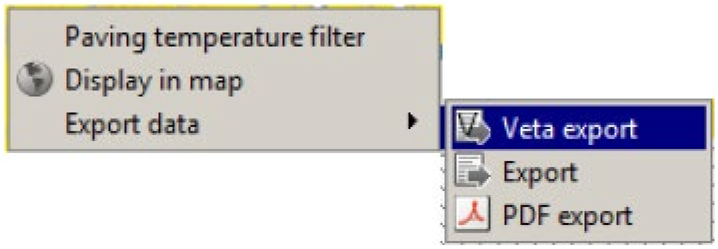
Select the graphic "Installation temperature [°C]" in the drop-down menu of one of the two graphics



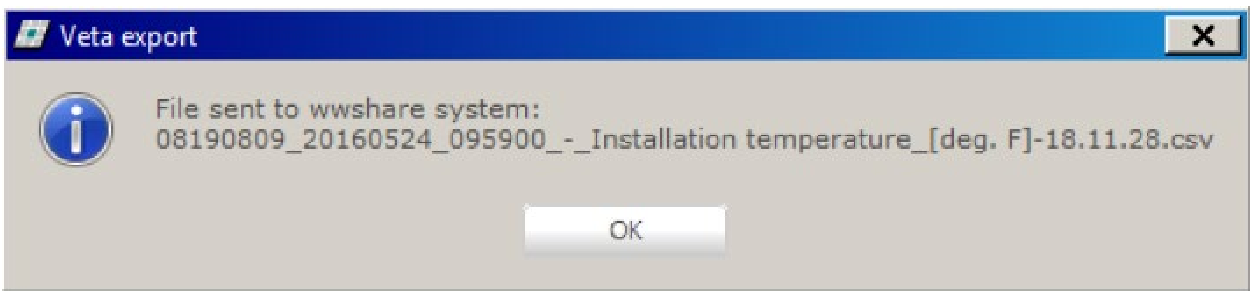


Step 5

Right-click on the diagram with the mouse to open the context menu.

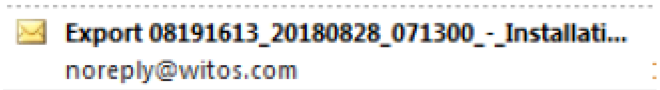


Select "Export data" from the context menu and click "Veta Export".
WITOS Paving Analysis confirms the export with a dialog box.



Step 6

The Veta export file is delivered to the e-mail address stored in the system for the respective user.



- The message contains a link to the WITOS wwshare system where the data can be downloaded.
- You can also forward the mail to third parties. This gives them access to unchanged data directly from the server.
- To download the data, click on the link or copy the link into the address bar of your Internet browser and start downloading the data there. Alternatively, some browsers also allow you to start a program directly (e.g. Microsoft Excel) to display the data.

Direct Download from Cloud to Veta

The Vogele PMTP data (*.csv files) can be imported directly from the Cloud to Veta.

The user needs to have a login credential and setup in Veta. Then, select the account, site, and time frame to download data.

Venders DPS Data

GSSI DPS Data

System Summary

<table>
<tr><td>Hardware</td><td></td></tr>
<tr><td>Onboard Display</td><td></td></tr>
<tr><td>Documentation</td><td>
</td></tr>
</table>

Figure 57. GSSI DPS system.

Data Management

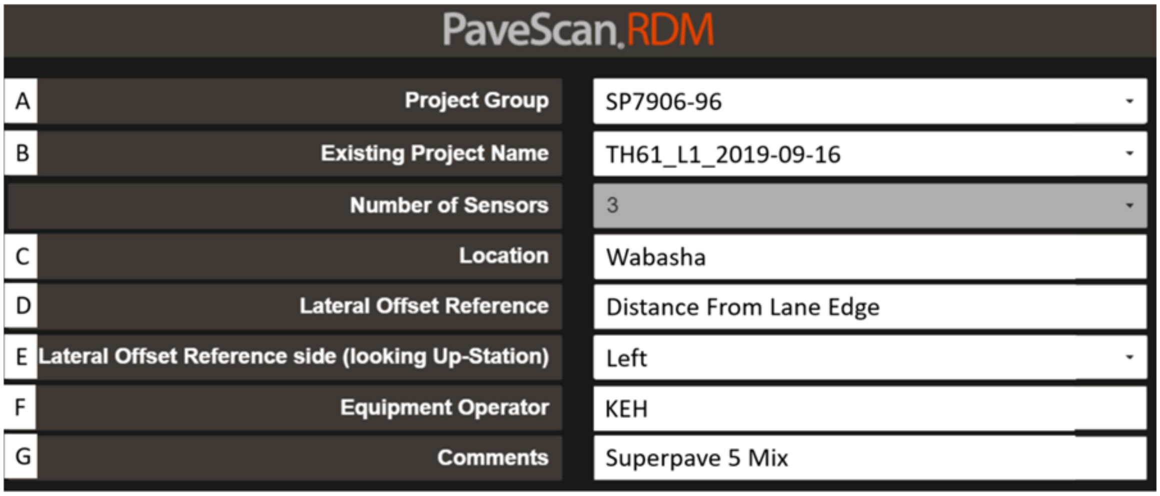


Figure 58. GSSI RDM PaveScan program.

Data Lot Names

NA

Data Export Procedures

The GSSI data need be exported to the *tds format to be compatible with Veta.

Direct Download from Cloud to Veta

NA

ESS DPS Data

System Summary

Hardware	
Onboard Display	
Documentation	Same as above.

Figure 59. ESS DPS system.

Data Management
(TBA)

Data Lot Names
NA

Data Export Procedures
The ESS DPS data need be exported to the *tds format to be compatible with Veta.
(TBA – export procedures)

Direct Download from Cloud to Veta
NA

Resources

Websites

- International Society for Intelligent Construction: is-ic.org
- Intelligent Construction Technologies: https://www.intelligentconstruction.com/

Recent ICT Research

- NRRA Evaluation of Levels 3-4 Intelligent Compaction Measurement Values (ICMV) for Soils Subgrade and Aggregate Subbase Compaction (https://www.intelligentconstruction.com/projects/nrra-level-3-4-icmv-project/)
- FHWA Feasibility of Utilizing Intelligent Compaction Equipment to Ensure Uniformity and Quality of Pavement Foundation (https://www.intelligentconstruction.com/projects/fhwa-ic-for-foundation-project/)
- NRRA Veta Enhancements for Material Delivery Management System (MDMS) Standardized Platform (https://www.intelligentconstruction.com/projects/veta-mdms-and-web/)

Documents

- FHWA Tech Brief on the Hot Mix Asphalt IC Demonstration
- FHWA Tech Brief on the Soils, Subbase, and Stabilized Base IC Demonstration
- FHWA-Transportation Pooled Fund: Intelligent Compaction Final Report
- FHWA Intelligent Compaction and Asphalt In-Place Study Final Report
- FHWA-TXDOT Intelligent Compaction Retrofit Kit Report (Appendix)
- FHWA Application Notes on an Asphalt IC Project at the Sitka Airport
- FHWA Application Notes on a Soils IC Project in Iowa
- FHWA Tech Brief: IC Pre-mapping
- FHWA Tech Brief: Color-coded IC Maps
- FHWA Tech Brief: IC Specifications
- FHWA Tech Brief: ICMV – A Road Map
- MoDOT IC-IR Final Report

Contact Information

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GKChang@TheTranstecGroup.com

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