TECHNICAL BRIEF

U.S. Department of Transportation
Federal Highway Administration

WHAT IS VETA?

Veta is a map-based software tool for viewing and analyzing geospatial data. Currently, Veta can import data from various IC machines and PMTP scanners to perform editing, filtering, spot test correlation, and statistical analysis as a post-processing tool.

One of the salient features of Veta is to view IC and PMTP data as color-coded maps on top of geographical road or aerial maps to facilitate quantitative interpretation.

Key examples are to evaluate consistency of rolling patterns, to identify cold blobs or streaks of temperature segregation, etc. Veta can allow users to select any specific passes to be viewed, including the last pass or final coverage.

The FHWA Veta Software was developed with funding from the FHWA, MnDOT, and the TPF-5(334) pooled fund study.

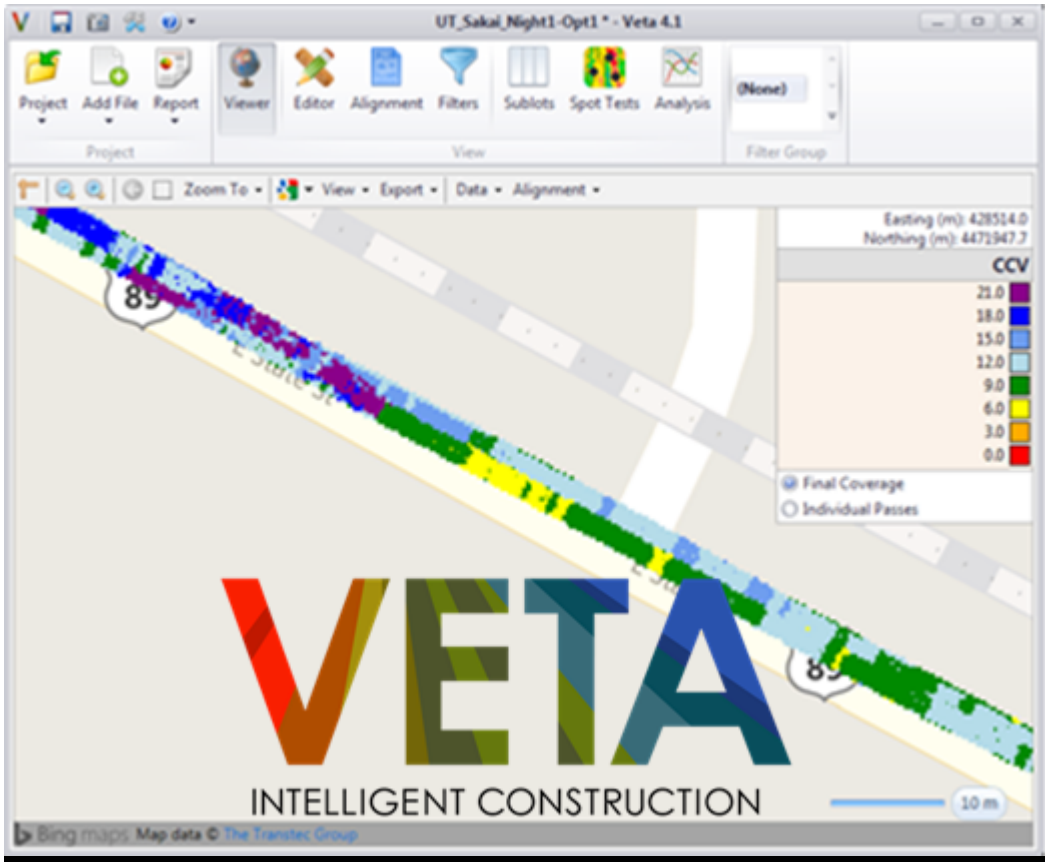
QUALITY ASSURANCE STATEMENT

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

COLOR-CODED IC MAPS
CONSISTENT VISUAL DATA INTERPRETATION

TECHNICAL BRIEF

SUMMER 2017



A screen shot of Veta – a map-based software tool for viewing and analyzing geospatial data.

BACKGROUND

Intelligent compaction (IC) and paver-mounted thermal profiler (PMTP) systems have been gaining popularity across the USA in the past 10 years to improve compaction quality and detect temperature segregation behind pavers. On IC and PMTP systems, color-coded maps from their onboard displays are used extensively for monitoring and visual inspection of collected field data and machine operation.

IC and PMTP systems gather a tremendous amount of complex geospatial data that poses challenges for data management, analysis, and reporting. These issues have become the main hurdles during implementation. To address the above issues, the Minnesota Department of Transportation and the FHWA have funded the development of the Veta software tool for IC and PMTP data viewing and analysis. Currently, the Transportation Pooled Fund (TPF) study "TPF-5(334) Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation" is leading the effort for enhancing and maintaining Veta to facilitate the national IC/PMTP implementation.

This Tech Brief will provide guidelines for IC color-coded maps in order to ensure clear field inspection of IC maps and interpretation of IC results.

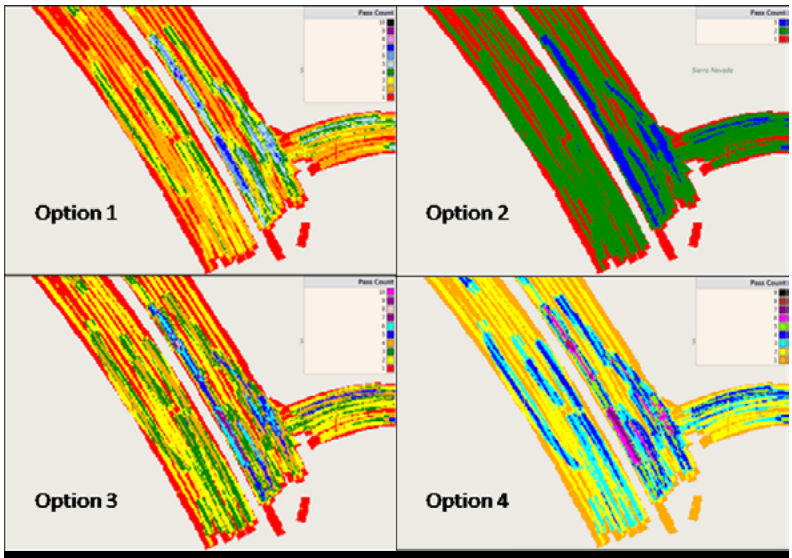
COLOR PALETTES FOR QUANTITATIVE DATA INTERPRETATION IN VETA

Currently, Veta provides 19 different default color palettes or legends for viewing colored-coded data maps. If users customize the color palettes in a project, the customized color palettes will be stored in the project file and the option file in users' system will be updated. In anticipation of future blending of multiple vendors' data, the color palette management in Veta is expected to be revamped.

Though most users have their own color preference, using consistent color palettes is essential to facilitate data interpretation and communication consistently, and to avoid confusion or misinterpretation. It is especially important during visual inspection of the color-coded maps displayed on onboard computers in the field, as well as during post-processing in Veta.

Color palettes cannot be too complicated, otherwise data interpretation will be hindered. As a rule of thumb, a color palette should contain less than nine colors. To make it suitable for machine operators, a three-color scheme is often used in the field. Also, consideration should be taken for color-blind issues (e.g., red and green should be separated).

A nine-color scheme for quantitative data representation.



Four different pass count maps for the same set of data but with different color palettes (Data Source: FHWA-TXDOT IC Retrofit Study - CA IC Rodeo – Hamm Day 1 – Asphalt Compaction)

The image to the left illustrates four different views of pass count maps with the same set of data but with different color palettes. Option 1: default Veta color palette; Option 2: simplified three-color scheme; Option 3: default from vendor A; Option 4: default from vendor B. These views are very different and may cause confusion or misinterpretation of the data.

The color-coded data maps that can be viewed in Veta are shown below (in the order of importance in using consistent color palettes):

1. Roller Pass Counts
2. Temperatures (IC or PMTP)
3. Intelligent Compaction Meter Value (ICMV)
4. Speeds (rollers or pavers)
5. Roller Vibration Frequencies
6. Roller Vibration Amplitudes

This document will focus on the top three items: roller pass counts, temperatures, and ICMV.

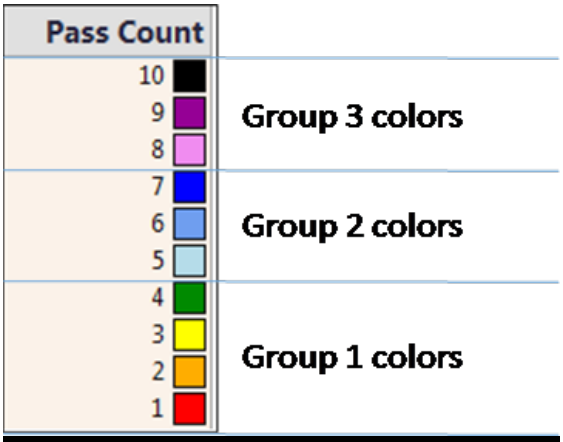
ROLLER PASS COUNTS

Key Points:

- Minimum pass counts are specification driven and often a moving target.
- Target pass counts may vary from one lift to another, from one day to another, or from one project to another.

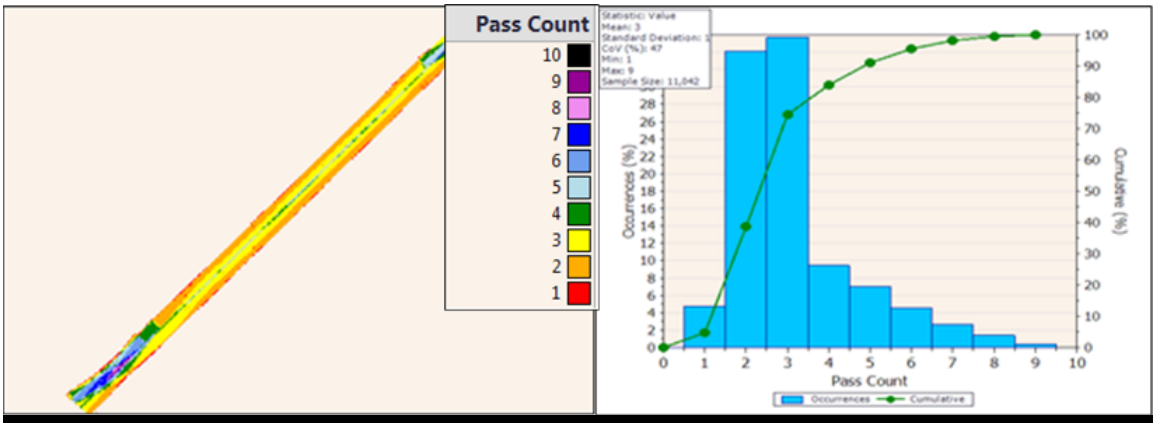
Veta's Default

- The pass count number for a specific color is a lower bound value.
- Four distinct and high contrast colors are used for the first four passes as the first group.
- Additional color groups are used for higher pass counts: blue colors for five to seven, purple colors for eight and nine, black for 10 and above.



Veta's default color palette for pass count maps

The following example shows the final coverage pass count map and histogram within a 250 foot rolling zone between two rolling transition areas. The rolling pattern is two to three passes.



An example of pass count map (using Veta's default color palette) and the associated histogram (Data Source: FHWA- IC and In-Place Asphalt Density Study - CA IC Project– BOMAG Night 2 – Asphalt Compaction)

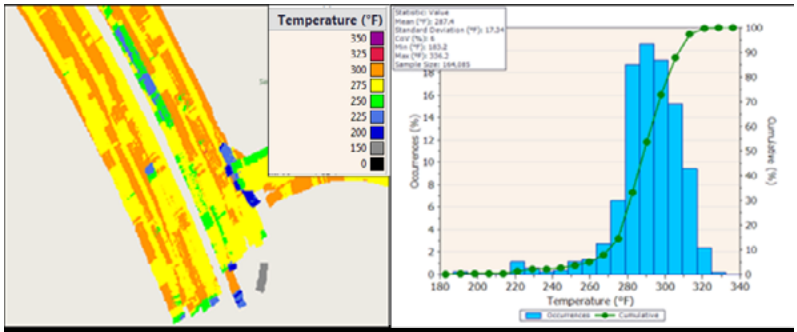
TEMPERATURES

Key Points:

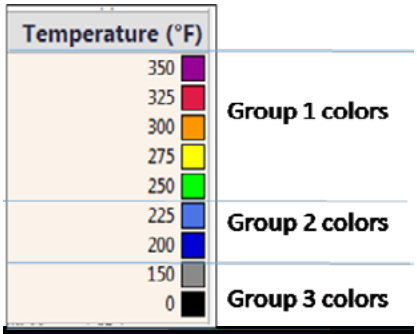
- PMTP temperature profiles indicate potential temperature segregation that may hinder subsequent compaction effects.
- Adequate compaction temperatures are dependent on the type of asphalt mixture, lift thickness, base temperature, and weather condition.
- Some agencies require specific ranges of asphalt temperatures during breakdown compaction in order to achieve target densities.

Veta's Default

- Currently, the same default is used for both PMTP and IC temperature data.
- The temperature for a specific color is a lower bound value.
- Group 1 colors are used for temperatures from 250°F and up.
- Group 2 colors are used for temperatures between 200°F and 250°F.
- Group 3 colors are for temperature from 200°F and below where temperatures of 150°F and below are displayed in black.



The IC temperature map using the Veta default color palette and associated histogram (Data Source: FHWA-TXDOT IC Retrofit Study - CA IC Rodeo – Hamm Day 1 – Asphalt Compaction)

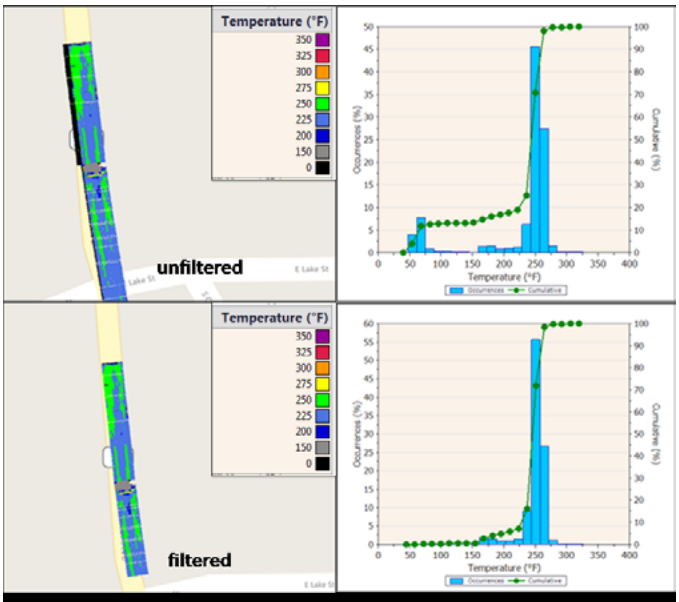


Veta's default color palette for temperature maps

The image above is an example of an IC temperature map and histogram from a breakdown roller. The mean final coverage temperature is 287°F. The map indicates a cold spot at the edge of two compacted areas.

The image to the right is an example of a PMTP temperature map and associated histograms.

The unfiltered temperature map indicates cold edges (in black, i.e., under 150°F) on its western border. The cold edges are often caused by excessive thermal scanning into adjacent existing pavement or shoulder. Therefore, an edge filter was applied to the original data to remove cold edges, as shown in the filtered temperature map and histogram.

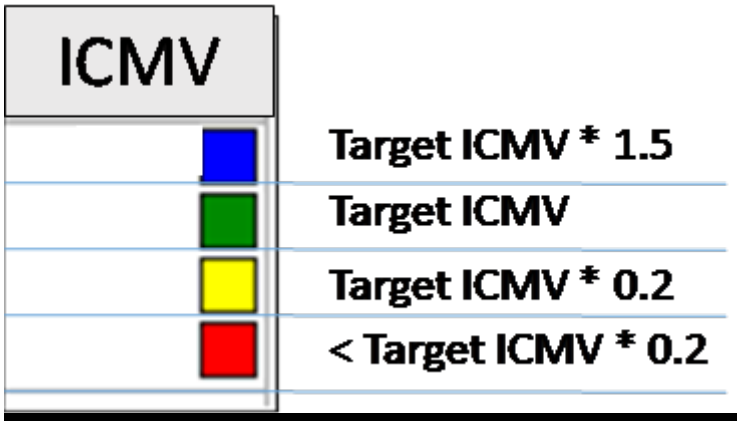


An example of temperature maps and histogram for unfiltered data and filtered data (Data Source: Undisclosed DOT data)

INTELLIGENT COMPACTION MEASUREMENT VALUES (ICMV)

Key Points:

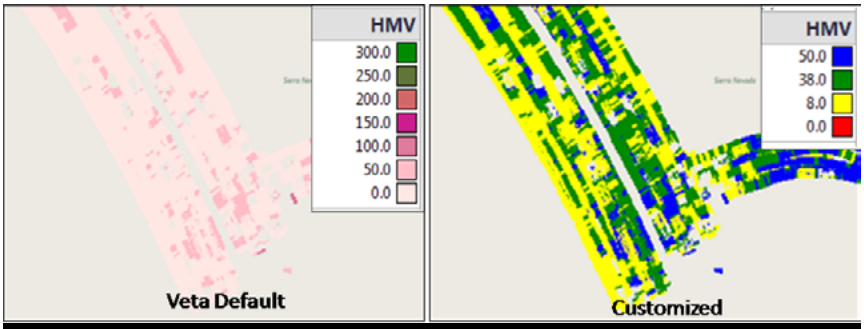
- ICMV is a generic term for intelligent compaction measurement values from all vendors.
- Using default color palettes for ICMV is challenging since there are different ICMV types/units and different ranges of values corresponding to different types of materials.
- To simplify the display, the chosen color palettes should include the ranges for the low (soft spot), medium (target) and high values (stiff). As an industry recommendation, 20 percent of the target ICMV and below can be considered "low;" and 50 percent more than the target ICMV can be considered "high." Double jumps can also be identified by a recommended specific value. Another option is to determine the above threshold values based on specifications, such as: mean + std, mean - std, mean – 1.28*std (i.e., 10 percentiles of ICMV), and minimum acceptable ICMV.
- The target ICMV is specific for a specific layer of specific materials under a specific support condition.
- Visual uniformity can be greatly influenced by the color palettes being used. Veta analysis results include numerical uniformity metrics such as coefficient of variance and semi-variogram
- ICMV should always be compared at a consistent vibration frequency/amplitude at a constant roller speed.
- Veta currently has different default color palettes for different vendors' ICMV. Those default palettes are produced to match vendors' settings. Changes are anticipated when Veta allows import of multiple vendors' data into the same project.
- A customized color palette can be based on the target ICMV determined from a test strip to indicate "low," "on target," "soft," and "potentially failed area that requires further investigation." The "low" value can be 20 percent value of the target ICMV. The "high" value can be set as 50 percent above the target ICMV. Therefore, a four-color palette can be customized: blue as stiff, green as on-target; yellow as soft, and red as potentially failed areas.



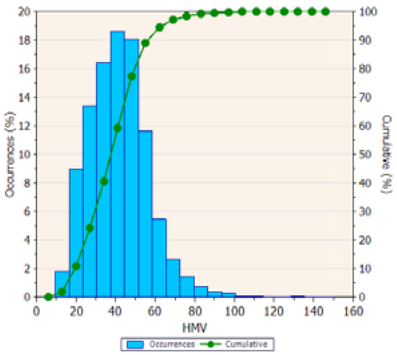
A customized color palette for ICMV based on target ICMV determine from a test strip (Source: an undisclosed vendor)

HAMM MEASUREMENT VALUE (HMV)

As an example, the following Hamm Measurement Value (HMV) data statistics indicate a mean value of 38 HMV which is assumed as the target ICMV. The "low" value can be 20 percent value of the target, i.e., 8 HMV. The "high" value can be set as 50 percent above the target, i.e., 50 HMV. The comparison of the HMV maps using the Veta's default and the customized palette are shown in the image below. The ICMV map using the customzied color palette appears to indicate relatively soft areas at the outer edges of compacted areas in both directions.



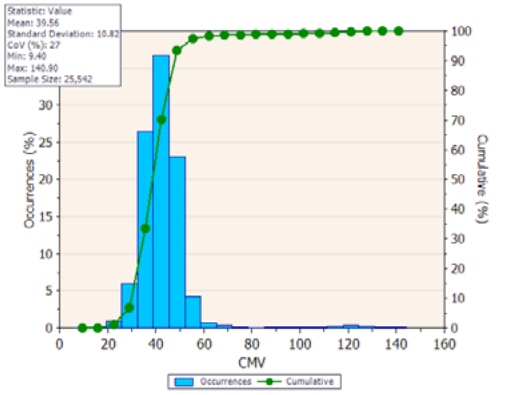
An example of HMV maps using the Veta default color palette and customized one. (Data Source: FHWA-TXDOT IC Retrofit Study - CA IC Rodeo – Hamm Day 1 – Asphalt Compaction)



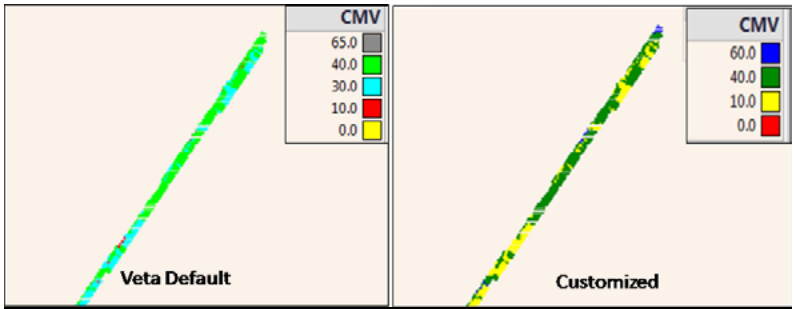
An example of HMV histogram. (Data Source: FHWA-TXDOT IC Retrofit Study - CA IC Rodeo – Hamm Day 1 – Asphalt Compaction)

COMPACTION METER VALUE (CMV)

An example is presented for Compaction Meter Value (CMV) similar to the above.



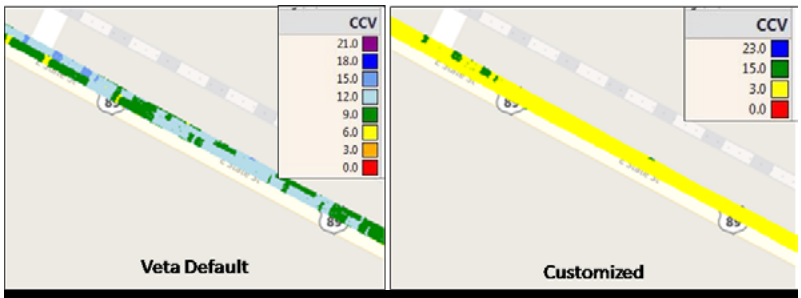
The CAT histogram. (Data Source: TPF FHWA IC and Asphalt In-Place Density Study - ME IC Project – Caterpillar Day 1 – Asphalt Compaction)



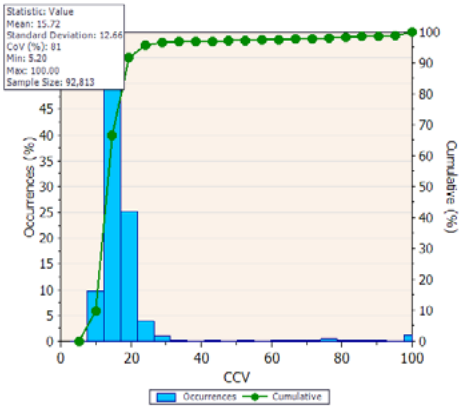
An example of CMV maps using the Veta default color palette and customized one. (Data Source: TPF FHWA IC and Asphalt In-Place Density Study - ME IC Project – Caterpillar Day 1 – Asphalt Compaction)

COMPACTION CONTROL VALUES (CCV)

An example is presented for Compaction Control Value (CCV) similar to the above.

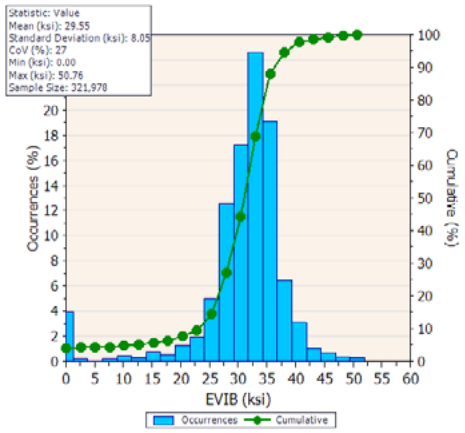


An example of CCV maps using the Veta default color palette and customized one. (Data Source: TPF FHWA IC and Asphalt In-Place Density Study - Utah IC Project – Sakai Night 1 – Asphalt Compaction)

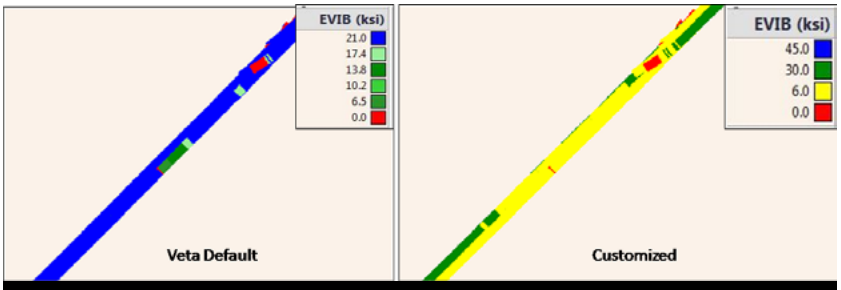


VIBRATION MODULUS (EVIB)

An example is presented for Vibration Modulus (EVIB) similar to the above.



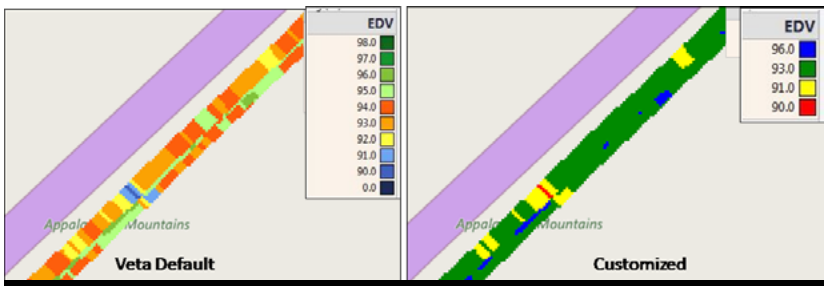
An example of Evib histogram. (Data Source: TPF FHWA IC and Asphalt In-Place Density Study - CA IC Project – BOMAG Night 2 – Asphalt Compaction)



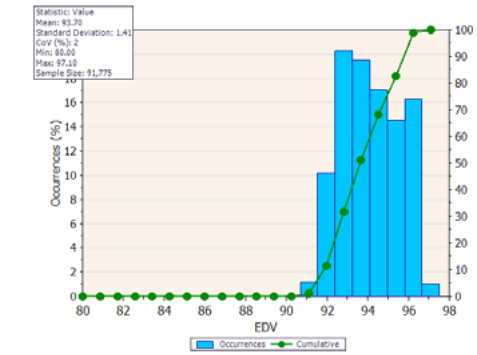
An example of EVIB maps using the Veta default color palette and customized one. (Data Source: TPF FHWA IC and Asphalt In-Place Density Study - CA IC Project – BOMAG Night 2 – Asphalt Compaction)

ESTIMATED DENSITY VALUE (EDV)

An example is presented for Estimated Density Value (EDV) similar to the above.



An example of EDV maps using the Veta default color palette and customized one. (Data Source: undisclosed vendor's data)



An example of EDV histogram. (Data Source: undisclosed vendor's data)

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IC WEBSITES

FHWA TSSC IC SUPPORT SITES
http://www.fhwa.dot.gov/construction/ictssc/support.cfm

ONE STOP-SHOP FOR INTELLIGENT COMPACTION
http://www.intelligentcompaction.com/

LIST OF US IC SPECIFICATIONS
http://www.intelligentcompaction.com/projects/specifications/

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FHWA-HIF-17-036

RECOMMENDATIONS

- Visual inspection of IC and PMTP color-coded maps are useful and important during real time quality monitoring and post-processing viewing/analysis.
- The same data set may produce very different color-coded data maps when using different color palettes.
- Using consistent color palettes can facilitate data interpretation and avoid confusion.
- It is recommended to adopt Veta's default color palettes for Pass Counts and Temperatures during post-processing viewing and analysis.
- It is recommended to customize Veta's color palettes for Intelligent Compaction Measurement Values (ICMV) based on the target ICMV determined from a test strip.
- It is recommended to implement a feature in Veta to facilitate customization of the ICMV color palettes based on a user-defined target ICMV.
- For complete data interpretation, both color-coded maps and the associated histogram and statistics are required.
- Since visual uniformity can be greatly influenced by color palettes, Veta's numerical uniformity metrics such as coefficient of variance and semi-variogram should be used for such purpose.