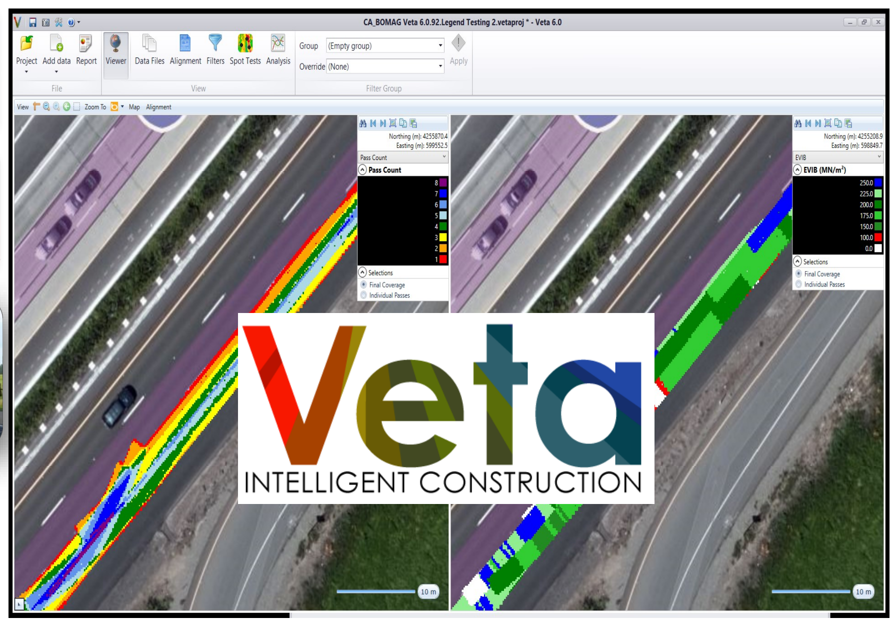
Veta 8.0 User's Manual

Veta INTELLIGENT CONSTRUCTION

Intelligent Construction Data Management

Many Systems **ONE SOFTWARE**



THE TRANSTEC GROUP
The World's Pavement Engineering Specialists

TRANSPORTATION POOLED FUND PROGRAM

Minnesota Department of Transportation

Veta 8.0 User's Manual

TABLE OF CONTENTS

TABLE OF FIGURES

INTRODUCTION

Veta is a geospatial software tool for Intelligent Construction Data Management (ICDM). Veta's functionality includes viewing and analyzing intelligent construction technologies (ICT), such as intelligent compaction (IC), paver-mounted thermal profiling (PMTP), and dielectric profiling system (DPS) data. Alignment files are optional to be imported to Veta to facilitate viewing and filtering. Spot test data can also be input to Veta to perform correlation analysis. ICT data can be displayed on various site maps for visual inspection. Data filtering is an essential and powerful Veta feature to extract desired data for viewing and analysis. Veta can perform various statistical analyses for the overall data and sublots, then create reports in various forms. This guide includes importing, viewing, filtering, and analyzing ICT data using Veta.

An intelligent construction data flow consists of data collection, transfer, and processing. Data is increasingly being collected and stored via wireless transmission from machines to vendor-specific cloud servers (i.e., telematic). The data can be downloaded from vendor software into a Veta-compatible data file and imported into Veta. Veta also supports direct import through select vendor cloud servers, as illustrated in Figure 1. Veta supports direct download from the cloud for the following vendor systems:

- MOBA (IC and PMTP)
- Topcon (IC)
- Trimble/Caterpillar (IC and PMTP)
- Vögele (PMTP)

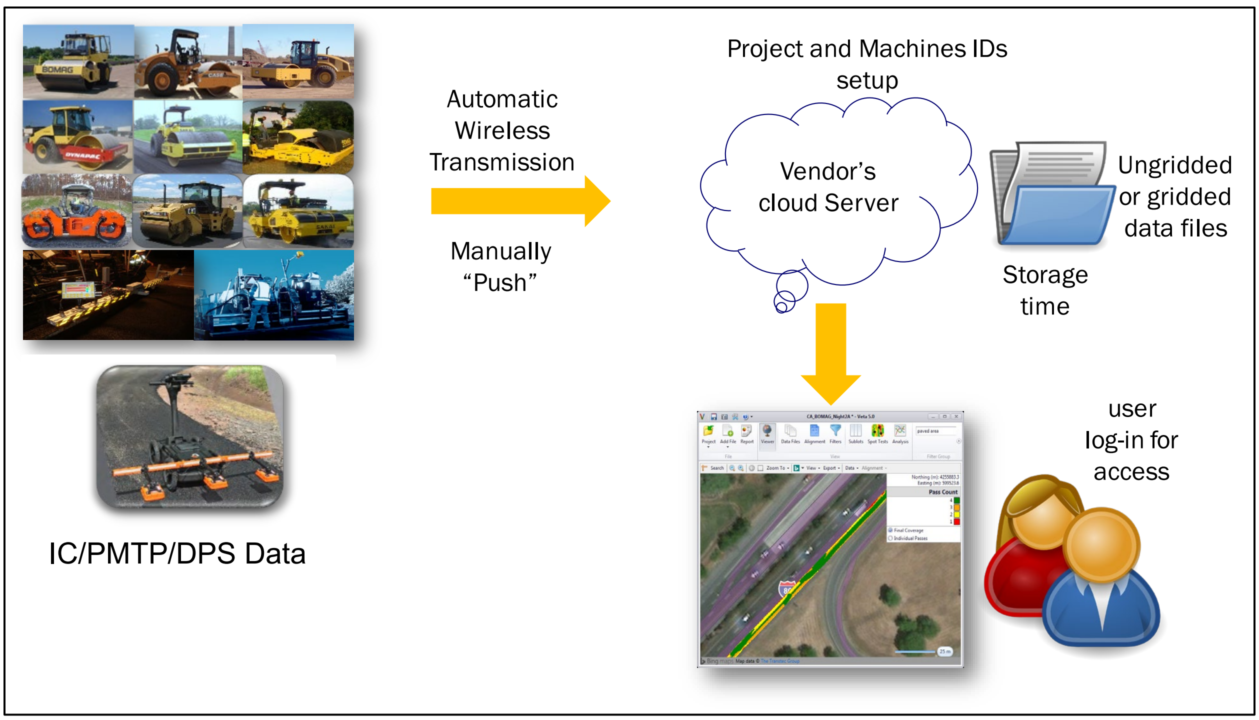


Figure 1. Veta supports direct download from the cloud for many vendor systems.

Data collected by the machine can also be manually downloaded using a USB drive from the onboard computer. This method is not preferable and prone to data loss. Therefore, wireless transmission is recommended to prevent data loss with more secure data transfer. Users must be trained using vendor-specific procedures for viewing and exporting data to Veta-compatible format if the direct download from the cloud option is not available.

Veta users can visit https://www.intelligentconstruction.com/ for more details regarding intelligent construction technologies basics, training workshops, literature, equipment information, specifications, research projects, and technical support.

Veta development is funded by the FHWA, Minnesota Department of Transportation (MnDOT), The Transtec Group, Transportation Pooled Fund 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)." Veta is required in AASHTO, some US State DOT, and other international agency specifications. Relative AASHTO specifications include:

- AASHTO R 110 Standard Practice for Continuous Thermal Profile of Asphalt Mixture Construction.
- AASHTO R 111 Standard Practice for Intelligent Compaction Technology for Embankment and Asphalt Paving Applications.
- AASHTO MP 39 Provisional Standard Specification for File Format of Intelligent Construction Data.
- AASHTO PP 98 Provisional Standard Specification for Asphalt Surface Dielectric Profiling System using Ground Penetrating Radar.
- AASHTO PP 114 Provisional Standard Practice for Data Lot Names for Intelligent Construction Technologies.

Intelligent construction technology is advancing rapidly – and so is Veta. It is recommended that users check https://www.intelligentconstruction.com/ often for the latest software updates. Users can subscribe to Veta updates for email notifications when new versions of Veta are available.

Veta can be freely downloaded from https://www.intelligentconstruction.com/. The intellectual property rights of Veta are owned by the Minnesota Department of Transportation and The Transtec Group. Users must observe the Veta License Agreement and Terms of Use.

INSTALLATION

System Requirements

Veta runs on PCs or PC emulation. We recommend the following minimum requirements for optimum performance:

- 2 GHz processor.
- 4 GB RAM (but 8 GB is better).
- 1280x1024 display resolution.
- Windows 10 v2004 (20H2) is the minimum supported operating system.

Veta 8.0 is only available in a 64-bit version for Windows 10 and higher. Microsoft .NET Framework 4.8 is required. If you are running a current version of Windows 10 or higher, the required .NET should already be installed.

An Internet connection and access to the following websites (as applicable) are required for full functionality:

- Base maps – https://dev.virtualearth.net
- MOBA thermal data download – https://moba.paveir.com
- MOBA compaction data download – https://www.moba-development.de/
- Topcon data download – https://www.sitelink3d.net
- Trimble data download – https://myconnectedsite.com/
- Vögele data download – https://wwshare.services.wirtgen-group.com/

Veta will still run without an internet connection, but direct download and base map features will not function.

Installation Procedure

Previous versions of the same software "family" will be automatically uninstalled. For example, a new 8.0.xx will uninstall previous 8.0.xx versions but will not uninstall 7.0.xx versions. The two version families can co-exist side-by-side. Veta 8.0 can open projects created in previous versions but not vice-versa.

You must have sufficient privileges to install applications on your computer. If you receive an error message during the installation, ask your administrator to install the software for you. If your administrator can also not install the software, please contact us.

Users can uninstall software versions through the Programs and Features in the Windows Control Panel. The following steps outline how to install Veta.

__Step 1. Download the .msi setup file from https://www.intelligentconstruction.com/veta/. Open the file to execute the installation.__

__Step 2. The Veta End-User License Agreement screen will automatically display (reference Figure 2). Read the Agreement and select "I accept the terms in the License Agreement." Click the Next button to continue the process.__

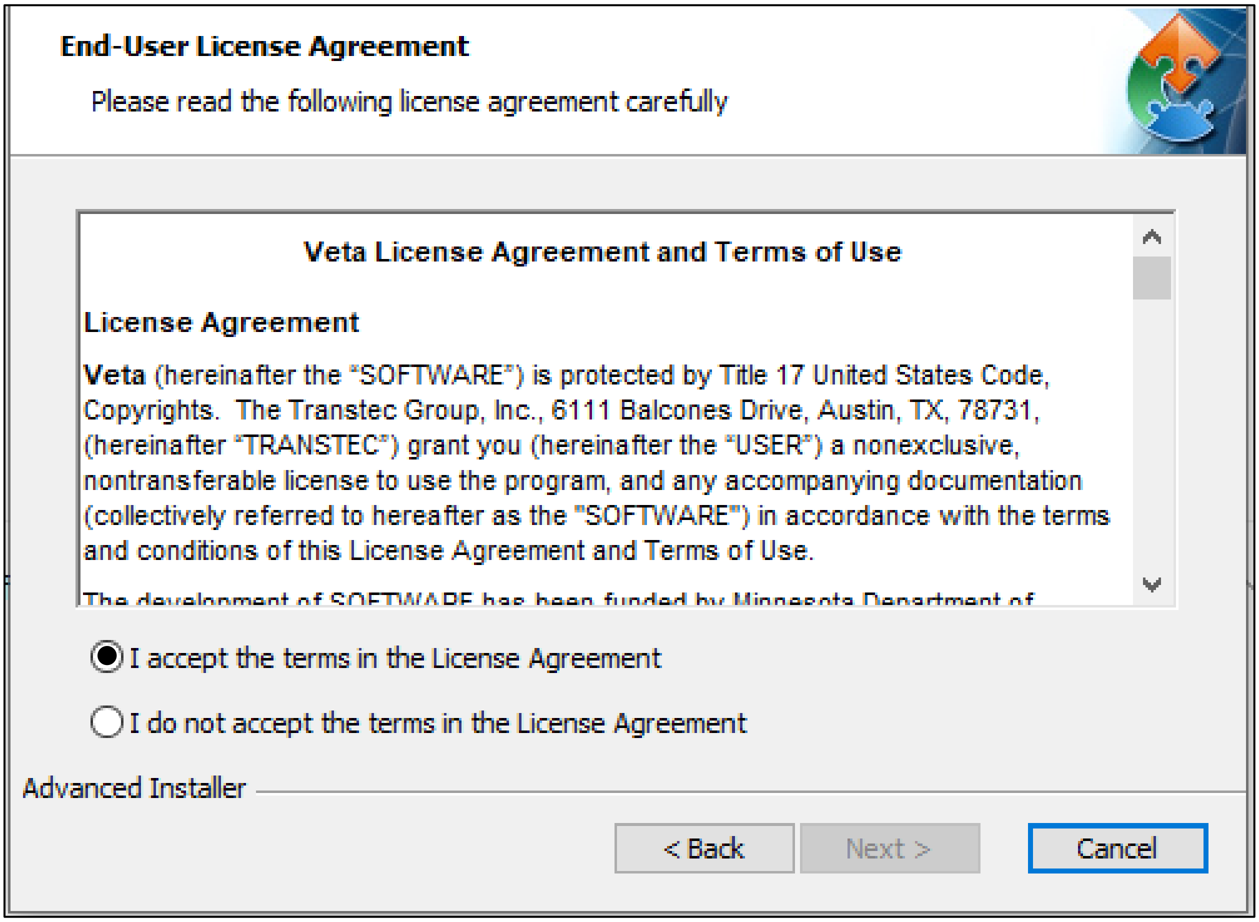


Figure 2. User's agreement window.

The "Modify, Repair, or Remove installation" window will appear if you re-install the same version. Select the desired action and proceed. The following steps show only the new installation process.

__Step 3. The "Select Installation Folder" prompts you to either use the default installation folder (recommended) or select a different folder (reference Figure 3). Click the Install button to complete the process.__

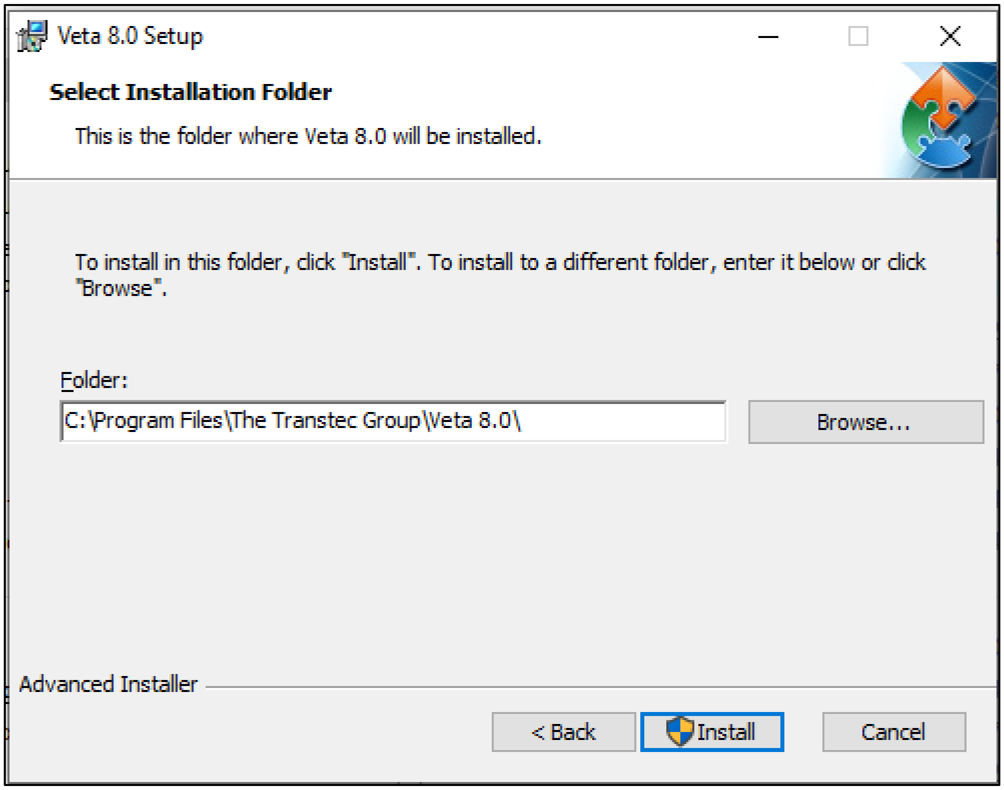


Figure 3. Installation folder window.

Step 4. The installation process may take a moment while the progress bar shows the installation status. If prompted, allow Veta to make changes to the computer. When the installation is complete, the final window of the Veta Installation Wizard will display. Click Finish.

Step 5. Navigate to Veta and launch the application to begin. Locate Veta by typing "Veta" in the Windows toolbar. Users may elect to pin Veta to the toolbar or desktop for easy access.

GETTING STARTED

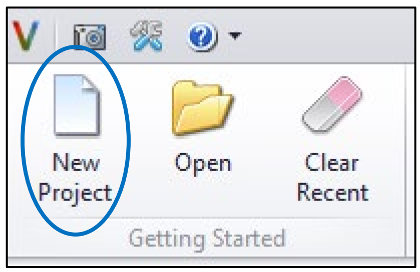
Opening Veta

The Veta welcome screen gives options for a **New Project** or to **Open** an existing project.

Projects created in previous versions (5.2 or newer) of Veta should work in new versions of Veta, but projects created in newer versions of Veta may not work in older versions of Veta.

Adding Data

1. One way to add data is to Select **New Project.** Veta automatically prompts for a new file name. Enter a file name to save the project, or click cancel if you do not wish to save the project.



2. Select the **Add Data** button, as shown in Figure 4. The available options include:
    - Add data files (add manually from a local hard drive or USB drive).
    - Download from MOBA (IC).
    - Download from MOBA (PMTP).
    - Download from Topcon.
    - Download from Trimble/CAT.
    - Download from Vögele.

Login credentials for direct download are vendor-specific. Users must request login credentials from their vendor. If no login credentials are available, select **Add data files** and navigate to the location on the computer where the files are saved. Select the file/s and click **Open**. Hold down the Ctrl key to select more than one file during file selection. Zipped files may be imported directly without extracting files. Zipped files are recommended as they take up less storage space. However, do not zip multiple files together (e.g., do not zip multiple days of data in one folder or multiple machine data files in one folder). ***Veta will only read the first data file in a zipped folder.*** Some vendors may include multiple machines in one data file that can be imported to Veta.

Only import multiple data files simultaneously if they use the same coordinate system. For example, if IC and PMTP files are available for a project, only import IC files with the same coordinate systems first. Additional data can be imported using different coordinate systems separately, as shown in Step 4.

Only IC "All-passes" data files should be imported into Veta. IC "Final Coverage" files are no longer allowed to import to Veta. Instead, the final IC coverage data is calculated in Veta.

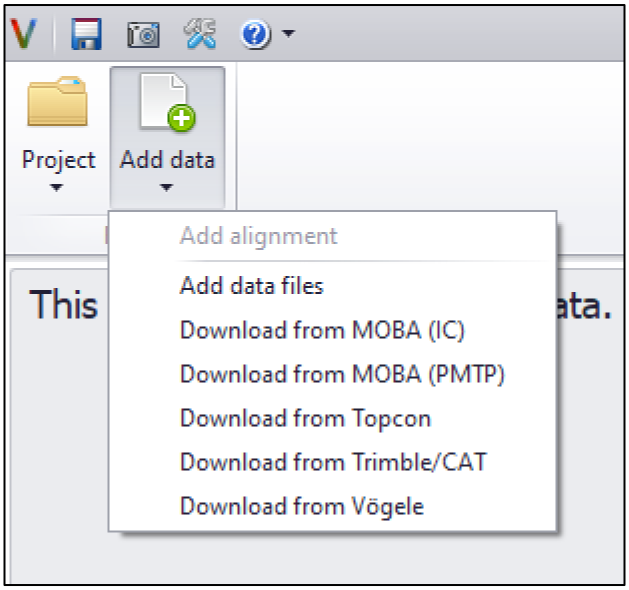


Figure 4. Add data button.

Veta supports files from any vendor that uses the standard file format defined by AASHTO MP 39. The following vendors' data file types are known to be Veta-compatible:

- BOMAG (IC)
- Caterpillar/Trimble (IC, PMTP)
- Dynapac (IC)
- Hamm/Wirtgen (IC)
- Sakai/Topcon (IC)
- Volvo (IC)
- MOBA (IC, PMTP)
- Leica (IC)
- Vogele (PMTP)
- Topcon (PMTP)
- GSSI (DPS)

New in Veta 8.0, users may input multiple IC vendor ungridded data into one project. For gridded data, multiple Intelligent Compaction Measurement Value (ICMV) types are only allowed if they are contained within the same file. ICMV will be listed in the drop-down menu and can be viewed individually, but different ICMV types cannot be combined.

3. Verify the auto-detected GPS coordinate information. Correct or enter any missing information for the coordinate system and units (if applicable). All supported coordinate systems are in the drop-down menu, as shown in Figure 5. Supported coordinate systems include:
    - Miscellaneous
        - GRS80-based (WGS84, NAD83)
        - Other (northing, easting) (i.e., local coordinate)
    - Australia and New Zealand
        - Australia GDA94, MGA94, GDA2020, MGA2020
        - New Zealand GD 2020 and TM 2020
    - Minnesota Counties
    - Oregon Coordinate Reference System
    - State Plane (NAD83)
    - UTM

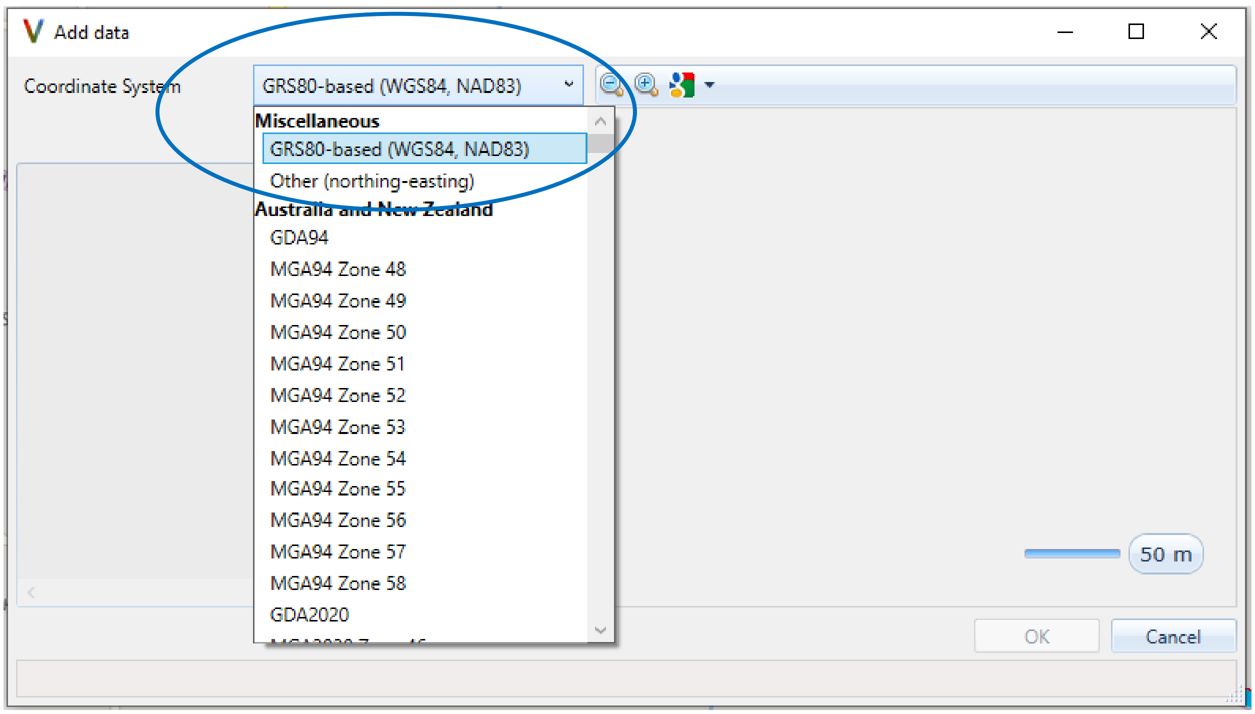


Figure 5. Add data window. Select the correct coordinate system before importing data.

4. Choose whether to save the project after adding data files using the **Save project** switch. Then click **Add Files.** The data will appear in the map display shown in Figure 6. If the data appears invalid on the map, check that the coordinate system and units are correct. If the data looks correct, click **OK.**

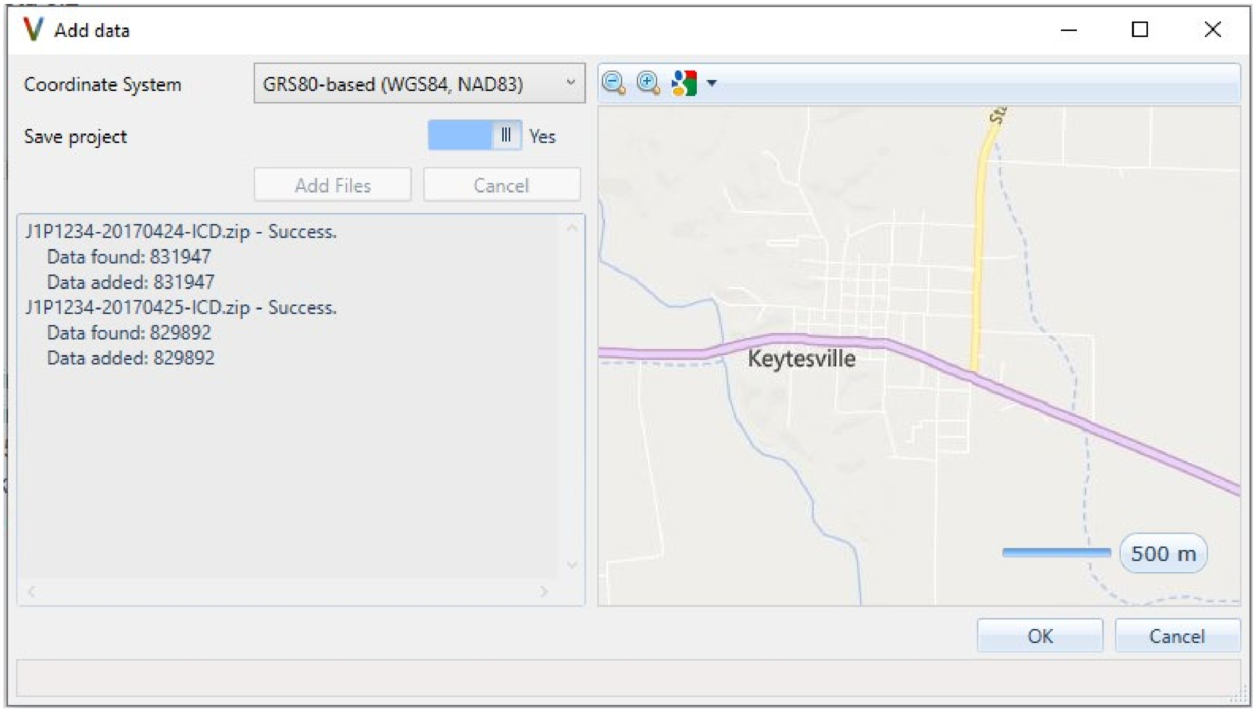


Figure 6. Add data window. The general map area of data is displayed.

5. Import additional data files to the project by selecting the **Add data** button. Choose from the available list of options. If no direct download login credentials are available, select **Add data files** and navigate where the data files are stored. Repeat step 3 for all data files. Multiple data types collected using different coordinate systems may be imported (separately) to one project. ***Each import should have the same data types and coordinate systems.***

Opening a Project or Data File

Figure 7 illustrates the Open Project button to open an existing Veta project file (*.vetaproj) or data file. Alternatively, select a recent project listed on the home screen. Users can also "drag and drop" a Veta Project file or data file to the empty Veta window.

Opening data files directly instead of creating a new project is (slightly) more efficient when using manual data import options. Another option is simply to drag-&-drop data files from File Explorer to the Veta software. Dragging-&-dropping automatically launches the data import wizard illustrated in Figure 5.

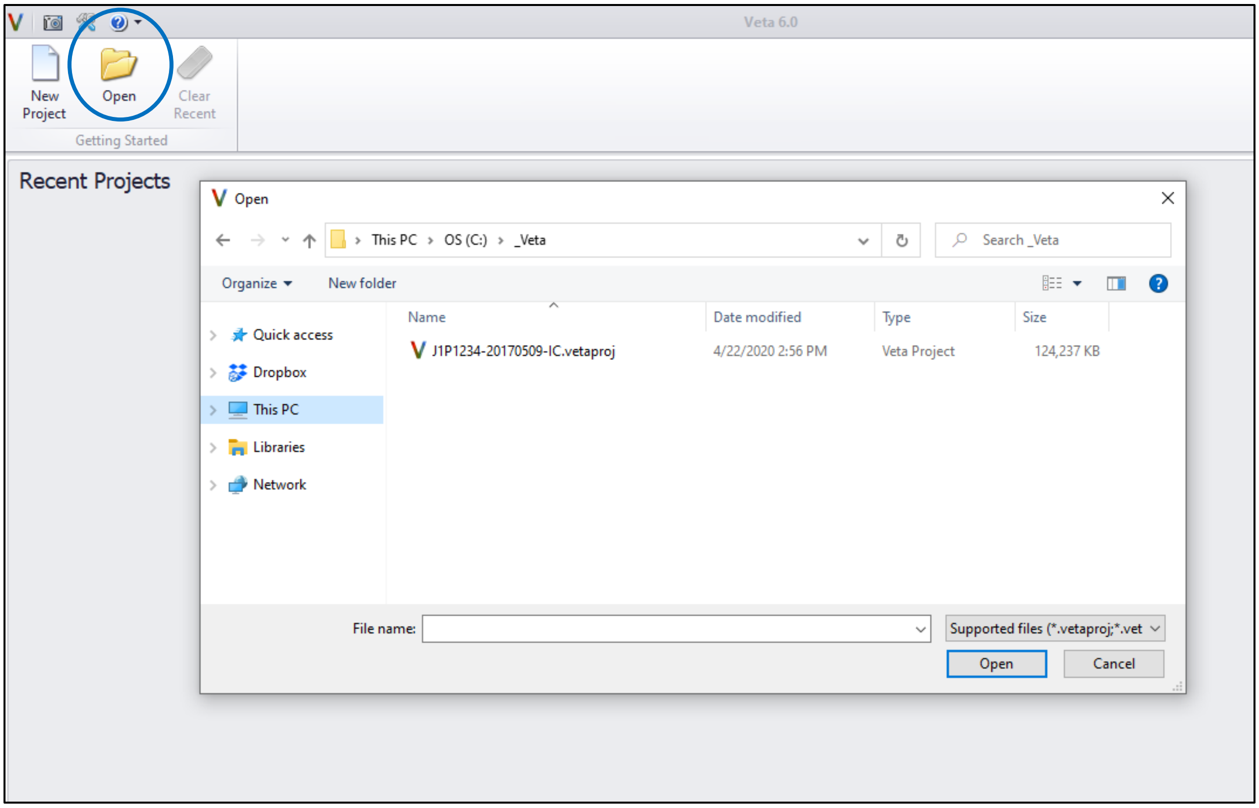


Figure 7. Open an existing project.

Using the Menu bar and Toolbars

The general layout of Veta and the name and description of each toolbar are illustrated in Figure 8. Users should become familiar with the layout and description of each toolbar and icon. The functions of different toolbars and icons are described in relevant chapters.

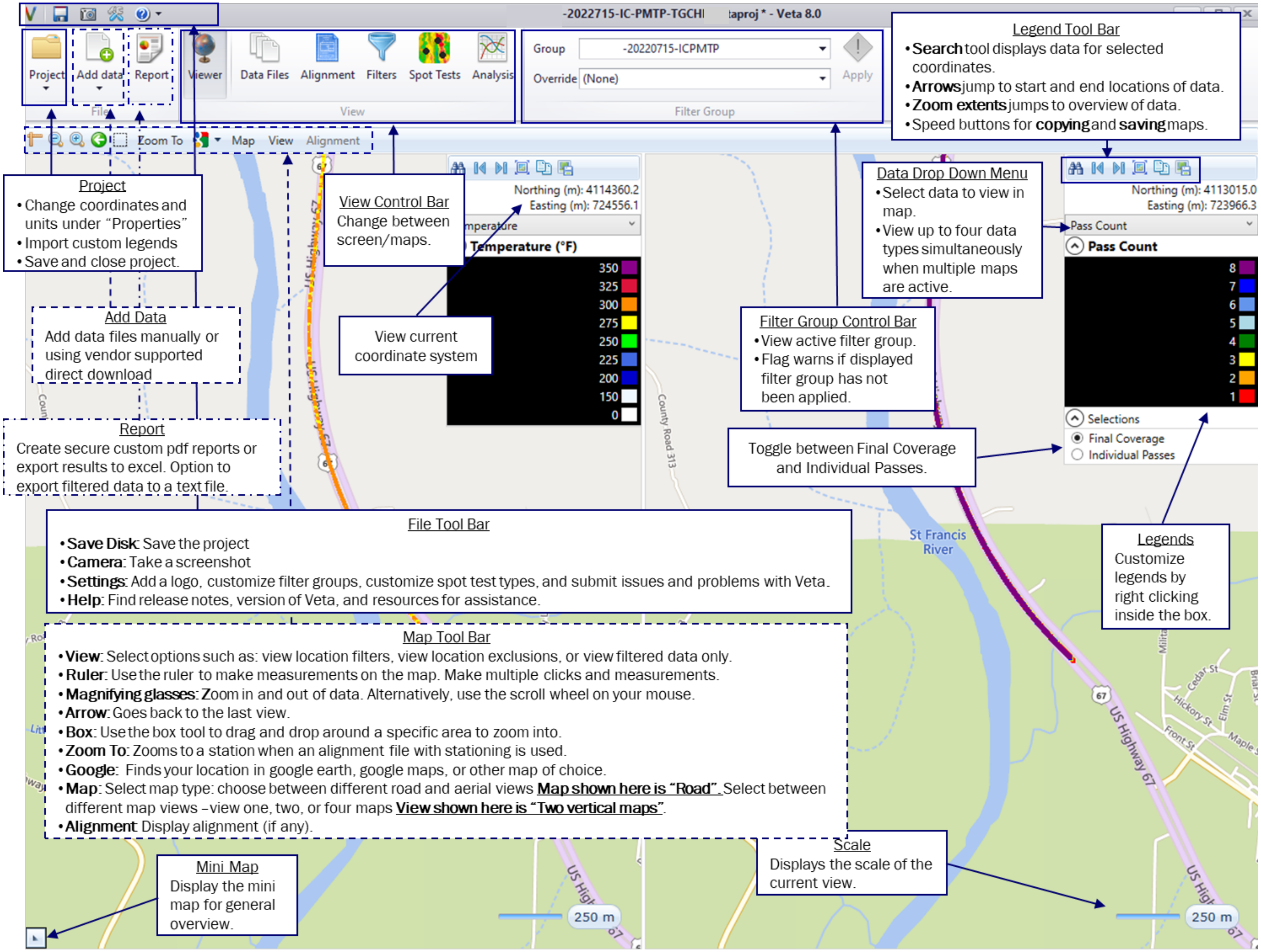
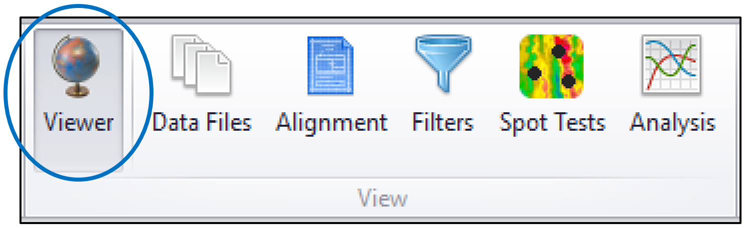


Figure 8. General layout and overview of Veta toolbars and functions. The map display shown is two vertical maps.

VIEWER



Click the **Viewer** button on the main toolbar to use the viewing feature. The purpose of the Viewer **screen** is to view the data. The **Viewer** screen will show a composite of all data files with any filters that have been applied (as further described in section **Filters**). Different views can be customized using the **Map Toolbar**(Figure 9) and **Legend toolbar** (Figure 10) functions, as described below.

Changes made in the Viewer screen only change the visualization of the data, and they do not filter the data. Filtering data is described in subsequent sections.

Map Configuration

Maps can be configured to view multiple data sets simultaneously. For example, a user may find it helpful to view IC breakdown temperature maps alongside thermal profiler temperature maps to visualize the loss of surface temperature between the paver screed and the first roller pass. Another practical scenario is to view IC pass count data alongside the intelligent compaction measurement value (ICMV) data to view the relationship between stiffness and pass count. There are various other helpful viewing configurations. To change the map view, select the configuration of choice under the **Map** dropdown menu in the **Map toolbar (**Figure 9). Figure 11 shows two vertical maps.

Figure 9. Map toolbar.

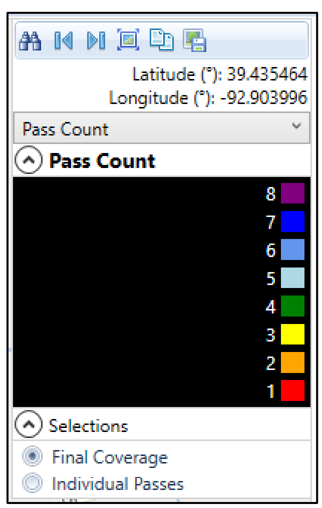


Figure 10. Legend toolbar.

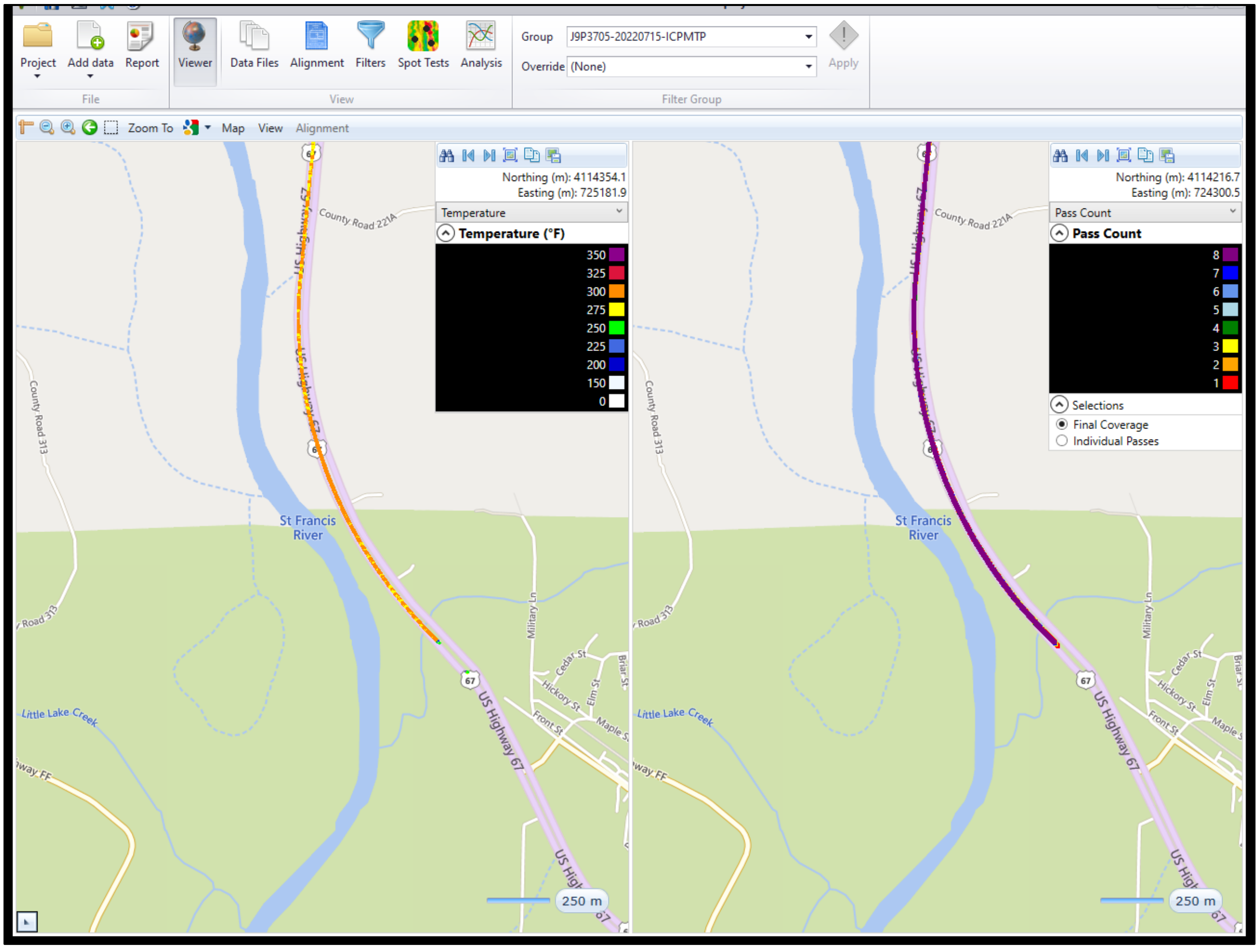


Figure 11. Two vertical maps are shown.

Users can change the map type by selecting an option for the **Map** drop-down menu in the **Map toolbar.** Users may find it helpful to view aerial maps to identify bridges and other features. For example, viewing some example data using aerial maps shows a bridge within the project. The bridge abutments are visible in the aerial view, as shown in Figure 12. The aerial view of the bridges explains the IC and thermal profiler data anomalies, as the bridge deck was skipped during paving.

Other useful icon functions on the **Map Toolbar** are described in Figure 8.

Users may pan the data by clicking and dragging the mouse. Scroll bars on the computer mouse work for zooming in and out. Other useful zoom tools include the dashed box illustrated in Figure 9. Use this tool to draw a box around the desired zoom-in location. The zoom extents button, located on the legend toolbar shown in Figure 10, can be used to show the entire extent of data. The first and last location buttons are located next to the zoom extents button and zoom to the first and last data points.

Users may find the mini-map useful for navigating data spanning large areas. The mini-map is activated by clicking the triangle button in the lower-left corner of the map, as shown in Figure 13.

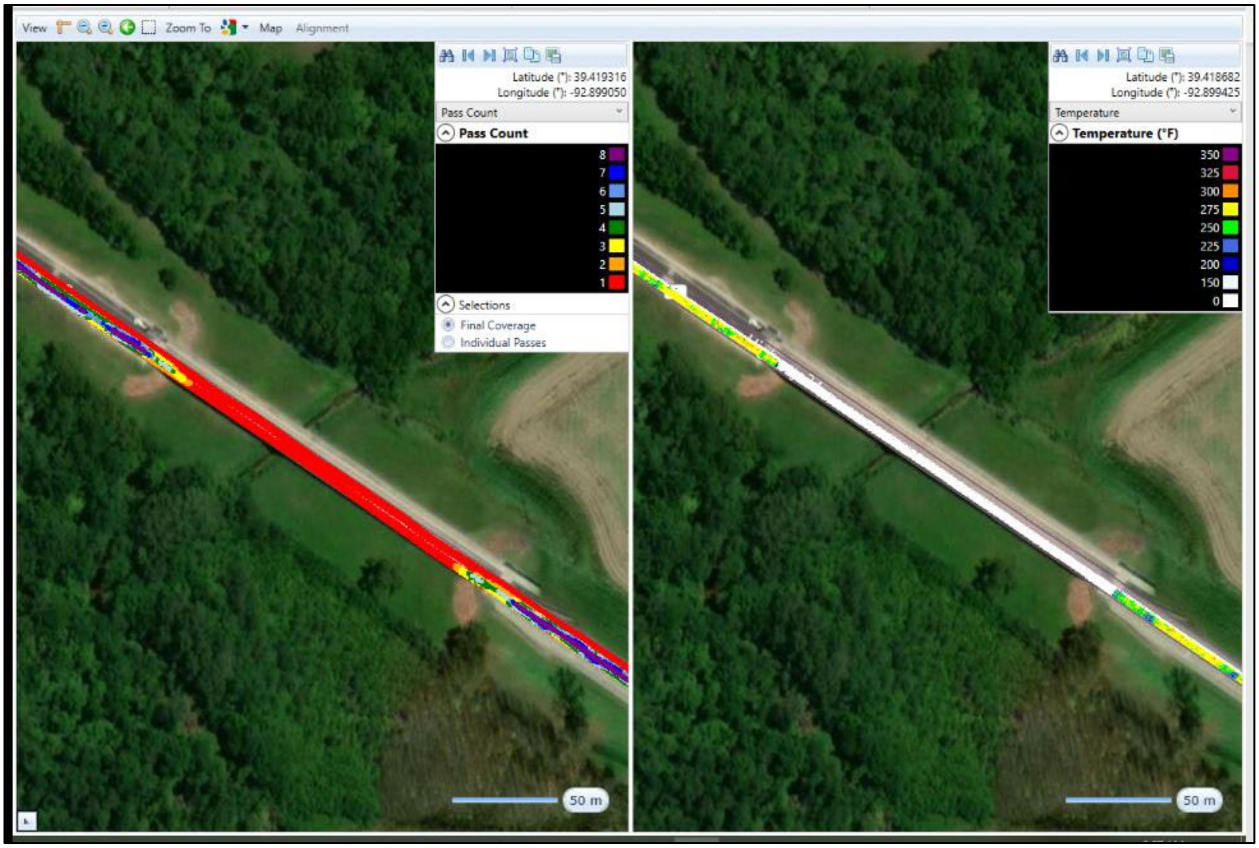


Figure 12. The aerial map view shows bridge features.

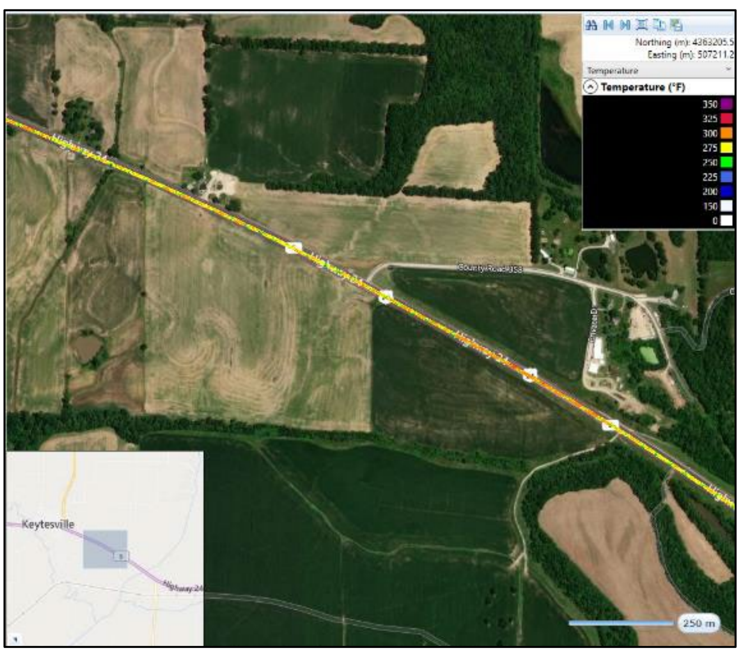


Figure 13. The mini-map provides a data overview for large data sets.

Data Configuration

Users can view and customize data and legends using the **Legend toolbar,** as illustrated in Figure 8. Examples of **Compactor** and **Thermal Profiler** data are shown in the drop-down menu in Figure 14, and available types of **Dielectric Profiler** data are shown in Figure 15. Users can view up to four data types simultaneously when four maps are selected in the **View** drop-down menu. Available data may vary by vendor, and users can check with their equipment vendor to learn more about the data included in their data files. Data types are briefly described in the section **Data filters and Data Descriptions.**

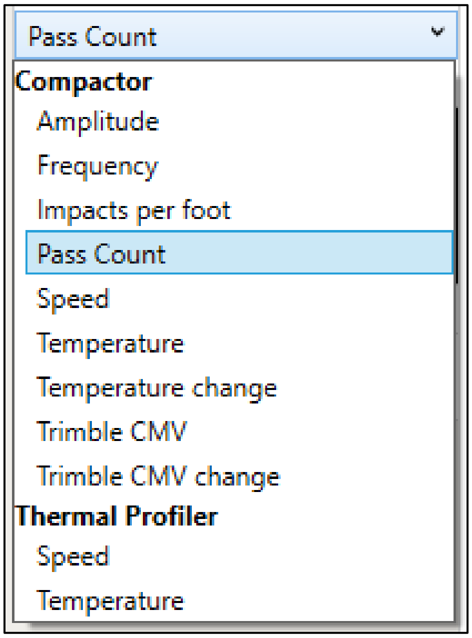


Figure 14. Compactor and thermal Profiler data drop-down menu.

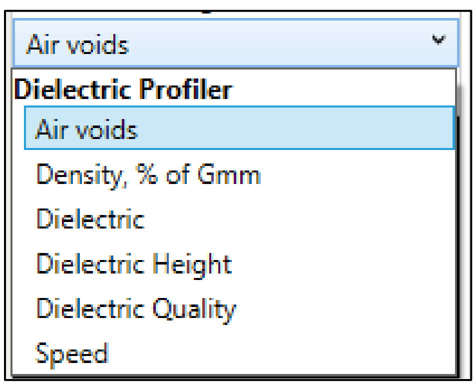


Figure 15. Dielectric profiler data drop-down menu.

The **Compactor** data in Figure 14 shows an option to view Trimble CMV. ICMV definitions and values vary by the equipment vendor. Other types of ICMV and more information regarding ICMV values can be found in supplemental documents at [www.intelligentconstruction.com.](http://www.intelligentconstruction.com)

Veta 8.0 supports multiple types of ICMV. Each vendor has a unique ICMV methodology; some vendors may provide different types of ICMVs or multiple ICMVs. The rules for supporting multiple types of ICMV are as follows:

- For ungridded data – different ICMV in different files may be imported.
- For gridded data – different ICMVs within the same file may be imported.
- ICMV will be listed in the drop-down menu and viewed individually. Different ICMV types cannot be combined.

The **Compactor** temperature change and ICMV change data are only valid for individual pass data on pass count two or greater. This data displays the change in value (temperature or ICMV) compared to the pass before. For example, Figure 16 shows the temperature change between passes three and four. If multiple individual passes are selected, the temperature change related to the highest selected pass and the previous pass is shown.

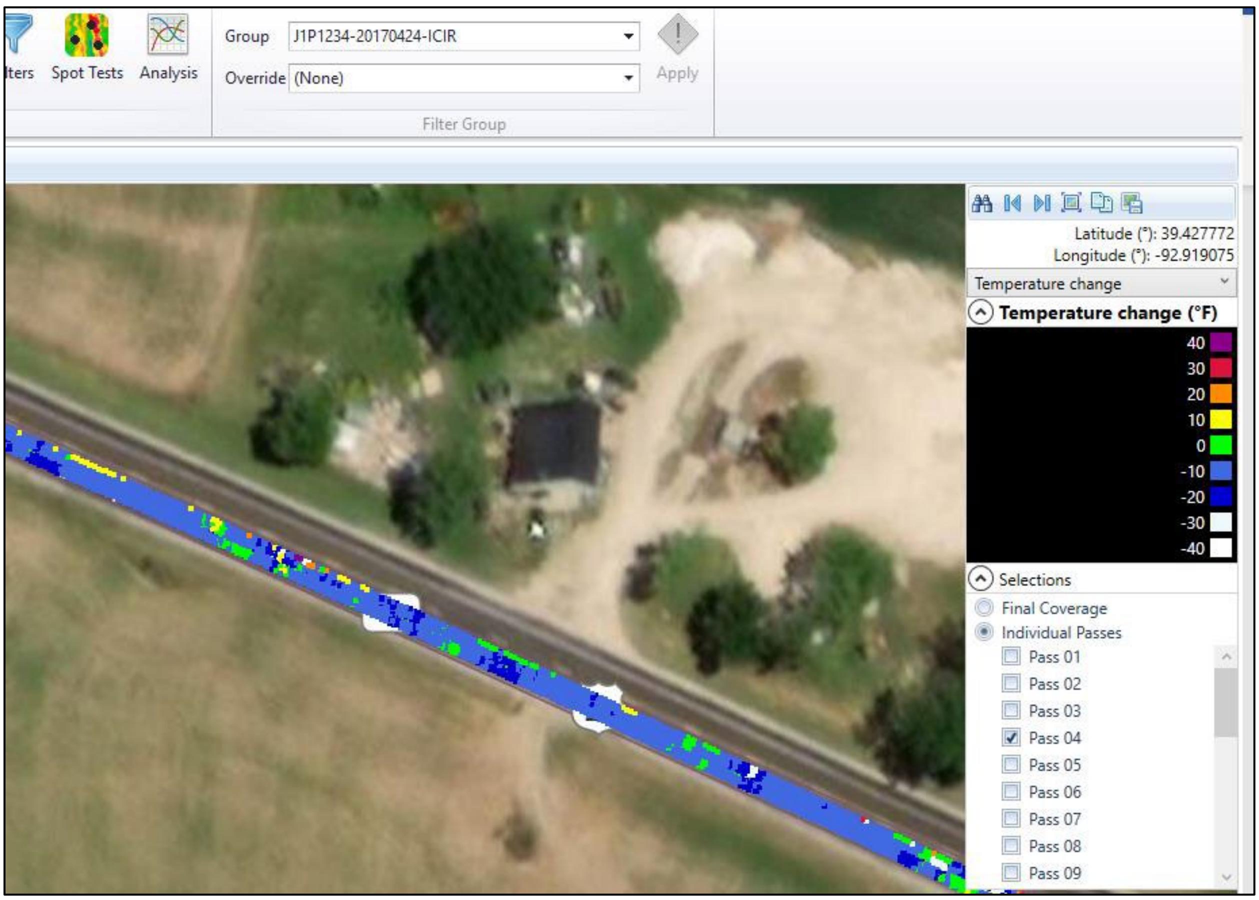


Figure 16. Temperature change shows the difference in temperature between the selected pass and the pass prior.

The current selected coordinate system is shown at the top of the **Legend toolbar** (Figure 17). The display shows the location of the cursor as the user navigates Veta.

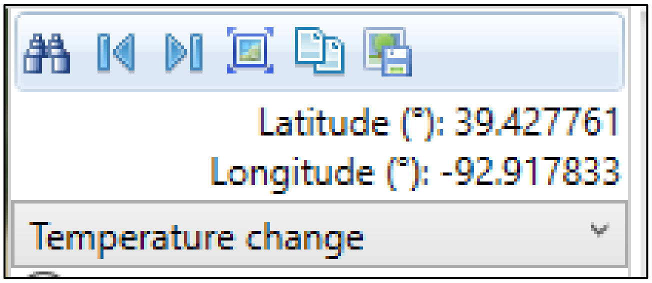


Figure 17. Current coordinate system and location of the cursor.

Users can toggle between applicable coordinate systems by selecting **Properties** under the **Project** button. Figure 18 shows the Project Properties box. Users can select applicable coordinate systems by scrolling through the list and selecting all applicable coordinate systems. Selecting coordinate systems from this list populates the **Coordinate System** drop-down menu. The coordinate system selected in the drop-down menu is the active coordinate system shown in the maps. Users may also select the coordinate **Location unit** of choice (US Survey Feet, Meters, or Feet). Users may display all data in **SI units** (e.g., temperature [˚C/˚F], speed [mph/kph], etc.) by marking the box next to **SI units**. If an alignment file with stationing is used, the station interval can be customized in the **Station interval** box.

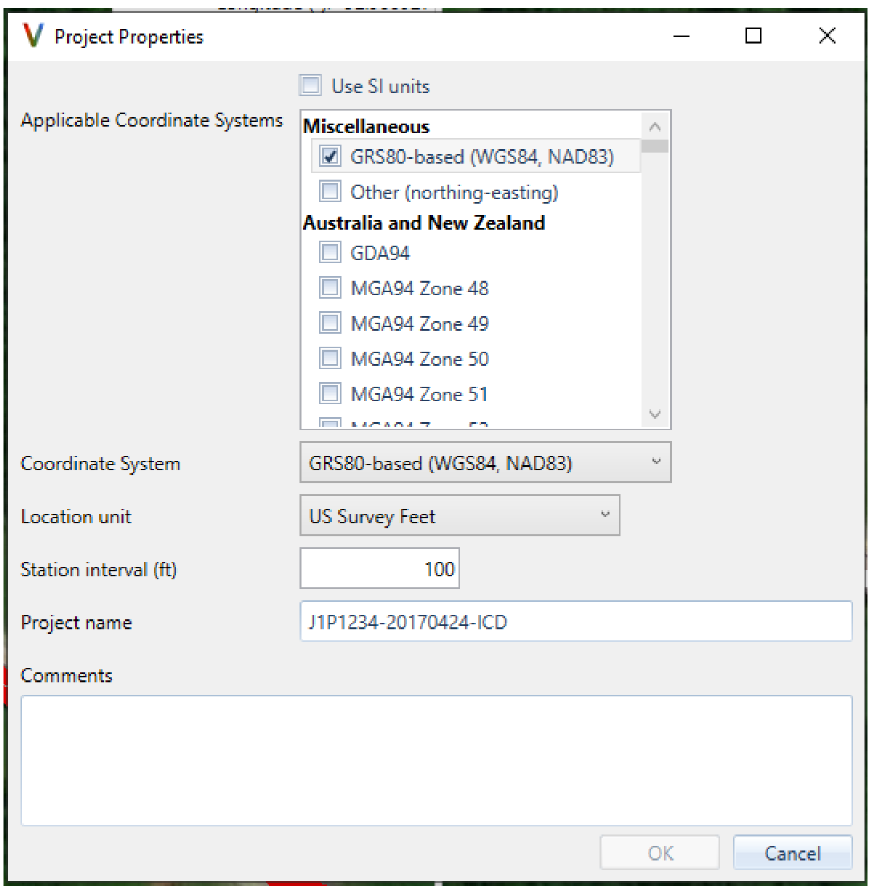


Figure 18. Project properties box.

Compactor, or IC, data can be viewed as final coverage or by individual passes by toggling between the **Final Coverage** and **Individual Passes** buttons. Figure 19 shows Compactor individual pass 01 data. Final coverage is calculated in Veta and can be described as a "layer" containing the final compaction data.

Final coverage uses the data from the last vibratory pass unless vibratory data is not present at a location (e.g., the gridded location or coordinate does not have vibratory data). Static data will not include vibratory-related metrics (e.g., ICMV, amplitude, frequency, impacts per foot). However, the final coverage pass count data includes vibratory and static passes.

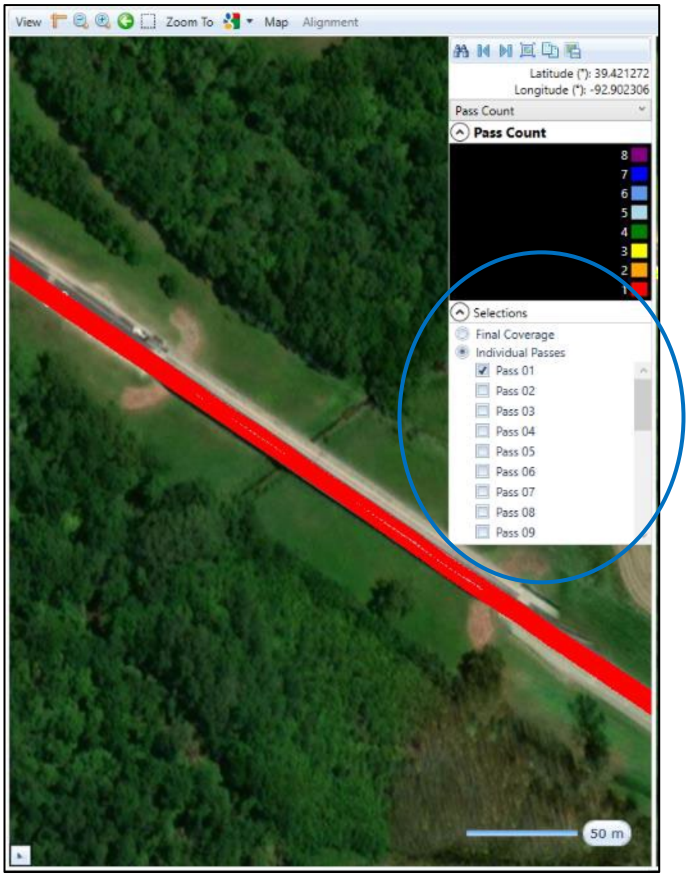


Figure 19. Viewing pass count data individual pass 01.

Legends

Each data type has a default legend, but all legends can be customized. To customize a legend, right-click within the black box of any data type legend and select **Customize.** The **Legend** customization box is shown in Figure 20. Users can add and delete data thresholds using the **Add** and **Delete** buttons, and threshold values are typed manually into the box. Users can select the color of choice for each threshold value. The background color can be changed to a color of choice using the **Background Color** drop-down menu. The background color is displayed when the base map is turned off.

FHWA completed a technical brief on Color-Coded IC Maps for Consistent Visual Data Interpretation in 2017. Users can consult this technical brief for recommendations on customizing legends.

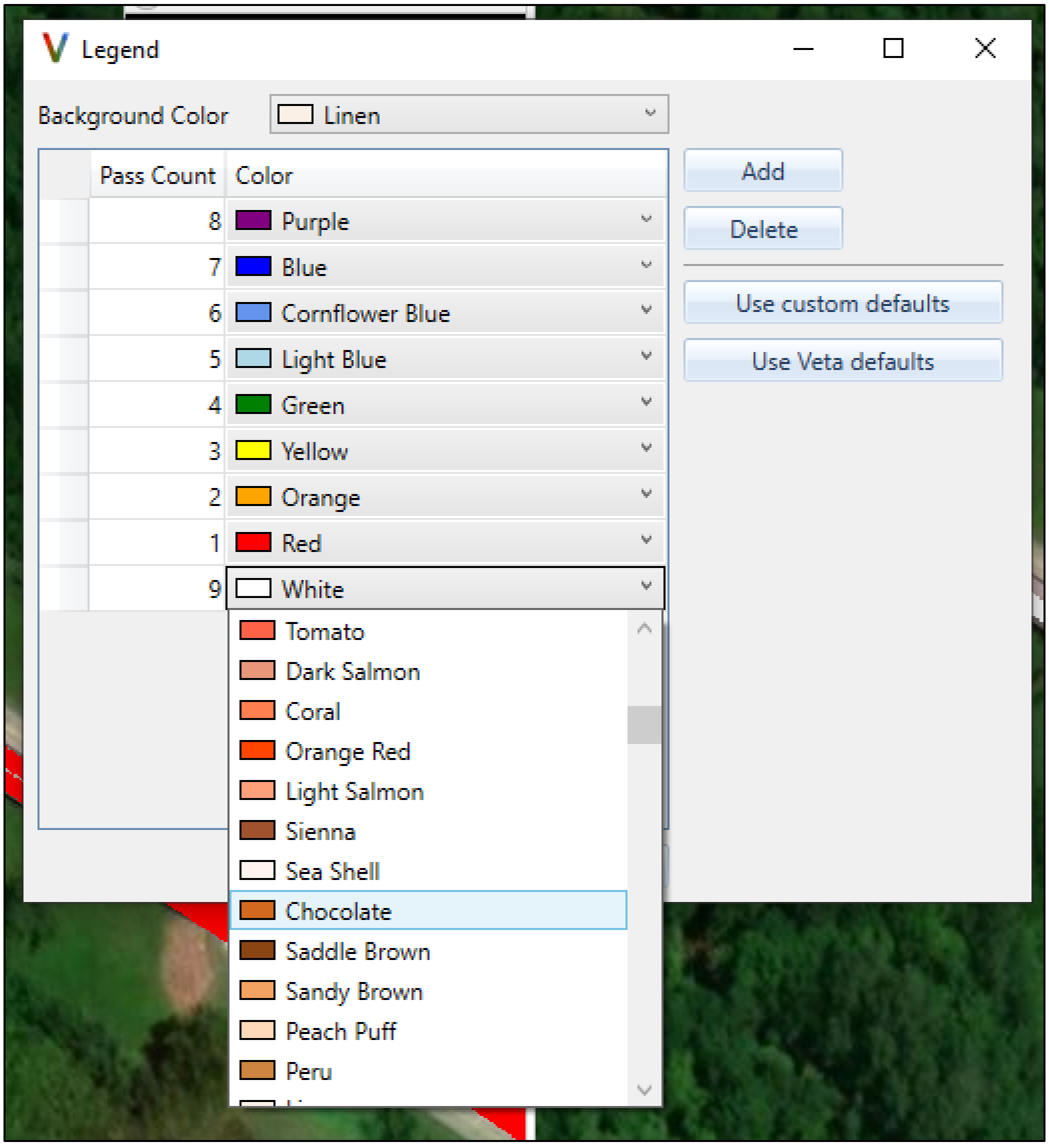
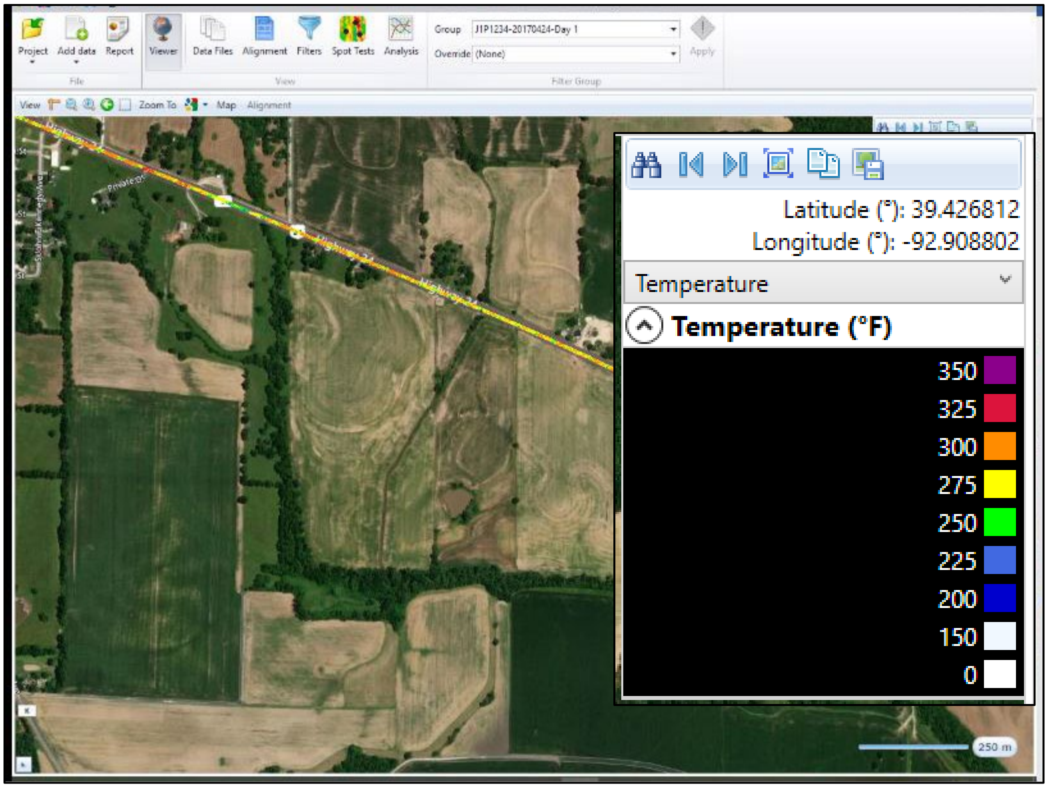


Figure 20. Legend customization box. The data shown are compactor pass counts.

The legends in the Viewer maps are also used in several analysis screens. For example, the **Thermal Profiler Temperature** legend is the same legend used for viewing the thermal profile during analysis, as illustrated in Figure 21. Users may use more detailed legends to capture more details within the thermal profiler. Additionally, the **Compactor Pass Count** legend is the same legend used for coverage pie charts. A pass count legend that reflects the target pass count will make coverage chart results easier to interpret, as further described in the section on **Analysis.**



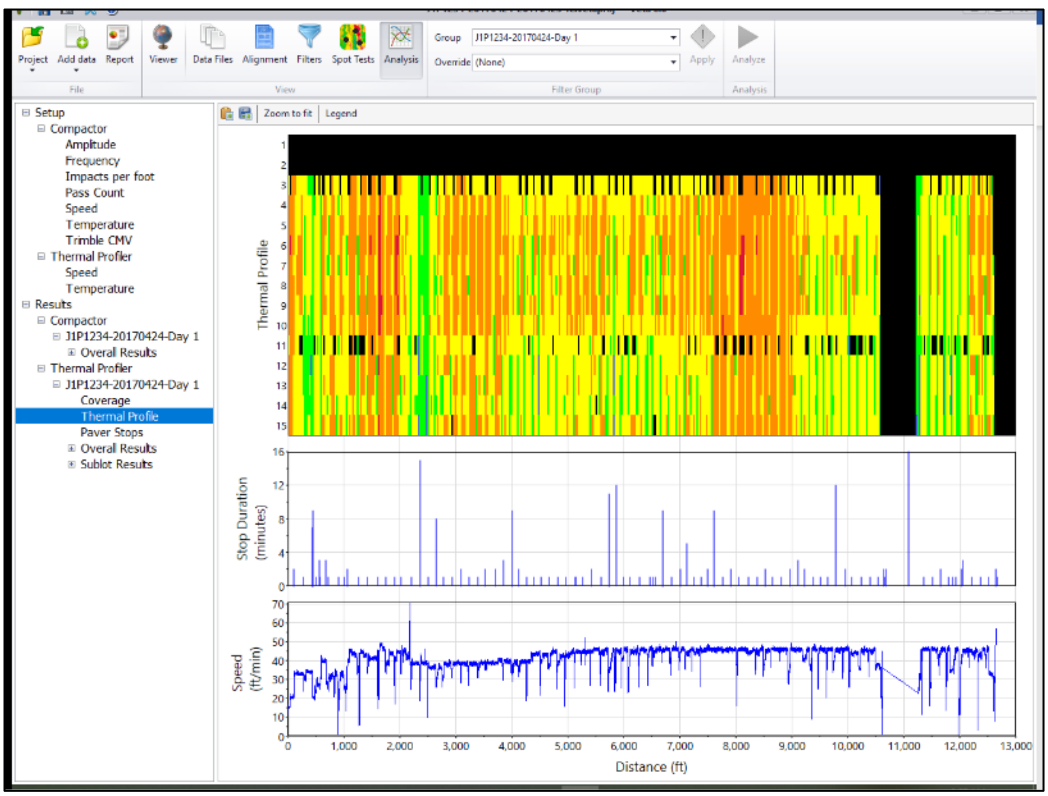


Figure 21. The legend used for viewing thermal profiler data (top) is the same legend used to generate thermal profiler during analysis (bottom).

Customized legends can be saved and imported to future projects. Saving and importing legends is performed by selecting **Legends** under the **Project** drop-down menu. The Legends box is shown in Figure 22.

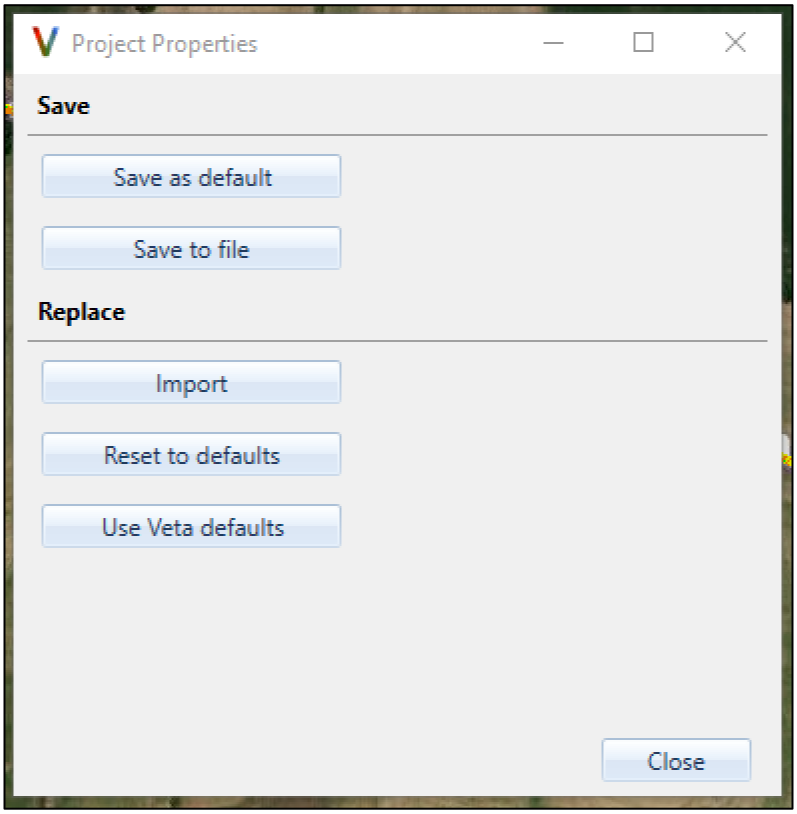


Figure 22. Legend box.

After the user has customized all of the legends for the project (if desired), the legends can be saved as a .xml file by selecting **Save to file**. Saving to file will bring up a dialog box with a default name. The user can navigate to the desired location on their computer, where the legend will be saved.

Previously saved legends can be imported to new projects by selecting **Import** and navigating to the location of the previously saved legends.

Other functions in the legend box include saving the created legends to the default legends (**Save as default**), resetting the legends in the project to previously saved default legends (**Reset to defaults**), and finally, resetting the legends to the Veta default legends (**Use Veta defaults**). Users should be cautioned that customized legends specific to a particular project may not translate well to other projects. For example, using a pass count legend that only shows 4 passes may not be visually useful if another project has an optimum pass count of 8.

The Veta default legends are a good starting point for new projects.

Search

Right-clicking any data on the map activates the search tool. Alternatively, the binoculars icon above the legend also opens the search box. The coordinate will display the location selected by right-clicking or can be manually typed in. The radius is customizable and changes the amount of data included in the search. For example, a one-foot radius will include all data within one foot of the coordinate. Users can toggle between filtered data or raw data using the switch.

Clicking the search button will bring up all data within the specified radius of the coordinate. Users can toggle between each data type to view all associated data. For example, suppose a user wants to investigate a low core density from a project. In that case, they can type in the location of the core and search through all relevant ICT data to troubleshoot temperatures, pass counts, machine settings, etc.

The search tool also offers a heat loss curve. This curve displays all temperature data from PMTP and compactor equipment. The PMTP temperature data populate the temperature data at time 0, and the other points are populated from the IC temperature data.

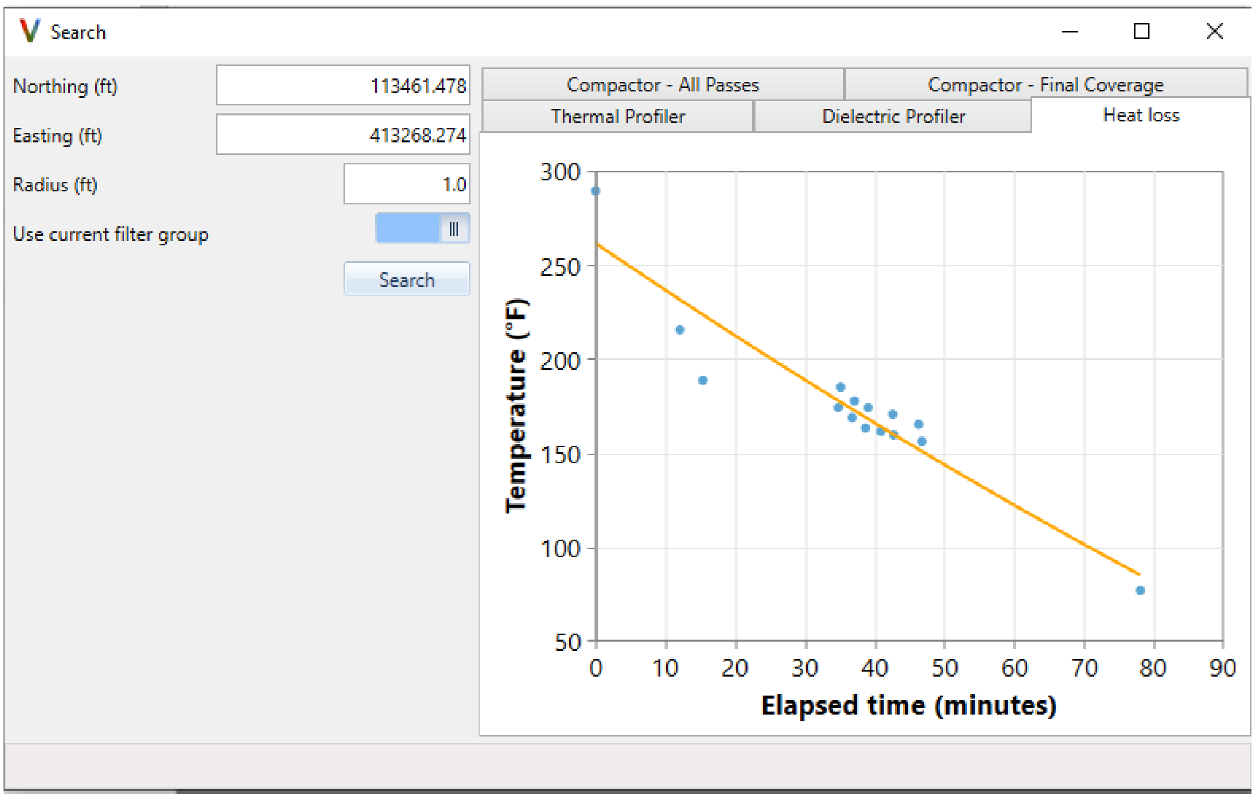
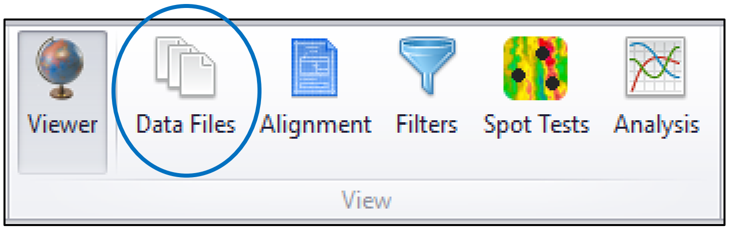


Figure 23 Heat loss curve found in the Search tool.

DATA FILES



The data files screen is similar to the viewer screen but shows each imported file individually (the viewer screen shows the composite data). Figure 24 shows an example of a project with two compactors' (ICD.zip) data files and two thermal profiler files (IRD.zip).

The same map and data configuration options in the viewer screen are available in the data files screen. Figure 24 shows two vertical maps in an aerial view. Compactor pass counts are shown on the left map, and thermal profiler temperatures are shown on the right map. The left map shows a message that **No data matched the selected filter group**. This message appears because a thermal profiler data file is highlighted in the data files box, so compactor pass counts do not apply.

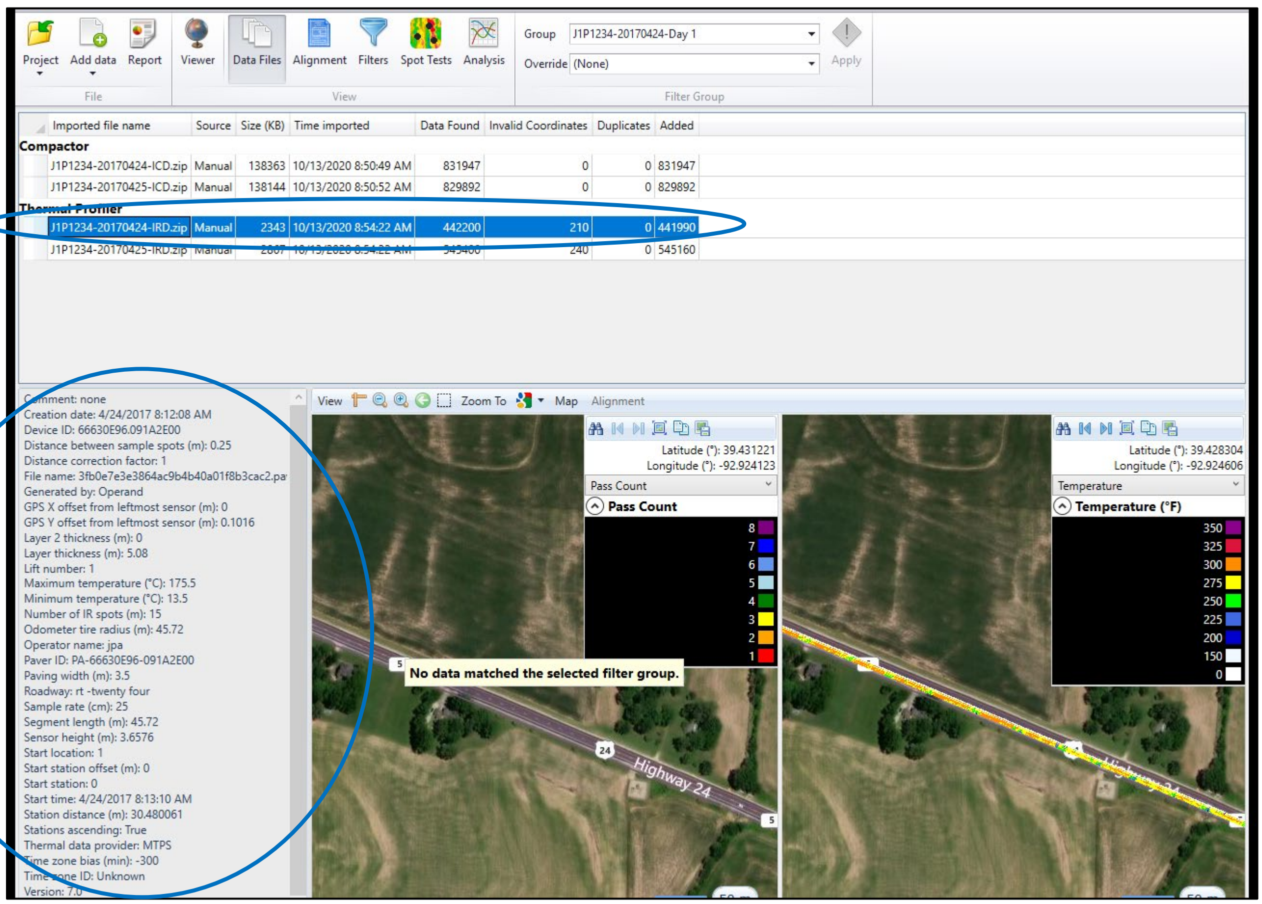
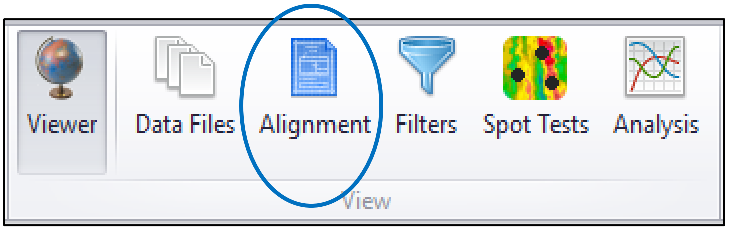


Figure 24. Data files screen. The example shows four data sets. One thermal profiler data set is highlighted/selected. Data header information is shown on the left.

The **data files** screen displays vendor-specific settings and header information (Figure 24, left of the maps). The data shown in Figure 24 is specific to MOBA thermal profiler equipment. The data shown here may be useful for quality assurance checks to ensure the equipment has been set up correctly (e.g., paving widths, minimum and maximum temperatures, etc.).

Users can also note any invalid coordinates found, duplicate data added, file sizes, and other relevant information in the data file table.

ALIGNMENT



Types of Alignments

Alignment files can be imported and used to view and filter data based on location. Veta supports .kmz files and LandXML files. Users should configure alignment files so one element, or line, can be selected in Veta. Different alignments and descriptions are illustrated in Figure 25 and Figure 26.

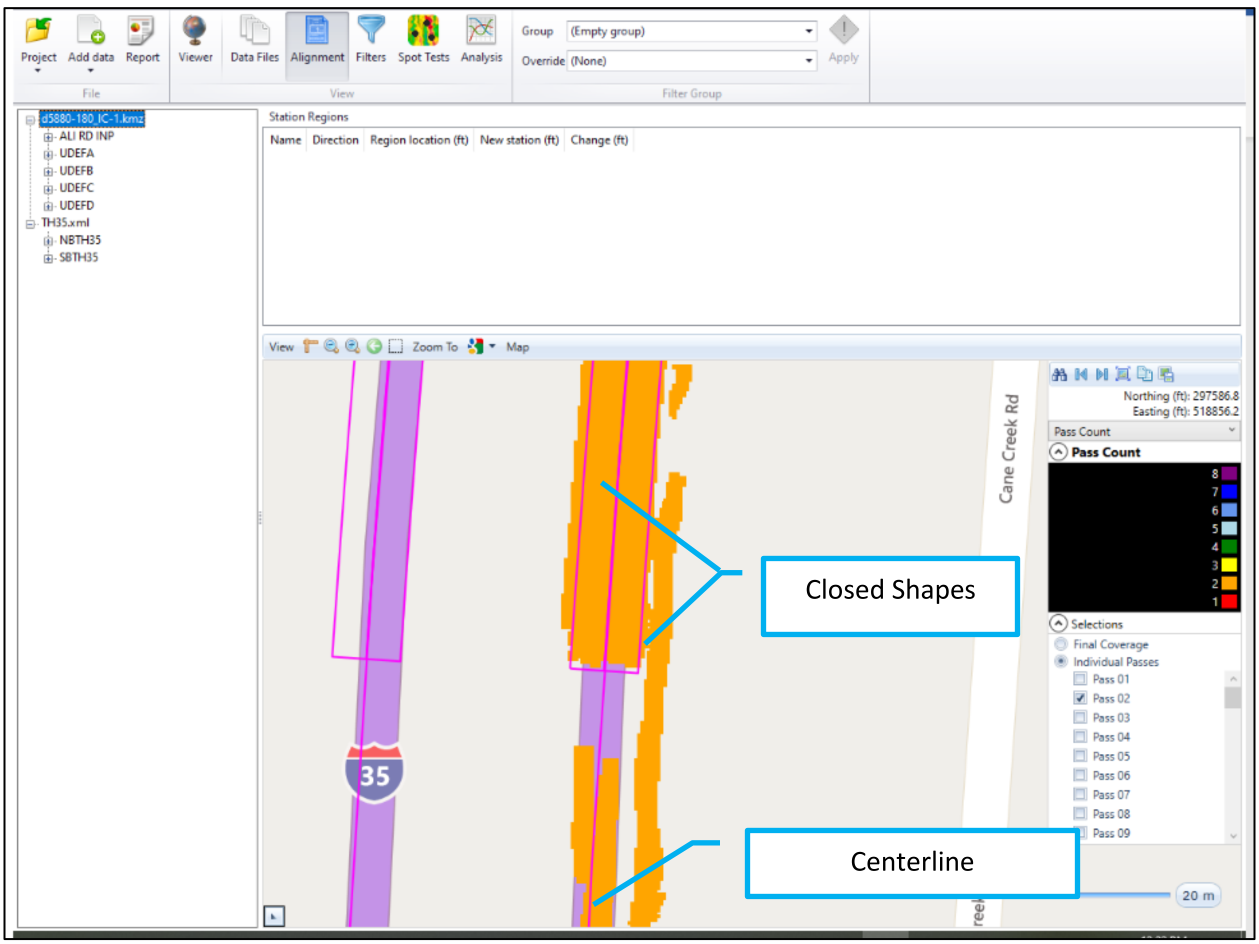


Figure 25. Available elements in an example .kmz alignment file.

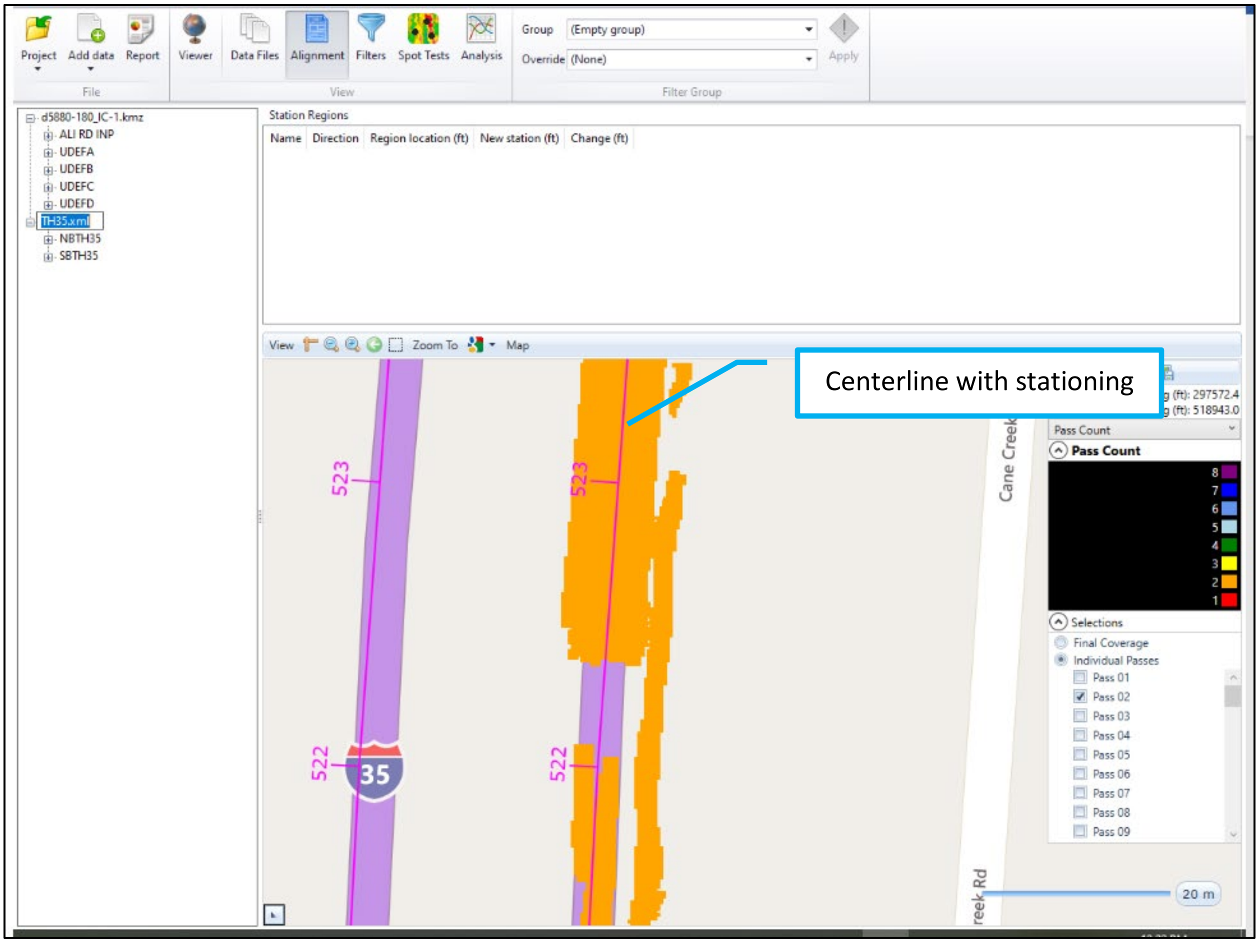


Figure 26. Available elements in example LandXML alignment file.

These elements can be used to filter data, as further described in chapter **Filters**. Note that individual points or multiple elements cannot be combined in Veta to create location filters. Users should ensure their alignment meets one of the supported elements shown in Figure 25 and Figure 26.

Minnesota Department of Transportation (MnDOT) has many resources regarding implementing intelligent construction technologies and using Veta. MnDOT uses alignment files during analysis and provides manuals, guides, and videos on the Advanced Materials & Technology website.

Adding an Alignment

Alignment files are imported using the **Add Data** button, as shown in Figure 27.

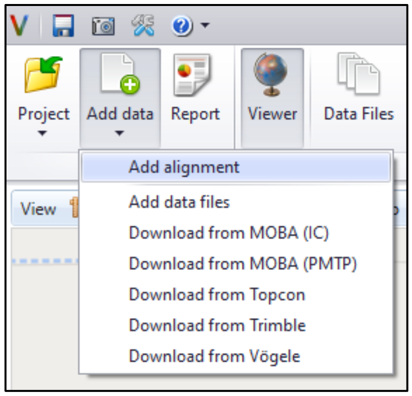


Figure 27. Add alignment files using the add data button.

Viewing Alignment Files

Alignment files are most commonly used to filter data based on location, as further described in chapter **Filters**.

The **Alignment** screen is used to view imported alignment files. Users can sort through and rename different elements (by right-clicking on them), as shown in Figure 28.

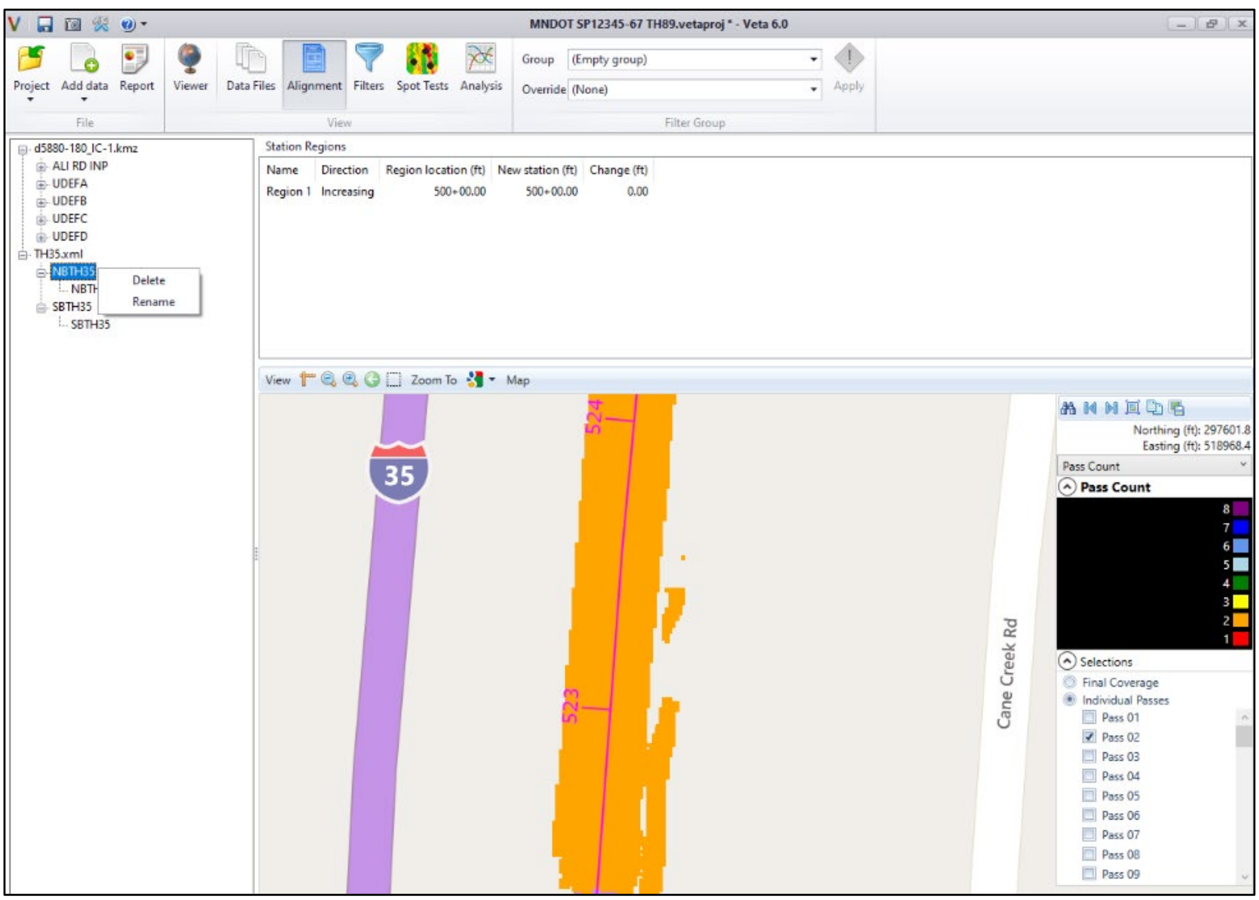
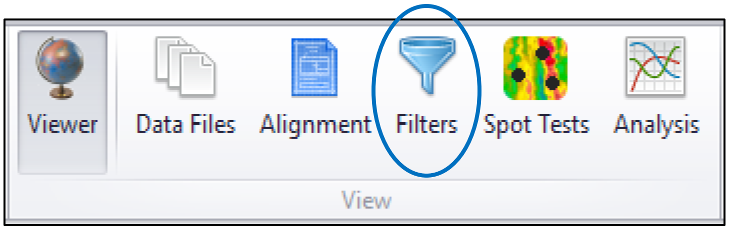


Figure 28. The alignment screen can be used to identify different elements in alignment files. Elements can be renamed or deleted by right-clicking on the element.

FILTERS



The filters screen includes powerful options allowing the user to filter the imported data so that an analysis representative and accurate to the construction efforts can be performed. ***Filtering data is critical and almost always essential for valid data analysis.***

Filter Groups

The first step in filtering data is always to create a filter group. Filter groups are containers that hold a selection of filters. Multiple filter groups can be created to analyze data according to different operations and data filters. Filter groups can contain multiple operation filters and one data filter, making filtering powerful and complex. Analyzing multiple filter groups simultaneously is further described in chapter **Analysis**. Users should understand the importance of data filtering when performing data analysis.

Figure 29 shows the layout of the **Filter Group** control bar. New filter groups are created by clicking the **Manage groups** button. Users should always create a filter group before creating data, operation, or override filters.

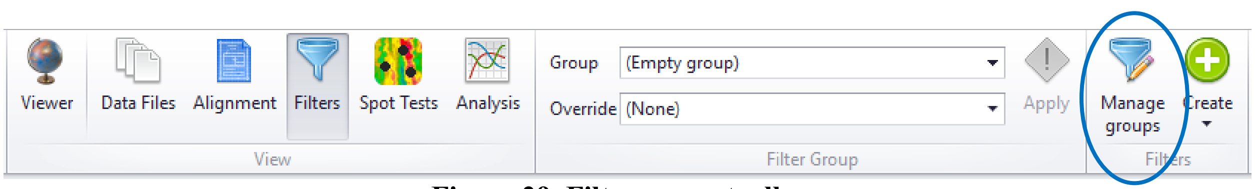


Figure 29. Filter group toolbar.

Create Filter Groups without Using Filter Naming Template

One way to create a filter group is to enter the filter group name and click the **Add** button, as shown in Figure 30. Users should change the folder from Miscellaneous to Data Lot to generate data lot results and use PMTP price adjustment functions. A standardized naming convention for filter group names is recommended for data management.

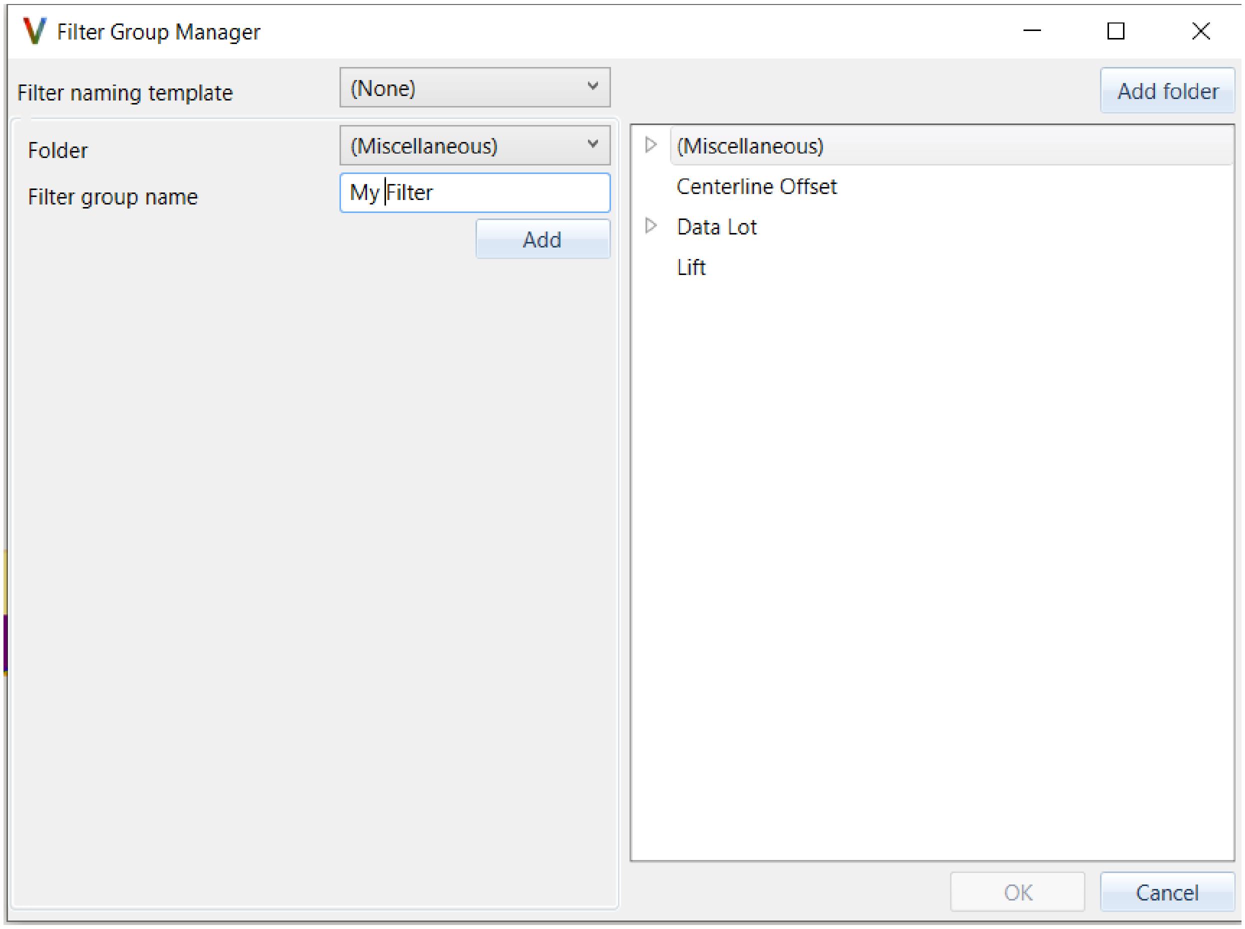


Figure 30. Filter group manager dialogue.

The active filter group is displayed in the **Group** drop-down menu illustrated in Figure 31. No filters are applied when (Empty group) is displayed in the Group drop-down menu. Users may always revert to **(Empty group)** to view the unfiltered data files.

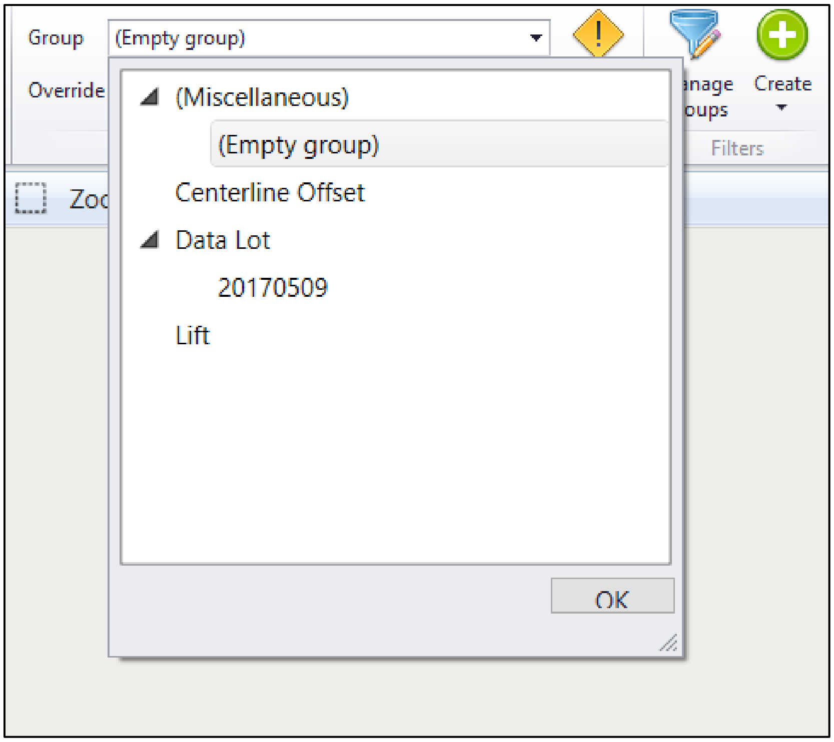


Figure 31. Existing filter groups in the Group drop-down.

Create Filter Groups using AASHTO PP 114 Filter Naming Template

There is an option to use the AASHTO **filter naming template** by selecting **AASHTO** from the drop-down menu. The AASHTO filter naming template follows AASHTO PP 114 Data Lot Names for use with Intelligent Construction Technologies. The Minnesota definitions for Route Systems, Materials, Lifts, and Centerline offsets are included by default in the AASHTO naming template in Veta. The **AASHTO filter naming template** is illustrated in Figure 32.

Renaming Filters using the AASHTO Template

Once at least one filter group is created, new filter groups can be quickly created using the renaming function. Right-clicking on an existing filter and selecting ***rename*** will auto-populate the inputs. Then, they can be modified for new filter groups using the ***add*** option.

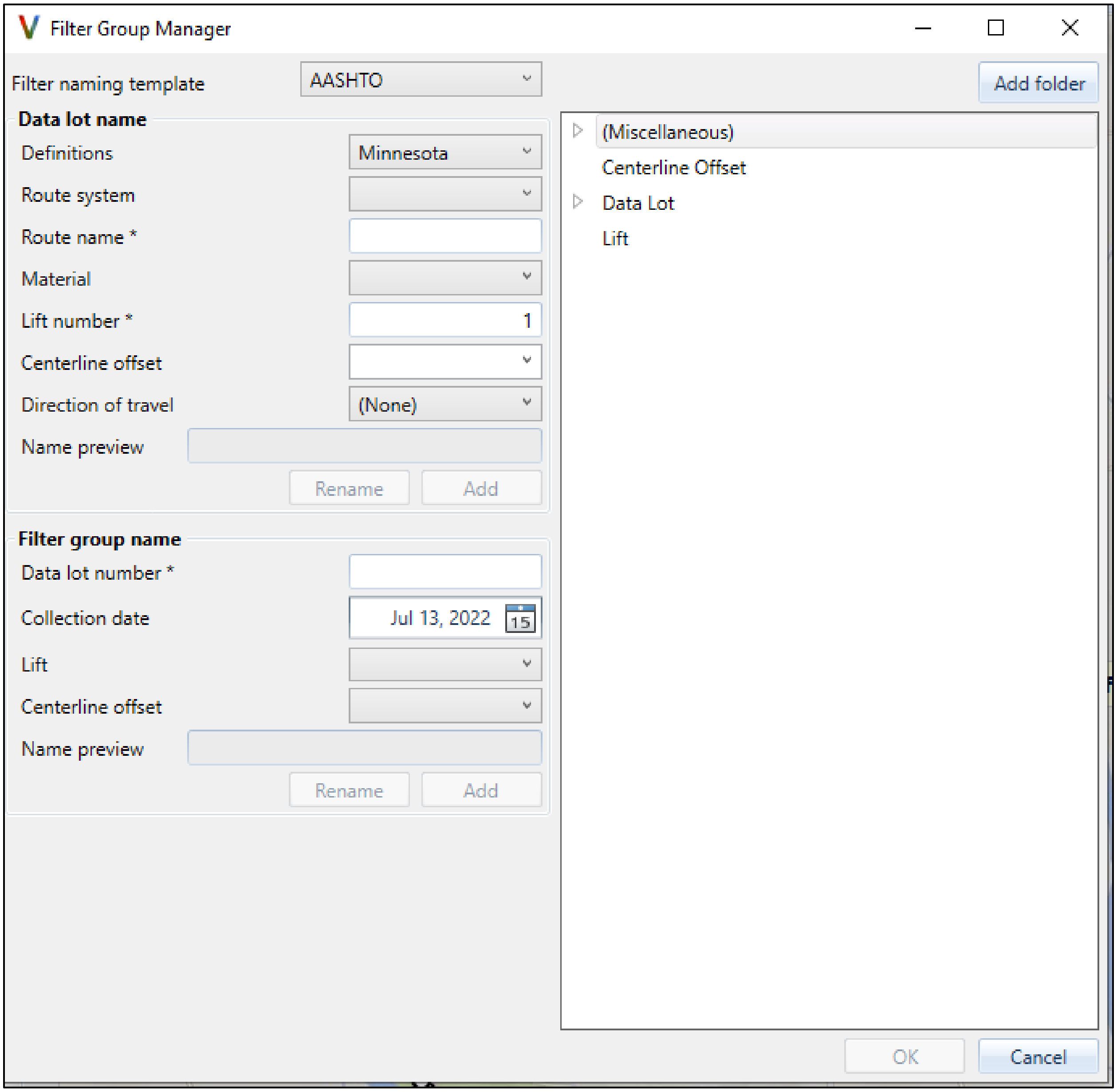


Figure 32. Create filter groups using the AASHTO Filter naming template.

States may enter their definitions for these inputs by selecting the **Options** wrench and hammer icon above the **File toolbar** and clicking the **Filters Naming tab.**

By selecting the green plus sign icon, new definitions can be added for each input column. New **Route systems**, **Materials**, and **Centerline offset** definitions can be added here. These definitions will be automatically transferred to the **AASHTO filter naming template**. The Filter naming options are illustrated in Figure 33. Users may reference AASHTO PP 114 for more guidance on standardized naming templates.

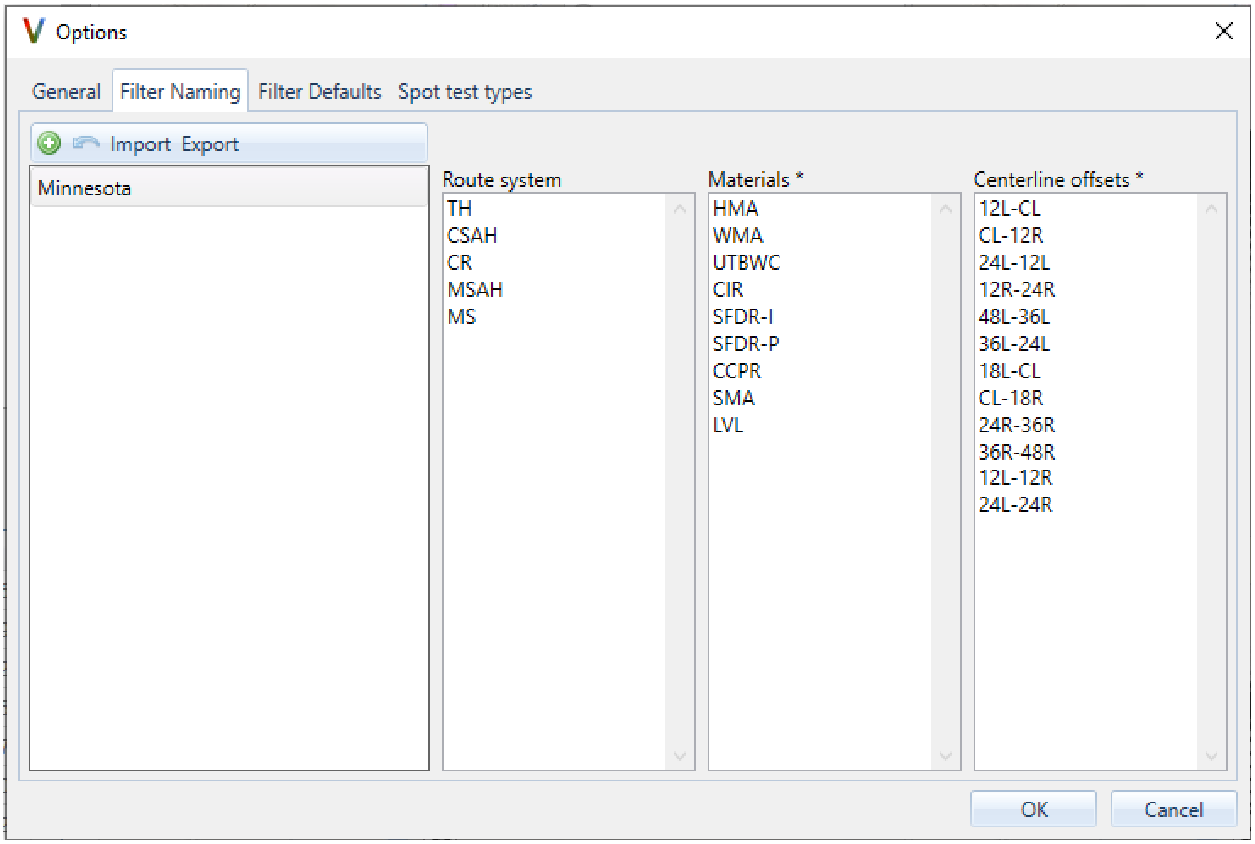


Figure 33. Filter naming options.

Calibration Functions (for DPS data only)

Calibration functions are applied to DPS dielectric constant data. DPS dielectric constant data can be transformed to estimated relative density (percent theoretical maximum specific gravity, or % Gmm) if the DPS sensors have been calibrated against field asphalt cores or laboratory gyratory samples. Though vendors may have various calibration methods, ***Veta supports only the first-order polynomial function for calibration against relative density (% Gmm):***

$$y = m * x + b$$

where:

y is the relative density (% Gmm)

m is the linear coefficient of the first order polynomial function,

x is the dielectric constant, and

b is the constant of the first-order polynomial function.

Veta will compute air voids based on the estimated % Gmm:

Air voids = 100% - % Gmm

To insert the calibration functions to a Veta project, right-click on **Dielectric Profiler** underneath **Calibration Functions** in the Filters screen and select **Create calibration** (Figure 34)**.** Then input a calibration name, linear coefficient (m), and constant (b) for the calibration function in the lower-left of the Filters window (Figure 35).

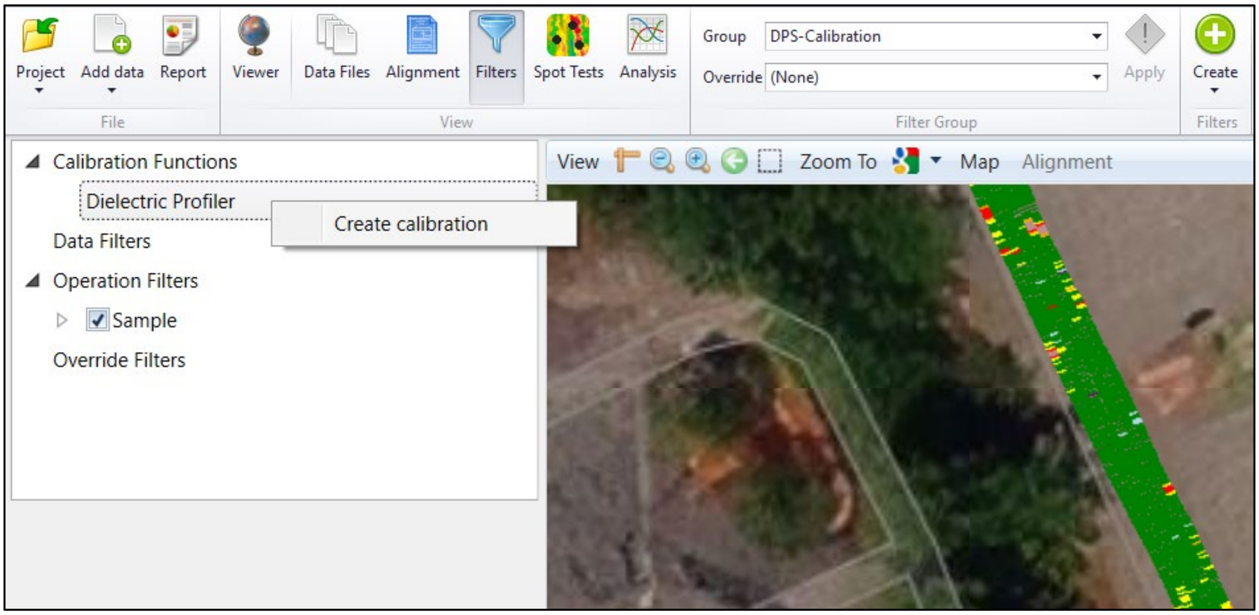


Figure 34. Create a calibration function for DPS.

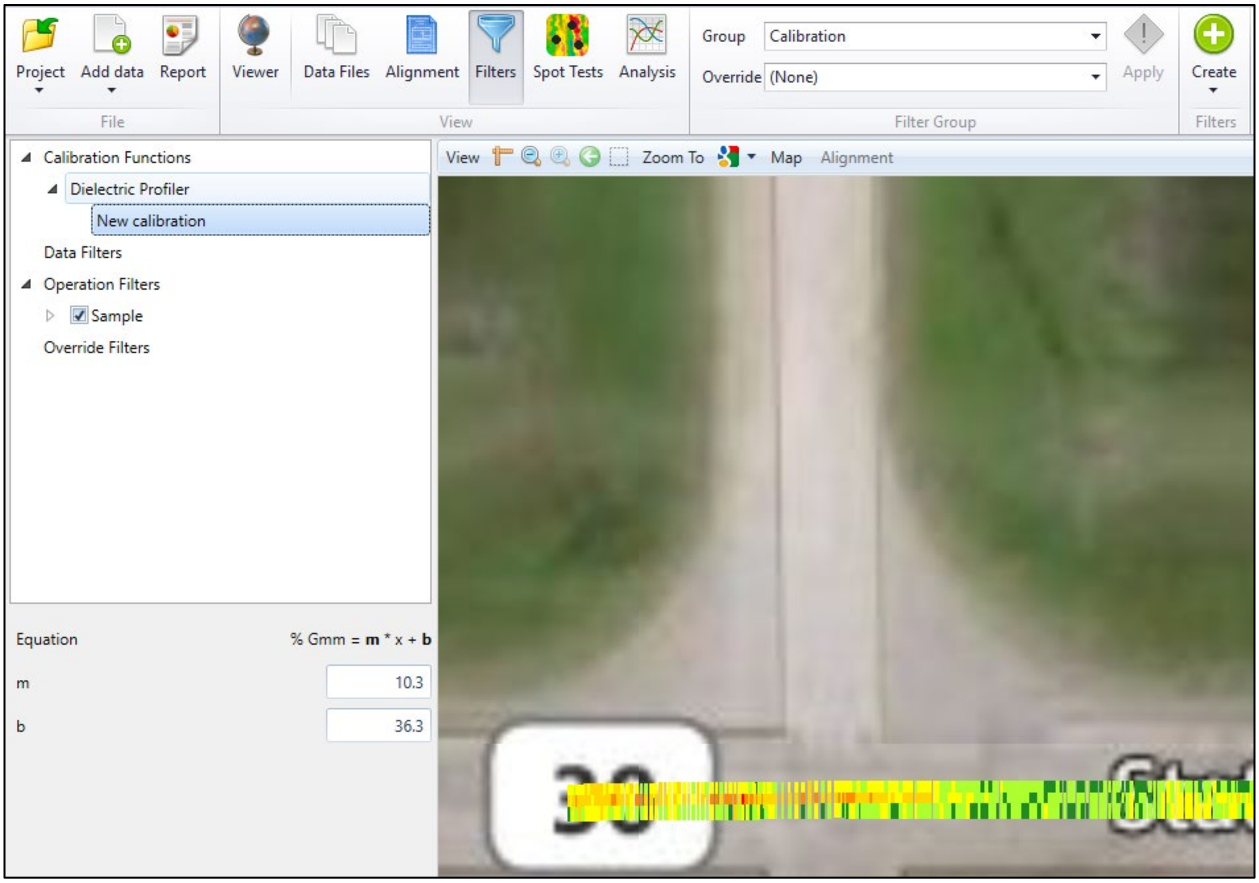


Figure 35. Naming a calibration function and inputting the linear coefficient and constant.

Users can create multiple calibration functions for specific needs, such as daily functions. After calibration functions are added, users can select the calibration functions under **Operation Filters → Dielectric Profiler → Calibration** (as described in the **Operation Filters** section) to transform the DPS dielectric constant data. Note that the calibration function is not applied until this has been performed.

Users should use whole numbers to represent the percent of density when establishing the calibration curve. For example, "94" would be used instead of (94%). The corresponding calibration coefficient and constant should be in the same order of magnitude as illustrated in Figure 35 (where m equals 10.3 and b equals 36.3).

Data Filters

First, make sure a filter group has been created before creating a data filter. Then, select **Create data filter** from the green **Create** button. Alternatively, right-click on **Data Filters** within the filters dialog box and select **Create data filter.**

Data filters can be added to filter groups to filter out data based on specific properties or thresholds. Some data filters are dependent on vendor data. Users can verify data availability through their equipment vendors.

The following sections describe each available data filter.

Compactor

The following data filters are available for IC data. Some data filters are irrelevant to some manufacturers. When in doubt, users can ask their equipment manufacturer.

Amplitude

Filters the data based on roller amplitude using user-defined minimum and/or maximum thresholds. Note that amplitude is only valid for vibratory compaction.

Frequency

Filters the data based on roller frequency using user-defined minimum and/or maximum thresholds. Note that frequency is only valid for vibratory compaction.

Impacts per foot

Filters the data based on impacts per foot. Impacts per foot are calculated in Veta using the vendor-provided frequency divided by the vendor-provided speed.

Speed

Filters the data based on roller speed using user-defined minimum and/or maximum thresholds. Speed filters can be useful for filtering roller data if IC data is collected (unintentionally) during equipment mobilization or demobilization. Such filters may be an alternative when location filters are not available. Roller mobilization is typically performed at much higher speeds than production rolling. Therefore, applying a compactor speed filter (e.g., Maximum speed (mph) < 5) would likely remove the majority of mobilization passes to the project site. This procedure may not be valid for some DOT specifications.

Temperature

Filters the data based on roller temperature using user-defined minimum and/or maximum thresholds. Temperature filters can be useful for filtering roller data if IC data is collected (unintentionally) during equipment mobilization or demobilization or when rollers overlap on cold edges of the asphalt. Such filters may be an alternative when location filters are not available. Some areas of roller overlap or mobilization may occur at much colder temperatures. Therefore, applying a compactor temperature filter (e.g., Minimum temperature (˚F) > 100) would likely remove the majority of mobilization passes and overlap on cold edges. This concept is illustrated in Figure 36 and Figure 37. Caution should be used so that relevant temperatures are not removed from the IC data. This procedure may not be valid for some DOT specifications.

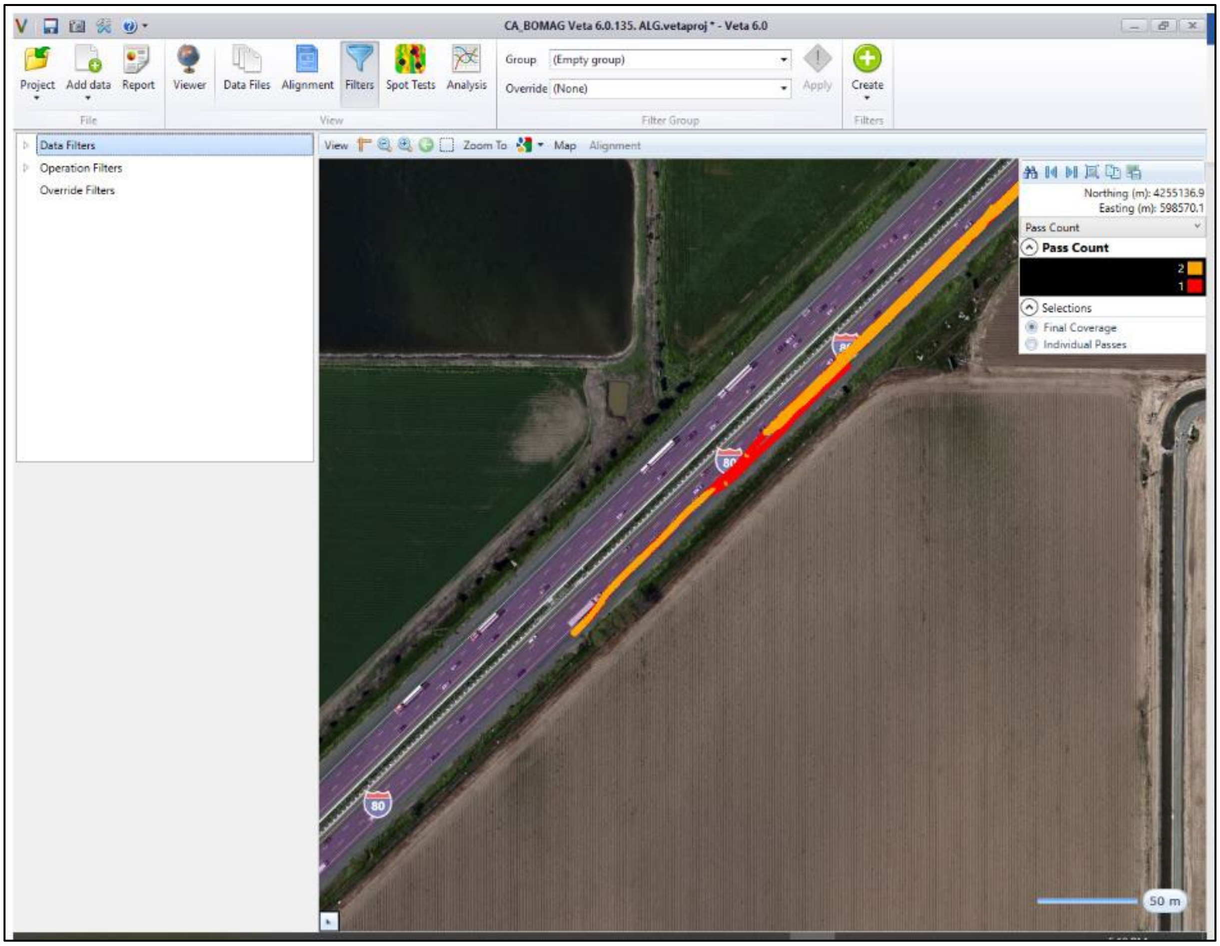


Figure 36. Data shows possible roller mobilization that does not apply to production rolling.

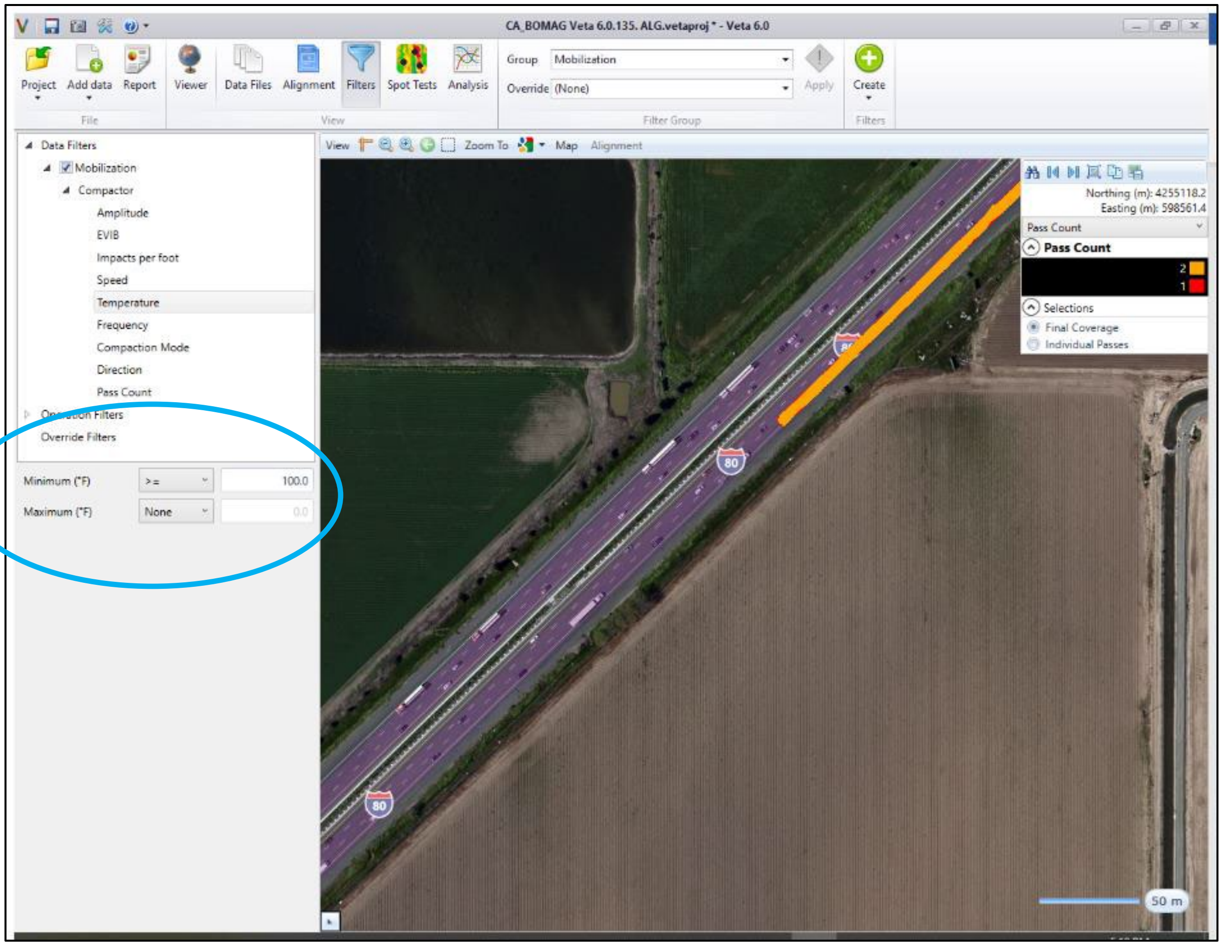


Figure 37. If no location boundary data is available, a reasonable minimum temperature data filter may be used to remove the data.

ICMV

Filters the data based on vendor-specific ICMV using user-defined minimum and/or maximum thresholds. Note that ICMV is only valid for vibratory compaction. ICMV values vary by vendor. More information regarding ICMV values can be found at https://www.intelligentconstruction.com/. Such filters may be useful for filtering out static passes if only vibratory passes are used in a rolling pattern (e.g., a minimum ICMV value > 1 would filter all static passes from the data. Alternatively, users can filter out static passes using the **Compaction Mode** data filter described below.

Compaction Mode

Filters the data based on compaction mode. Available compaction modes include **Vibratory**, **Static**, and **Oscillation**. Not all compaction modes apply to all compactors. For example, many rollers may not have Oscillation compaction. This filter is useful for filtering out static passes if only vibratory passes are used in a rolling pattern. The removal of static passes may dramatically change the pass count coverage.

In most cases, breakdown compaction efforts include vibratory compaction. Static passes may not achieve the same level of compaction as vibratory passes. Therefore, it is useful to remove the static passes so that only vibratory compaction is analyzed. Removing static passes from IC data is a powerful filter that may reveal inadequate compaction efforts by shutting off vibratory efforts too soon at rolling pattern transitions. This concept is illustrated in Figure 38 and Figure 39.

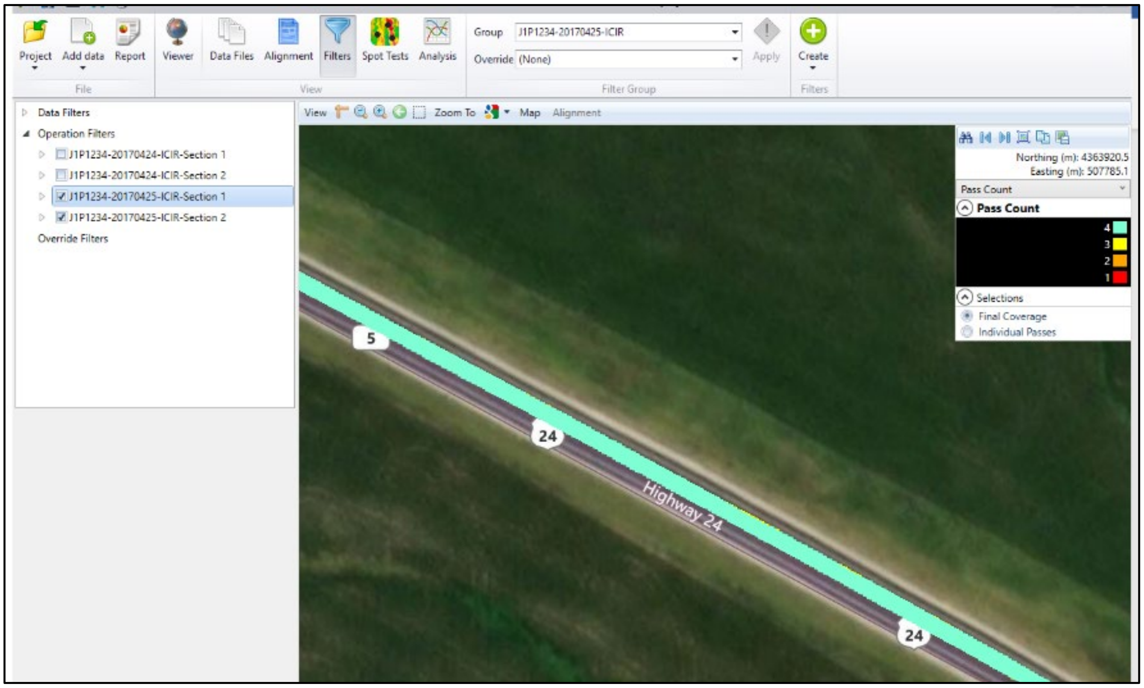


Figure 38. IC pass count data appears to have consistent coverage at 4 passes.

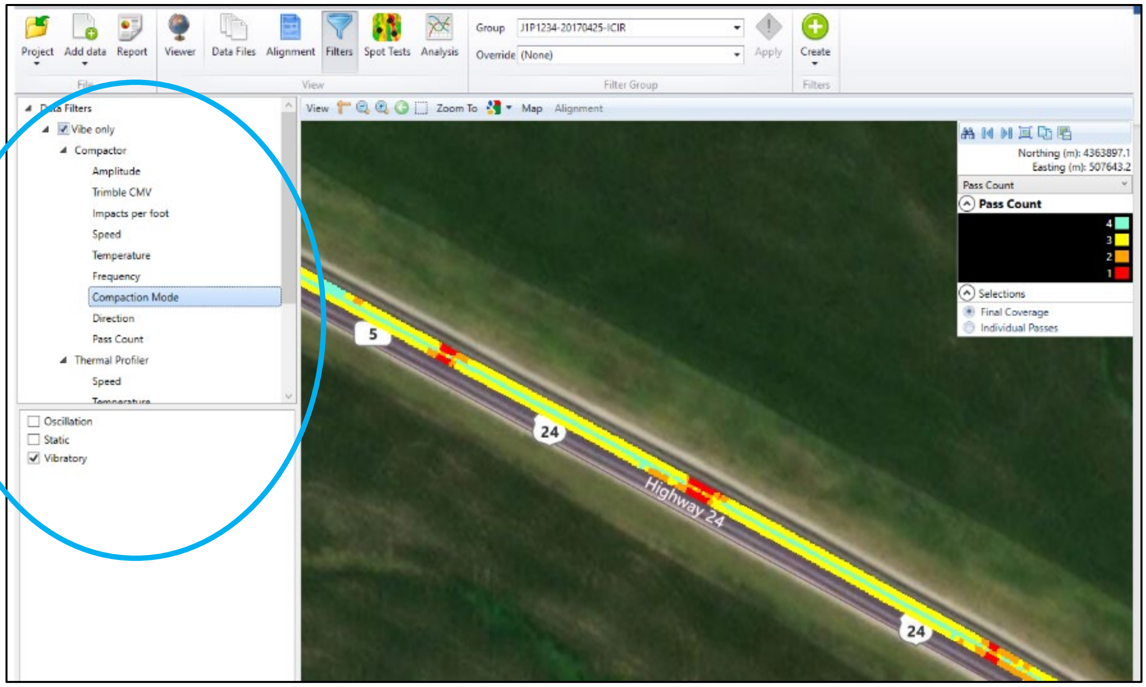


Figure 39. Viewing only vibratory passes reveals a pass count of 3 vibratory passes. Areas of red and orange are the result of turning off vibratory compaction too early or turning them on too late.

Direction

Filters the data based on the direction of the roller. Available directions include **Forward**, **Reverse**, and **Neutral**. Direction data may not be included in all vendor data files.

Pass Count

Filters the data based on pass count. Compaction data often includes additional passes beyond the optimum or target pass count. Rollers may make additional passes in static mode to avoid stopping the roller behind the paver. Additionally, there may be extra passes or "ghost passes" required by rollers to return to the paver and start a new rolling pattern. Ghost passes are generally unavoidable during paving. Final Coverage is calculated in Veta and is described as data from the final or last pass at a grid location. More information regarding final coverage and grid or mesh spacing can be found at https://www.intelligentconstruction.com/.

The sublot analysis (described further in chapter **Analysis**) is based on final coverage, and users may want to analyze sublots based on optimum or target pass count. For example, it may be useful to analyze compactor temperatures by sublot within the target pass count (e.g., view the sublot temperatures at pass 4 to ensure they are within the target parameters and identify sublots outside target parameters). To accomplish this, a pass count filter should be used to view passes 1 through 4. This concept is displayed in the following figures.

Figure 40 shows roller data for a project with a target pass count of four. The following observations are made from Figure 40.

- There are areas of overlap at the start and stop of the rolling pattern where the pass count is as high as 7.
- There are areas of longitudinal overlap between passes where the pass count is as high as 8.
- There is a "ghost pass" in the north pass that was necessary to start the new rolling pattern behind the paver.

These scenarios are all expected in normal paving operations. However, applying a pass count filter can be useful so that only 4 passes are analyzed. Such filtering is accomplished by unchecking the boxes next to passes 5 through 20 in a data filter shown in Figure 41.

The final coverage is based on the target pass count of 4. ***Users should be sure that there are no maximum pass-count requirements in their project specifications. Pass count filters should not be used for maximum pass count requirements.***

Users may combine multiple data filters. Figure 42 shows the pass count filter that removes passes 5 through 20. Also, a **compaction mode** filter is applied to show only vibratory passes. Removing static passes reveals that the fourth pass illustrated in Figure 42 is static.

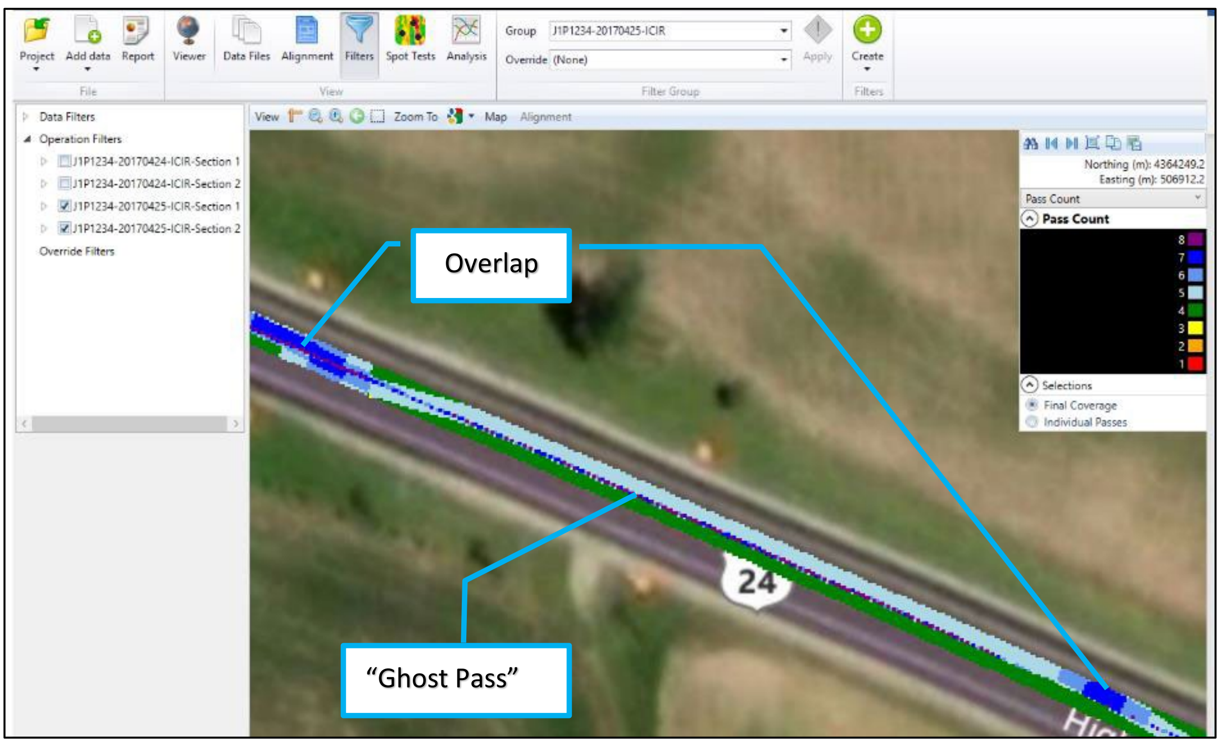


Figure 40. Final coverage shows areas of overlap (dark blue) and a "ghost pass" (light blue) in the north pass.

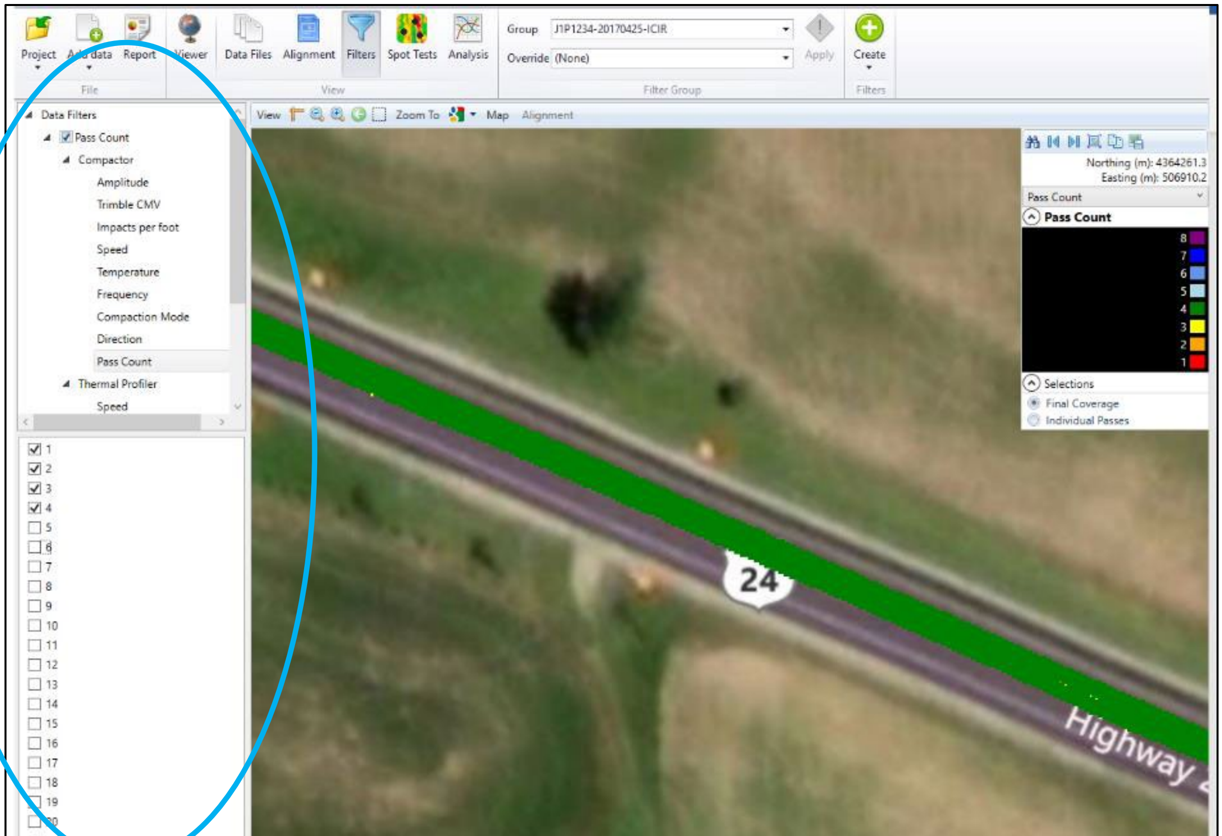


Figure 41. Pass count filter applied.

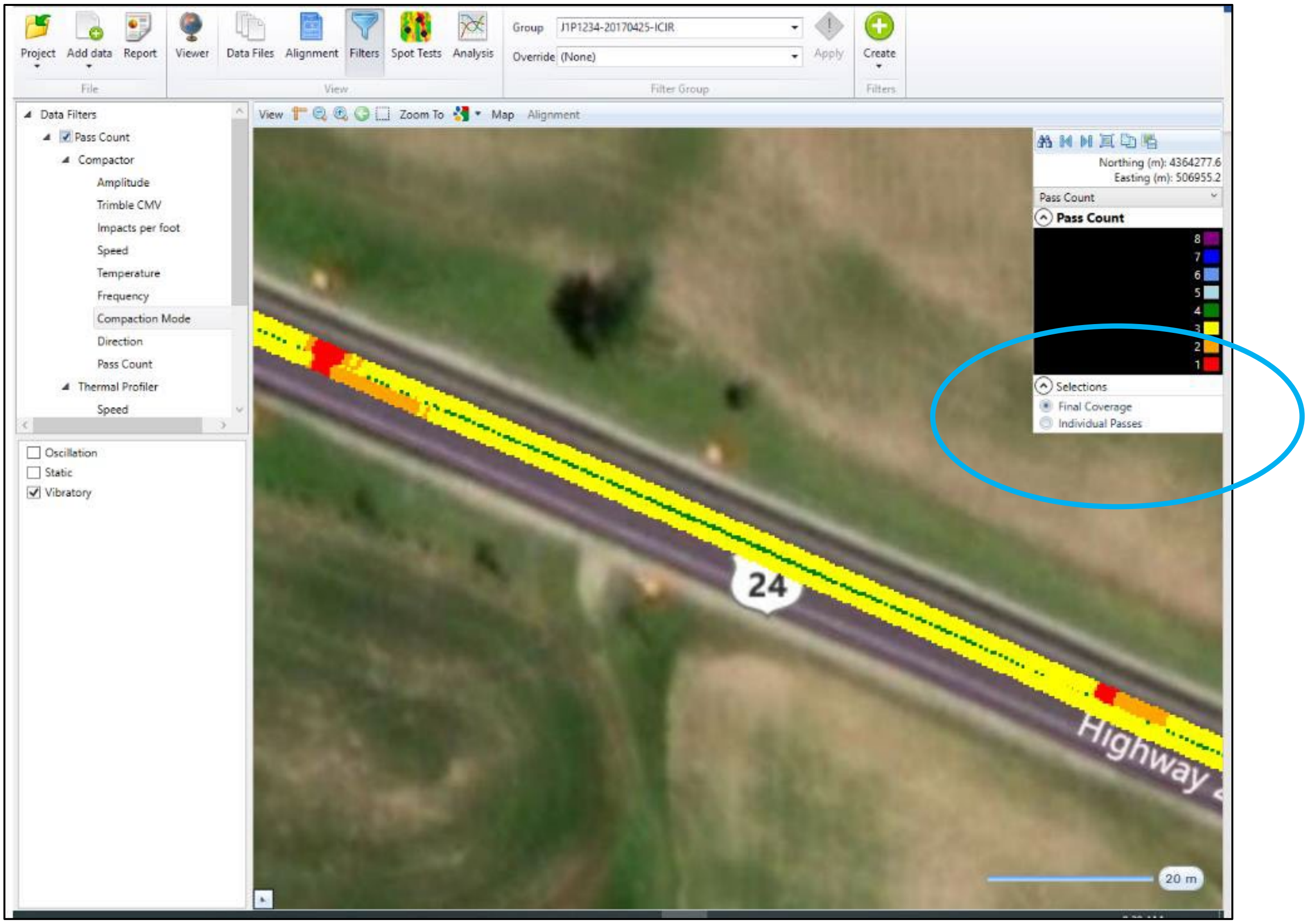


Figure 42. Applying combined pass count filters and compaction mode filters.

Users should note the difference between using legend customizations and **individual pass** controls and applying a pass count filter. ***These do not have the same outcome.*** Viewing individual passes in the **legend toolbar or customizing a legend** will show the same results on the viewer screen. ***However, this only changes how the data is viewed on the map and will not affect the data analysis. Alternatively, applying a pass count filter removes passes from the data during analysis.***

Thermal Profiler

The following data filters are available for thermal profiler data.

Speed

Filters the data based on paver speed using user-defined minimum and/or maximum thresholds.

Temperature

Filters the data based on temperatures behind the screed using user-defined minimum and/or maximum thresholds. Temperature data filters are recommended before analyzing thermal profiler data. A minimum temperature filter will remove invalid temperatures from cold edges, people standing on the asphalt mat, or other similar and inevitable scenarios. According to AASHTO R 110 Appendix X.5, surface temperature readings of less than 180 ˚F are excluded from the analysis. An example of this concept is illustrated in Figure 43. Applying a minimum thermal profiler temperature of ≥ 180 ˚F removes these from analysis, as shown in Figure 43.

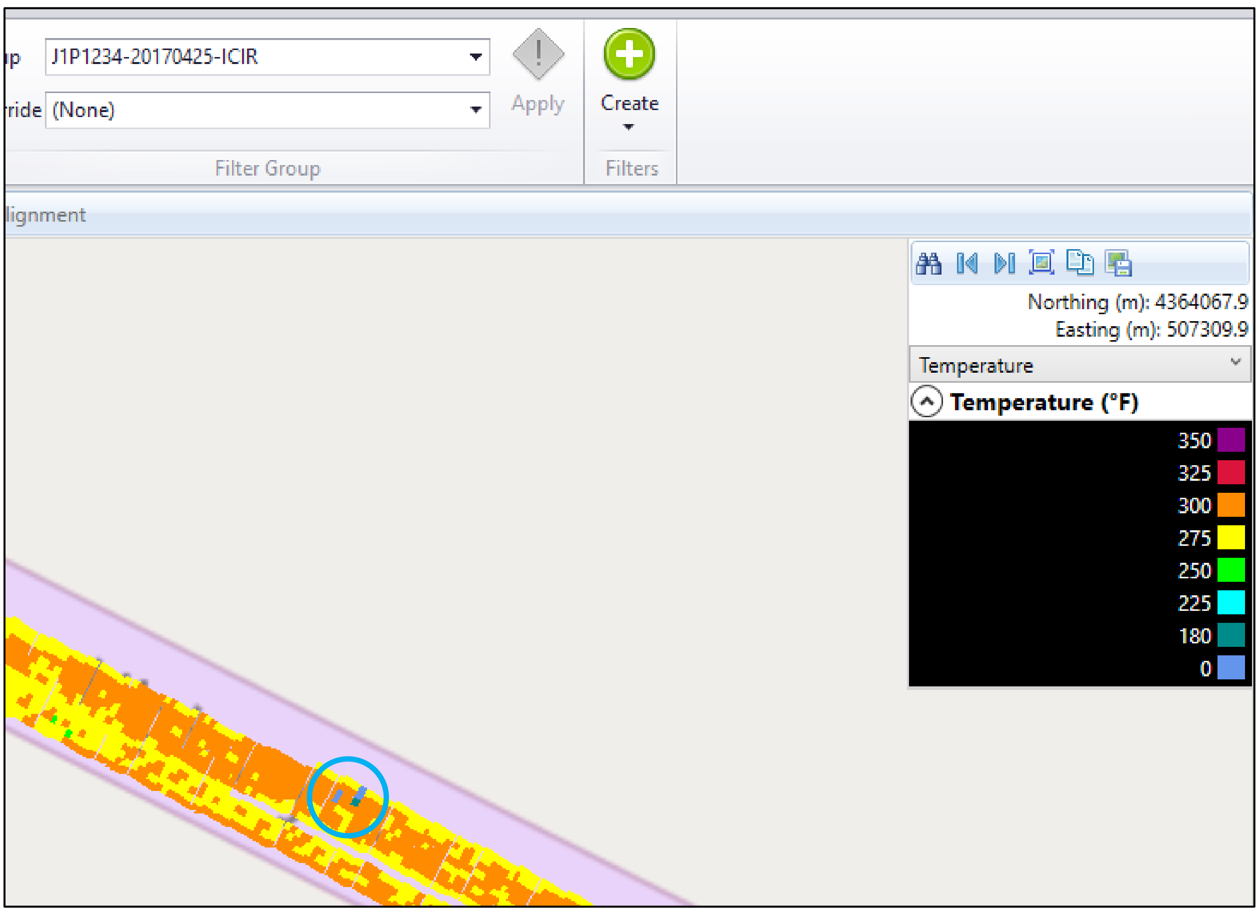


Figure 43. Areas with temperatures below 180˚F, possibly caused by workers on the mat.

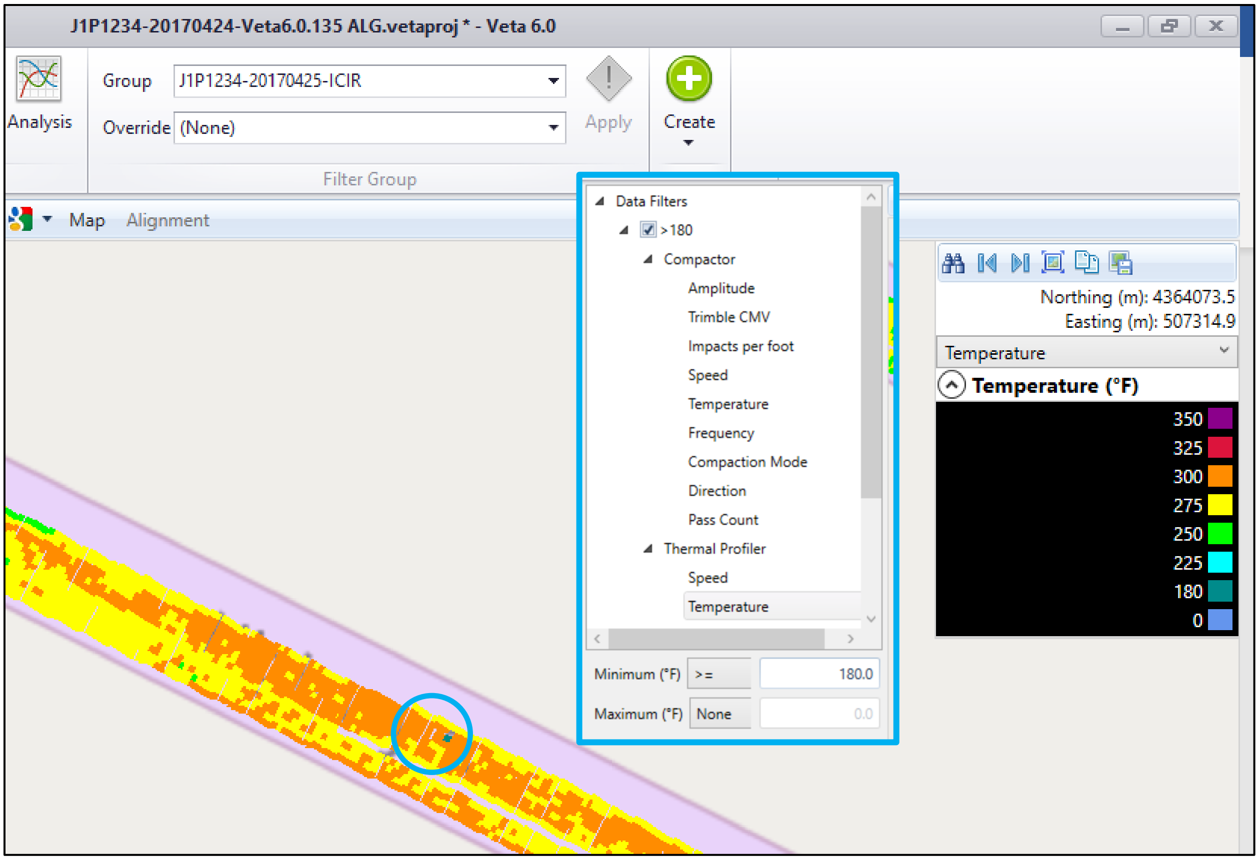


Figure 44. To remove invalid data, add a thermal profiler filter with a minimum temperature of ≥ 180˚F.

Users should use caution when applying data filters for speed or temperature. There are speed and temperature data filters for compactors and thermal profilers, and users should apply the data filters to the desired equipment types.

Dielectric Profilers

The following data filters are available for dielectric profiler data.

Air voids

Filters the data based on air voids using user-defined minimum and/or maximum thresholds. Air voids are calculated using vendor calibrations. For more information, reference the section **Calibration Functions.**

Density, % of Gmm

Filters the data based on % of Gmm using user-defined minimum and/or maximum thresholds. Density (% of Gmm) is calculated using vendor calibrations. For more information, reference the section **Calibration Functions.**

Dielectric
Filters the data based dielectric data using user-defined minimum and/or maximum thresholds.

Dielectric height
Filters the data based on dielectric height using user-defined minimum and/or maximum thresholds. Dielectric height is the distance between the bottom of the sensor and the asphalt surface. A change in dielectric height may be used as a quality control tool to ensure data quality.

Dielectric quality
Filters the data based on dielectric quality using user-defined minimum and/or maximum thresholds. Dielectric quality may vary by vendor but can be calculated using variables such as sensor temperature (electronics temperature inside the sensor), normalized signal amplitude, and noise level.

Speed
Filters the data based on equipment speed using user-defined minimum and/or maximum thresholds.

Operation Filters
To create an operation filter, first, make sure a filter group has been created. Then, select **Create operation filter** from the green **Create** button. Alternatively, right-click on **Operation Filters** within the filters dialog box and select **Create operation filter,** as illustrated in Figure 45**.**

Upon creating an operation filter, the user will be prompted to rename the operation filter, as shown in Figure 46. It is recommended that standard naming conventions are used, and this is good data management practice.

Yellow warning flags indicate that data files have not been selected for filtering. The operation filter will not be applied if the data files are not selected. Users can select which data files to filter by clicking on the data lot or file names. Selecting the boxes next to the file names activates the filter for that data file, as illustrated in Figure 47. Warning flags are removed after the selection of the files. Note that the box next to the operation filter must also be selected to activate the filter.

Users may also use the **Use all** feature to select all the boxes quickly and efficiently, which is particularly useful when a project has as many data files as illustrated in Figure 48. Users can set **Filter Defaults** to automatically select the **Use all** feature described in the **Filter Defaults** section.

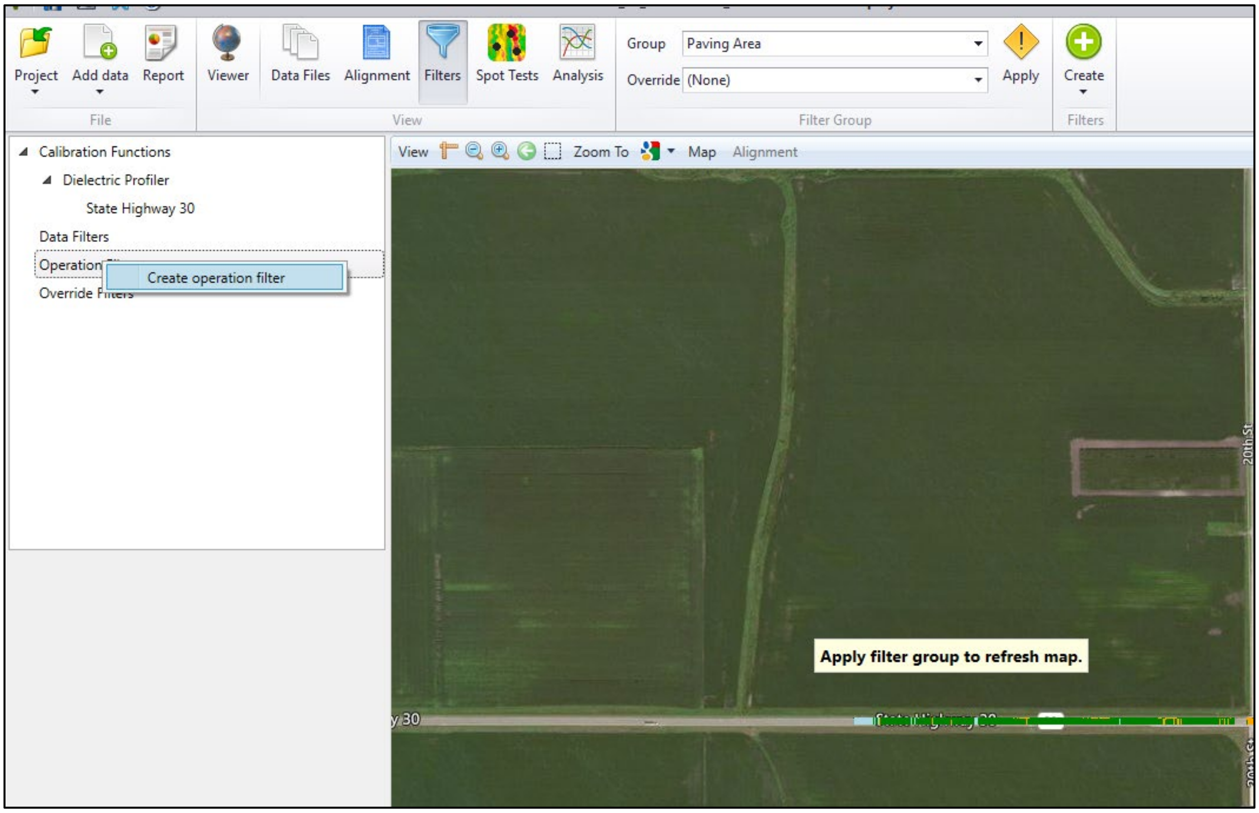


Figure 45. Creating an operation filter.

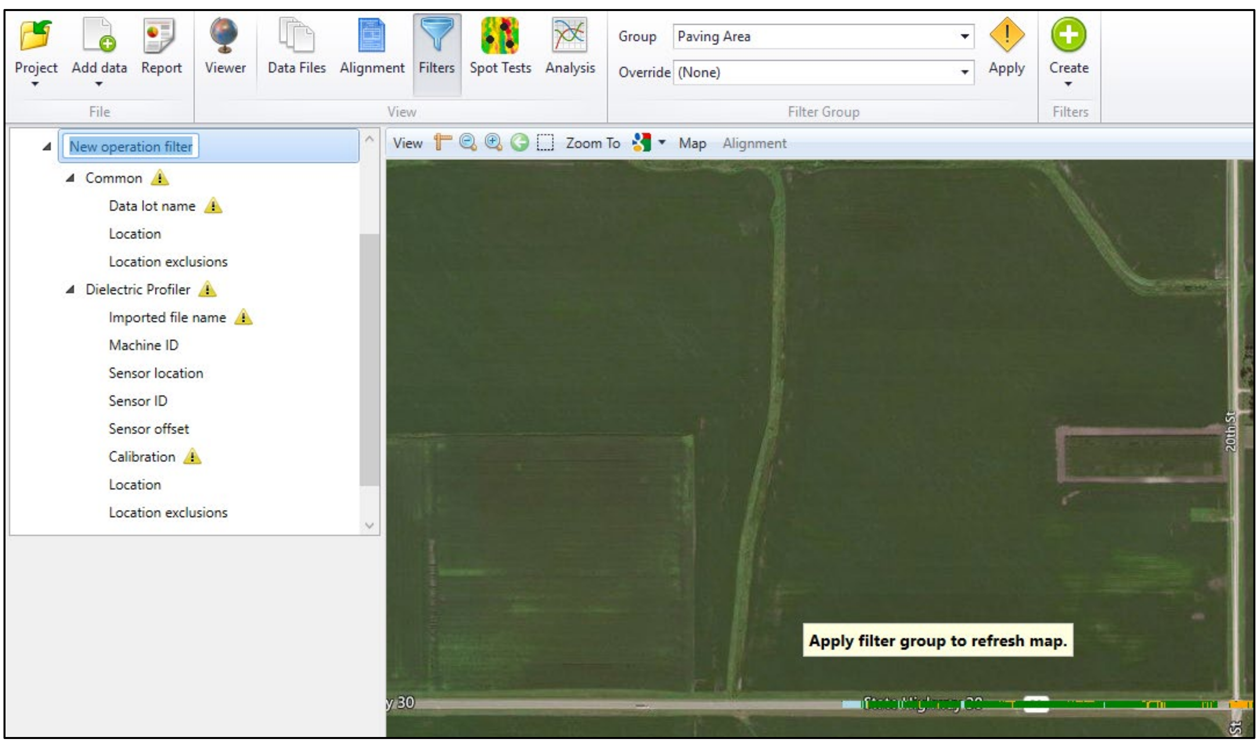


Figure 46. New operation filter with warning flags.

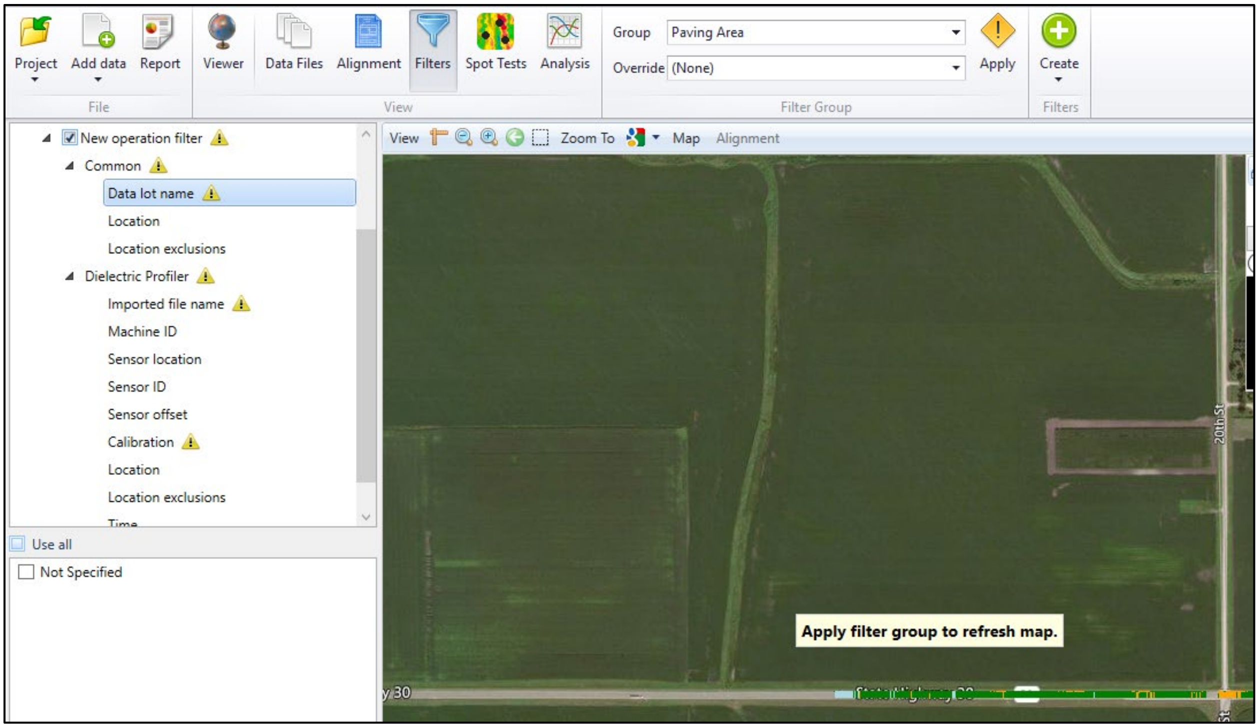


Figure 47. Selecting the boxes next to the data lot name and imported file name under common and compactor activates the operation filter for all selected files.

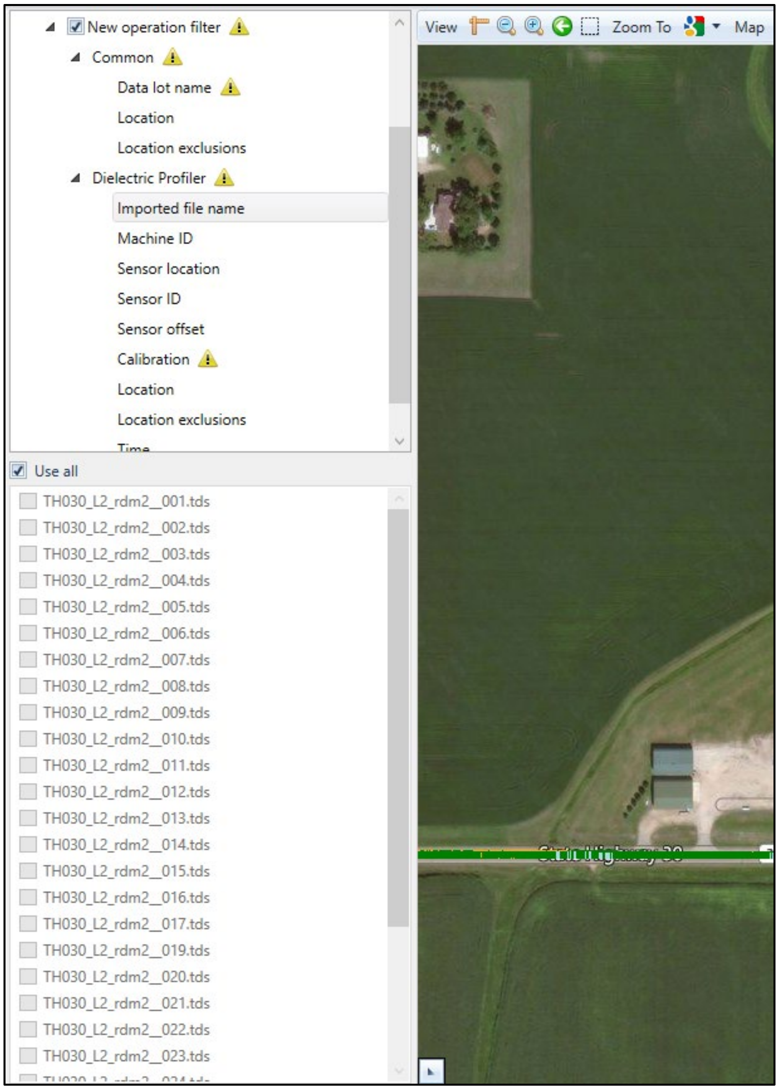


Figure 48. Checking the use all box selects all files.

Operation filters are grouped into the following categories:

- Common: operation filters in the Common operation filter will apply to all data types in the project.
- Compactor: operation filters will only apply to IC data files.
- Thermal Profiler: operation filters will only apply to thermal profiler data files.
- Dielectric Profiler: operation filters will only apply to dielectric profiler data files.

Operation filters allow users to filter out data elements related to location/position, time, imported file name, and machine ID. Thermal profiler operation filters include options for turning off thermal profiler "sensor" locations (corresponding to the vendor-specific data size) or removing cold edges and ride brackets from a thermal data set. Each operation filter is described in more detail in the following sections. For dielectric profilers, users can filter sensors and offsets and apply calibration factors to the data to estimate air voids.

Common

Common filters are applied to all the data files selected under the operation filter. The exception is if override filters are used as described under equipment-specific **Location Filters**.

Data Lot Name

The data lot name is set up in the vendor-specific software and equipment, and users should consult the vendor for assistance with setting up or changing data lot names. Data lot names may be equipment and machine specific. All boxes next to the data lot name should be checked for inclusion in the project. Appropriate data lot names are required to make the AASHTO PP 114 naming template function.

Location

Location filters trim the data based on location. Location filters are commonly used to trim out unwanted roller pass data. It is common for roller operators to leave IC systems running while mobilizing and demobilizing equipment to the project and/or leaving the paving operation for water. There is also inevitably overlap on existing lanes. To accurately assess that the paved mat was covered according to the desired pass count, these locations must be excluded from the analysis. Failure to trim unwanted passes may result in falsely low coverage analysis.

Location filters may be extracted from an alignment file. LandXML and .kmz files are supported in Veta. Adding and viewing alignment files are described in chapter **Alignment**.

There are several ways to use alignment files to create a location filter or boundary. The most common and convenient is to use the **Offset** function. This function takes a line from the alignment file, applies user-defined offsets, and starts and stops stationing to create a boundary. Figure 49 shows an example of selecting a line from an alignment file using the **Offset** function. The **location filter source box** appears when the **Source** button is clicked under **Location Filter.** Alignment files that have been imported will be available for selection in the **Alignment** file drop-down menu. Users can select the portion of the alignment file to use under the **Alignment** and **Line** drop-down menus to generate a boundary. More information on alignment files is described in the chapter **Alignment**.

Once the line from the alignment file is selected, the location filter dialog box populates with **Start offset** and **Stop offset** to generate the boundary extents. Users have the option to use **stations** or **coordinates** for the beginning and end of the boundary. Offsets may be positive or negative relative to the alignment line. For example, Figure 50 shows offsets of 0 feet and 12 feet. The alignment line previously selected is the road's centerline, so an offset of 0 places the **Start offset** at the centerline. The **Stop offset** of 12 feet places the extent of the boundary 12 feet from the centerline. Entering these offsets creates a boundary on the northbound outside the driving lane. To capture the northbound inside driving lanes, users would input a start offset of -12 feet and a stop offset of 0 feet. The entire northbound section can be selected with offsets of -12 feet to 12 feet. The start and stop stations are selected to complete the boundary. Users may toggle between the alignment and filter screen to visualize the stationing.

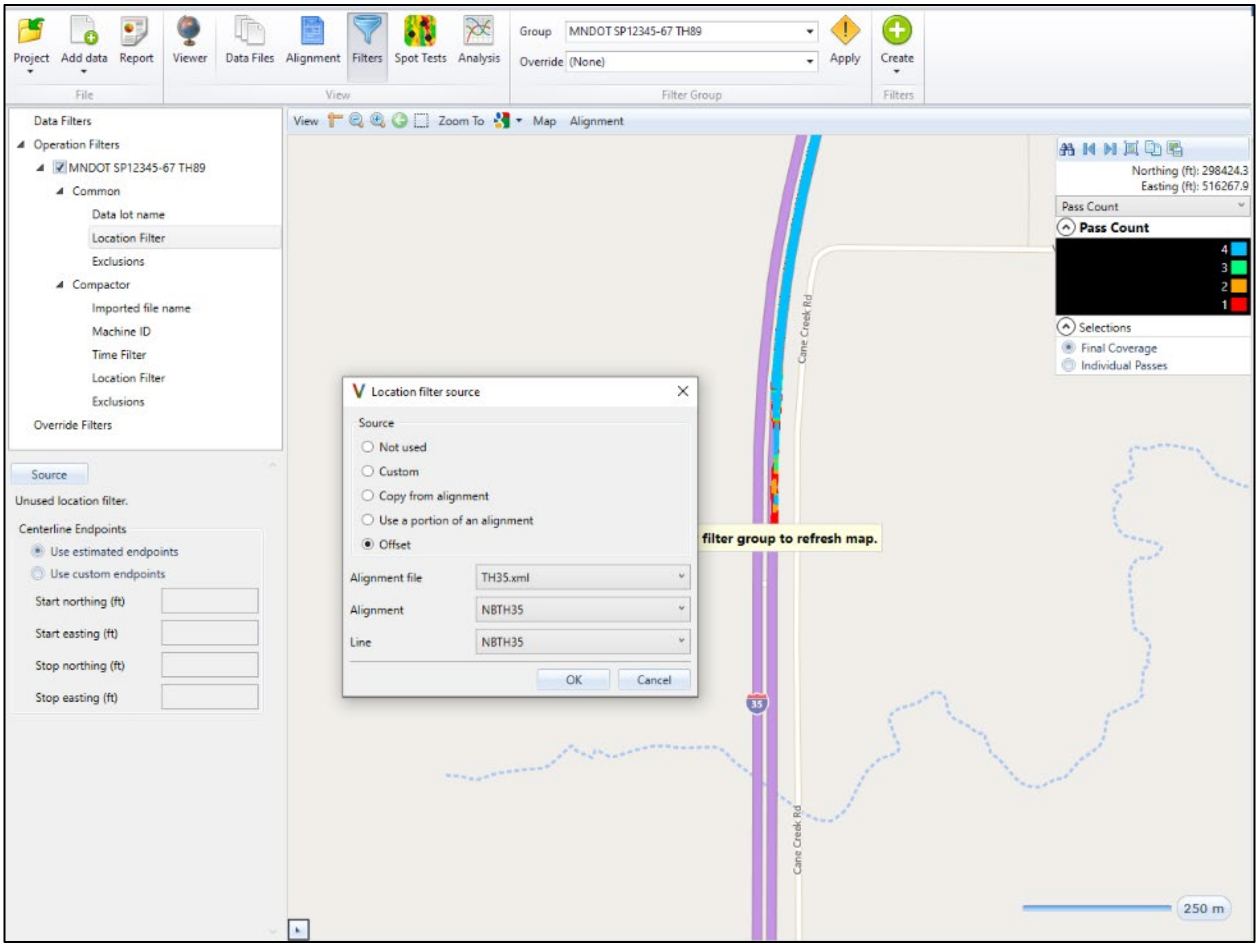


Figure 49. Using the offset source to select an alignment file, alignment, and line to use as a boundary.

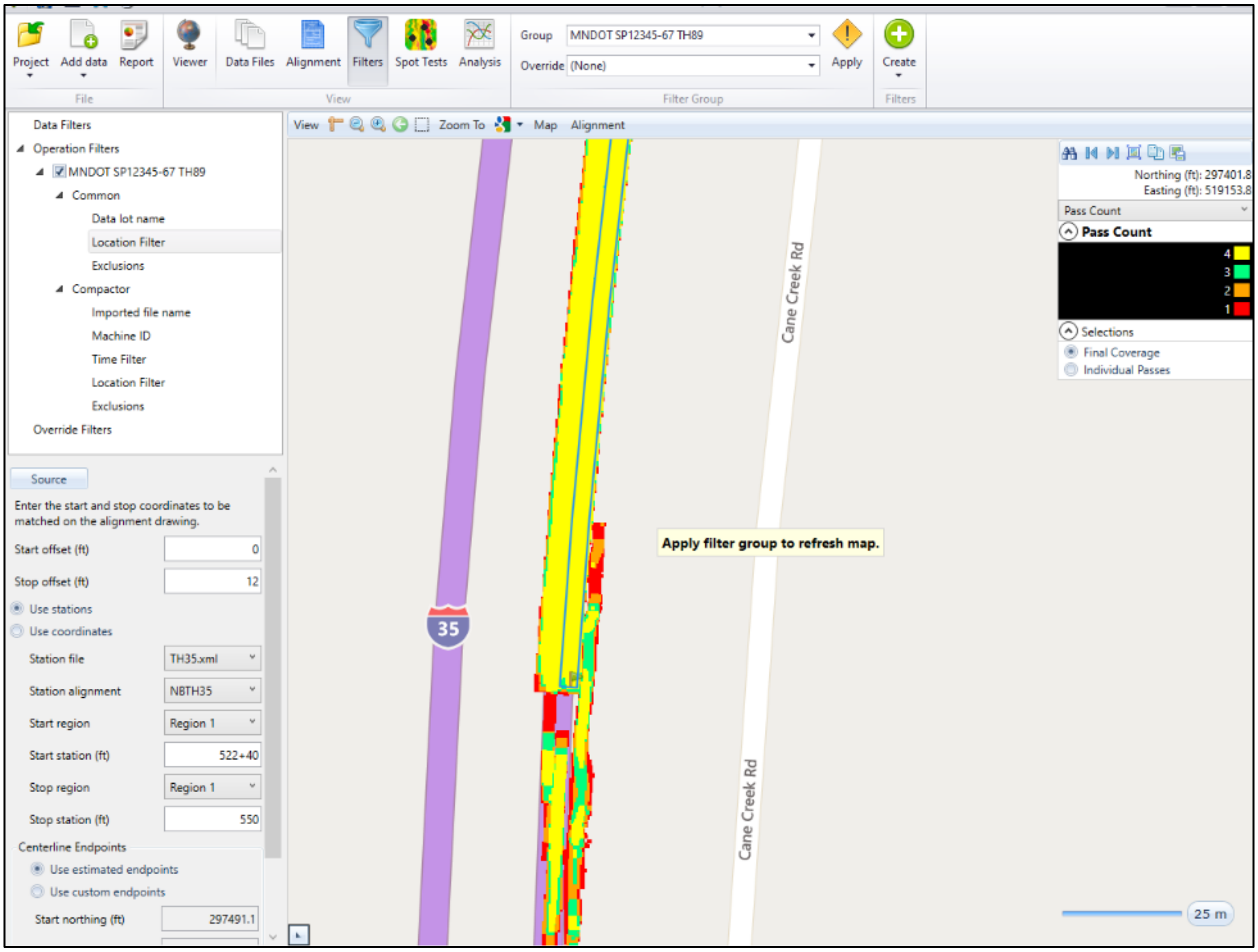


Figure 50. Start and stop offsets and stationing are used to select a boundary on the northbound outside driving lane.

Alternatively, if alignment files are unavailable, coordinates can be copied and pasted from an excel document. Coordinates may be collected using a hand-held rover. It is generally recommended that hand-collected boundary points be spaced every 100 feet at curves and 200 feet for straight segments. ***Boundary coordinates must be input in Veta in a clockwise or counterclockwise direction so that the order of the coordinates forms a continuous loop. If data points are not sorted correctly, the boundary file will not be drawn correctly.*** Hand collecting boundary coordinates can be tedious. New technologies are evolving to collect location coordinates via high-speed vehicles. These technologies include 3D LiDAR and paver-mounted GPS. Users should check with their equipment vendors for these evolving technologies.

To use manually collected coordinates to create a boundary, select **Custom** from the **Location filter** source dialog box. After selecting **Custom,** the filter dialog box is populated with an empty coordinates table, as shown in Figure 51. Users can copy and paste coordinates from an excel spreadsheet into the coordinate box. ***Users may need to adjust the coordinates exported from handheld data collectors to ensure that the data points are listed in a clockwise or counterclockwise circle. Failure to do so will cause boundary errors. The coordinate headers must be included with the coordinates as shown in***

Figure 52*.* The coordinates can be pasted in Veta by right-clicking inside the empty coordinate box and selecting **Paste locations.**

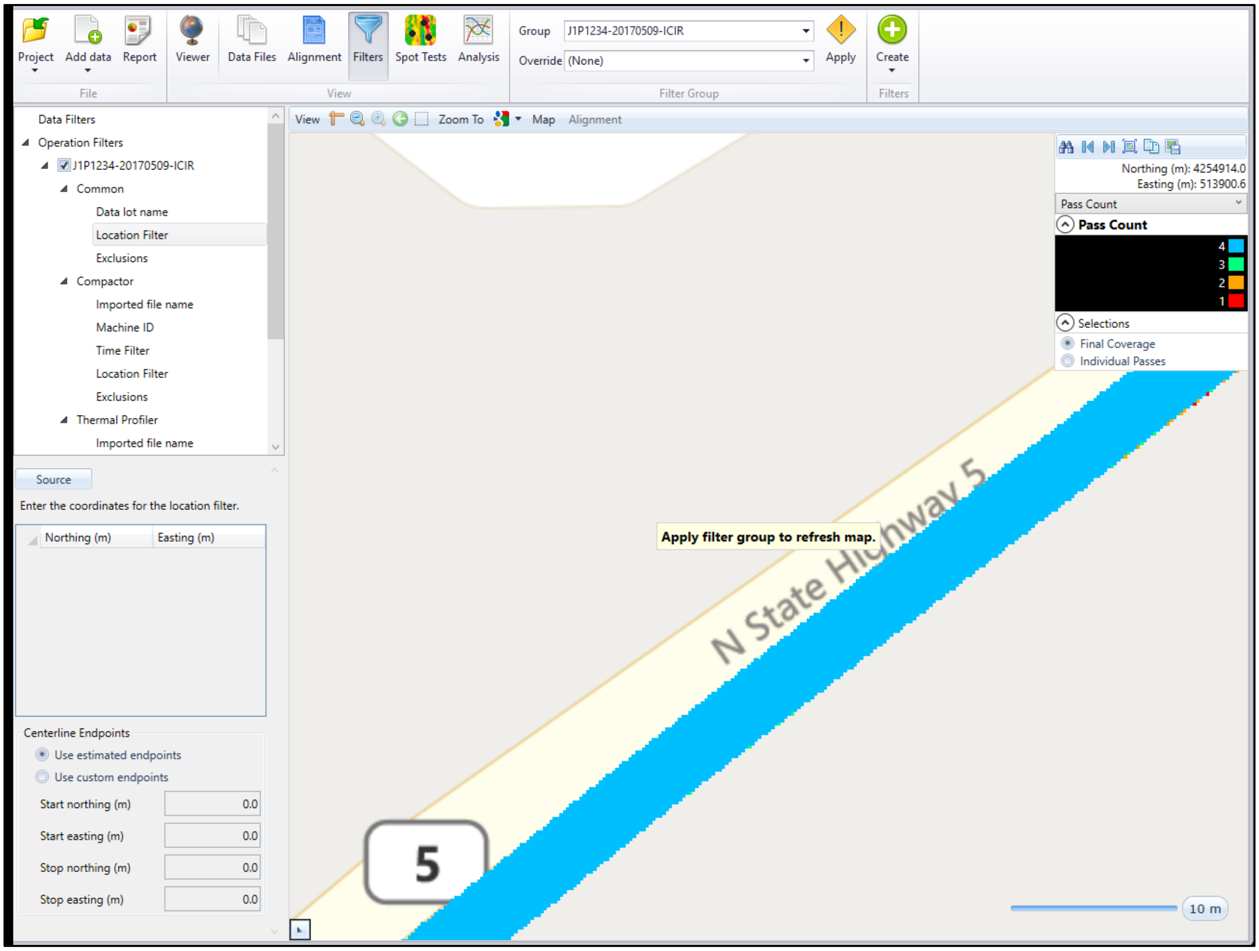


Figure 51. Selecting custom in the location filter source dialog box populates an empty coordinate box.

	Shot #	Northing (m)	Easting (m)		Label
	100	4253786.3232	512986.1791		ER ST ER1 ST
	103	4253801.4005	512988.6815		ER
	104	4253817.1276	512992.2203		ER
	107	4253832.9802	512996.4607		ER
	108	4253848.1950	513001.4582		ER
	111	4253863.3975	513007.6039		ER
	112	4253877.5811	513014.0995		ER

Figure 52. Hand-collected coordinates (including headers) are copied from an excel sheet and pasted into the coordinate box in Veta. Note: only partial coordinate data is shown. The data has been sorted in excel to create a clockwise circle.

The pasted coordinates create a boundary, as illustrated in Figure 53. These coordinates can be quickly removed if needed by highlighting a point, right-clicking, and selecting **Delete**. Delete multiple coordinates by holding shift or control and selecting multiple points.

Location filter points may also be created manually in Veta. Users may select **Custom** under **Source** and create boundary points by right-clicking anywhere on the map and selecting **Add location.** Manual boundaries may not be a very accurate method for creating boundaries and should be used with discretion. The same general rules apply for manually selected coordinates in Veta (e.g., select points in a clockwise or counterclockwise direction).

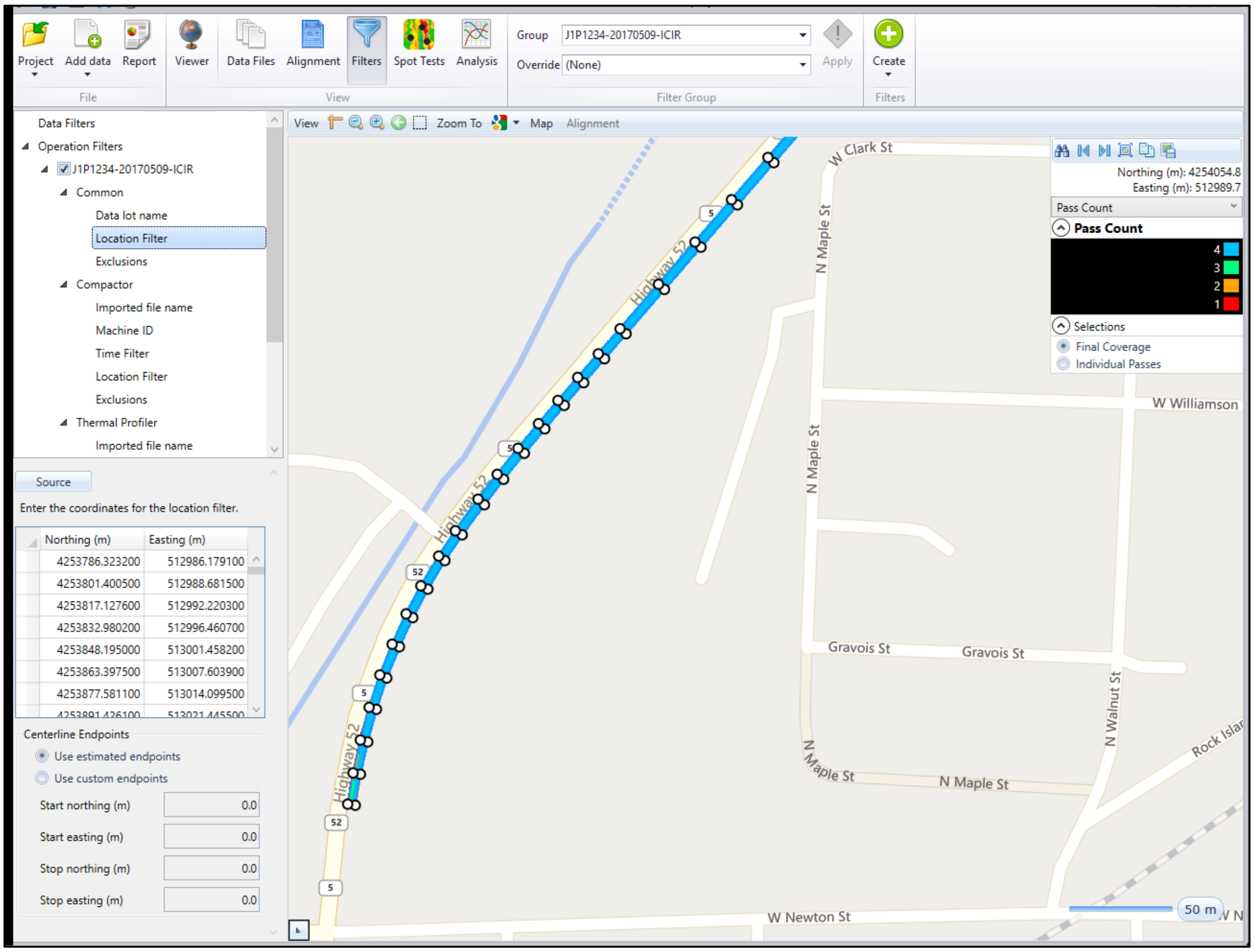


Figure 53. Pasted coordinates create a boundary for the data under the common location filter.

Using location filters to trim the edges off thermal profiler data is also desirable. However, at this time, many thermal profiler manufacturers do not use RTK GPS. Therefore, the accuracy and precision of GPS are not “good” enough to filter data by location. This concept is illustrated in Figure 54. Eventually, it is anticipated that thermal profiler vendors will adopt RTK GPS precision, and location filters can reasonably be used to filter thermal profiler data. As described in subsequent sections, other options exist to filter thermal profiler data by temperature.

Common location filters may be utilized effectively when thermal profiler vendors adopt RTK GPS. Until then, users may choose to filter IC data only by location in one of two ways:

1. Apply a common location filter to the entire project, then override the **common location filter** under the **thermal profiler location filter.**
2. **Override the common location filter** and apply the location filter to the **Compactor** data only.

Each of these processes results in the same outcome.

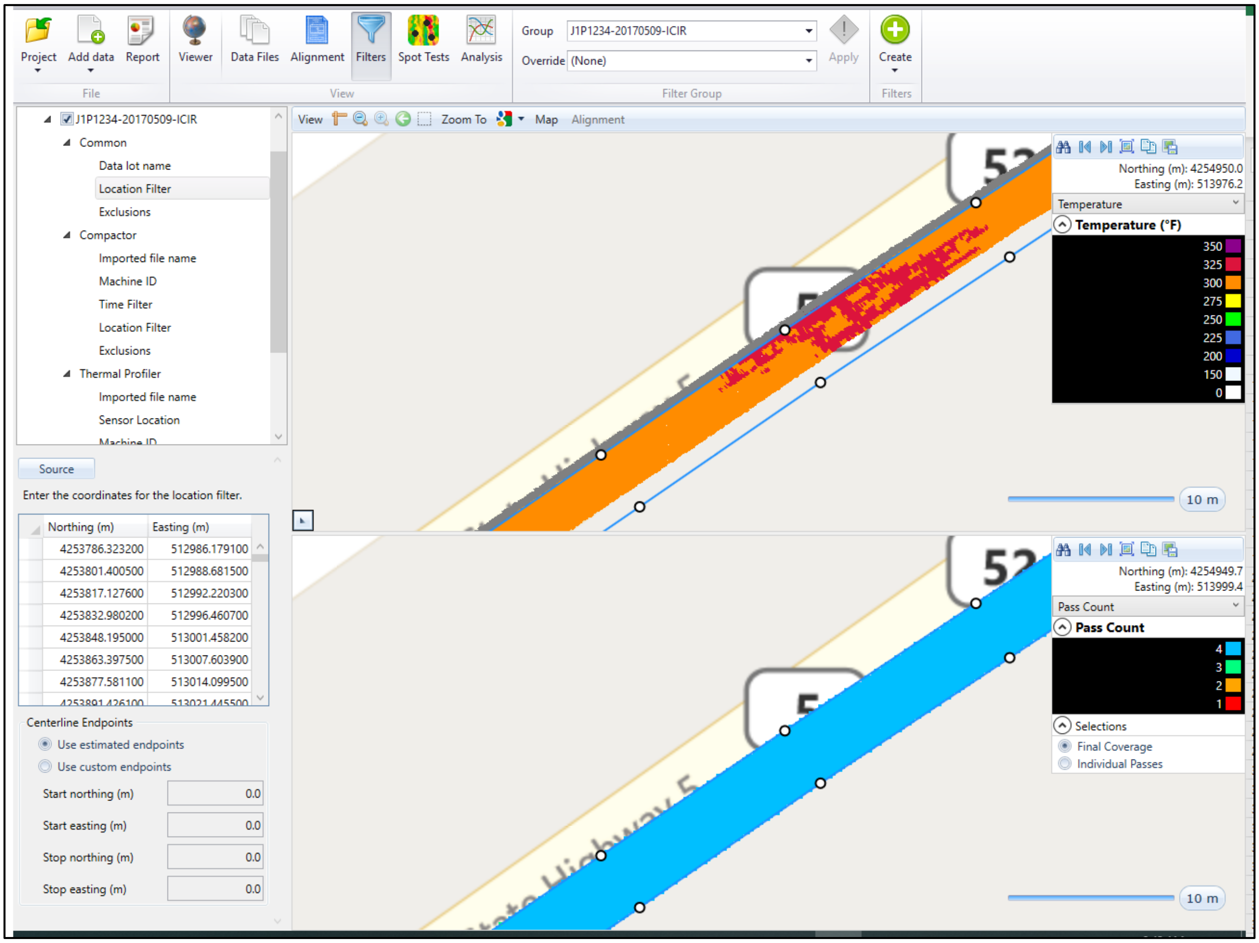


Figure 54. The location filter removes unwanted data from the thermal profiler data (shown in gray on the top map) due to the low accuracy GPS used on thermal profiler equipment.

Multiple Operation Filters

Users can have multiple operation filters per filter group and, thus, multiple location filters. Multiple operation filters are useful for areas of non-continuous paving. Non-continuous paving may occur when skipping over bridge decks or when paving in different lanes within one production shift. The following steps and figures show an example of using multiple location filters in one filter group.

Figure 55 shows the **Data Files** screen for a sample project. Note that there are two production days of paving: April 24, 2017, and April 25, 2017. The project includes IC and PMTP data files. Selecting a data file from April 24 reveals that the EB driving lane was paved during this shift, and the WB lane was paved on April 25. In this example, the contractor wants to set up filters to analyze each lane separately, which is accomplished using two **filter groups.**

Step 1. Using the respective dates, two filter groups are created and named according to the project naming convention.

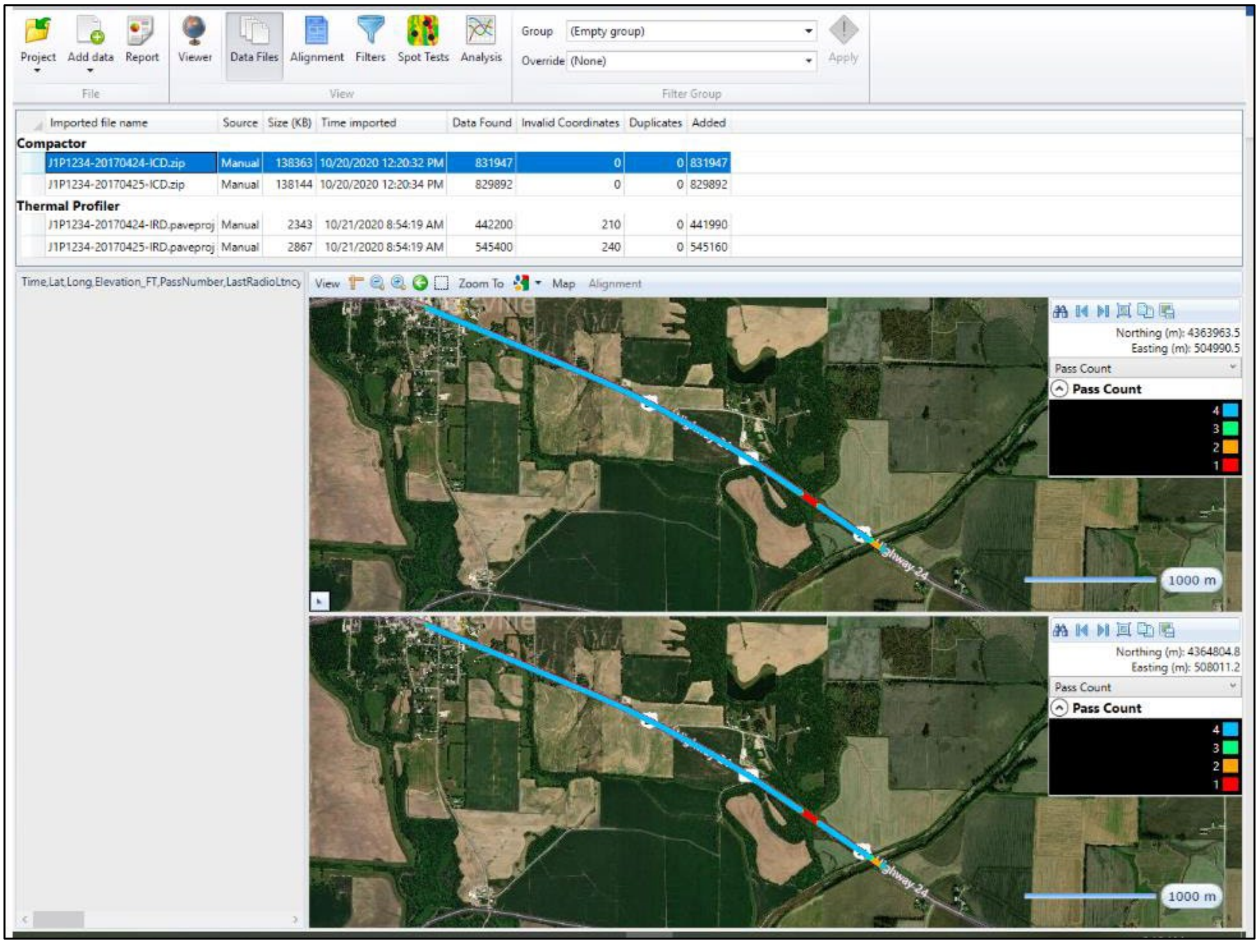


Figure 55. Data files screen for a sample project. Four total data files are included in the project.

Upon further investigation, there appears to be a gap in the data. The aerial maps reveal two bridges that were not included in the project, as illustrated in Figure 56. The contractor collected two sets of coordinates per day to use as two separate location filters to analyze the data correctly. One set of coordinates is for the section west of the first bridge, and the other is for the smaller section between the two bridges.

Step 2. Create two operation filters per filter group for a total of four operation filters. The filter structure is shown in Figure 57.

Shortcut: Existing filter groups and filters can be copied by right-clicking on the existing filter (e.g., right-clicking on an operation filter and selecting Copy will produce an identical operation filter that can quickly be renamed and modified).

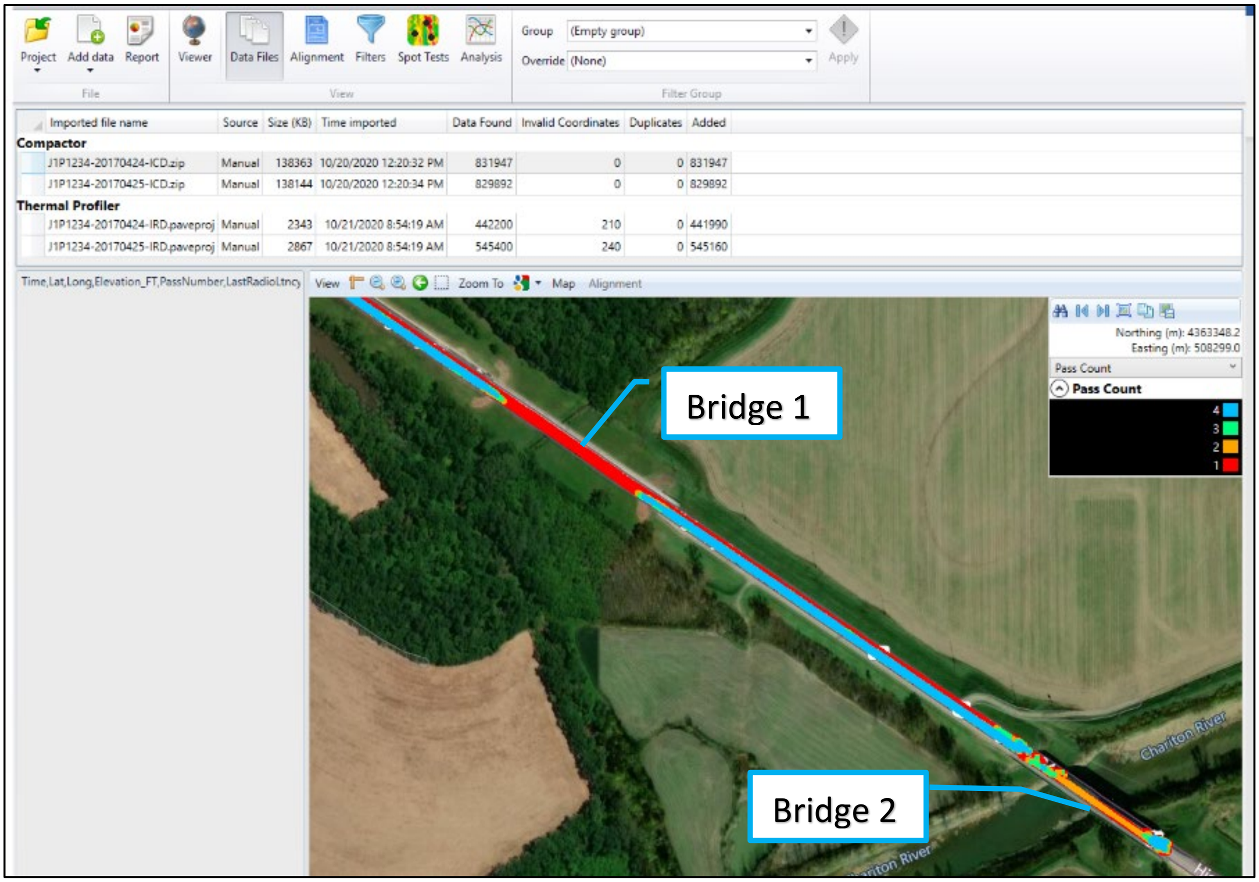


Figure 56. Aerial maps reveal two bridges that were not part of the project.

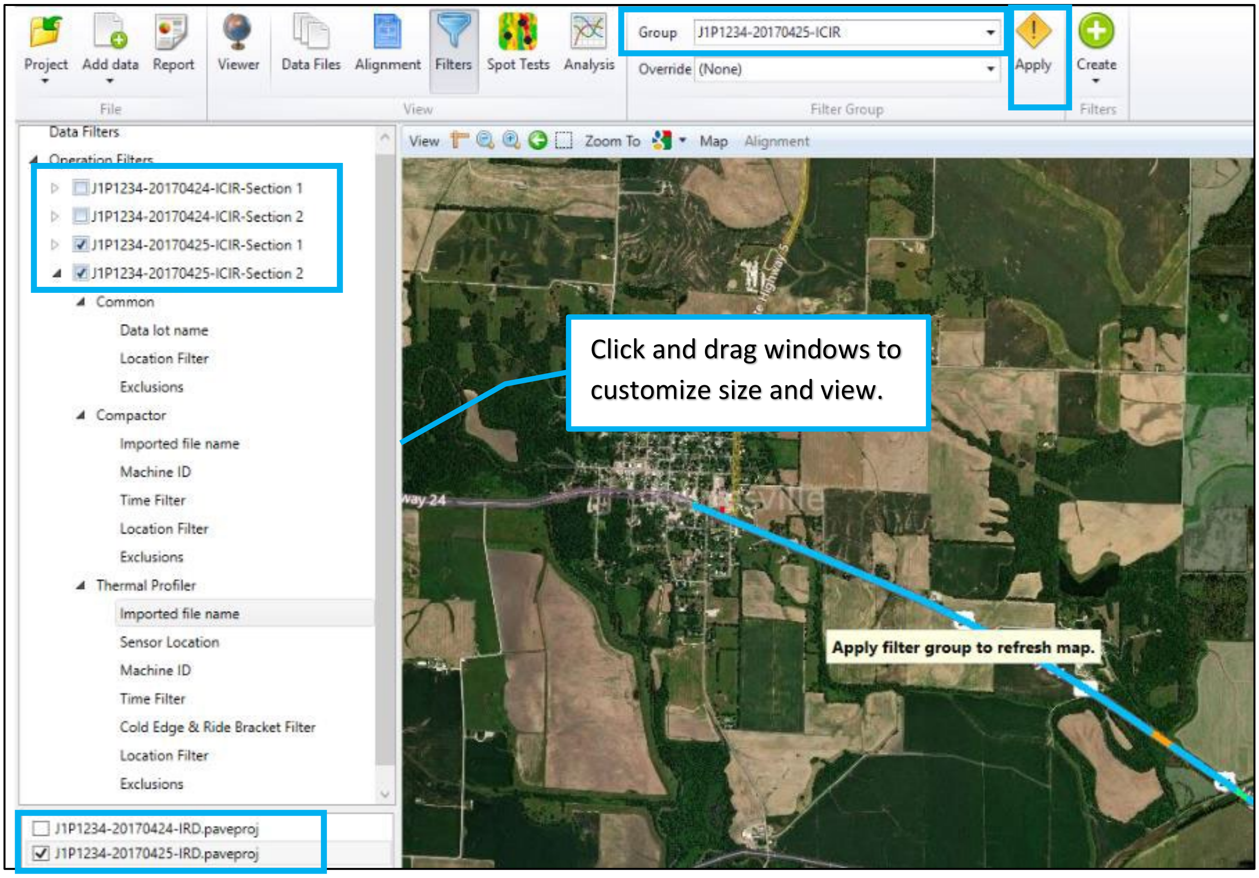


Figure 57. Operation filters are illustrated in the left filter panel.

Note the following observations from Figure 57:

1. The active filter group is shown in the Filter Group toolbar (J1P1234-20170425-ICIR). This filter group corresponds to April 25 (WB lanes). Users can toggle between filter groups using the drop-down menu. Note that the filter group and operation filters in this example do not use the AASHTO naming convention.
2. The left panel shows four total operation filters. Only two are active, noted by checkmarks. The active operation filters correspond to the active filter group from April 25. Click the triangles next to the checkmarks to expand the operation filter information.
3. The imported file name for the active operation filters only includes the data files from April 25, as indicated by checkmarks next to the imported file name.
4. The yellow apply flag next to the active filter group indicates that the filter group is not current. Click this button to apply any changes made to the active filter group.
5. The bar separating the windows in the left panel can be moved to change the size of each window.

Step 3. Apply the boundary coordinates to the active operation filters.

Each active operation filter has a unique set of boundary coordinates to use as a location filter, which is copied and pasted from the excel file into the corresponding operation filters. The filtered data for April 25 is illustrated in Figure 58. Note that the bridge decks have been removed from the data.

Step 4. The same process can be repeated for the EB lanes paved on April 24.

Change the filter group using the drop-down menu so that the data collected on April 24 is active. Repeat Step 3 for the data on April 24.

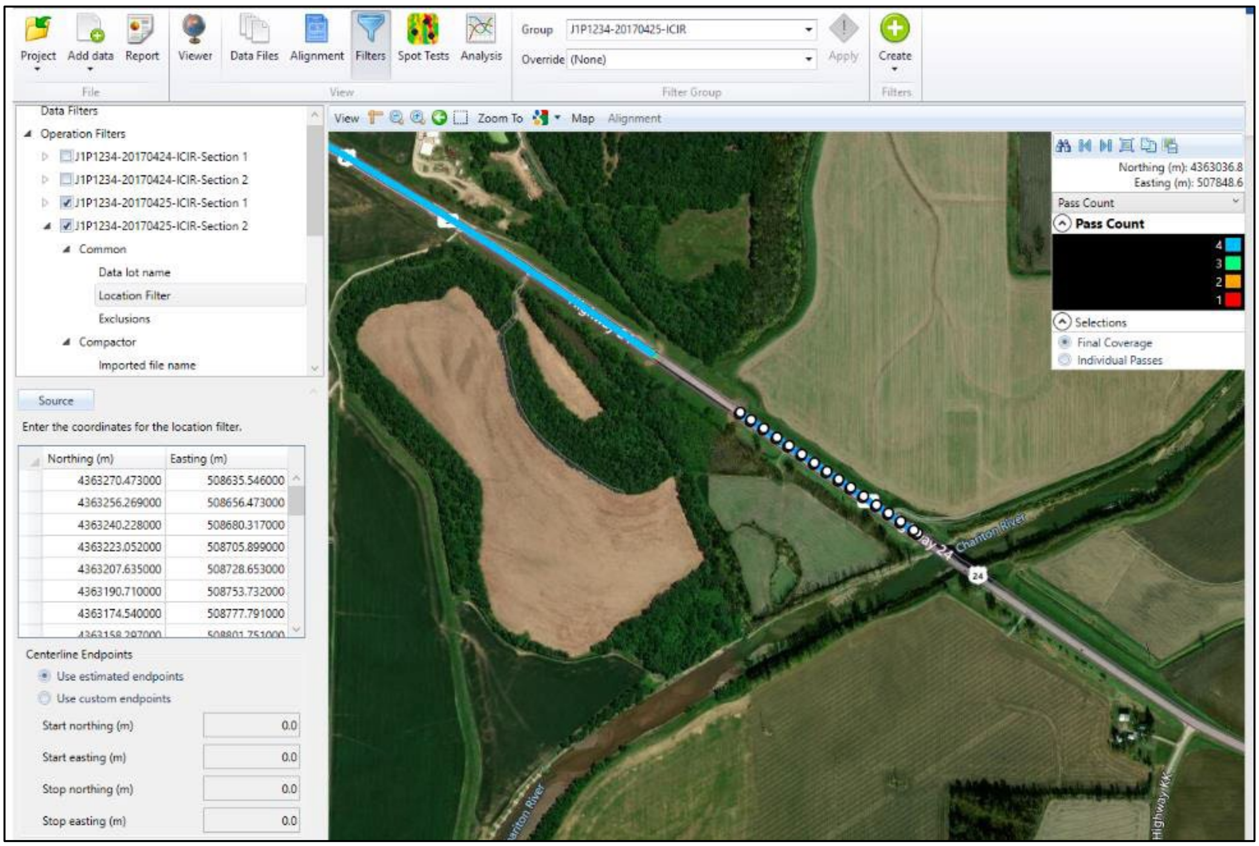


Figure 58. Filtered data for April 25. Location coordinates for Section 2 are illustrated.

Sublot Endpoints

Sublots are commonly used to analyze intelligent construction data. As of Veta 6.0, sublots are automatically generated, and the Sublots screen has been removed. Users can define the length of the sublot for analysis in the **Analysis** screen, as described in chapter Analysis. Veta will select start and stop endpoints automatically from the **Location filters.** Users may select custom start and stop endpoints if desired using options in the Centerline Endpoints dialog box. ***Note that the automatic start and stop endpoints are most reliable for location filters generated from alignment files. If location filter boundaries are imported from manually collected coordinates, it is recommended that custom endpoints are used to ensure accurate sublot generation.***

To **Use custom endpoints**, select the corresponding button under **Centerline Endpoints**. Right-click on the start of data (increase accuracy by zooming in) and select **Set centerline start.** A green flag is placed at the selected location. This process is illustrated in Figure 59.

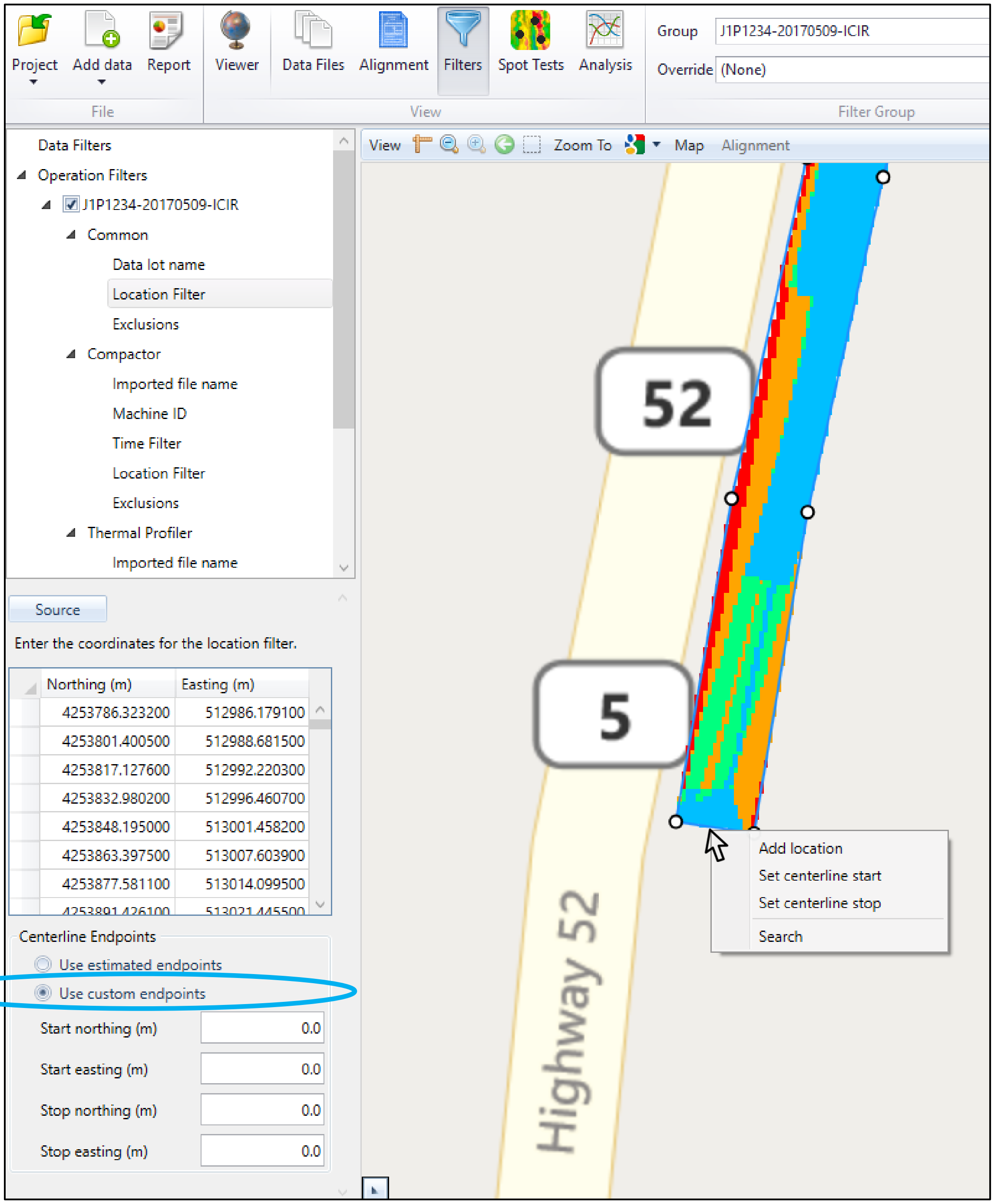


Figure 59. Users can select custom endpoints for sublot generation.

Note that this populates the **Start northing** and **Start easting** boxes. To create the **Stop northing** and **Stop easting**, right-click on the edge of the end of data or desired stop location and select **Set centerline stop**. A black and white checkered flag will appear. Navigating to the ends of the data is easily performed using the **First location** and **Last location** speed buttons on the **Legend toolbar,** as shown in Figure 60.

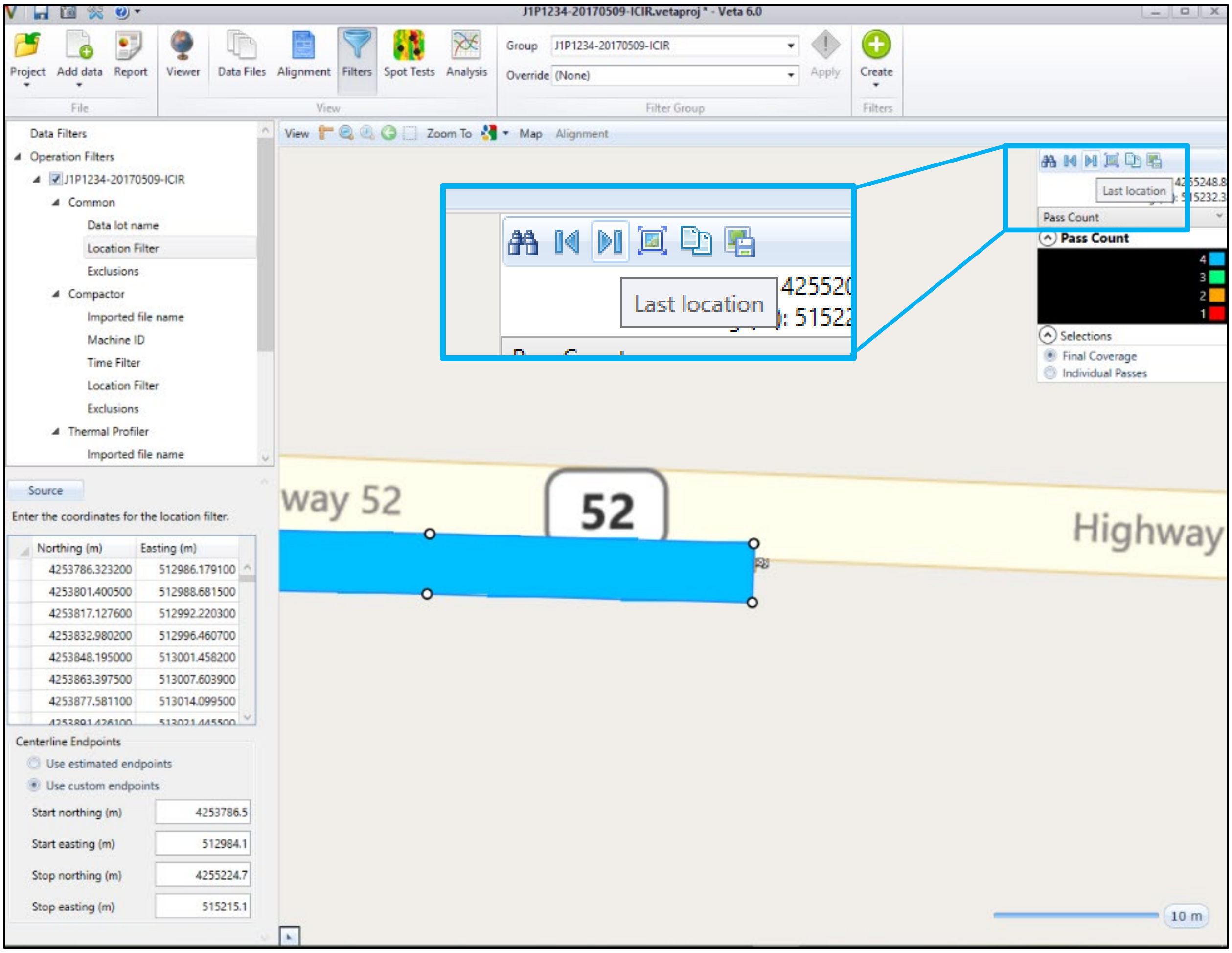


Figure 60. Navigating to the end of the data using the last location speed button.

It is recommended that users check the sublot generation during analysis to ensure that they look correct. Erroneous data may cause issues with automated sublot generation, and Non-continuous data may cause issues with automated sublot generation. ***Users should select custom endpoints for thermal profiler data separately from compactor data if separate location filters are used as previously described.***

Users should use custom endpoints corresponding to each location filter when multiple location filters are used, as shown in the example in the section Multiple Location Filters, as illustrated in Figure 61.

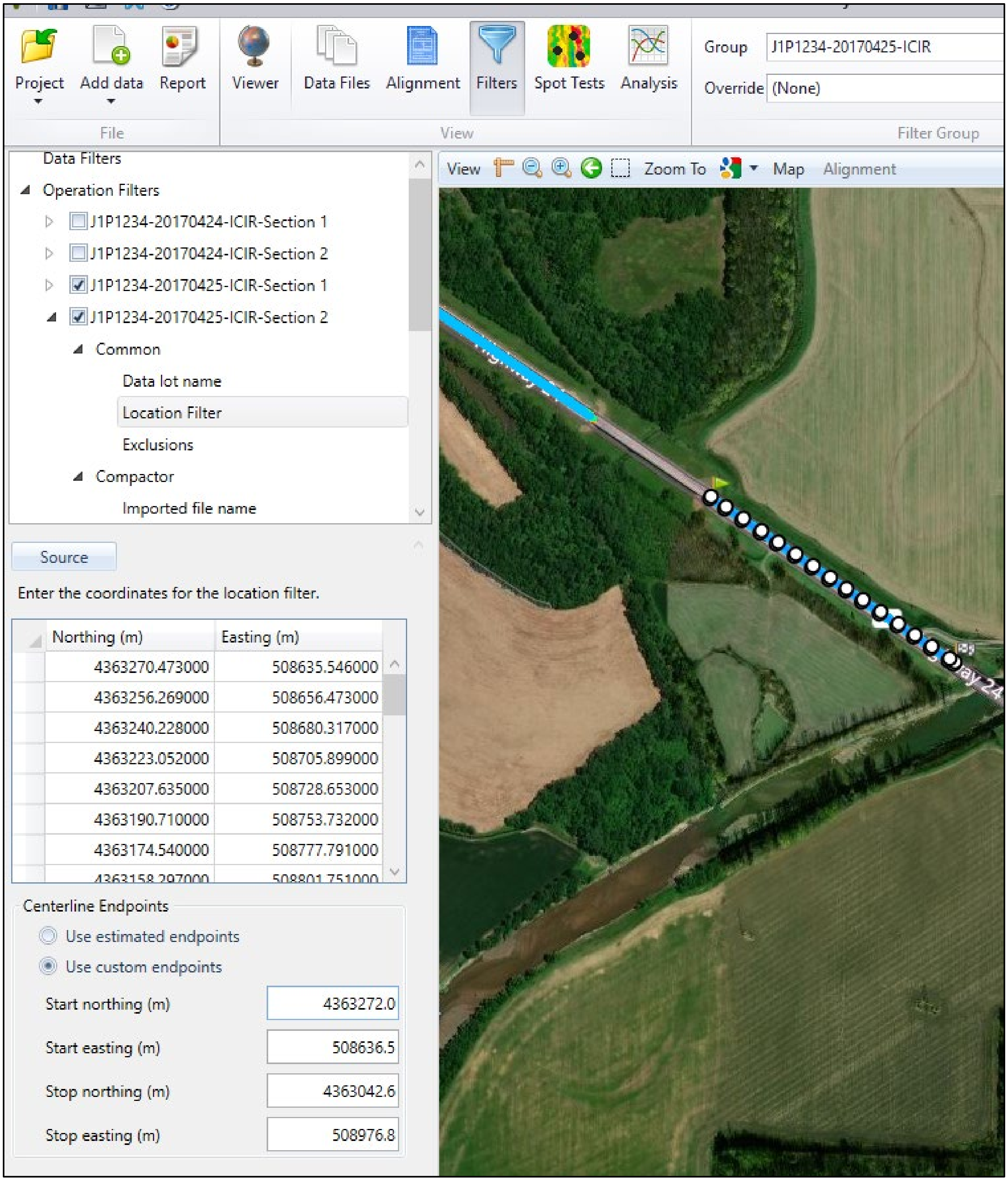


Figure 61. Custom endpoints are used for each location filter. Location filter corresponding to the data from April 25 Section 2 illustrated.

Location Exclusions

Exclusions can be used to exclude areas of data within the location filter. A common use of exclusions is removing bridge decks that do not apply to the same roller pass count as the main driving lanes, which may be used instead of separate location filters. Exclusions can also be used to remove erroneous data caused by GPS obstruction or equipment malfunction. ***Users should check with their project requirements for more information on the appropriate and allowed methodology for using exclusions.***

Location Exclusions are created using the same methods used to create location filters. ***Location filters must be created before an exclusion, and e***xclusions must be created under the same operation filter as the location file. For example, only common exclusions could be created if a common location filter was added. Alternatively, if the common location filter was overridden and a compactor location filter was added, only compactor exclusions may be added. Thermal profiler exclusions can only be used if a location filter is applied to the thermal profiler data. Location filters require using high accuracy GPS on thermal profiler equipment as previously described.

To create an exclusion, right-click on **Location Exclusions** under the applicable operation filter and select **Create exclusions**. Name the new exclusion and use the **Source** button to select **Custom** for manually collected coordinates or hand-select the exclusion area in Veta. Use one of the other options if using an existing alignment file. These options were previously described in the previous sections on location filters.

Note that sublots do not "skip" over exclusions. If sublots are being used to analyze data, it is recommended that multiple location filters are used with custom endpoints, as previously described in the section* Multiple Location Filters*.

The following example uses a manual exclusion to remove erroneous data underneath an overpass.

Step 1. Create a filter group, operation filter, and location filter for the data.

The filtered data is shown in Figure 62. Note that the underpass blocked the GPS signal and caused data loss.

Step 2. Create and name exclusion under the corresponding location filter. Right-click on Exclusion and select Create exclusion.

An exclusion named "Underpass at Dixon Ave." was created for the project.

Step 3. Click Source and select Custom. Right-click in a counterclockwise or clockwise direction around the corners of the area to exclude, selecting Add location at each corner. Note that the exclusion snaps to the location filter upon selecting the fourth location.

Exclusions are illustrated in Figure 63 and Figure 64. Alternatively, coordinates of bridge decks or other known exclusions can be collected using handheld GPS and copied and pasted into the coordinates box. When alignment files are used, exclusions can be set using offsets and stationing.

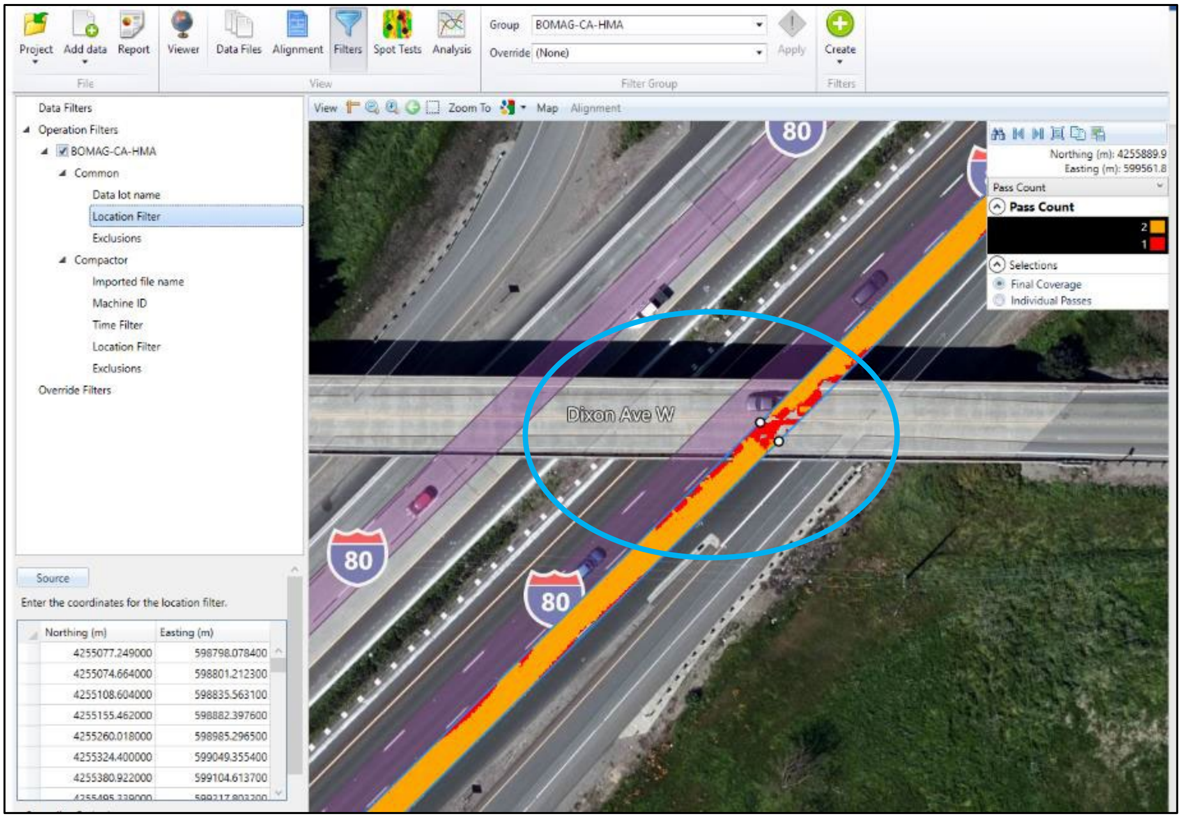


Figure 62. Filtered data with data loss at Dixon Ave.

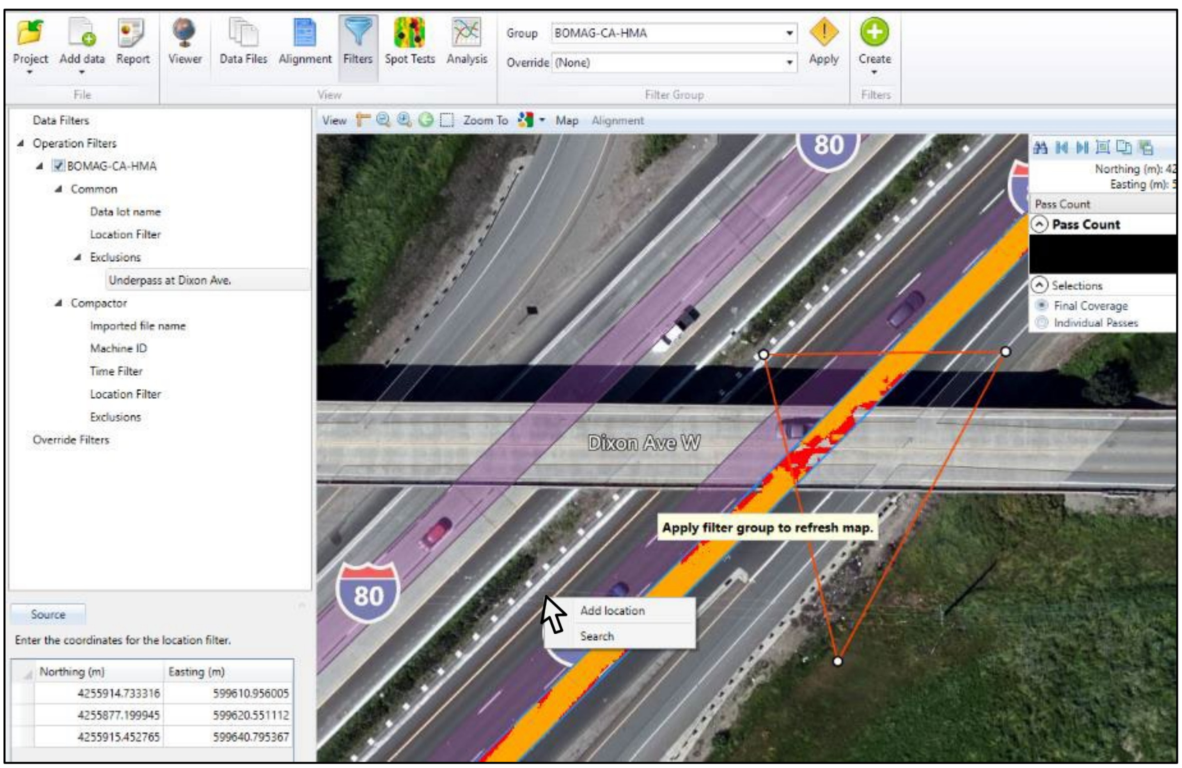


Figure 63. Selecting points at each corner of exclusion. Note that the coordinates are populating in the lower-left box. The last corner is about to be selected in the lower left.

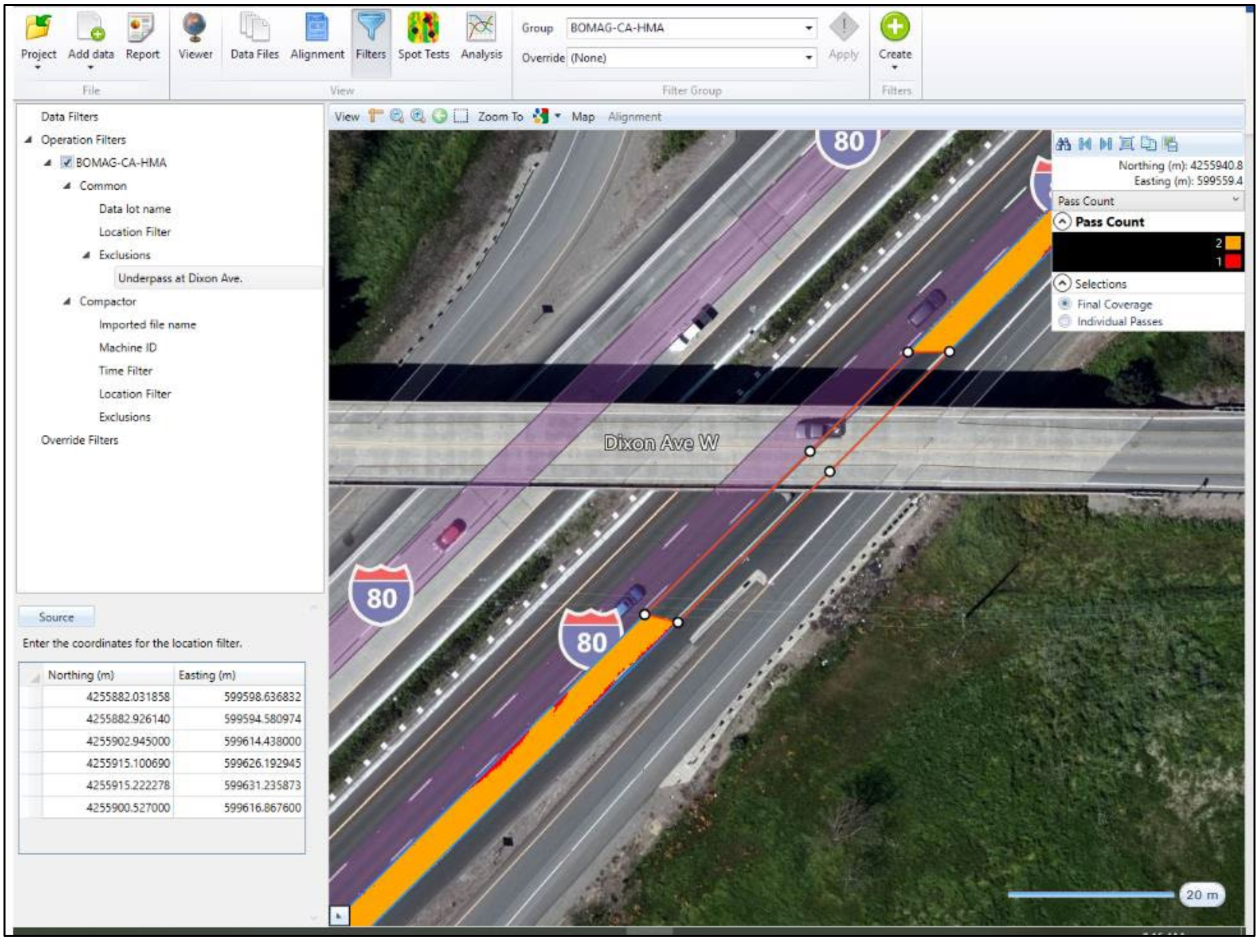


Figure 64. Exclusion "snapped" to location filter. Data were excluded after applying the exclusion.

Compactor

Compactor filters only apply to the IC data files selected under the compactor **Imported File Name** and **Common Data Lot Name.** The following describes each available compactor operation filter.

Imported File Name

The imported file name shows all available compactor data files. Users may select one or more imported file names for analysis. Imported file names are included when the check box next to the file name is selected.

Machine ID

The machine ID shows all rollers included in the imported compactor data files. Some vendors include all rollers in one data file, and others may include one roller per data file. Users should consult with their equipment vendors to understand vendor-specific data file management. Machine IDs are named in vendor-provided software. Only selected rollers will be included in the filter group.

Location

Location filters were described under the section **Common**. Users may choose to override the common location filter and apply a compactor-specific location filter—reference section **Common Location Filter** for more information.

Location Exclusions

Location Exclusions were described under the section **Common**. Users may override the common location filter and apply a compactor-specific location filter and compactor-specific exclusions. Reference section **Common Location Filter** and **Common Location Exclusions** for more information.

Time

All data is time-stamped. Therefore, data can be filtered based on time. Users should work with their vendors to ensure their equipment clock is correct for valid time stamps.

Users can include multiple time filters in one operation filter. There are two ways to filter using time, inclusion or exclusion. Inclusions will include the selected data or range and remove all other data, and exclusions will remove the selected date or range. To use a time filter, users can select by date or, more specifically, by the time of day. Select **Range** to filter by a specific time of day. Selecting **Range** populates a **Start date** and **Stop date,** as illustrated in Figure 65**.**

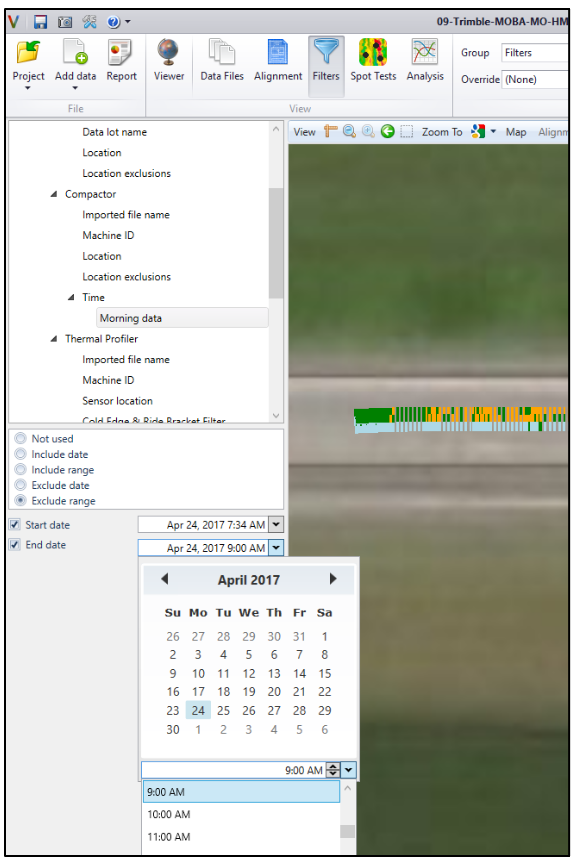


Figure 65. Creating a Time Filter for compactor data.

Once the checkboxes next to the **Start date** and **End date** are selected, users can customize the time filter using the drop-down calendar and list of times. Concise times can be typed in manually.

It may be useful to check the timestamps of the data using the **Search** tool. Users can right-click on any data point and select **Search** to bring up the **Search box.** The **Search box** is illustrated in Figure 66. The **Northing** and **Easting** are populated based on where the user right-clicked on the map. The **Radius** may be changed to broaden the search area. For example, changing the **Radius** to 1 meter would include all data within 1 m of the coordinate displayed.

Clicking the **Search** button results in all data within the specified radius of the displayed coordinate, including the time stamp. Users can toggle between the data tabs to view IC all passes, IC final coverage, thermal profiler, or DPS data. ***Users should zoom in to ensure they click on data points or expand the radius if no data is displayed.***

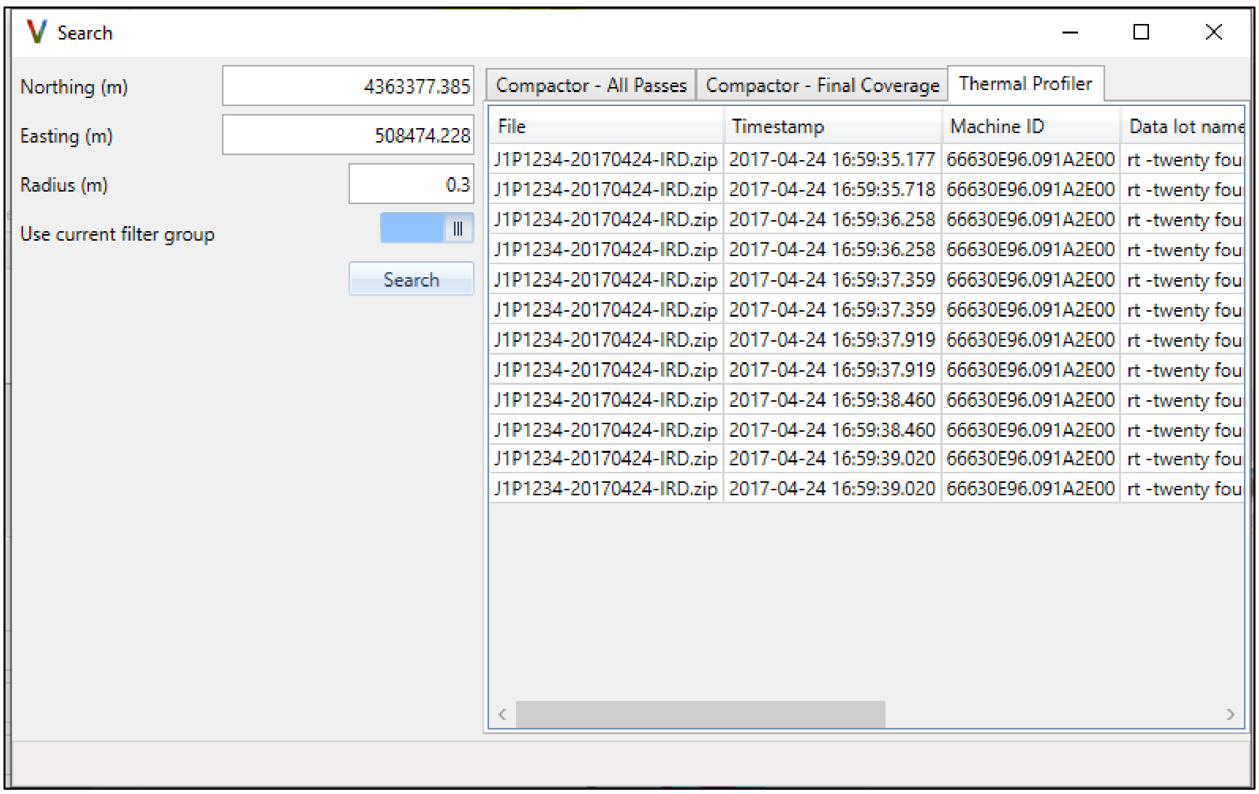


Figure 66. Search box.

Thermal Profiler

Thermal Profiler Operation filters are only applied to the data files selected under the thermal profiler **Imported File Name** and **Common Data Lot Name.** The following describes each available thermal profiler operation filter.

Imported File Name

The imported file name shows all available thermal profiler data files. Users may select one or more imported file names for analysis. Imported file names are included when the check box next to the file name is selected.

Machine ID

This field corresponds to each machine ID. Typically there is only one thermal profiler per paving train. Echelon paving may use multiple thermal profiling systems.

Sensor Location

The sensor location corresponds to data based on the vendors' data spacing. Users should consult their equipment vendors for data spacing, which is generally between four and twelve inches. For example, if a vendor uses a twelve-inch data spacing, each sensor location corresponds to one foot of data. Users can exclude sensor locations by unchecking the box next to the sensor. This concept is illustrated in Figure 67 and Figure 68.

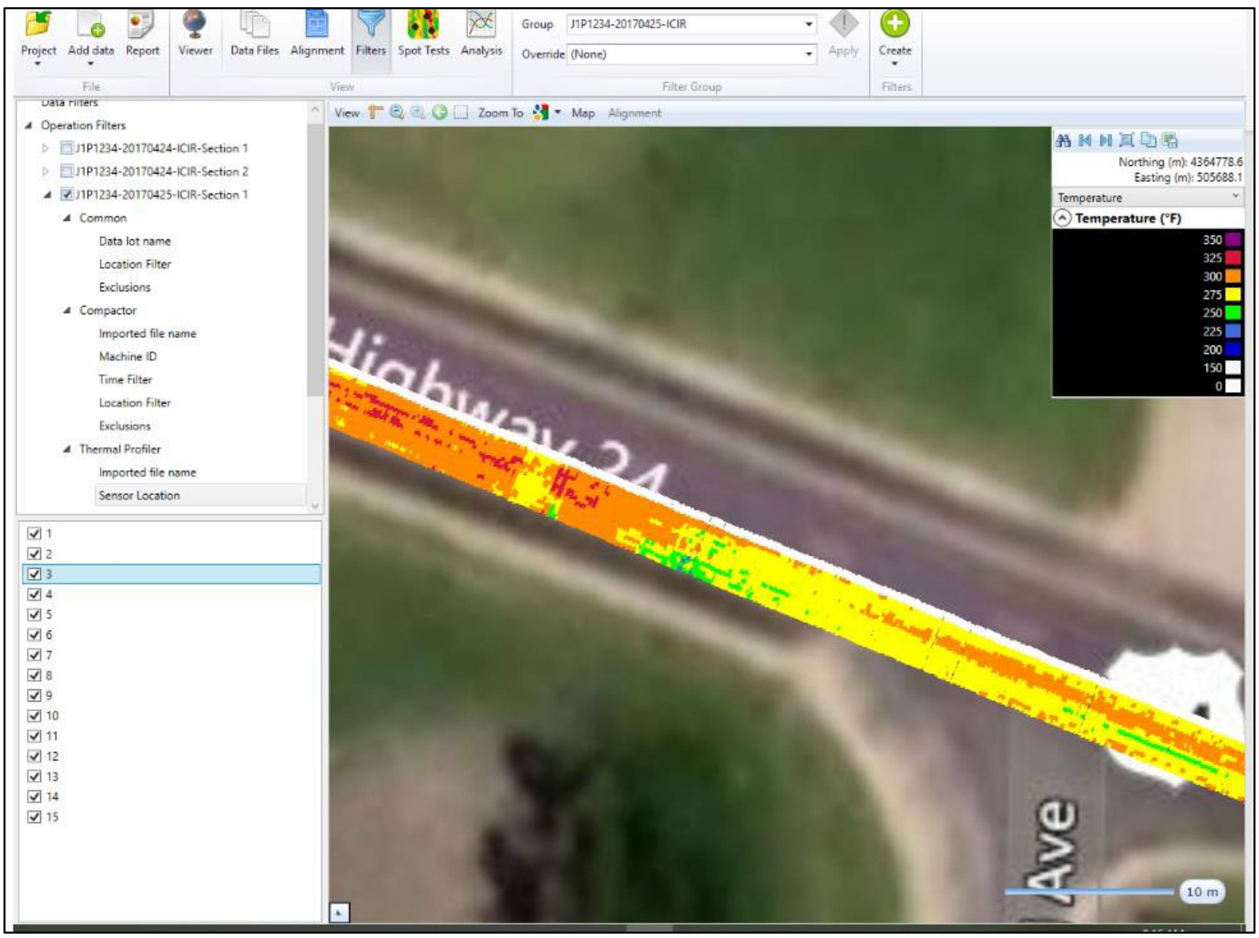


Figure 67. All sensors selected. Note the cold edge on the north end of the profile.

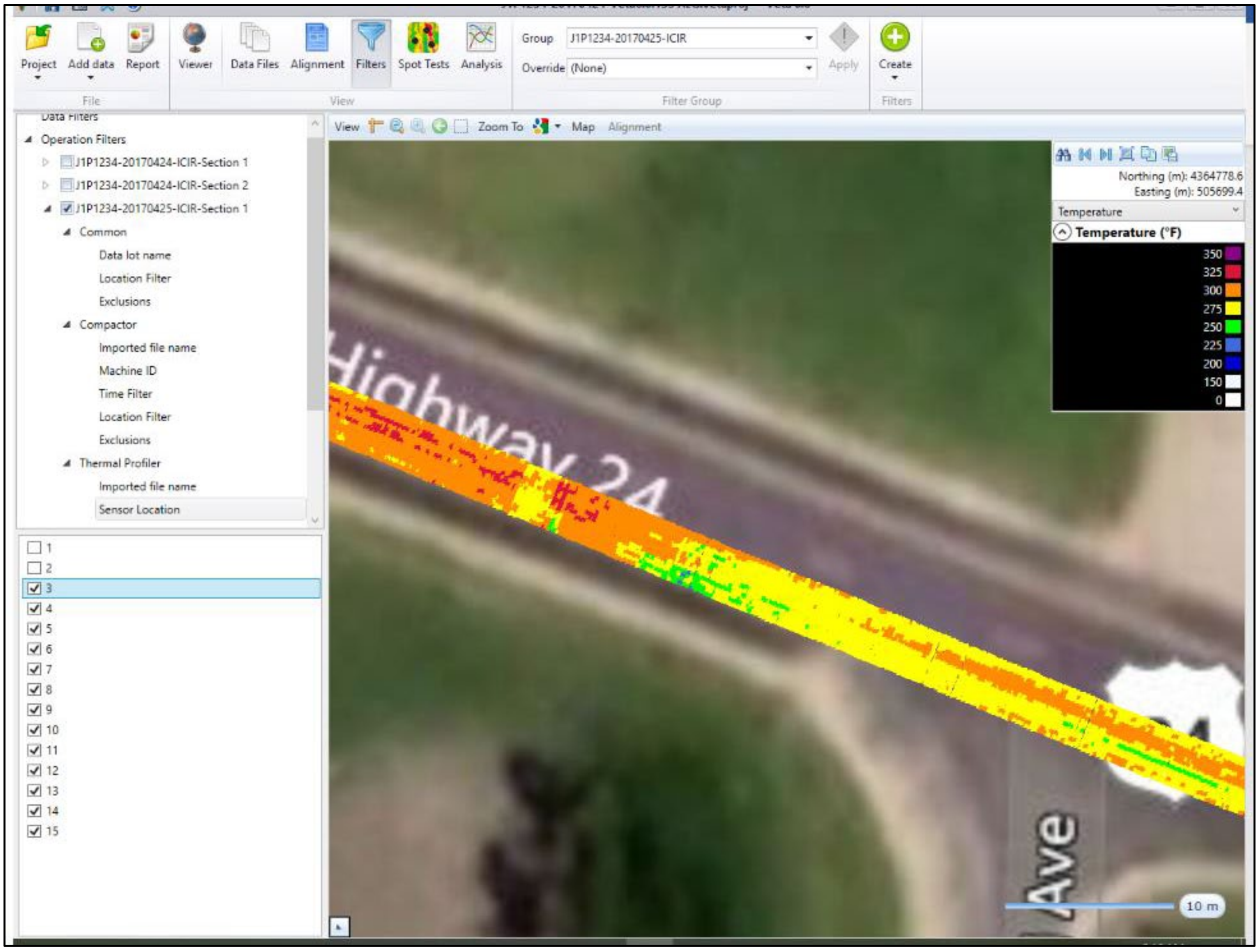


Figure 68. Sensors 1 and 2 were removed, corresponding to two units of vendor-specific data spacing (typically 4-12 inches).

Note that this process of filtering data is not very precise as vendor grid spacing varies. This process of filtering data should be used with caution.

Cold Edge & Ride Bracket Filter

The cold edge & ride bracket filter is an algorithm that statistically detects and removes cold edges & ride brackets (smoothness skis). The algorithm evaluates the thermal profiler data, looks for a continuous length of significantly colder temperatures, and removes these areas. This filter is the recommended method for removing the adjacent edges of the existing pavement picked up during thermal profiling, as illustrated in Figure 69 and Figure 70.

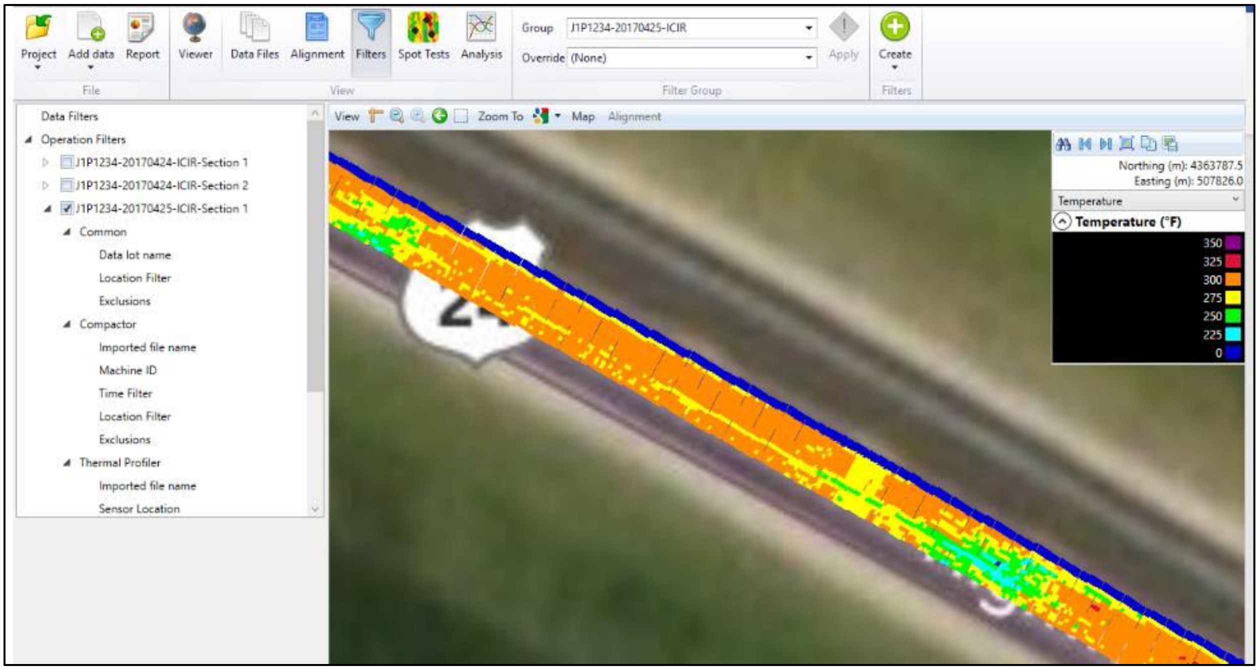


Figure 69. Cold edge on the north side of the paved mat from the adjacent existing pavement. A ride bracket is shown from the contact ski.

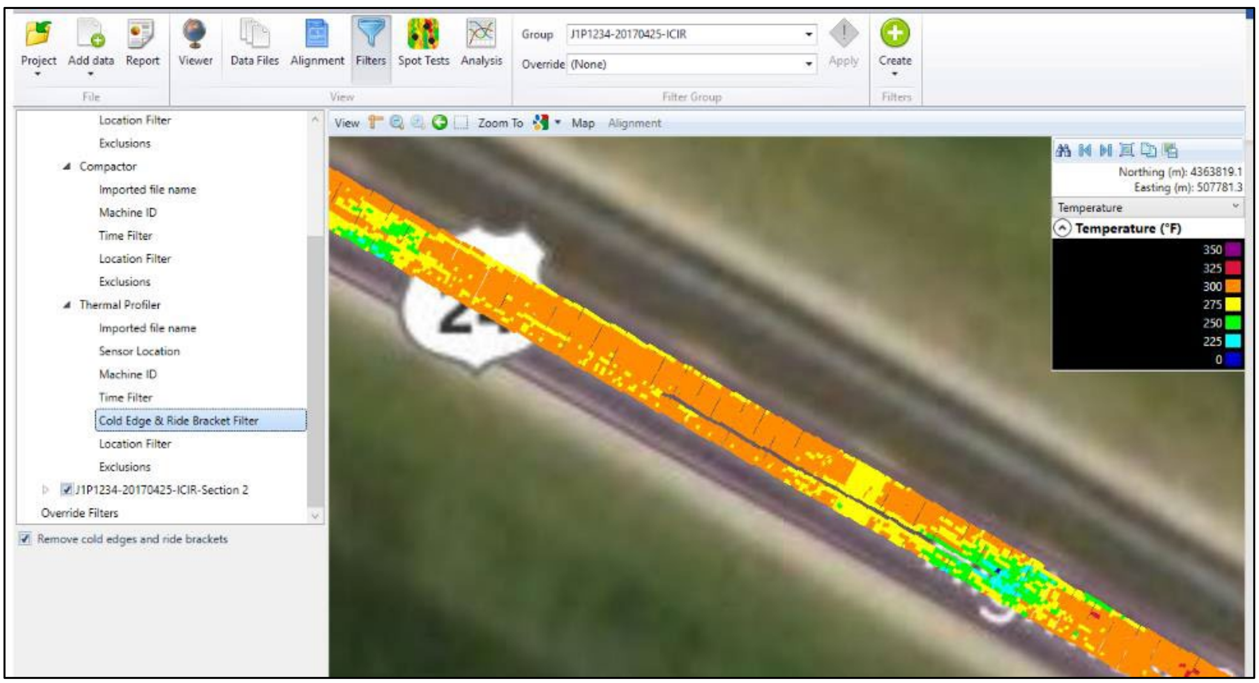


Figure 70. Cold Edge & Ride Bracket Filter used to filter data before analysis.

Location

Location filters were described under the section **Common**. Users may override the common location filter and apply a thermal profiler-specific location filter. Reference section **Common Location Filter** for more information. It is recommended that users only consider location filters if using RTK accuracy GPS.

Location Exclusions

Location Exclusions were described under the section **Common**. Users may override the common location filter and apply a thermal profiler-specific location filter and thermal profiler-specific exclusions. Reference section **Common Location Filter** and **Common Location Exclusions** for more information. It is recommended that users only consider location filters if using RTK accuracy GPS.

Time

Time filters were described under section **Compactor**. The same process can be used to filter thermal profiler data.

Dielectric Profiler

Dielectric Profiler Operation filters are only applied to the dielectric profiler data files selected under the dielectric profiler **Imported File Name** and **Common Data Lot Name.** The following describes each available dielectric profiler operation filter.

Imported File Name

The imported file name shows all available dielectric profiler data files. Users may select one or more imported file names for analysis. Imported file names are included when the check box next to the file name is selected.

Machine ID

This field corresponds to each machine ID used to collect DPS data.

Sensor Location

The sensor location corresponds to the vendor-specific setup. Users should consult with their equipment vendors about the number of sensors used during DPS data collection.

Sensor ID

The sensor ID corresponds to each sensor used during DPS data collection.

Sensor Offset

The sensor offset corresponds to the vendor-specific setup. This field should be the sensor offset from a reference line (e.g., curb, centerline). Users should consult their equipment vendors for the number of sensors and offsets used during DPS data collection.

Calibration

Calibrations are performed according to vendor recommendations to estimate air voids and relative density from DPS data. The linear calibration coefficient and constant can be input, as described in **Calibration Functions.** Once a calibration function is selected, the air voids and Density (% of Gmm) data can be viewed as shown in Figure 71.

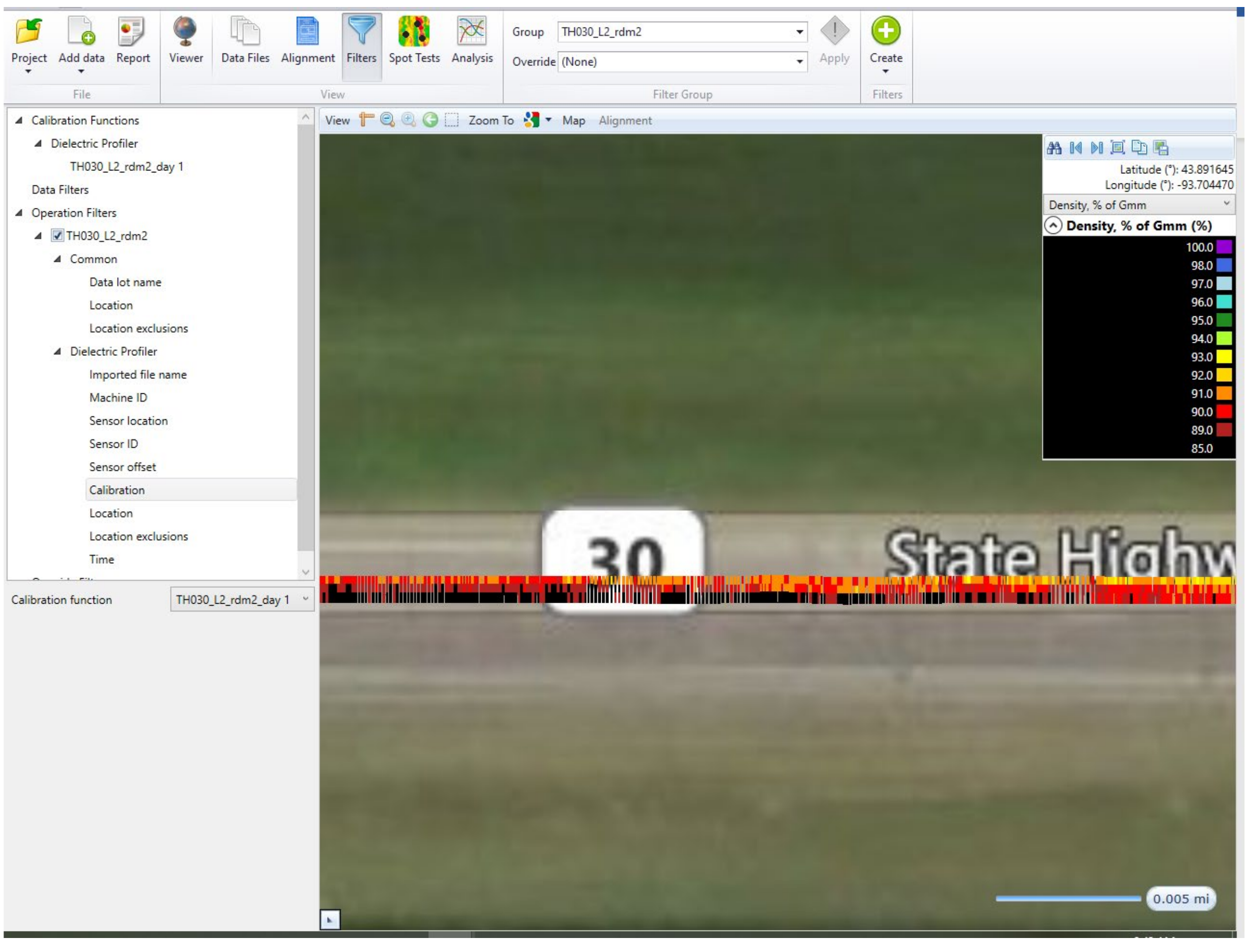


Figure 71. Viewing the air voids data after selection of calibration function.

Location

Location filters were described under the section **Common**. Users may override the common location filter and apply a dielectric profiler-specific location filter. Reference section **Common Location Filter** for more information. It is recommended that users only consider location filters if using RTK accuracy GPS.

Location Exclusions

Location Exclusions were described under the section **Common**. Users may override the common location filter and apply a dielectric profiler-specific location filter and dielectric profiler-specific exclusions. Reference section **Common Location Filter** and **Common Location Exclusions** for more information. It is recommended that users only consider location filters if using RTK accuracy GPS.

Time

Time filters were described under section **Compactor**. The same process can be used to filter dielectric profiler data.

Override Filters

Override filters are used in Veta for specialized analysis that requires multiple filter groups. Available **Override Filters** include the following:

- Compactor
    - Machine ID
    - Pass Count
    - Compaction Mode
    - Temperature
- Thermal Profiler
    - Machine ID
- Dielectric Profiler
    - Machine ID

These parameters were previously described under the section **Data Filters.**

For example, a user may want to analyze one day of paving production using three rollers. To report final coverage, the user may need to run a final analysis using all three rollers' combined compaction efforts. However, the user may find it useful to analyze all three rollers individually to evaluate the individual rolling patterns.

Another scenario where override filters are useful is if the user wants to run the final analysis to see overall compaction temperatures and analyze the initial breakdown pass (Pass 1) temperature by sublot. ***Because sublot analysis is performed on final coverage data only, the user must filter out all other passes for this analysis.*** An example of this scenario is shown below. There are multiple opportunities to optimize data analysis using override filters, and users should experiment with different scenarios.

Step 1. Create a project with appropriate filters for standard analysis.

IC data files and a location filter have been applied, as shown in Figure 72. Two roller temperature maps are shown. The left map shows the first breakdown roller pass (Pass 01). The right map shows the final coverage temperatures. The contractor can perform the final coverage analysis to ensure the target pass count is achieved. However, the contractor would also like to view the sublot results for the first breakdown pass for quality control purposes. Override filters are a simple and efficient way to run both analyses back to back without making changes to the original project filters.

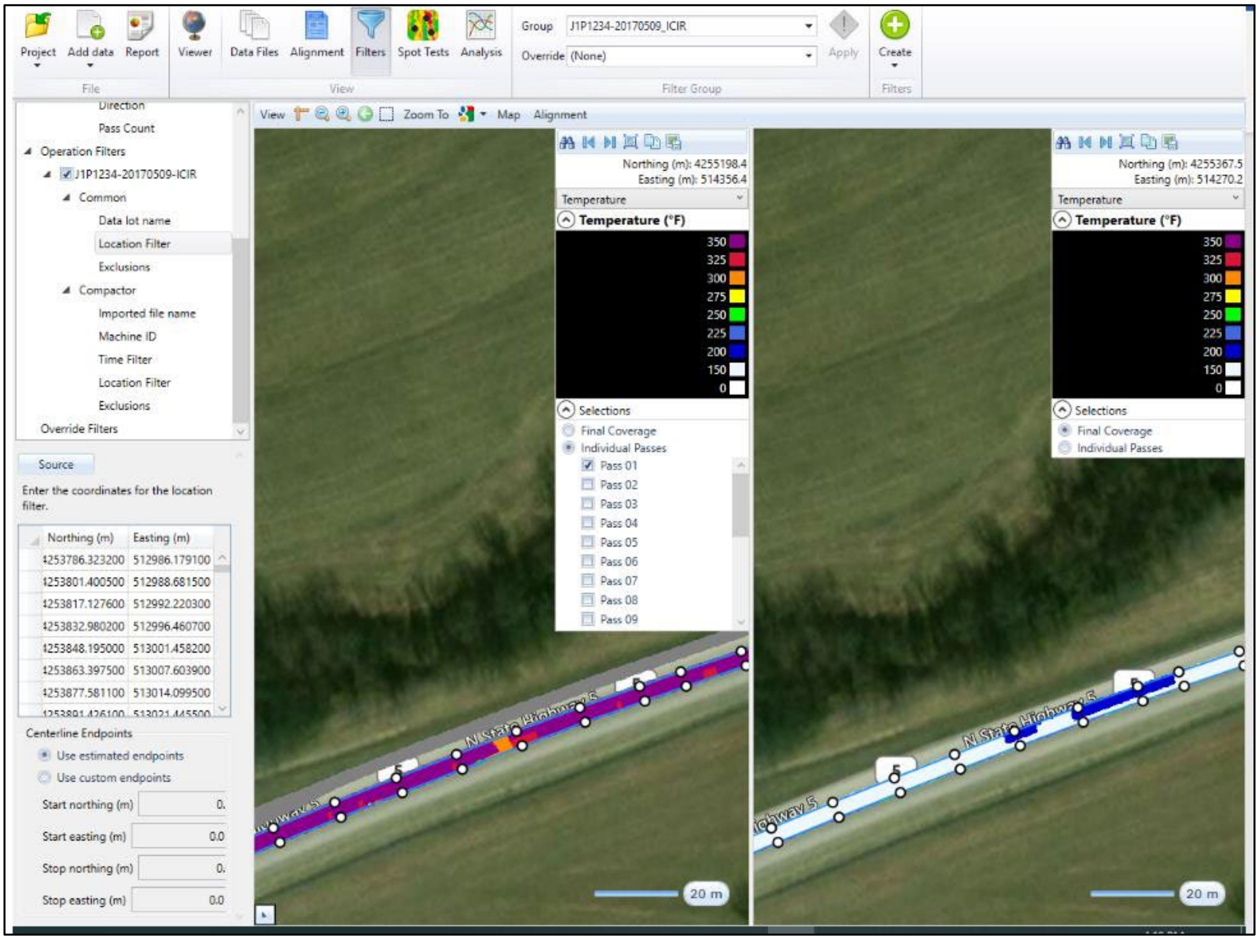


Figure 72. Compactor temperature maps. Pass one is shown on the left, and the final coverage is shown on the right.

Step 2. Create an override filter.

Create an override filter by right-clicking on **Override Filters.** Alternatively, use the **Create** button, and Veta will prompt the user for a filter name.

Step 3. Under the Compactor Pass Count, uncheck all passes except Pass 1.

Setting the pass count filter is illustrated in Figure 73. Note that the name of the **Override Filter** is Breakdown Pass 1.

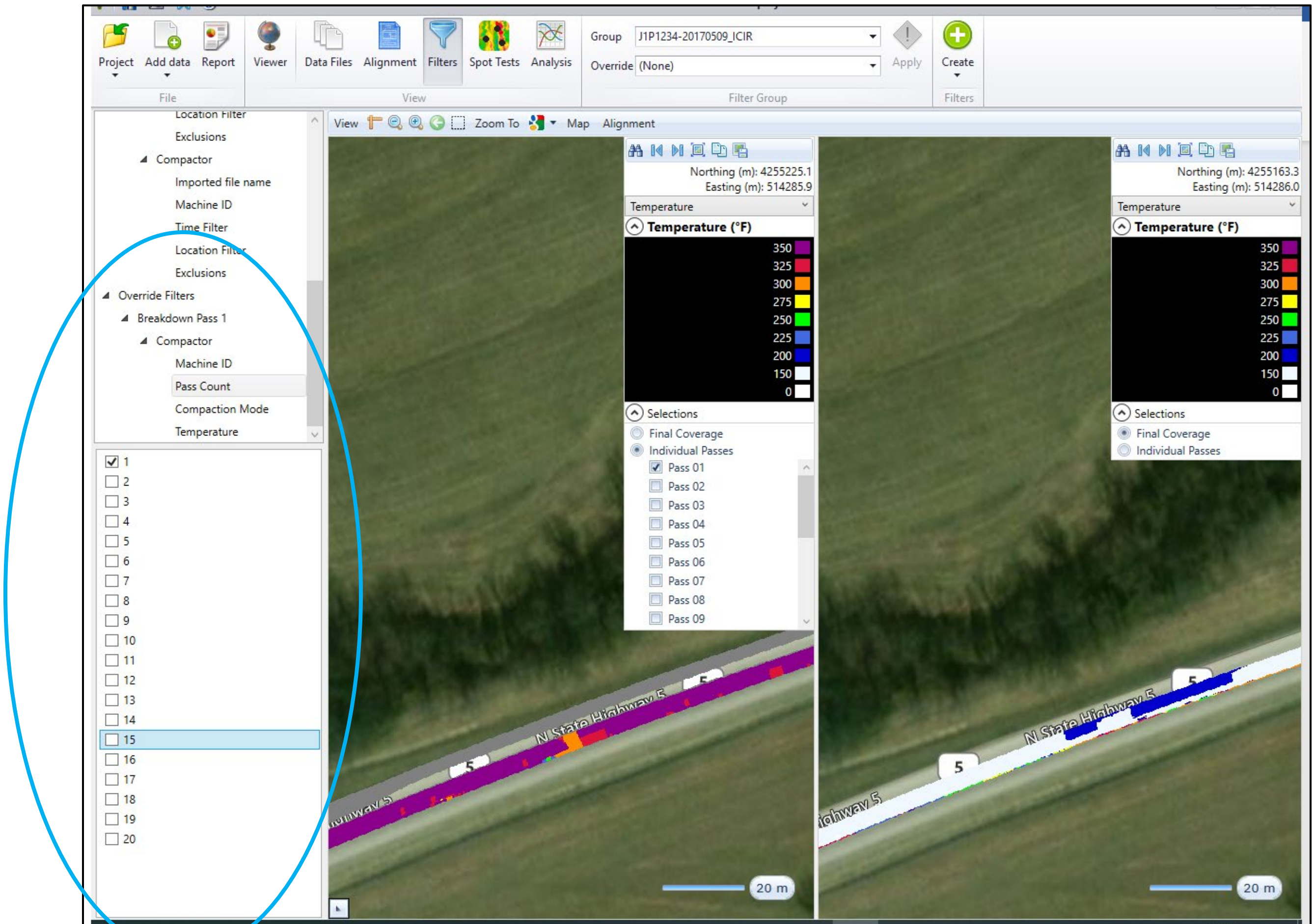


Figure 73. An override filter is created for pass count 1.

Step 4. Select the override filter during analysis.

The contractor can now analyze the project according to standard project requirements and run the analysis using the override filter. Analysis options are further described in chapter **Analysis** under **Analyzing Override Filters.**

Filter Defaults

Starting in Veta 7.0, users can create filter defaults specific to unique project needs or personal preferences. Filter defaults are accessed and customized under **options** in the **file toolbar,** as shown in Figure 74. The **Filter Defaults** customization box is illustrated in Figure 75.

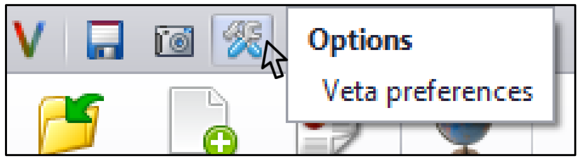


Figure 74. Options are located in the file toolbar.

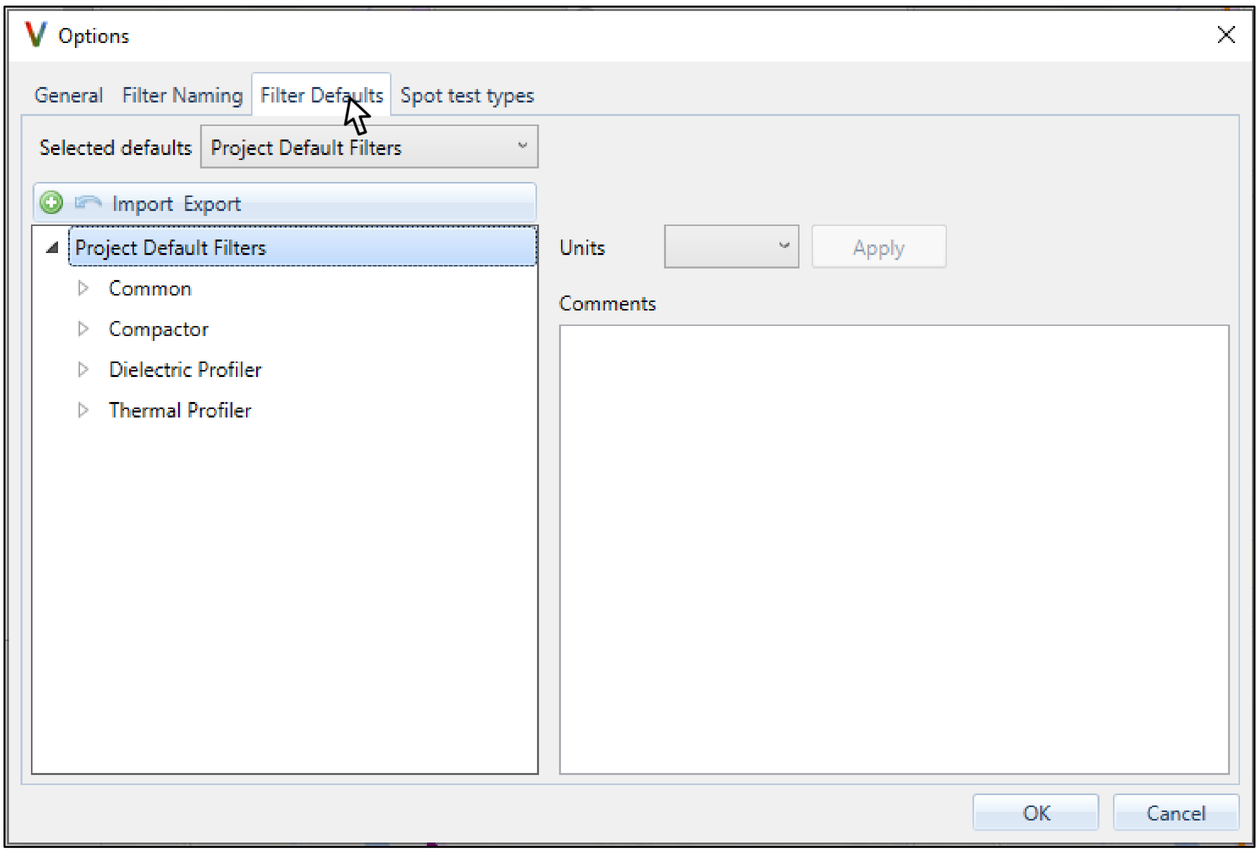


Figure 75. Filter Defaults customization box.

Filter Defaults can be created for individual projects. New **Filter Defaults** are created using the green **Add** button. Multiple default options can be created and should have unique names, and a standard (and descriptive) naming convention is recommended.

Once **Filter Defaults** are created, they can be accessed using the **Selected defaults** drop-down menu. Users can save specific **Filter Defaults** to a file using the **Export** button. The saved **Filter Defaults** file can be added to projects using the **Import** button.

The following sections describe the options for **Filter Defaults.**

Units

Default units can be set under the **Veta Defaults** menu using the drop-down menu (Figure 75). Options for units are **Metric** or **USCS**.

Common

Users have the option to select **Use all** as a default for the **data lot name** by checking the box in the Filter Defaults customization box. Selecting **Use all** will automatically select each data lot name file in the project, as (previously) illustrated in Figure 48.

Compactor

Users can select Use all as a default for the Imported file name or Machine ID by checking the Filter Defaults customization box. Selecting **Use all** will automatically select each available option for the project, as previously illustrated in Figure 48.

Users can set automatic data filters for any of the data available in their IC system. For example, users only interested in vibratory passes can create a default filter that excludes **static** passes from **Compaction Mode**. Another useful filter default is to create a pass count filter that reflects the optimum pass count for the project established during a trial or test section. Other options include filtering by **ICMV, temperature, speed, amplitude,** or **frequency**.

Dielectric Profiler

Users can select Use all as a default for the Imported file name, Machine ID, Sensor location, Sensor ID, or Sensor offset by checking the Filter Defaults customization box. Selecting **Use all** will automatically select each available option for the project, as previously illustrated in Figure 48.

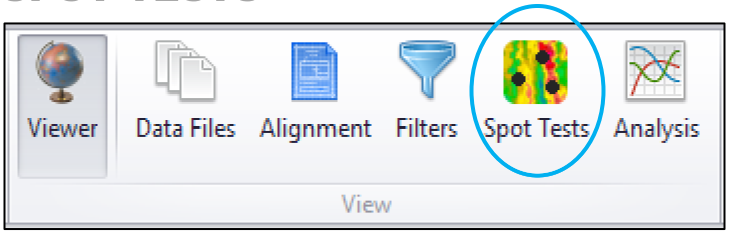
Other options include setting default filters for **Air voids, Dielectric, Dielectric Height, Dielectric Quality, Speed,** or **Temperature.**

Thermal Profiler

Users can select Use all as a default for the Imported file name, Machine ID, or Sensor location by checking the Filter Defaults customization box. Selecting **Use all** will automatically select each available option for the project, as previously illustrated in Figure 48.

Other options include automatically selecting the **Cold Edge & Ride Bracket Filter** and can set default filters for **Speed** or **Temperature**.

SPOT TESTS



The spot test screen is used to import the results of field tests into Veta. Spot tests are useful for performing correlations between field tests and intelligent construction data (e.g., correlations between core density results and pass count, temperature, or ICMV). An overview of the **Spot Tests** screen is shown in Figure 76. There are different tabs for different types of spot test data. The different data tabs and directions for adding spot tests are described in the following sections.

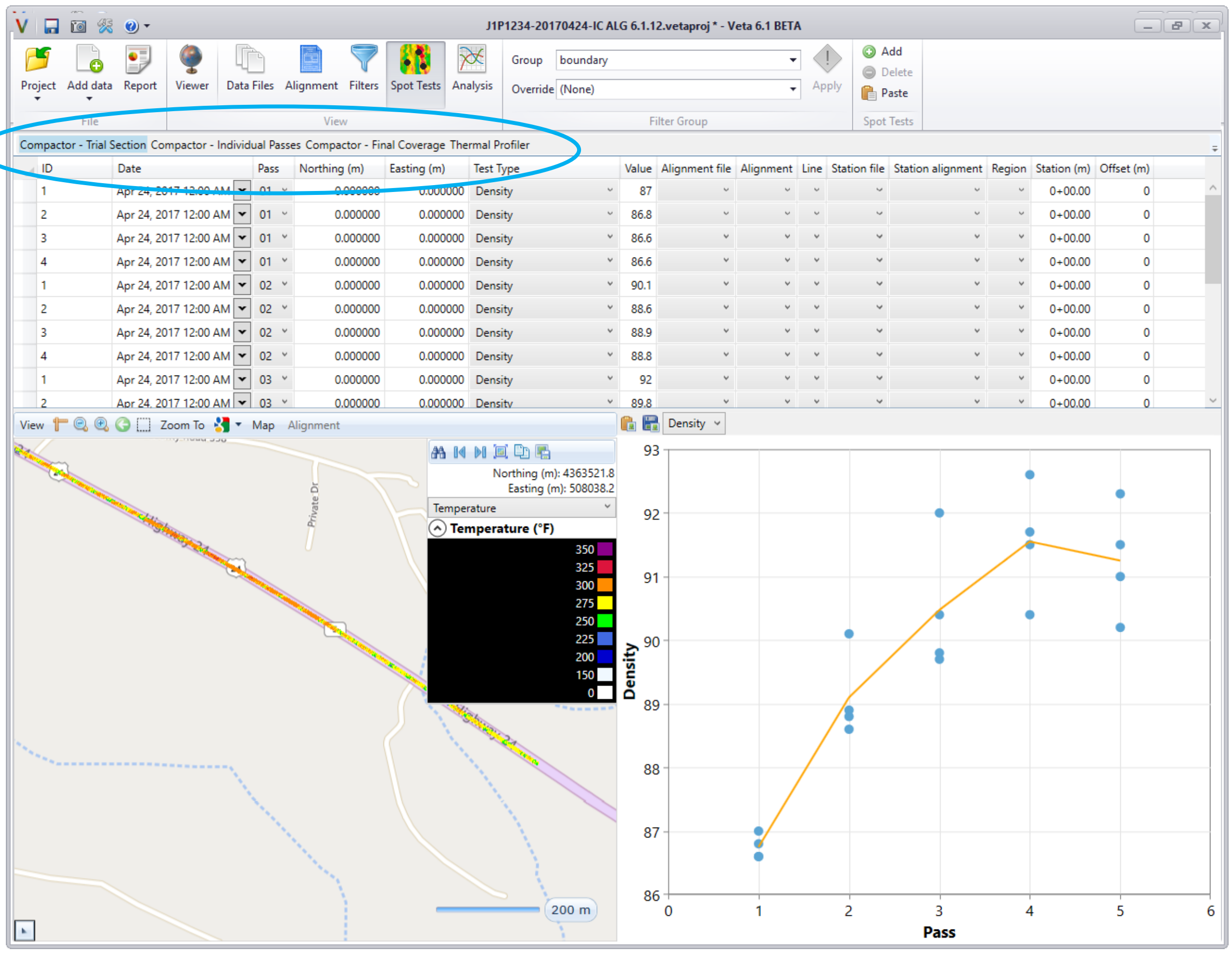


Figure 76. Spot tests screen.

Compactor - Trial Section

The **trial section tab** can plot a rolling pattern based on pass count and test value. Figure 76 shows an example trial section. Location coordinates are not required for a trial section but may be included. Trial sections should include unique IDs for each test location and the spot test results (example shown uses a density gauge) at each location for different passes. The data generally creates a curve that can be used to identify a target pass count. Figure 76 shows a trial section curve. The data set includes four test locations with density data collected at passes one through five. The curve peaks at a pass count of four. This “optimum pass count” can be used as a target pass count when analyzing future data sets for this project.

Note that the spot test screen includes tooltips. Hovering over data points with the mouse cursor displays information for each point, as shown in Figure 77.

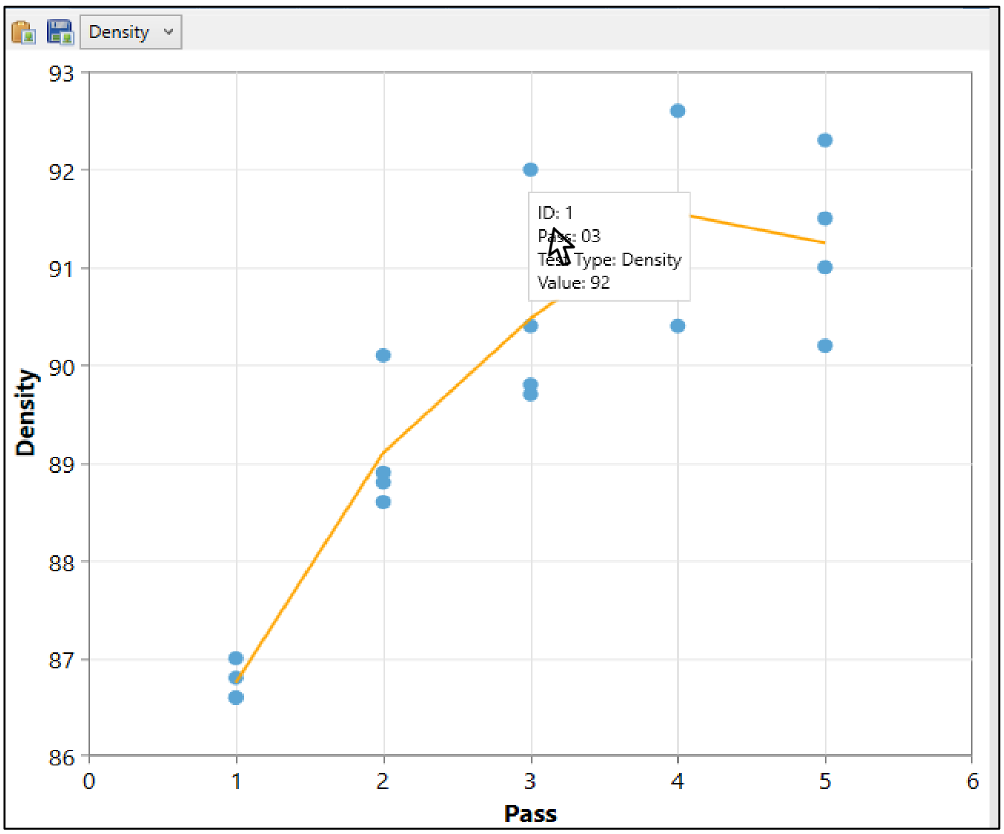


Figure 77. Tooltips in the spot test screen.

Compactor - Individual Passes

The **compactor individual passes** tab can map and correlate spot test data to IC data. Individual pass data should include a unique ID, the pass when data was collected, coordinates of test location, test type, and the test value. Alternatively, if a LandXML alignment file is used, stationing and offset data may be used to mark the location of spot tests. Figure 78 shows data plotted on the compactor individual passes tab.

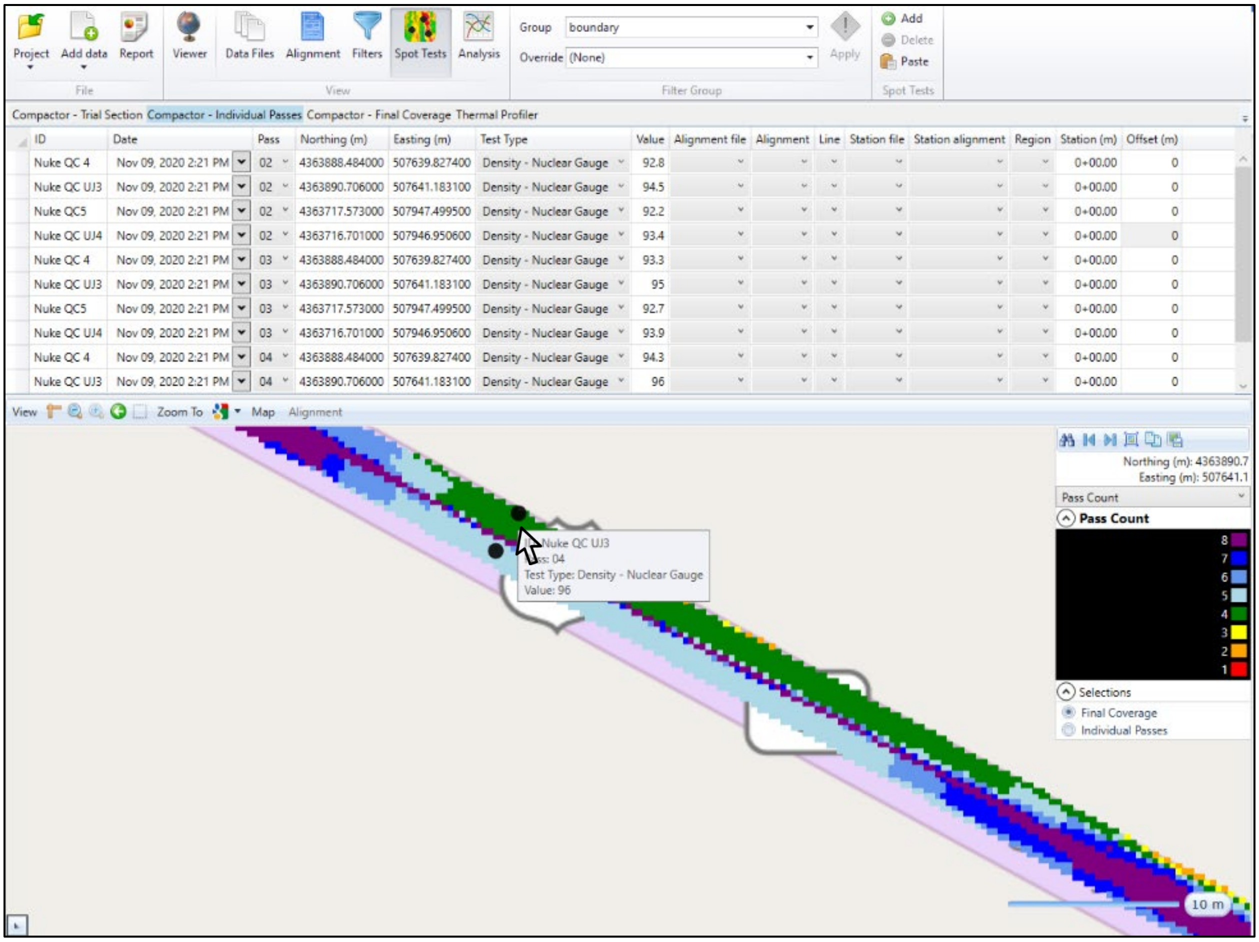


Figure 78. Compactor individual passes tab.

Compactor - Final Coverage

The compactor **final coverage tab** is identical to the **compactor individual passes** tab, except it is used for spot tests performed after all rolling is complete. For example, core density data should be included in the **final coverage tab.**

Thermal Profiler

The thermal profiler tab is for correlating spot tests against thermal profiler data.

Dielectric Profiler

The dielectric profiler tab is for correlating spot tests against dielectric profiler data.

Adding Spot Tests

Spot tests can be added using the green **Add** button and typing in the data for each spot test. Alternatively, the information can be cut and pasted from a spreadsheet. Cutting and pasting may be more efficient if coordinate data and test IDs already exist in a spreadsheet format. Users should ensure that the data headers and values match the Veta requirements. The simplest way to achieve this is to copy a sample spot test in Veta to the clipboard and paste it into an excel spreadsheet as follows:

Step 1. Use the green button to add a spot test in Veta, as shown in Figure 79. Note that the date is automatically populated.

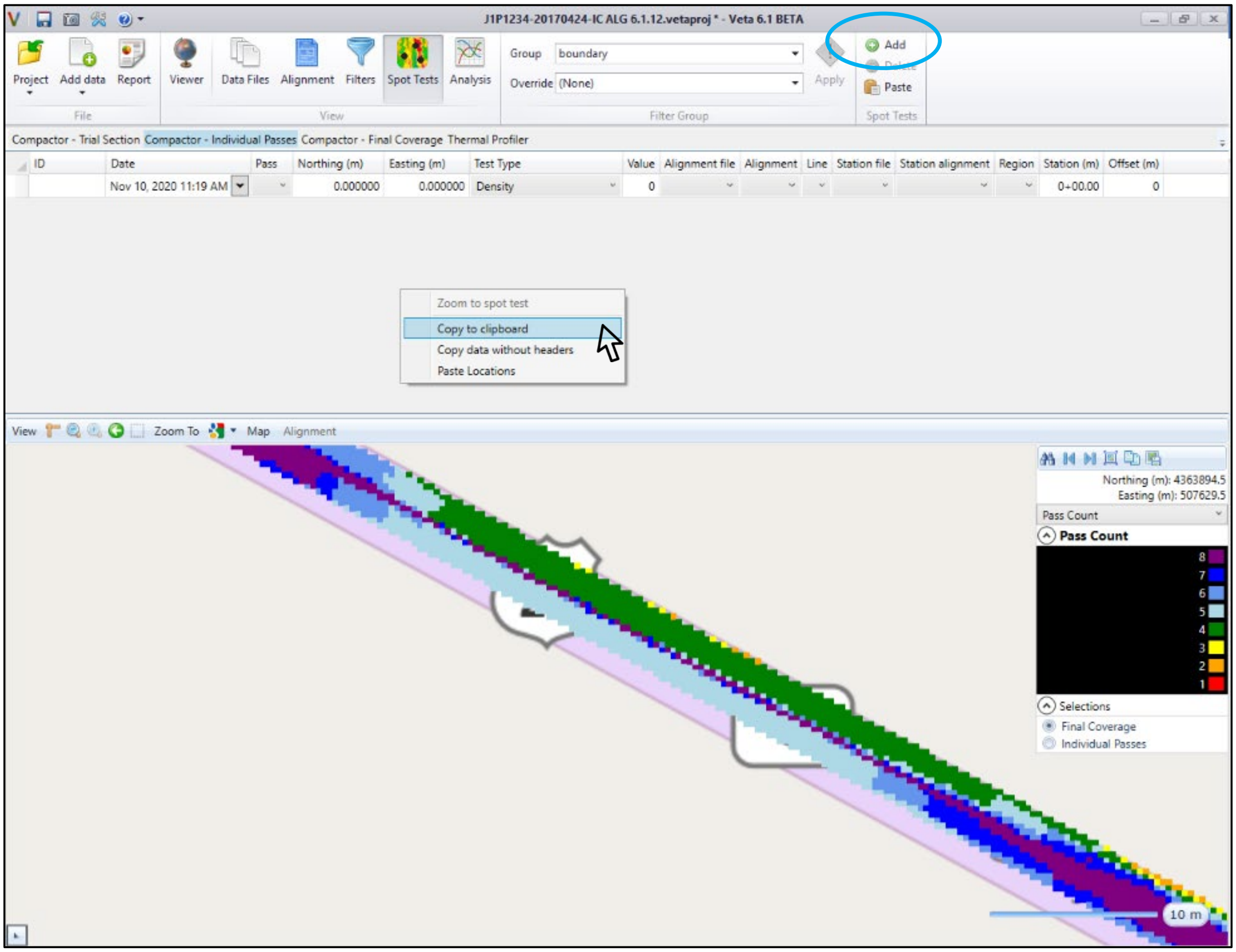
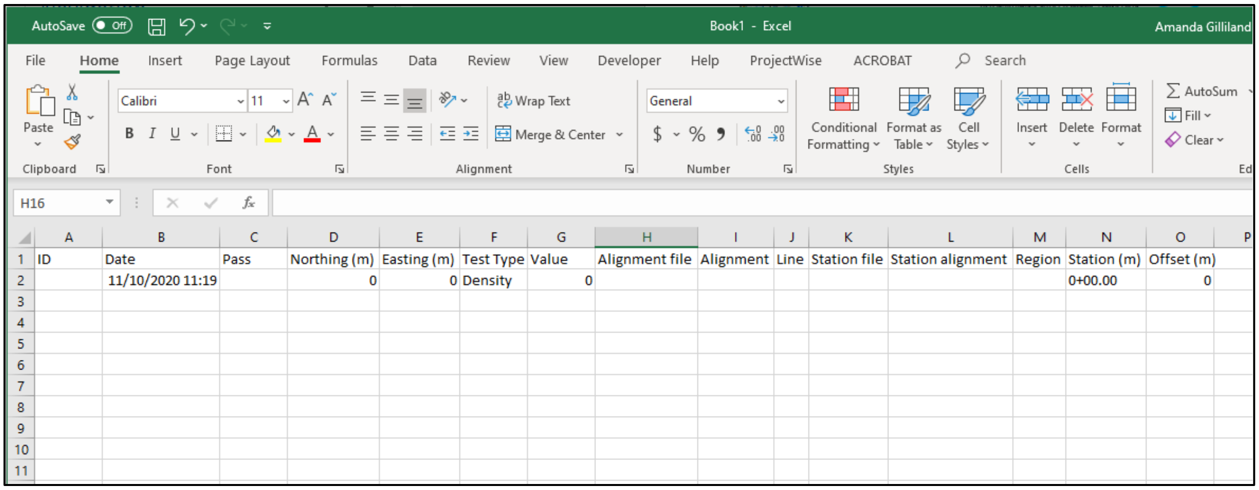


Figure 79. Adding a spot test manually using the add button and copying the data to the clipboard.

Step 2. Copy the data to the clipboard by right-clicking inside the spot test box, as illustrated in Figure 79.

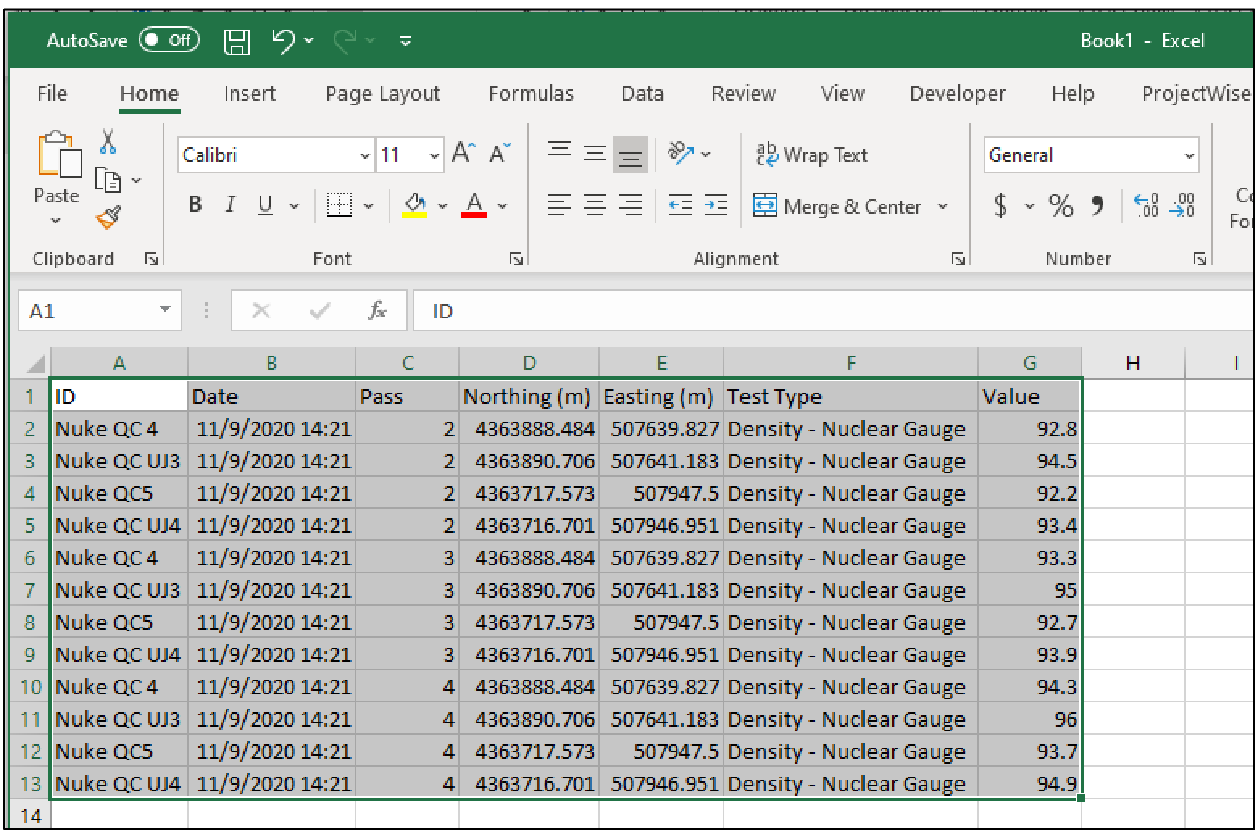
Step 3. Paste the data into an excel spreadsheet and populate the columns as illustrated in Figure 80.



ID	Date	Pass	Northing (m)	Easting (m)	Test Type	Value	Alignment file	Alignment	Line	Station file	Station alignment	Region	Station (m)	Offset (m)
	11/10/2020 11:19		0	0	Density	0							0+00.00	0

Figure 80. Pasted data into an excel spreadsheet.

Step 4. Populate the excel spreadsheet using spot test data as shown in Figure 81. Note that unused columns may be deleted.



ID	Date	Pass	Northing (m)	Easting (m)	Test Type	Value
Nuke QC 4	11/9/2020 14:21	2	4363888.484	507639.827	Density - Nuclear Gauge	92.8
Nuke QC UJ3	11/9/2020 14:21	2	4363890.706	507641.183	Density - Nuclear Gauge	94.5
Nuke QC5	11/9/2020 14:21	2	4363717.573	507947.5	Density - Nuclear Gauge	92.2
Nuke QC UJ4	11/9/2020 14:21	2	4363716.701	507946.951	Density - Nuclear Gauge	93.4
Nuke QC 4	11/9/2020 14:21	3	4363888.484	507639.827	Density - Nuclear Gauge	93.3
Nuke QC UJ3	11/9/2020 14:21	3	4363890.706	507641.183	Density - Nuclear Gauge	95
Nuke QC5	11/9/2020 14:21	3	4363717.573	507947.5	Density - Nuclear Gauge	92.7
Nuke QC UJ4	11/9/2020 14:21	3	4363716.701	507946.951	Density - Nuclear Gauge	93.9
Nuke QC 4	11/9/2020 14:21	4	4363888.484	507639.827	Density - Nuclear Gauge	94.3
Nuke QC UJ3	11/9/2020 14:21	4	4363890.706	507641.183	Density - Nuclear Gauge	96
Nuke QC5	11/9/2020 14:21	4	4363717.573	507947.5	Density - Nuclear Gauge	93.7
Nuke QC UJ4	11/9/2020 14:21	4	4363716.701	507946.951	Density - Nuclear Gauge	94.9

Figure 81. Populated data with extra columns removed.

Step 5. Paste the data back into Veta using copy and paste functions. Make sure data headers are included in the selection. Note that the "Pass" column only applies to individual or trial section data.

Customizing Spot Test Types

Spot tests can be customized to match user-specific needs. Users can set default or project-specific customizations as described in the following sections.

Spot Test Defaults

Spot test defaults can be set under ***Options*** (wrench and hammer icon). Veta automatically includes two defaults (USCS and SI). Customizations can be made to the Veta defaults, or new spot test defaults can be added using the green plus sign. Default legends and values can be set according to project specifications or quality control standards. For example, in Figure 82, the default spot test legend will color core density spot tests green if they are ≥95% relative density, orange if they are between 92-95%, red if they are between 90-92%, and dark red if they are less than 90. The legends set here are saved to Veta and can be pulled into projects for spot test viewing, as described in the following section. Users can add and delete legend rows by right-clicking inside the "Legend" box. Default spot test types may also be exported to a file using the "export" button.

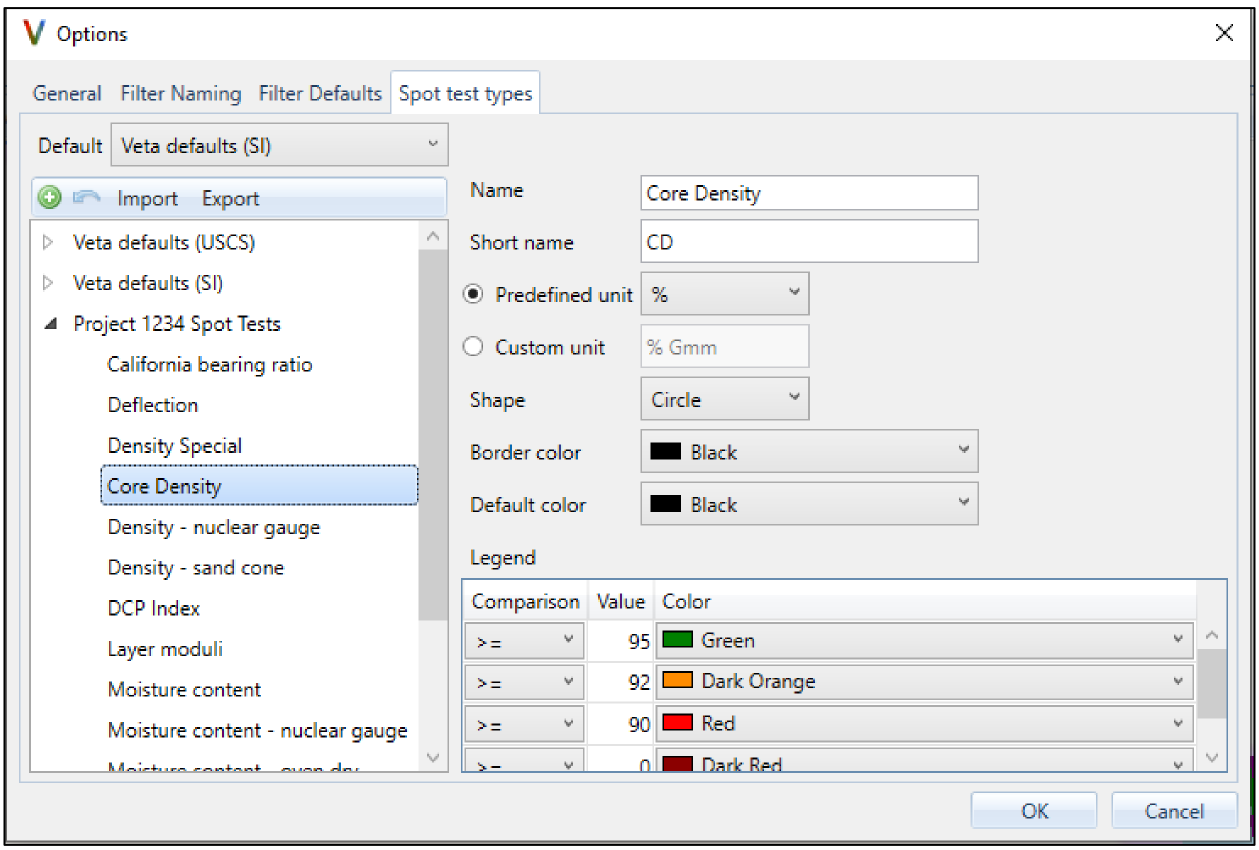


Figure 82. Default spot test types can be customized under "options."

Project Customizations

Spot tests can be customized to match user-specific needs. Users can import default spot tests that have already been created in Veta (as shown in Figure 82) and make project-specific customizations. Project spot tests are set by selecting ***Properties*** under the ***Project*** menu. The spot test types screen is shown in Figure 83. Users can Import spot test legends from the default legends (as described in the previous section) or import them from a file. They are selecting ***Import from this device*** lists all default spot test criteria. Users can make project-specific changes to the default criteria after importing them here.

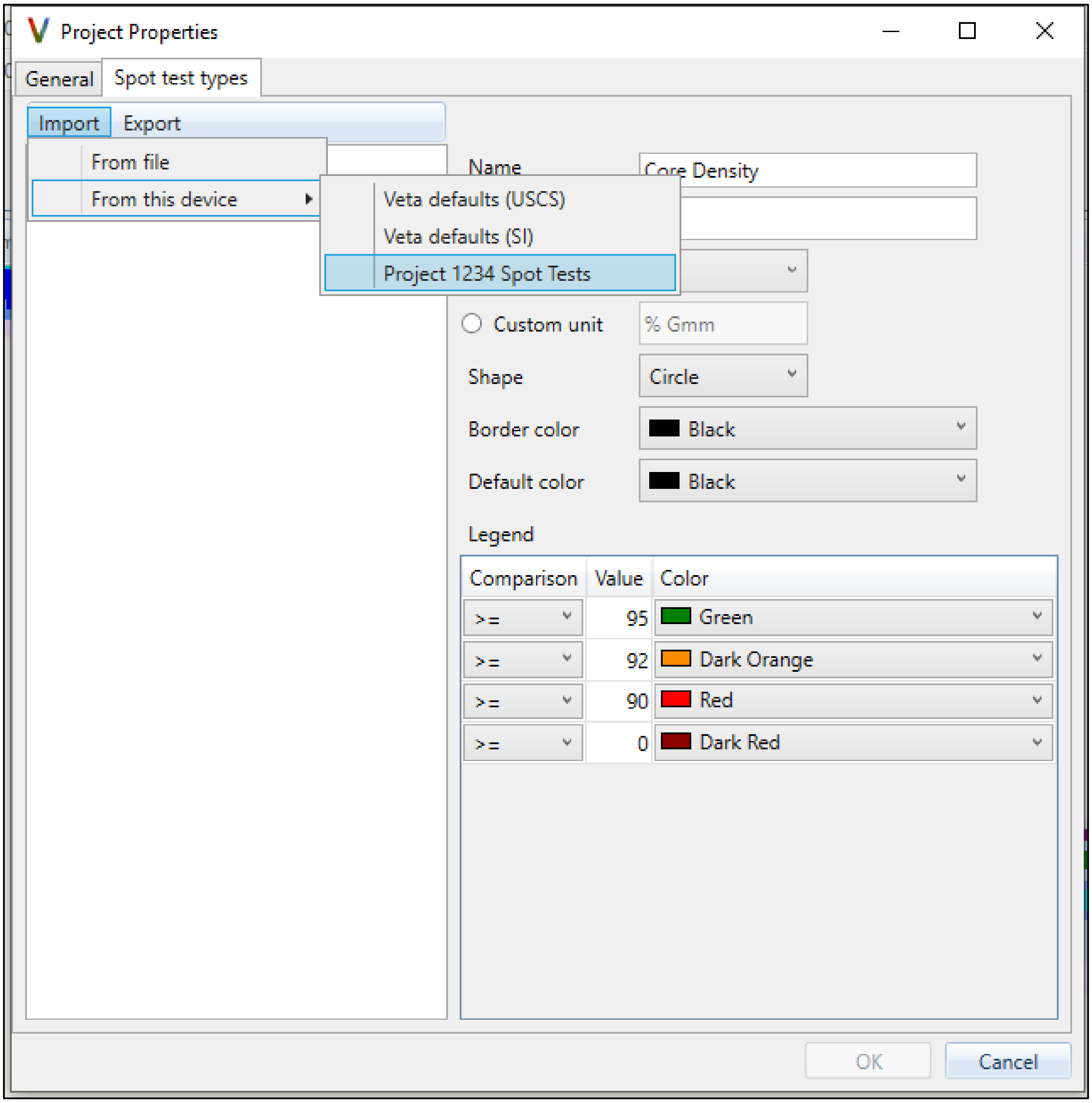


Figure 83. Spot tests can be assigned to the project under Project → Properties.

The example legend shown in Figure 82 is mapped on the ***Spot Tests*** screen in Figure 84. Note that the dark red circle indicates a density of 89%. This core density falls outside the customized legend and is easily flagged for troubleshooting. Users can toggle between data types to troubleshoot the low-density core (note that the values in Figure 84 are fictitious to demonstrate different legend values and do not reflect actual data).

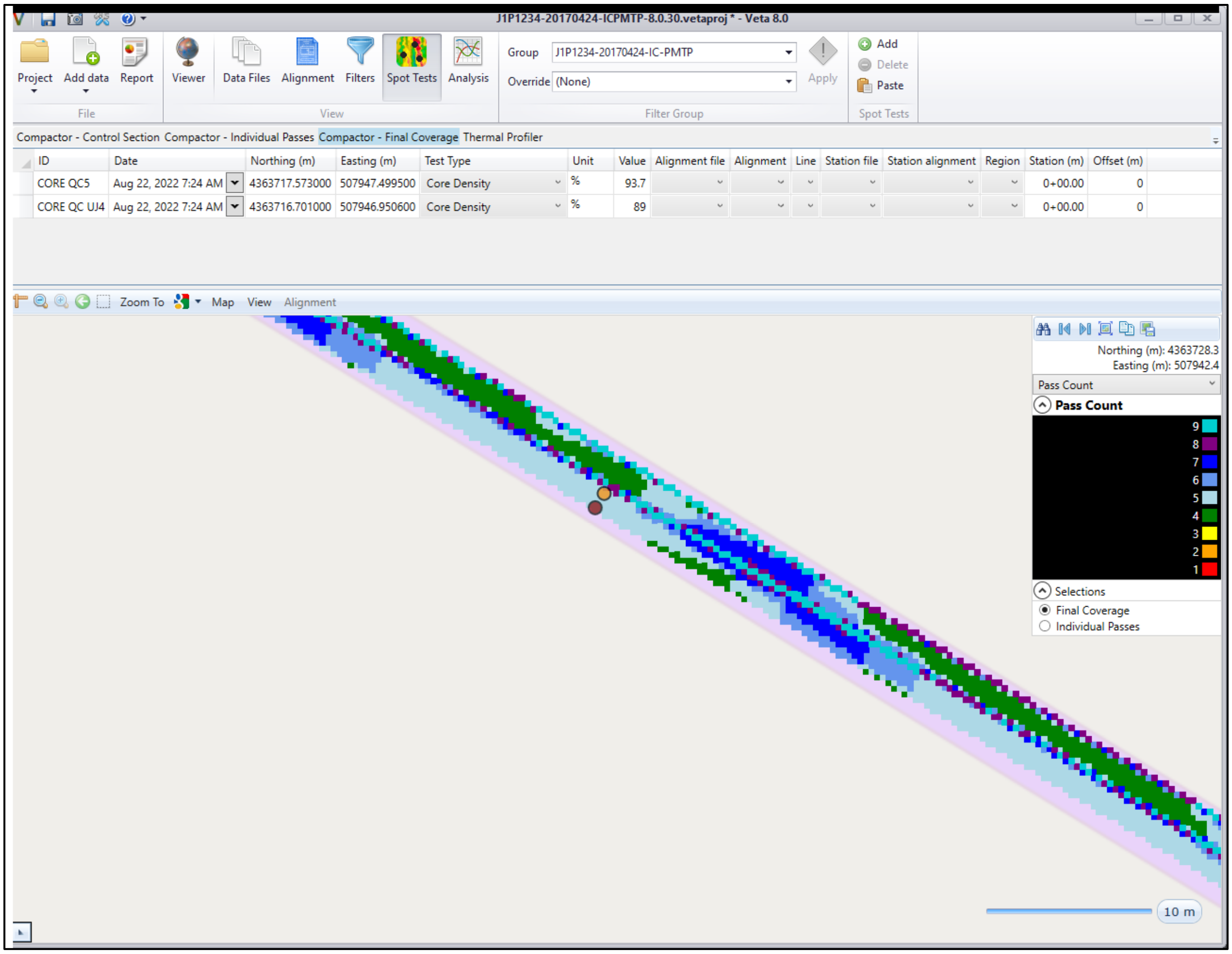
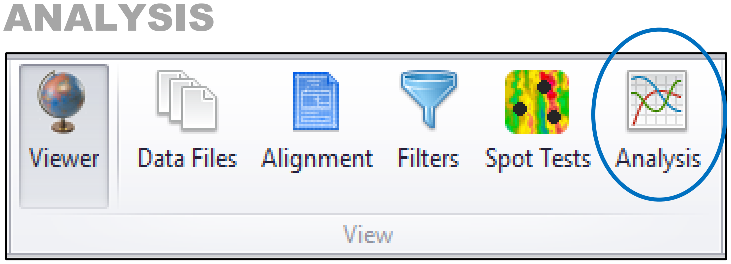


Figure 84. Fictitious cores using a customized legend.

ANALYSIS



The analysis screen is used to customize analysis options. General setup and individual options for Compactor, Thermal Profiler, and Dielectric Profiler data are summarized in the following sections.

Filter Review

The filter review section is used as a quality check to ensure that projects are filtered according to MnDOT protocols. More information on the MnDOT protocols can be found on the MnDOT materials website. The filter review tab makes the following checks:

- A filter group exists.
- Filter values match the defaults defined in Veta's Options.
- One operation filter per group.
- Operation filter name matches group name.
- Only one data lot was selected.
- Data lot name matches group name.
- The time filter matches the date in the group name.
- Only one time filter exists.
- Location filter start and stop offsets match group names.
- Checks if there are multiple exclusions.
- Checks if a custom operation filter exists.
- Location and exclusion source settings match each other.

The user populates the top box with the known location filter and exclusion extents, then presses the review button. Veta will compare the project filters with the data entered in the top box and the criteria above.

General Setup

Click on **Setup** in the left control bar to select the machine categories to analyze, as illustrated in Figure 85. The setup tab is also used to configure filter groups, as described in the following section.

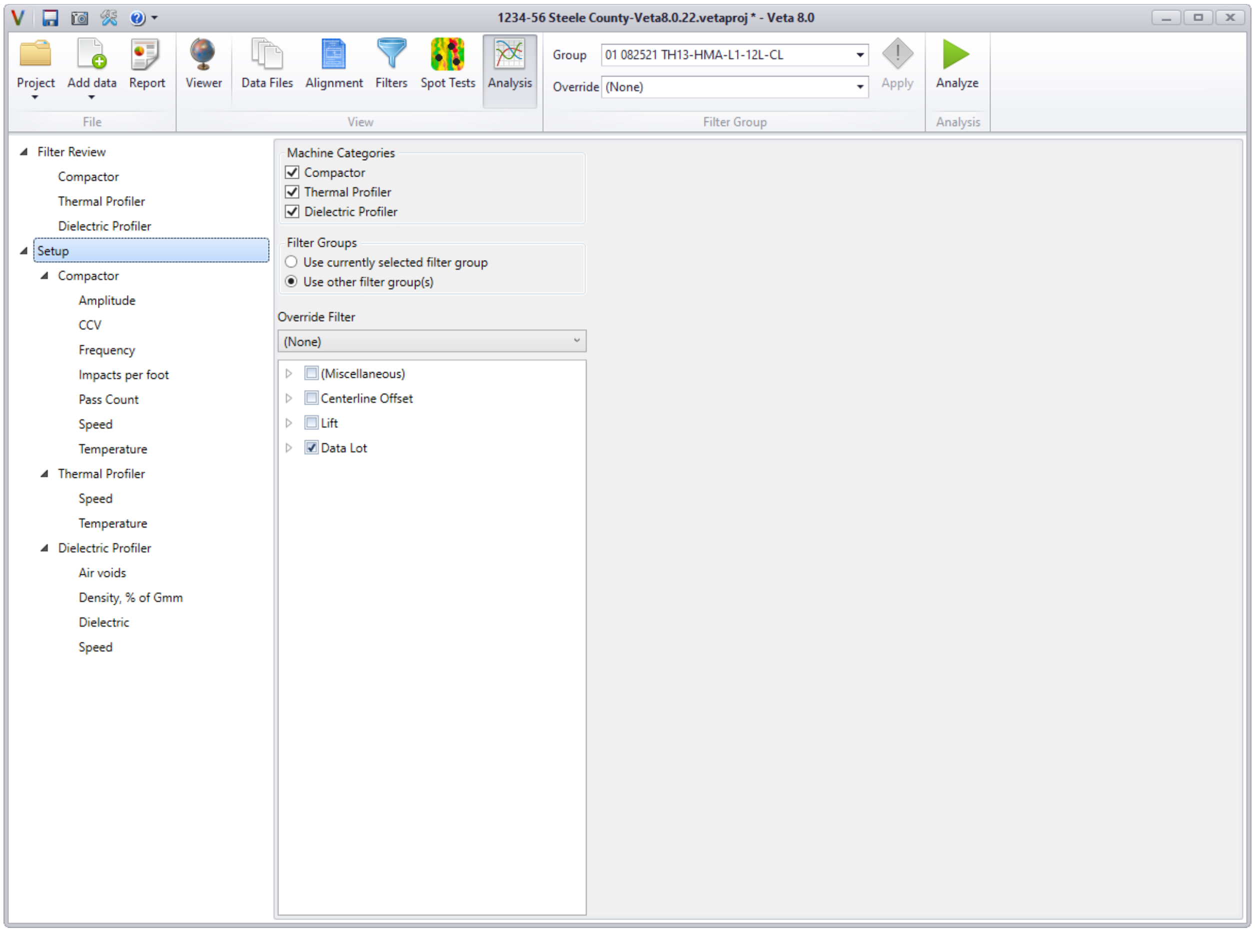


Figure 85. Analysis set up screen. Navigate the analysis options in the left control bar.

Filter Groups

Users may **use the currently selected filter group by** selecting the button. Alternatively, users may select to **use other filter groups.**

Selecting **use other filter groups** allows users to perform one of the following:

- Select an override filter.
- Select multiple filter groups to run simultaneously.

The difference between these two analysis options is that the override filter will use the parameters in the selected filter group and add the override filter parameters, producing one set of analysis results. Selecting multiple filter groups produces multiple separate analysis results.

For example, the following figures show analysis results using a currently selected filter group, then an override filter as described in chapter **Filters**. Figure 86 shows the sublot temperature results using a standard filter group. The temperatures represent final coverage. Figure 87 illustrates applying an override filter in the setup screen. This override filter has a pass count data filter that only includes the first breakdown pass. Figure 88 shows the sublot temperature results using the override filter. Note the difference in temperatures between final coverage and pass one data.

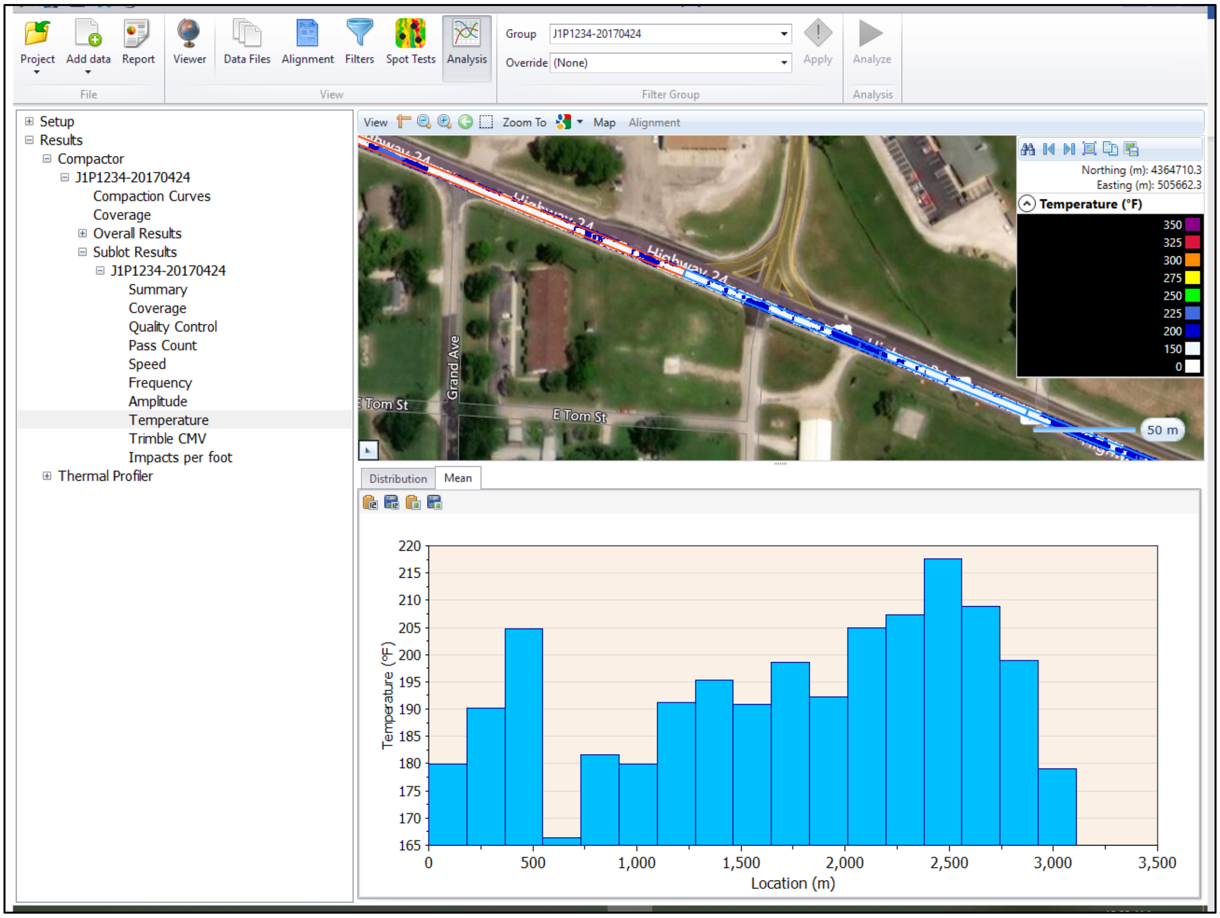


Figure 86. Sublot temperature analysis using standard filter group. Data represents final coverage.

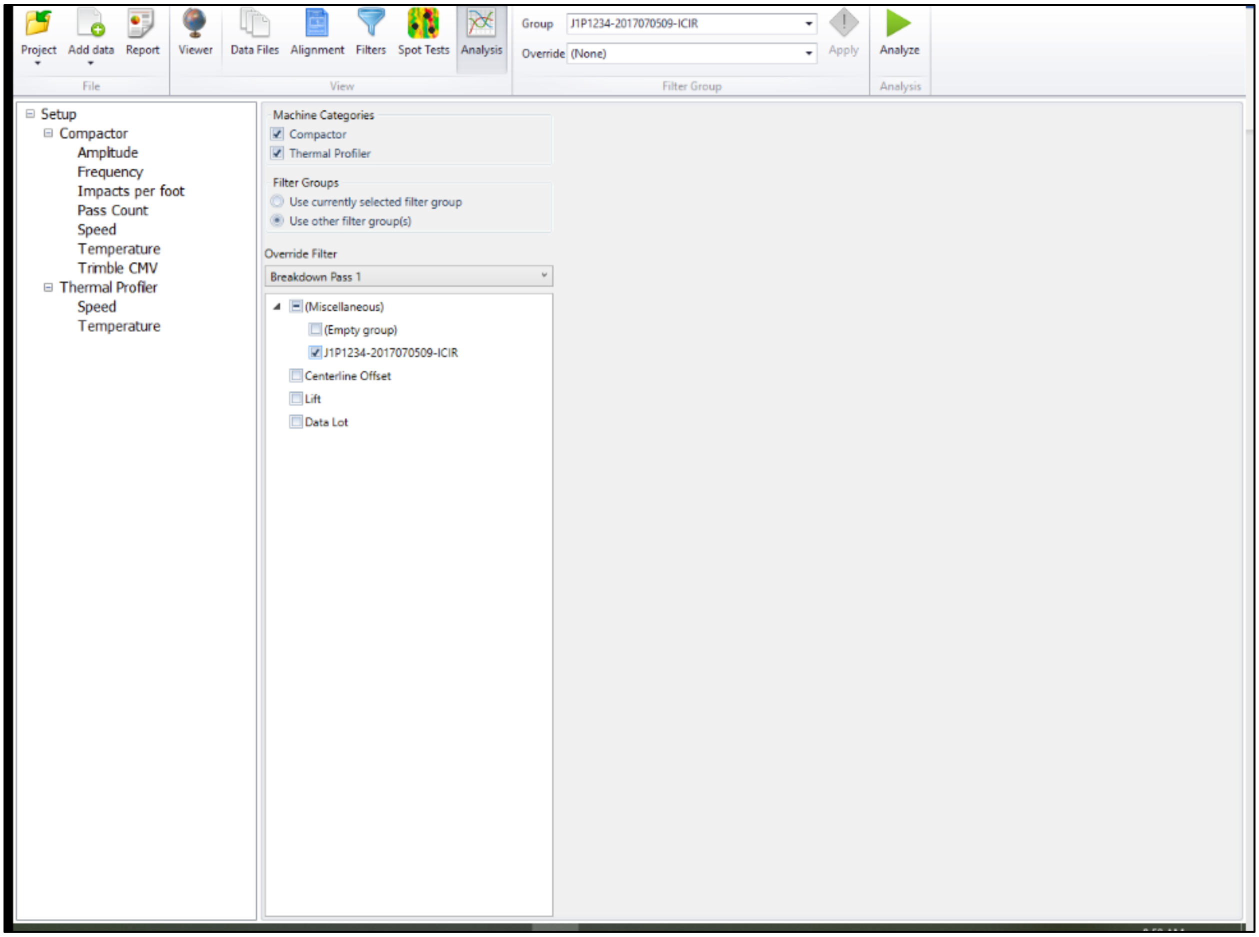


Figure 87. Applying an override filter to the standard filter group.

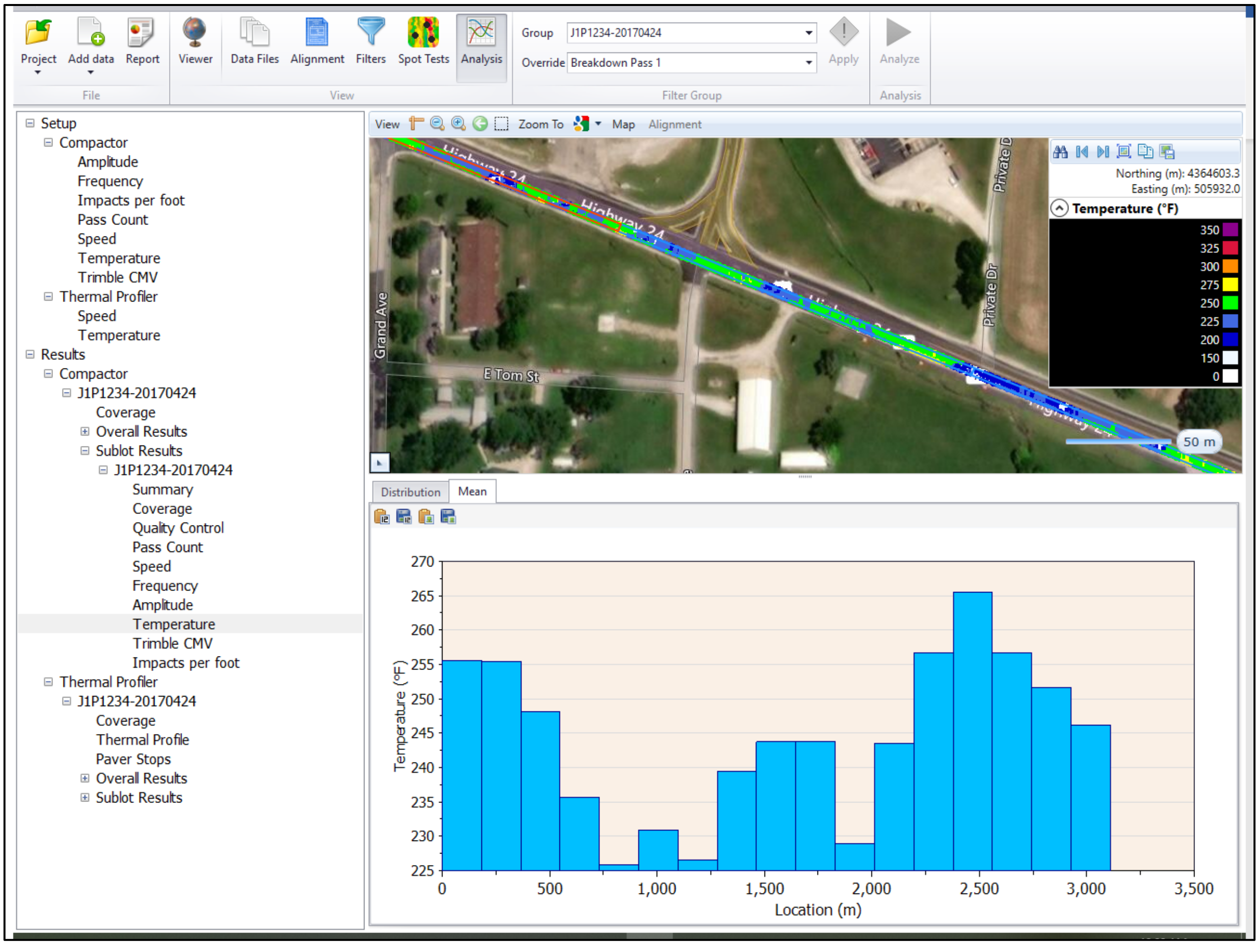


Figure 88. Sublot temperature analysis using override filter. Data represents pass one data.

As an alternative to using an override filter, users may elect to set up two different filter groups to achieve similar results. For example, the results shown in Figure 86 through Figure 88 can be replicated using two filter groups. Each filter group contains the same location filters and other standard filters. However, the second filter group contains a data filter that only selects the first pass for analysis. Creating a second filter group with the same standard filters is easily performed by copying and pasting existing filter groups described in chapter **Filters**. Setting up analysis using multiple filter groups is illustrated in Figure 89. Note that no override is selected. Running multiple filter groups will produce multiple results, as shown in Figure 90.

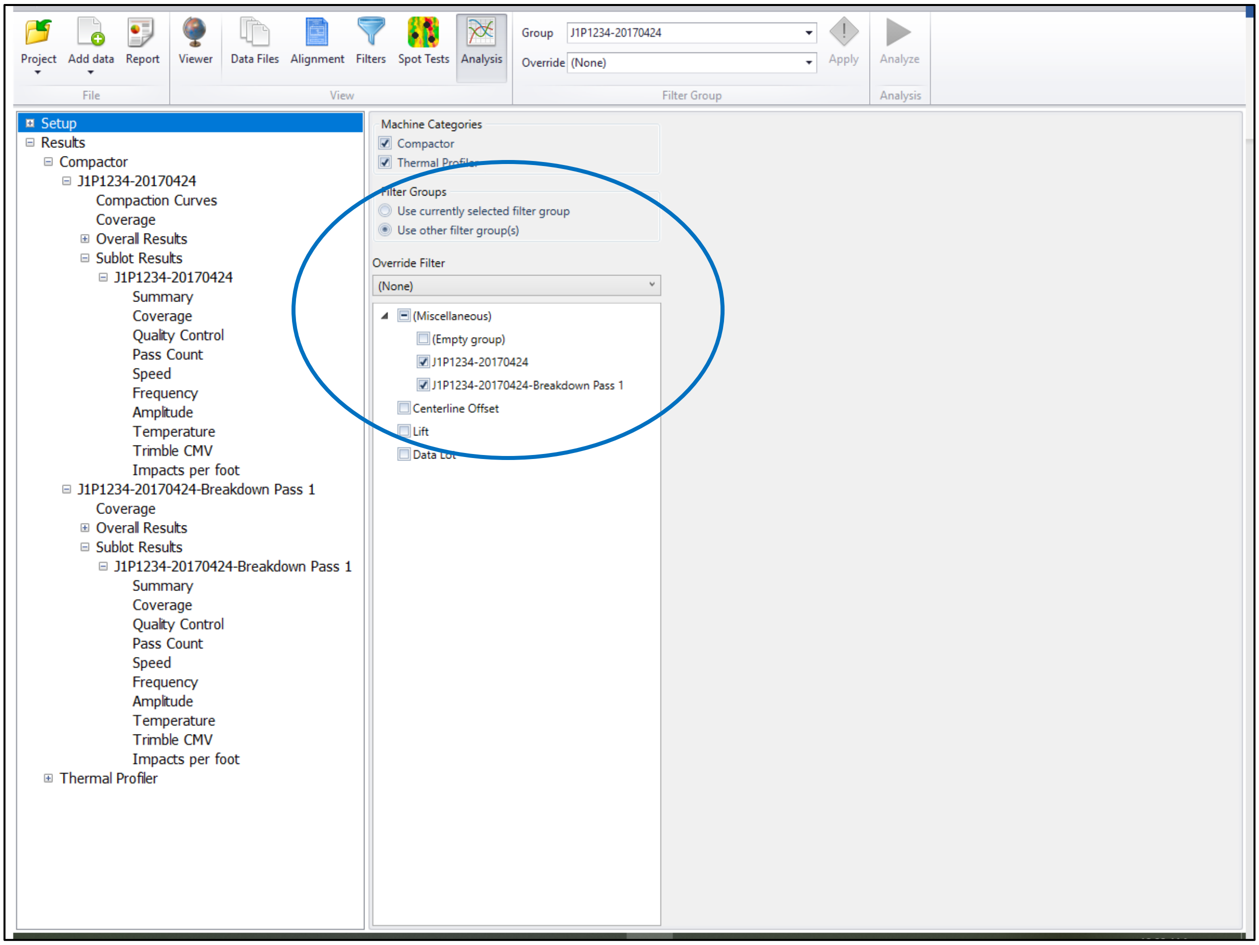


Figure 89. Setting up analysis with multiple filter groups.

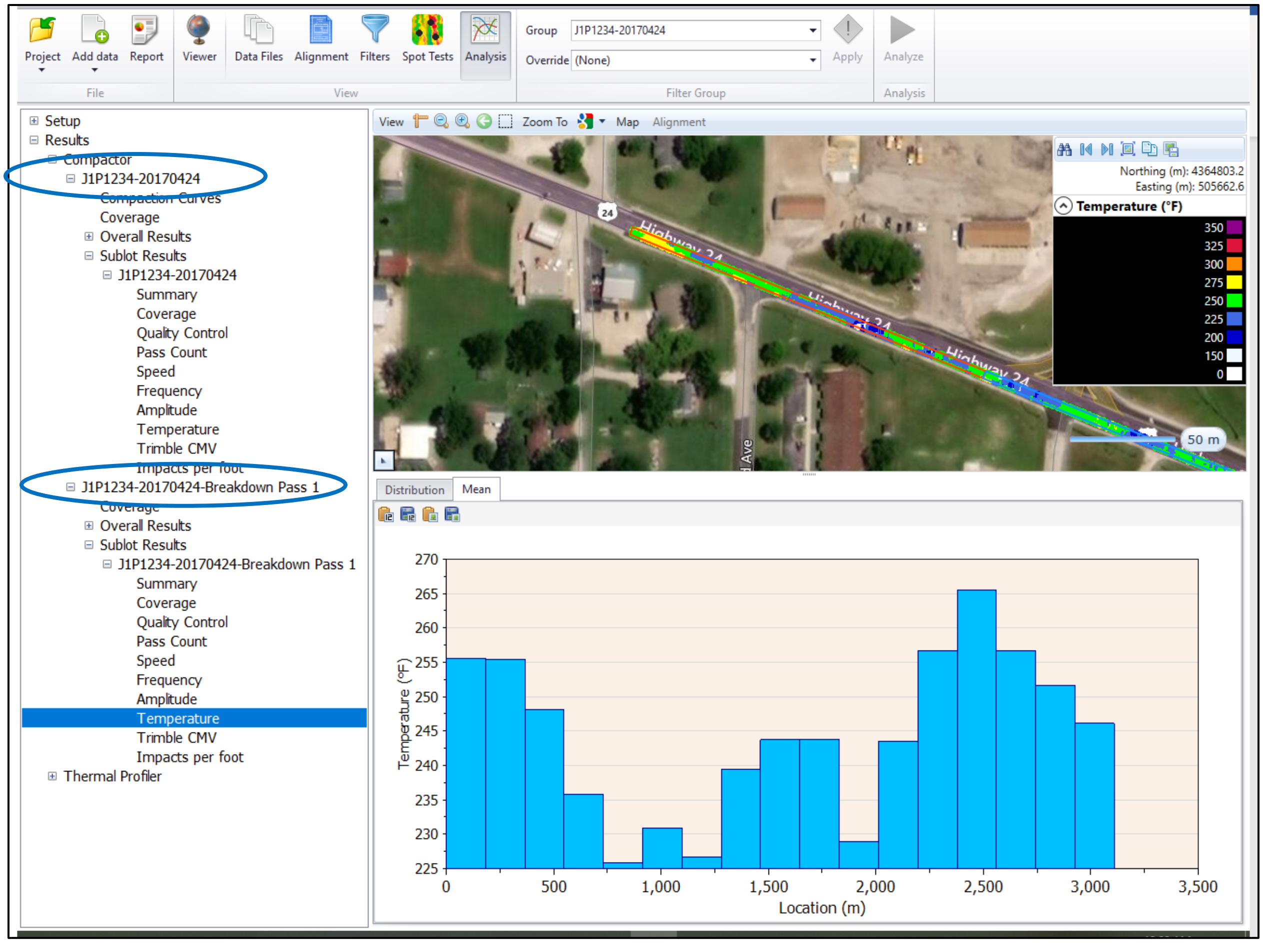


Figure 90. Analysis results using multiple filter groups.

Compactor Setup

The compactor analysis setup can be customized by selecting **Compactor** in the left control bar on the analysis screen. The compactor analysis options are shown in Figure 91 and described in the following sections.

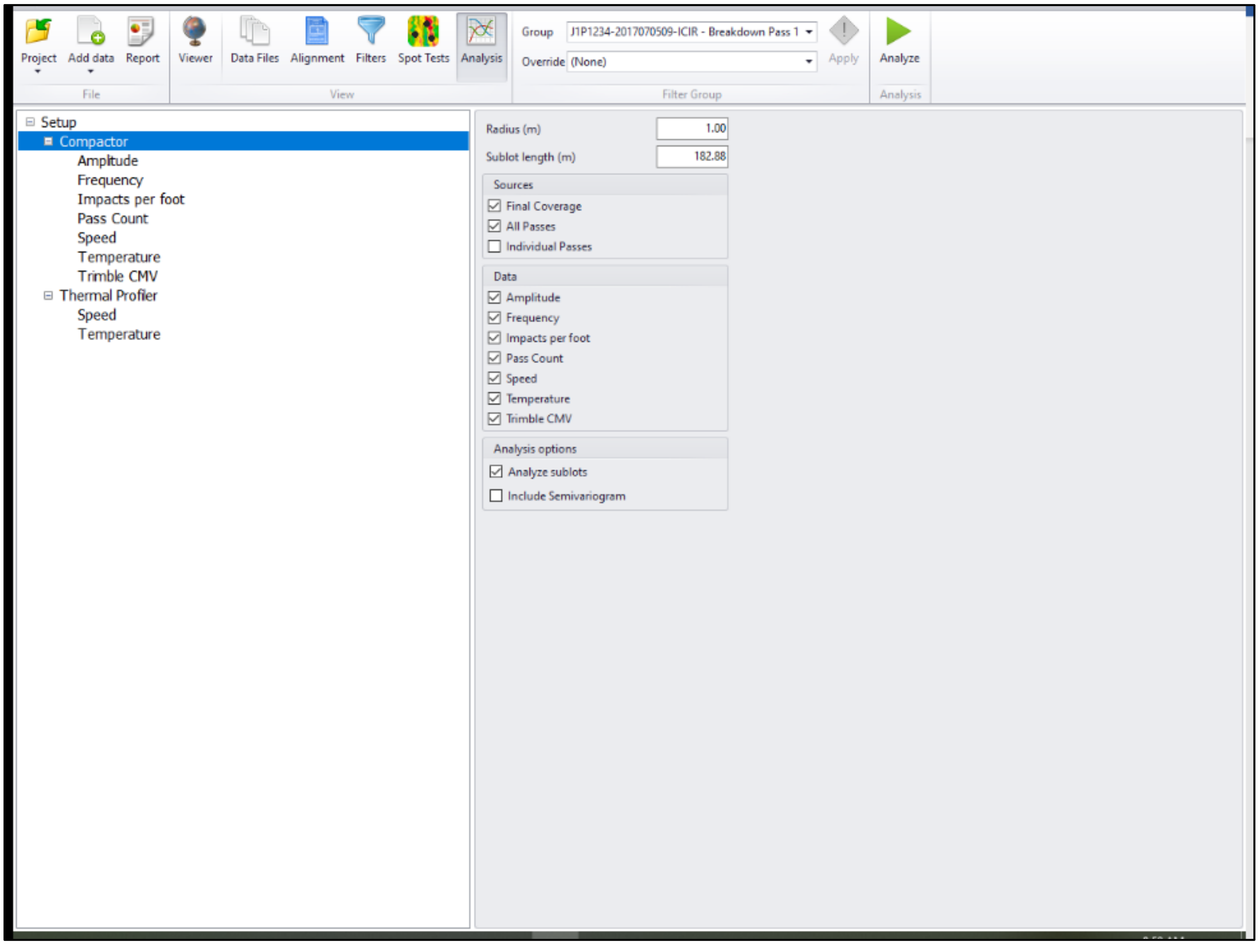


Figure 91. Compactor setup screen.

Radius

Radius refers to the data around a spot test that will be included in the correlation analysis. For example, Figure 91 shows that the data within a 1 meter (3.28 feet) radius of each spot test will be included for correlation.

Sublot Length

The sublot length can be modified to meet individual needs. Users should consult their specifications for sublot length requirements. Figure 91 shows a compactor sublot length of 182.88 meters (600 feet).

Sources

Users may analyze final coverage, all-passes, or individual passes for compactor data. Users can select the different sources by checking or unchecking the boxes next to the options. At least one source must be selected to perform the analysis.

Analysis Options

Users may toggle the options to analyze sublots on or off under the **analysis options.** Users may select to **include semivariogram** to perform a semivariogram analysis, as further described in the **Results** section.

Data

Users may select the different data parameters to analyze by checking or unchecking the boxes next to the **data** options. Each selected data metric can be further analyzed using the following options. At least one data type must be selected to perform the analysis.

Cumulative Specification

Cumulative specifications can be applied to each data metric selected for analysis and are for final coverage data only. Figure 92 shows an example of a cumulative specification for ICMV where 75% of the (final coverage) data should be greater than or equal to 25. More information on selecting target ICMV values can be found in supplemental documents at https://www.intelligentconstruction.com/.

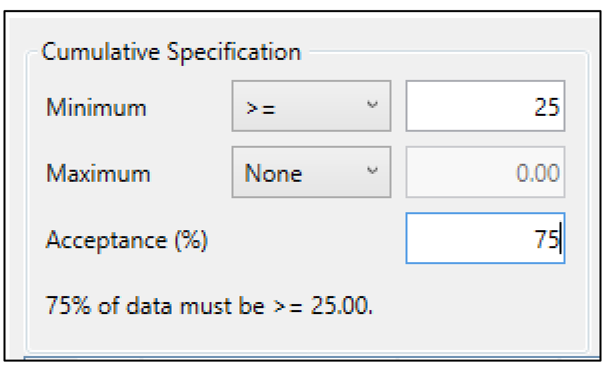


Figure 92. Cumulative specification for ICMV.

Quality Control Thresholds

Quality control thresholds can be applied to the following compactor settings:

- ICMV
- Impact per foot
- Speed
- Temperature

Quality control analysis is further described in the **Results** section.

Individual Pass Specification

Individual pass specifications can be applied to the following compactor settings for selected passes:

- ICMV
- Temperature

An example of using the individual temperature specification is illustrated in Figure 93. This example shows that 75% of the pass 1 (initial breakdown) temperatures should be above 250 degrees, and 75% of the pass 6 data (target/optimum pass) should be above 180 degrees. The individual specification analysis is only performed if **individual passes** are selected under the **compactor setup**. The results of this analysis are further described in the **Results** section.

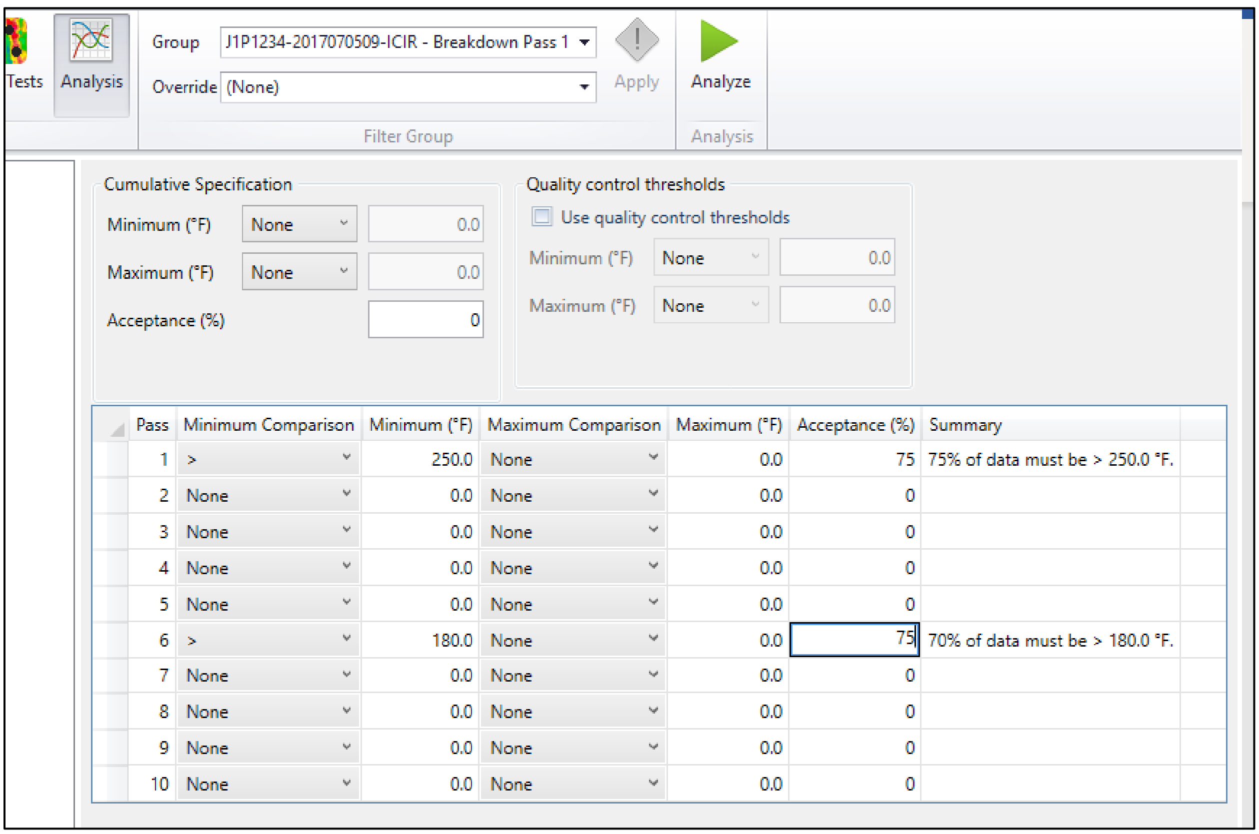


Figure 93. The individual specification for compactor temperature analysis.

Thermal Profiler Setup

The thermal profiler setup screen is shown in Figure 94. The analysis options for thermal profilers are generally the same as those for compactors described in the previous section. Note that thermal profiler data is simpler than compactor data because there is no need to consider the different data sources (final coverage, all-passes, and individual passes). There is only one data source for thermal profiler data. Thermal profiler data and compactor data typically have different sublot length requirements, which are easily accommodated on separate setup screens. Users may remove paver stops from analysis, as described in the following section.

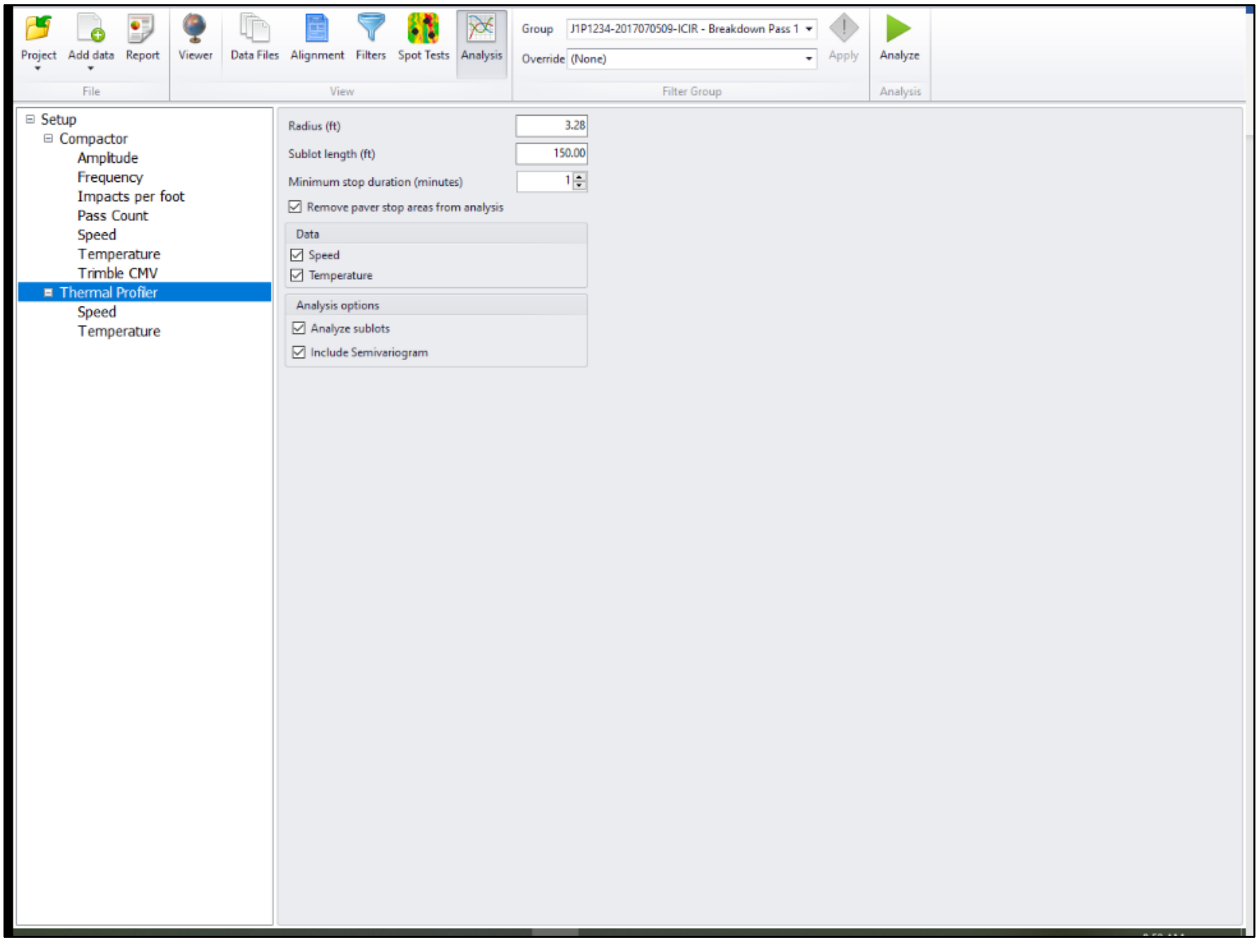


Figure 94. Thermal profiler setup screen.

Radius

Radius refers to the data around a spot test that will be included in the correlation analysis. For example, Figure 91 shows that the data within a 1 meter (3.28 feet) radius of each spot test will be included for correlation.

Sublot Length

The sublot length can be modified to meet individual needs. Users should consult their specifications for sublot length requirements. A thermal profile data sublot length is typically 45.72 meters (150 feet).

Minimum Stop Duration

According to AASHTO R 110 Appendix X5, it is standard to remove paver stops more than 1 minute in duration, but this may vary by agency.

Remove Paver Stop Areas from Analysis

Paver stop areas can be removed from the analysis by selecting the box next to **Remove paver stop areas from analysis.** When this option is selected, surface temperature readings 2 feet before and 8 feet after paver stops (that meet the minimum stop duration specified) are removed.

Analysis Options

Users may toggle the options to analyze sublots on or off under the **analysis options.** Users may also select to **include a semivariogram** to perform a semivariogram analysis, as further described in the **Results** section.

Data

Users may analyze speed and temperature data. Users can select the different data by checking or unchecking the boxes next to the options. At least one data must be selected to perform the analysis.

Each selected data metric can be further analyzed using the following options. At least one data type must be selected to perform the analysis.

Cumulative Specification

Cumulative specifications can be applied to each data metric selected for speed and temperature data analysis. Users can set the minimum, maximum, and acceptance (%) based on their specifications.

Quality Control Thresholds

Users can select the Use quality control thresholds and set the minimum and maximum values for Quality Control analysis for speed and temperature data.

Coverage and Temperature Segregation Specifications

Additional specifications for thermal profilers include the coverage, differential range statistics (DRS), and thermal segregation index (TSI) specifications, which can be set up under the **Temperature** tab, as illustrated in Figure 95. When the TSI is selected, users must also select ***Include Semivariogram*** under **Thermal Profiler** setup (Figure 94).

These specification requirements will vary by the agencies. For more information on these specifications, reference AASHTO R 110 Standard Practice for Continuous Thermal Profile of Asphalt Mixture Construction.

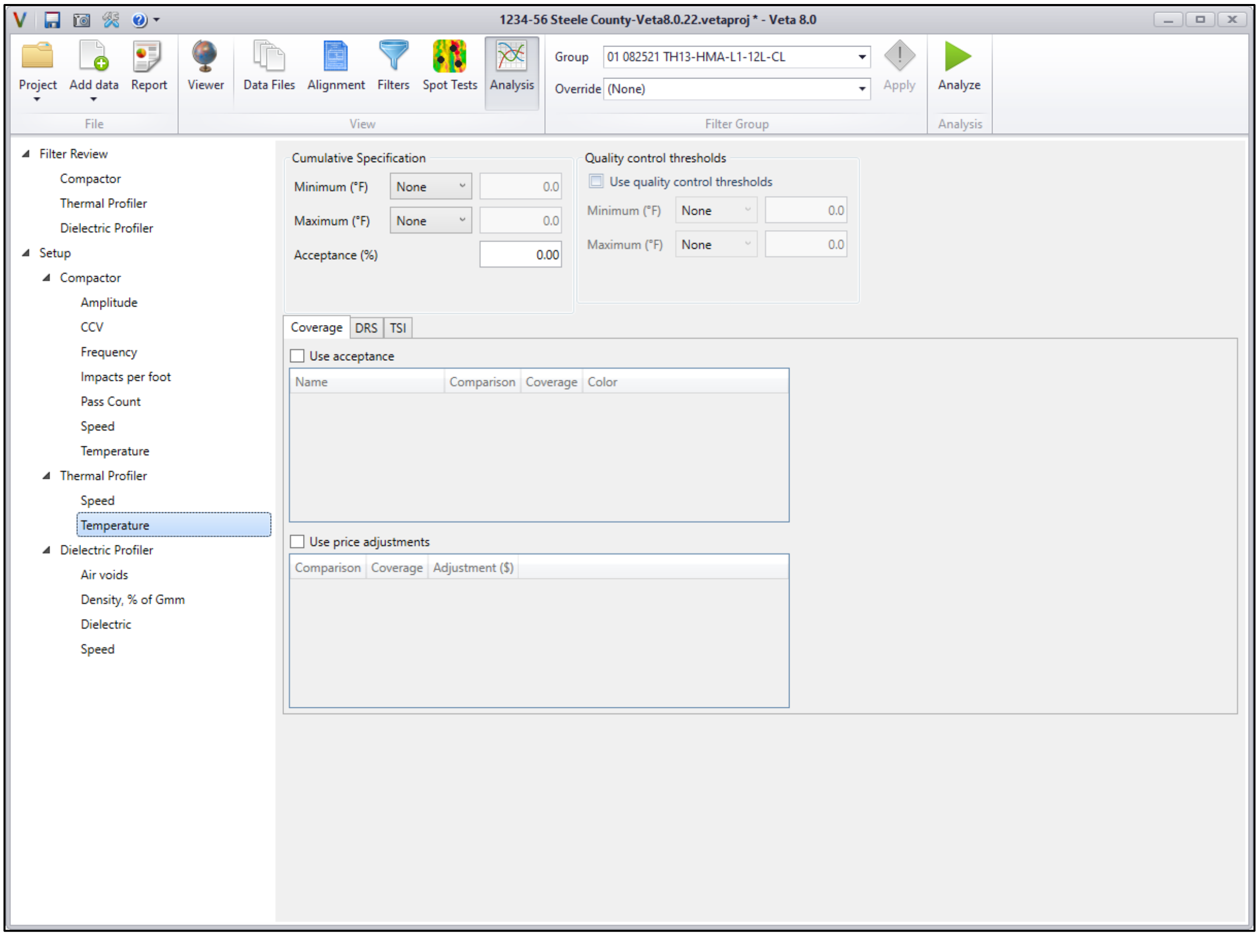


Figure 95. Thermal profiler temperature specification setup.

Acceptance criteria and price adjustments can be set for coverage, DRS, and TSI by selecting the boxes next to **Use acceptance** and **Use price adjustments**. Fields can be added and deleted by right-clicking inside the boxes. The criteria are fully customizable. Users can choose between a linear or step function for price adjustments (or a combination of both), as illustrated in Figure 96 and Figure 97, respectively.

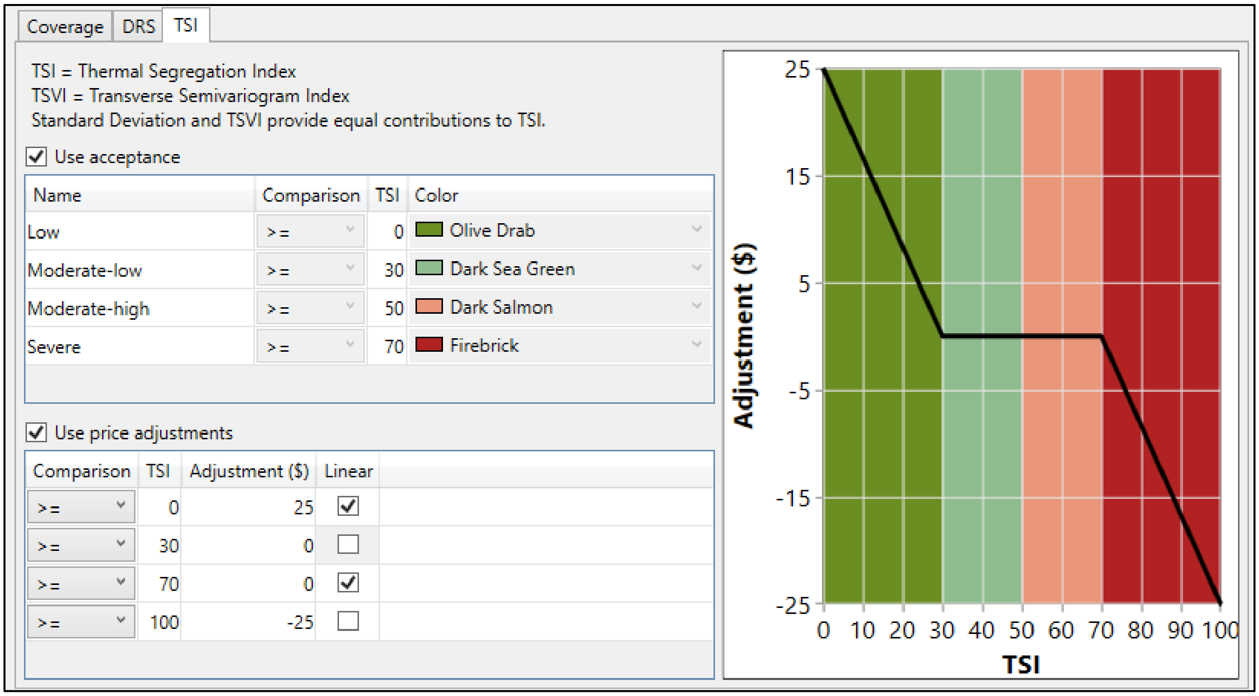


Figure 96. Example of a linear price adjustment using TSI thermal classification.

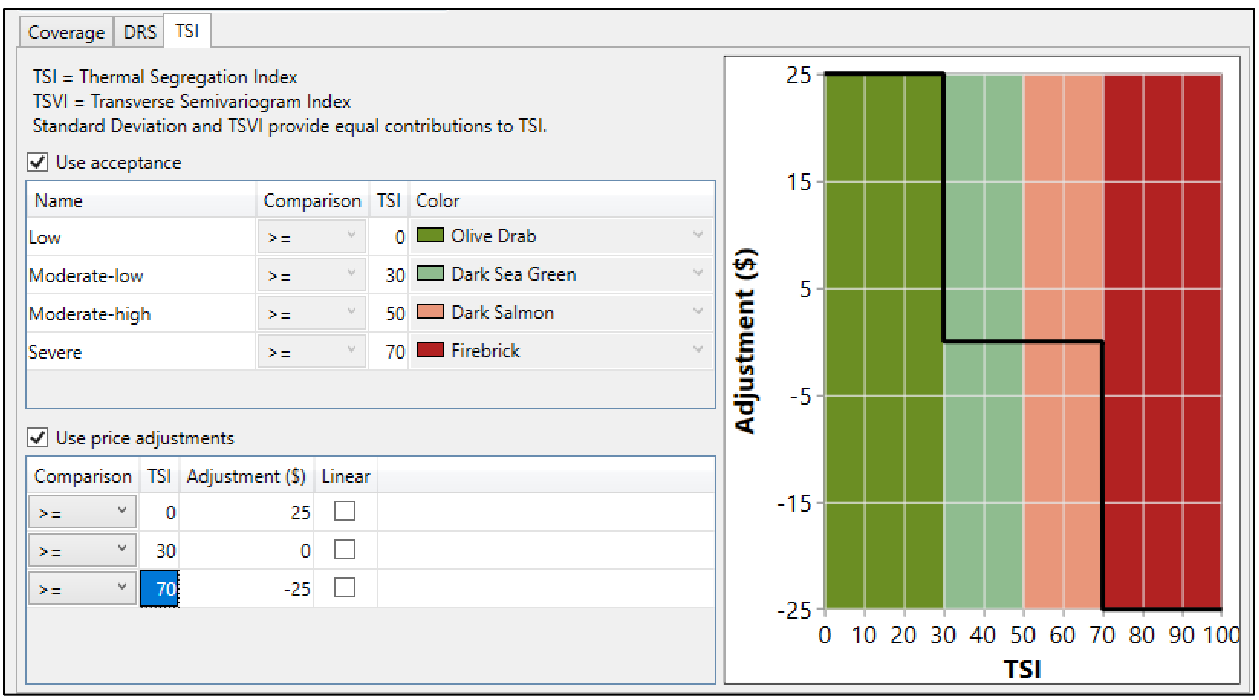


Figure 97. Example of step function price adjustment using TSI thermal classification.

Dielectric Profiler Setup

The dielectric profiler setup screen is shown in Figure 98. The analysis options are similar to those for compactors described in the previous section, except that there is no semi-variogram analysis for DPS.

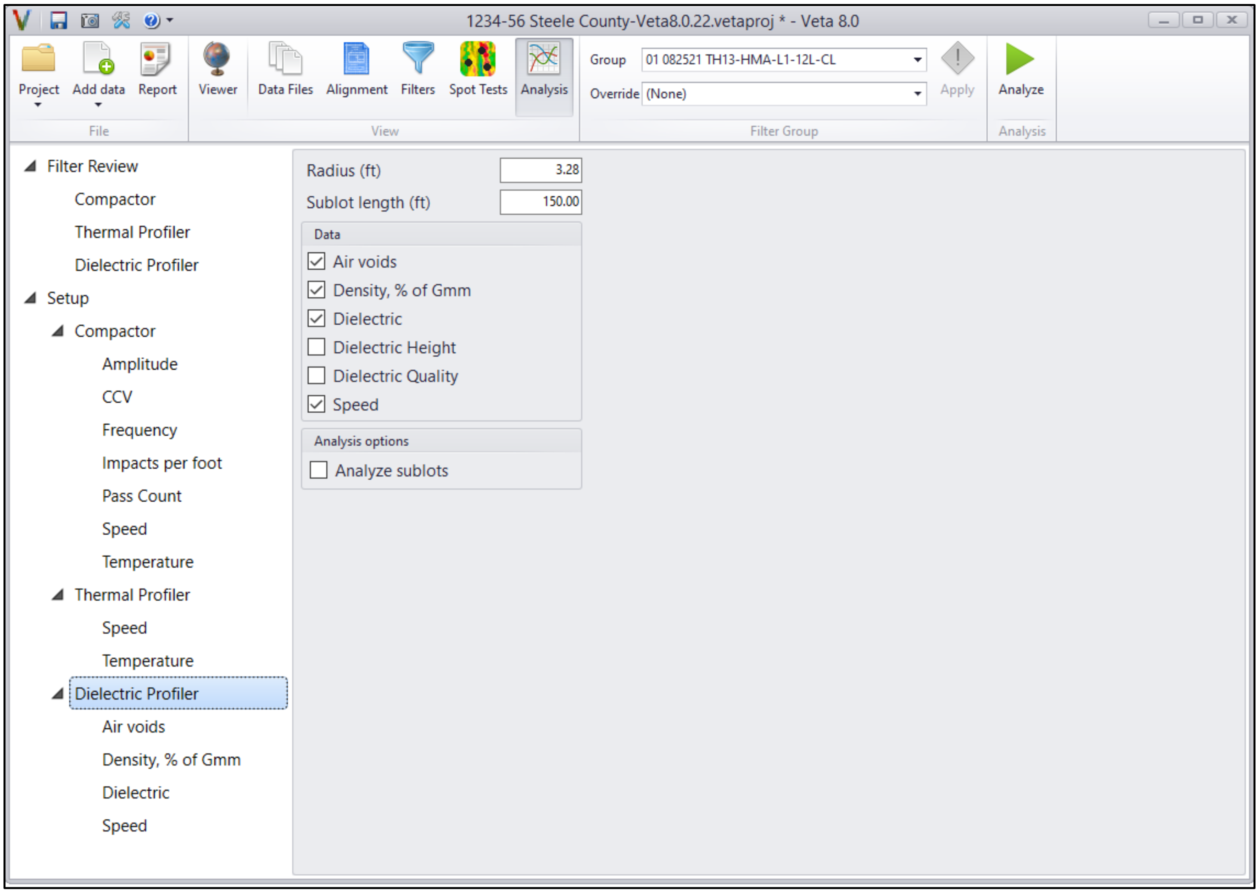


Figure 98. Dielectric profiler setup screen.

Radius

Radius refers to the data around a spot test that will be included in the correlation analysis. For example, Figure 91 shows that the data within a 1 meter (3.28 feet) radius of each spot test will be included for correlation.

Sublot Length

The sublot length can be modified to meet individual needs. Users should consult their specifications for sublot length requirements. A dielectric profile data sublot length is typically 45.72 meters (150 feet).

Analysis Options

Users may toggle the options to analyze sublots on or off under the **analysis options.**

Data

Users may analyze any dielectric data. Users can select the different data by checking or unchecking the boxes next to the options. At least one data must be selected to perform the analysis.

Each selected data metric can be further analyzed using the following options. At least one data type must be selected to perform the analysis.

Cumulative Specification

Cumulative specifications can be set for any dielectric data, including density and air voids, if the calibration has been entered and applied. The minimum, maximum, and acceptance (%) can be set to match the user's specifications.

Results

After the parameters have been set up according to user specifications, push the green analyze button to perform the analysis/analyses. The results will appear in the left control bar under the setup options. The following sections describe the analysis results.

The results can be viewed by clicking each result item from the left control panel. Some results may need to be expanded to be visible by clicking the plus sign icon, as illustrated in Figure 99.

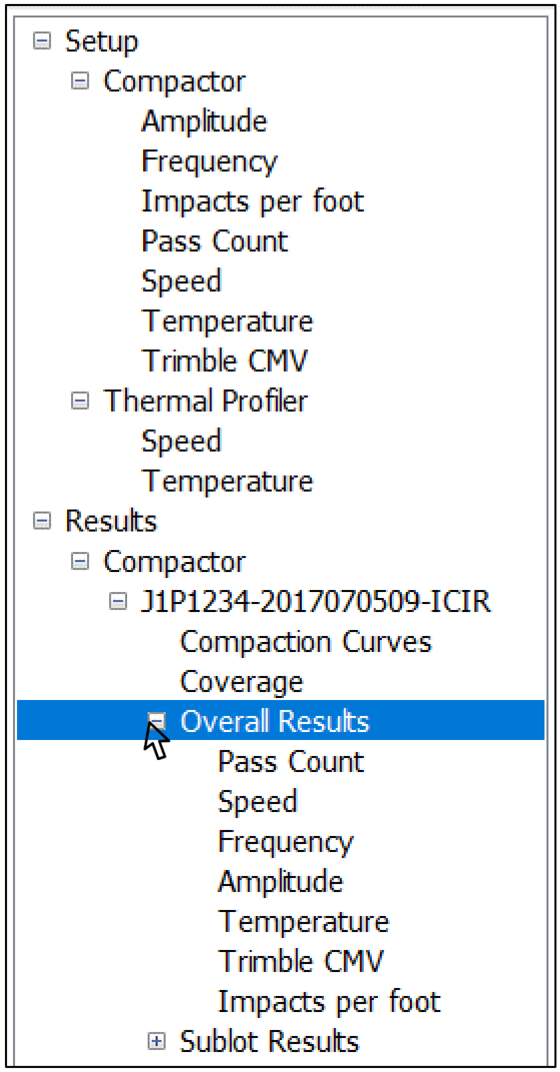


Figure 99. Expanding the overall results.

Compactor

The following sections describe the analysis results for compactors.

Data Lot

The data lot results show the mean data lot (as defined in AASHTO PP 114) temperatures and pass counts for all data lots in the project. The data lot results are activated by checking the box next to ***Data Lot***, as illustrated in Figure 100. The compactor data lot results are illustrated in Figure 101.

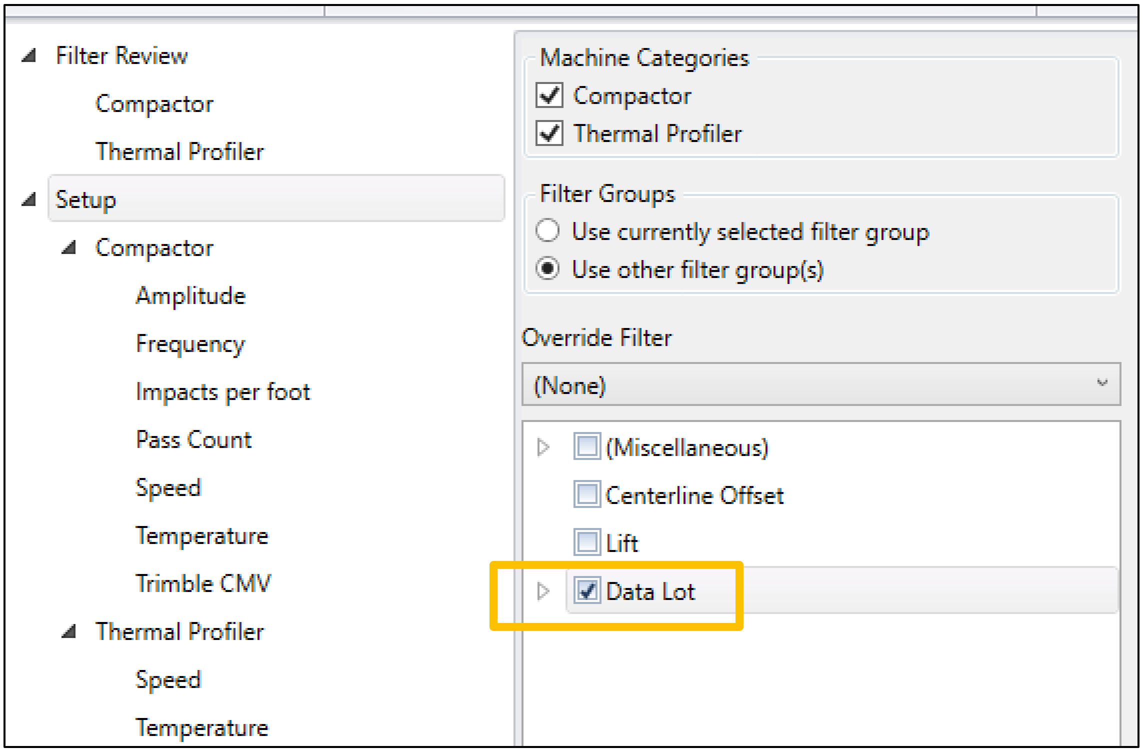


Figure 100. Data Lot analysis setup.

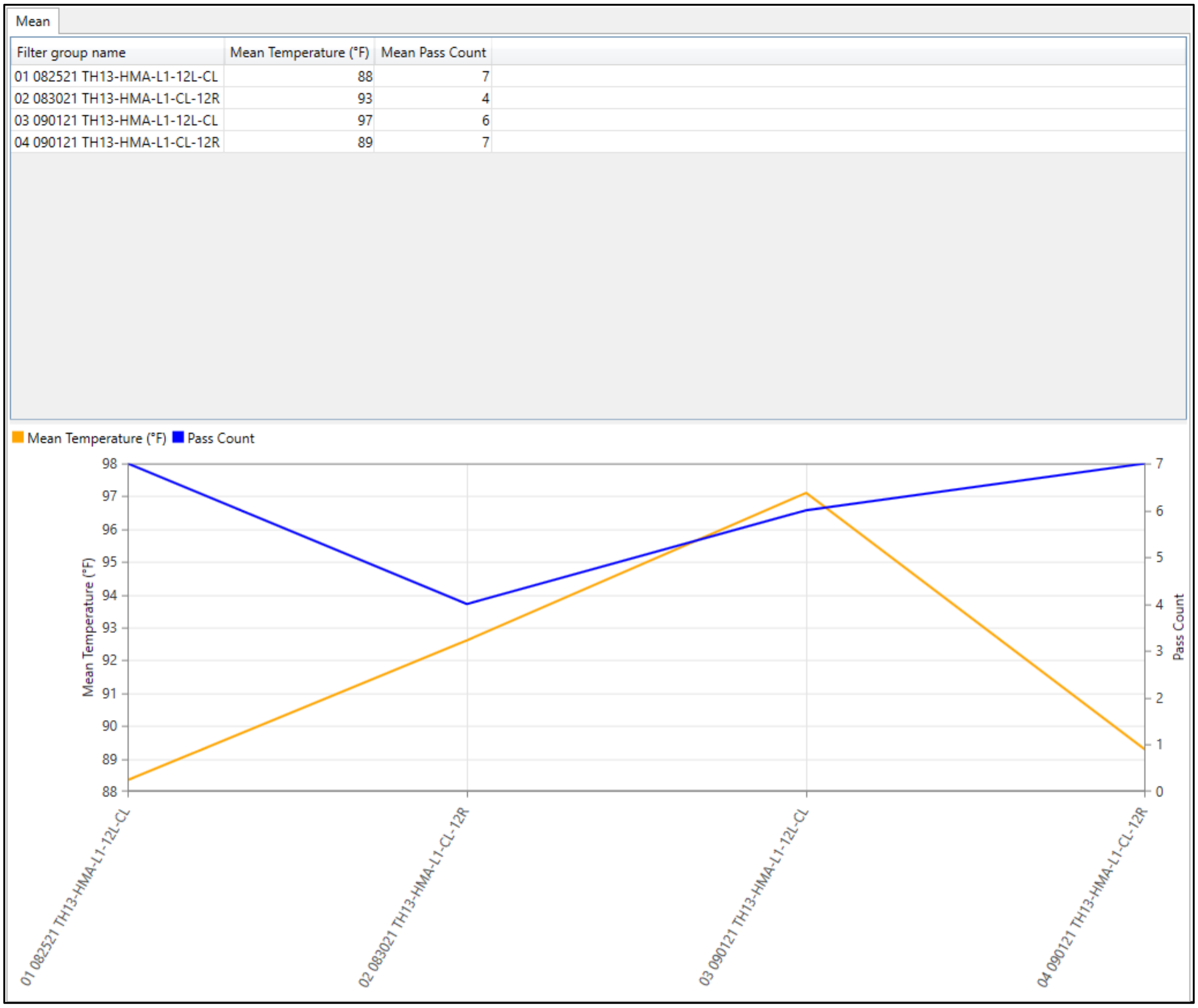


Figure 101. Compactor pass count and temperature data lot summary.

Coverage

The **coverage** results display a statistics table that includes the area covered in square feet or square meters (units may be changed in the **project properties box**). If the analysis includes a location filter, statistics are given for the area and percent covered by at least one pass. The table shows how much of the location filter (as a percent and by area) is covered by each pass count. The pie chart graphically shows pass count coverage. The pie chart's legend is tied to the legend that can be customized on the viewer screen. It is recommended that the legend is customized to match the target or optimum pass count, as previously described in chapter **Filters**. An example of the **coverage** results is illustrated in Figure 102. The legend was adjusted to match a target pass count of four, as shown in the pie chart.

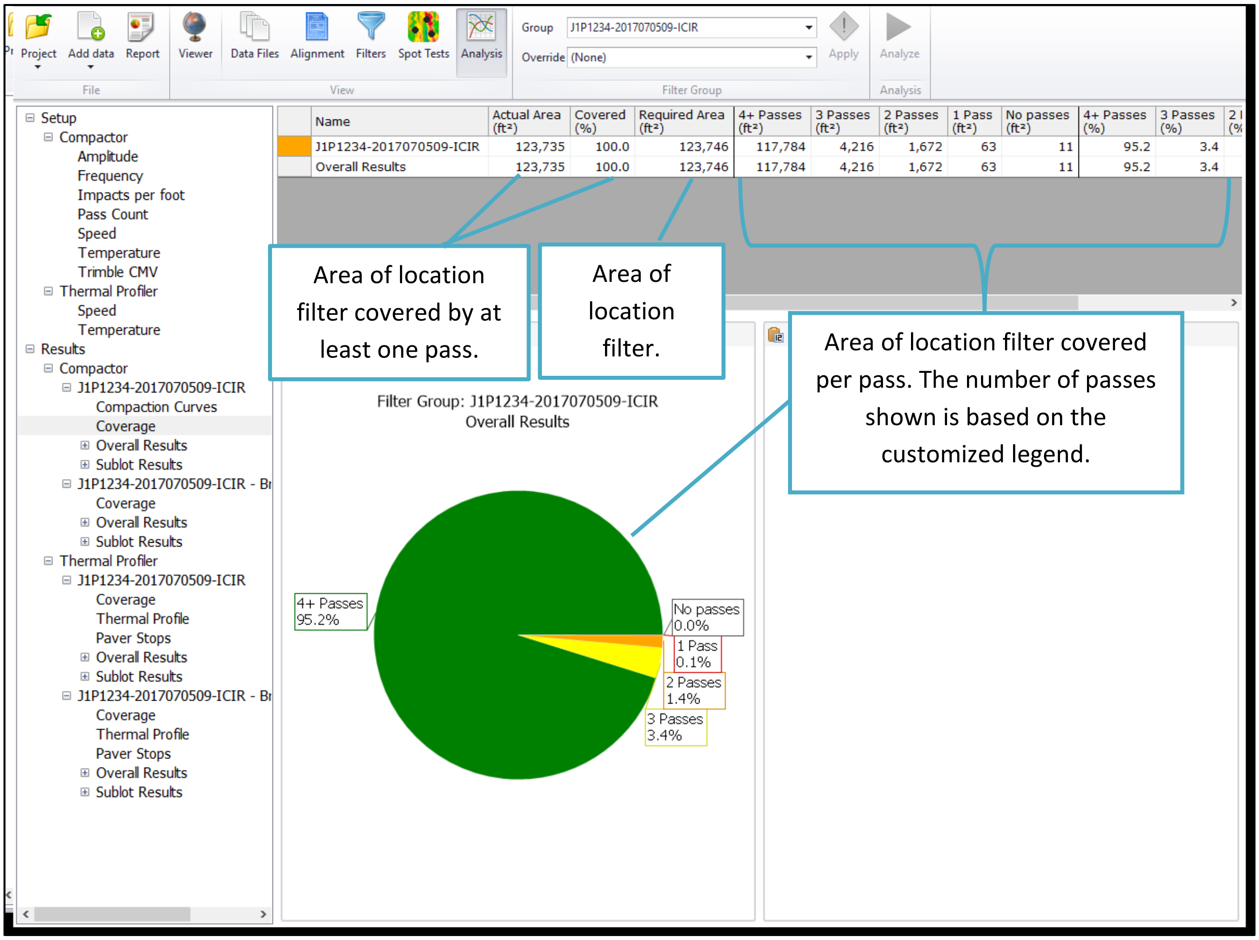


Figure 102. Coverage results.

Overall Results

The **Overall Results** include statistics for all data metrics selected for analysis. Users can view different results by clicking different data metrics. Final Coverage data is shown by default. Users can toggle between final coverage, all-passes, and individual passes using the drop-down menu, as illustrated in Figure 103.

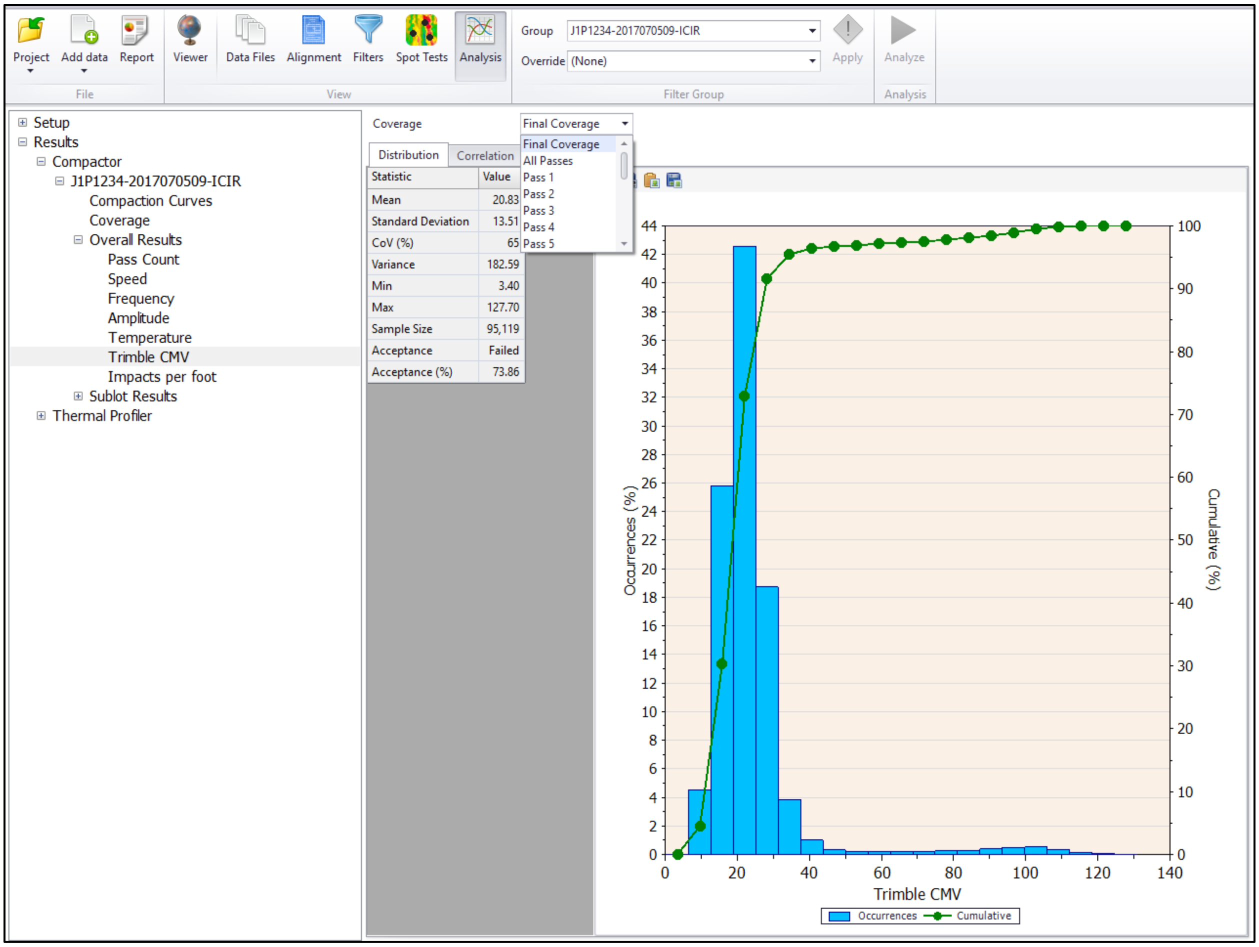


Figure 103. Overall results for ICMV.

Distribution

The **distribution tab** displays statistics for the selected variable, including mean, standard deviation, coefficient of variation, minimum, maximum, and sample size. If a specification target was included for that variable, the table includes the target status (Passed/Failed) and % of target achieved. Histograms show the occurrence frequency of each dataset based on the center value of each range. A line shows the cumulative frequency distribution, plotting the percent of data at or below each value.

Correlation

The **Correlation tab** shows the linear regression between the selected metric and in-situ spot tests. Correlation curves can represent final coverage, all-passes, or individual pass data. The chart includes a plot of the selected data metric correlated to the spot test data points and a linear fit with a fitted equation and an R^2 value. The data surrounding the spot test used for correlation analysis is identified by the radius defined in the setup. The final coverage correlation analysis report can be used to determine the target value of ICMV when the ICMV metric is selected for analysis. The final Coverage correlation is illustrated in Figure 104, where a target density of 95% corresponds to an ICMV value of 18.5.

Alternatively, if no spot test data is available, the target ICMV can be established using the compaction curve, as described under **Section Sublot Results**. ***Note that in Veta 7.0 and later, the compaction curve data is only visible under sublot results.***

The correlation between density and ICMV depends on the sophistication of ICMV equipment used to collect the data. Users should use caution when evaluating the ICMV data and consider the influence of variables on the data as described in the FHWA ICMV Road Map Tech Brief.

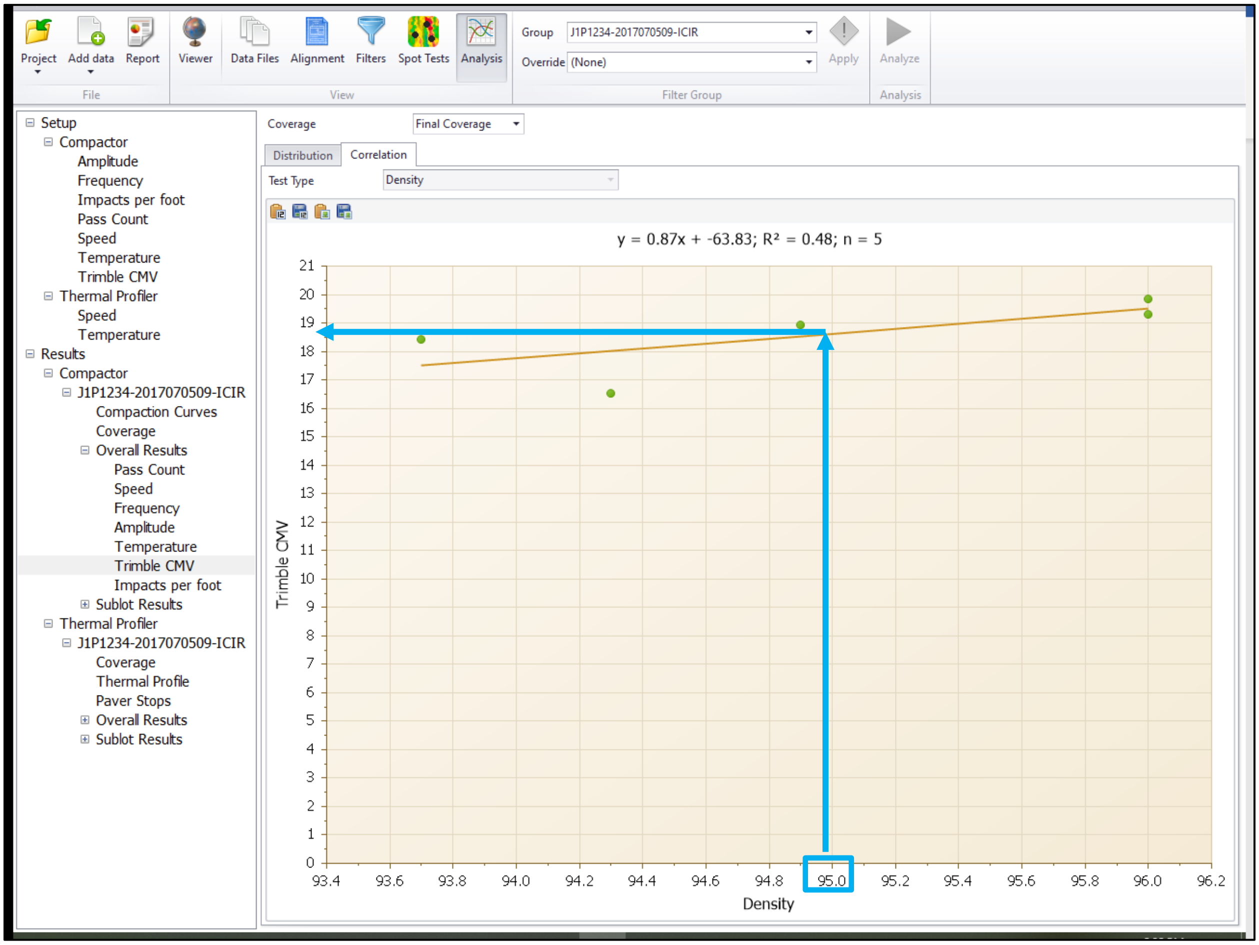


Figure 104. Correlation curve showing the relationship between core density data and ICMV.

Sublot Results

If **Analyze sublots** are selected on the Setup screen, a sublot analysis is performed. Expand the sublot results and filter group tab to view the sublot results. Users can customize sublot lengths on the setup screen.

Summary

The summary tab includes up to four components, including:

- Summary of mean values (or pass/fail when cumulative specifications are used) for all data metrics (as selected under the data setup) for each sublot.
- Map of sublots.
- Distribution tab with statistics for selected sublot.
- Compaction curve data (for ICMV and temperature only).

An example of the sublot results summary is illustrated in Figure 105. The windows can be custom-sized by dragging the dividers. Note that when cumulative specifications are used, the summary table populates with **passed** or **failed**. When cumulative specifications are not used, the mean value is populated in the summary table.

Users can click on the individual metrics to show details for that metric. The statistics and charts display the corresponding sublot results. When users click on temperature or ICMV metrics, a compaction curve tab is available. The compaction curves show the results for the corresponding sublot, as illustrated in Figure 106 and described in the following section.

The last sublot length is displayed on the summary page (the last sublot length is typically longer or shorter than the rest of the sublots.

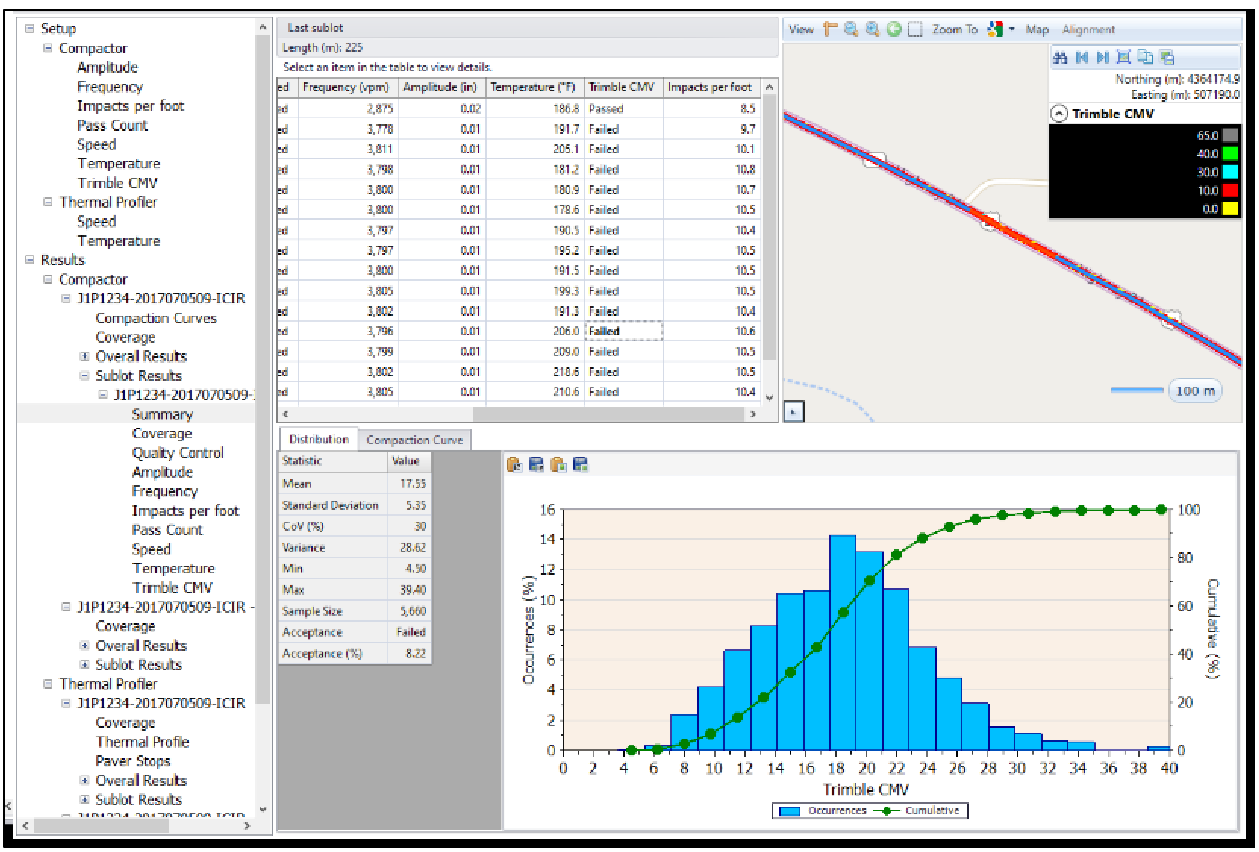


Figure 105. Sublot summary results.

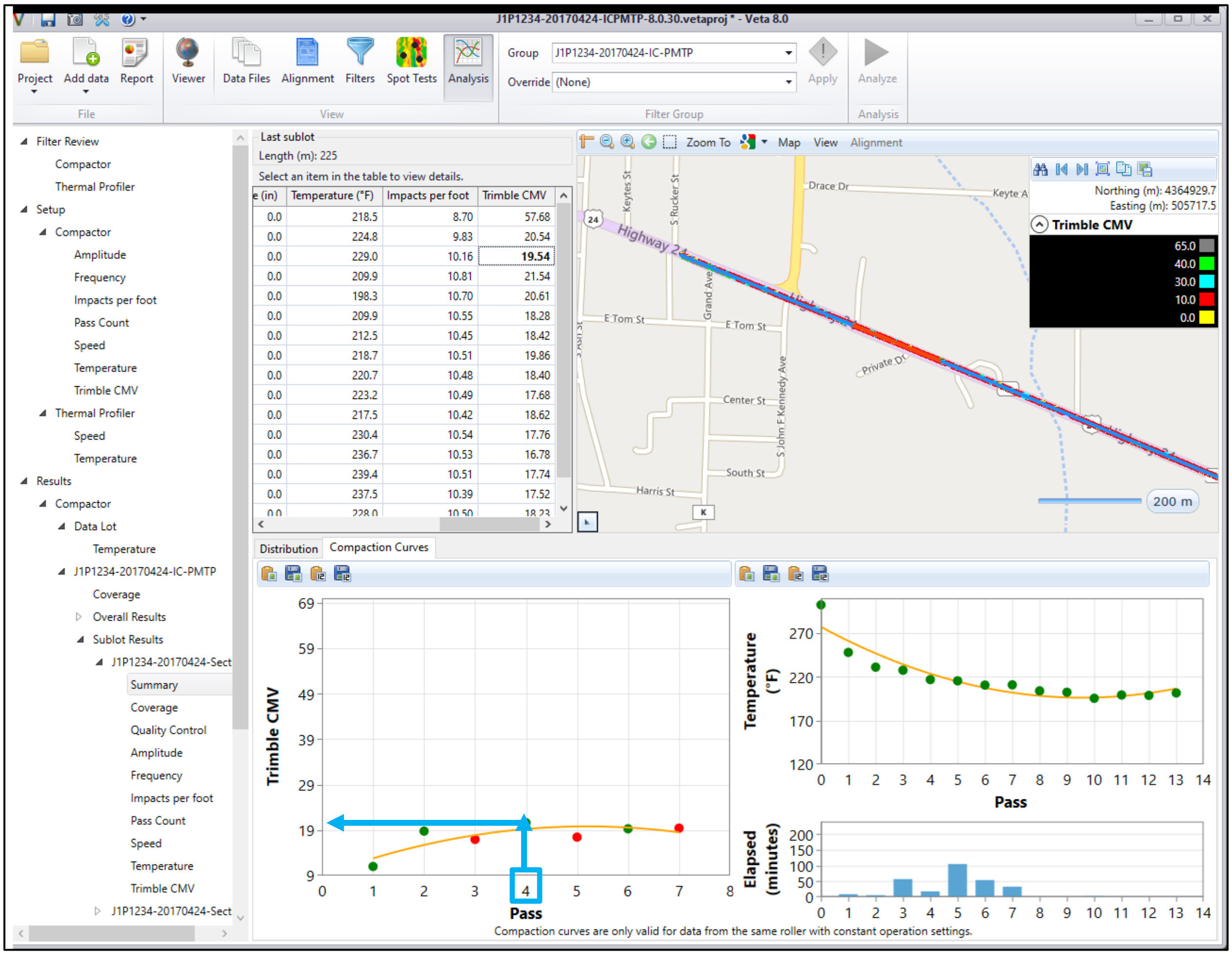


Figure 106. Sublot summary compaction curve tab results.

Compaction Curves

The compaction curves results show the compaction curve for ICMV versus pass count data. ICMV values are only collected during vibratory compaction. This curve can be used to determine an optimum ICMV value based on a target pass count (alternatively, a correlation curve can be used to establish a target ICMV value, which is further described in the section **Overall Results**).

For example, Figure 106 shows a sublot with an optimum pass count of 4. The target ICMV value for a pass count of 4 is around 19. This value can be used to evaluate the consistency of ICMV data on the project. The summary table is a quick way to view all the mean ICMV values, and the compaction curves can provide further details.

Caution should be used when evaluating ICMV data. Most commercially available IC equipment use accelerometers that are only capable of level 1-2 ICMV values. As previously described, these are significantly influenced by equipment, environmental, and material changes. For more information, reference the [FHWA ICMV Road Map Tech Brief](). ICMV Compaction curves are only valid for vibratory compaction without significant changes to the material, environment, and equipment variables.

For asphalt projects, the compaction curve results also show a temperature loss curve based on the mean temperature recorded at each pass. The average time between passes is shown below the temperature cooling curve (Figure 106). This information may be useful to monitor surface temperatures during rolling and set quality control thresholds. The information in the compaction curves results is based on the all-passes data, i.e., the compaction history. If PMTP data is included in the project, ***Pass 0*** will include the average PMTP temperature within the lot.

Coverage

Coverage can be viewed for each sublot (when location filters, or boundaries, are used). Coverage can be useful to view and isolate areas that did not meet coverage requirements. Coverage can be viewed by chart and table. The **Chart** shows total coverage for at least one pass. There is typically more than one pass in an optimum rolling pattern for IC data. The **Table** tab shows the coverage for cumulative passes. The number of passes shown in the table depends on the number of passes customized in the legend. Coverage is shown in square units (feet or meters) and by %. Figure 107 shows the sublot coverage table for a project with an optimum pass count of 8. Note that the first sublot does not meet the coverage requirements.

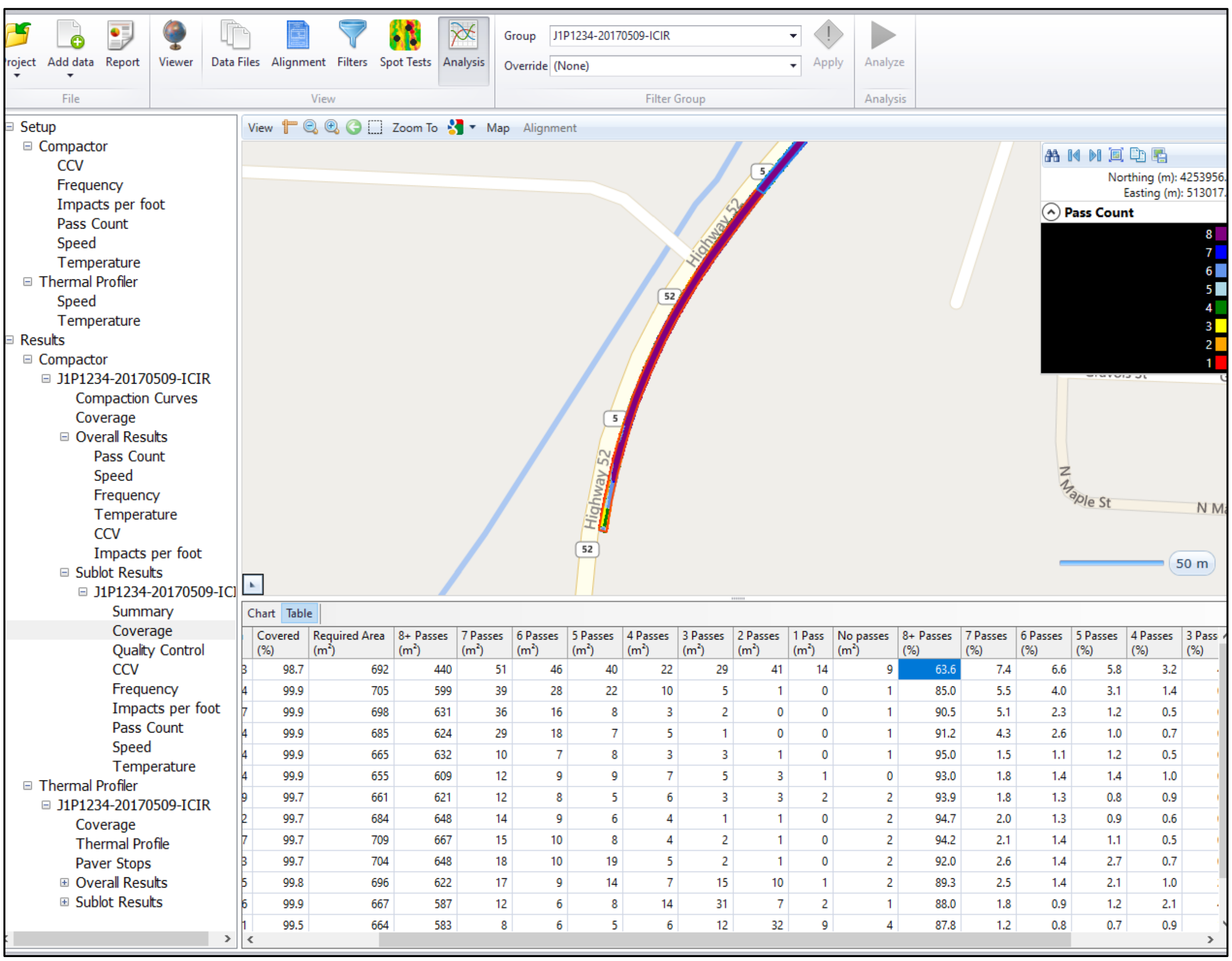


Figure 107. Sublot coverage results.

Quality Control

Quality control thresholds can be set for temperature and speeds, and setting thresholds is a useful quality control tool for monitoring these variables. The thresholds are set under the **Compactor** analysis setup. Figure 108 shows the quality control results for sublot mean speeds with thresholds set from 2.5 to 3.0 mph. This chart quickly identifies areas where the speed was outside these thresholds.

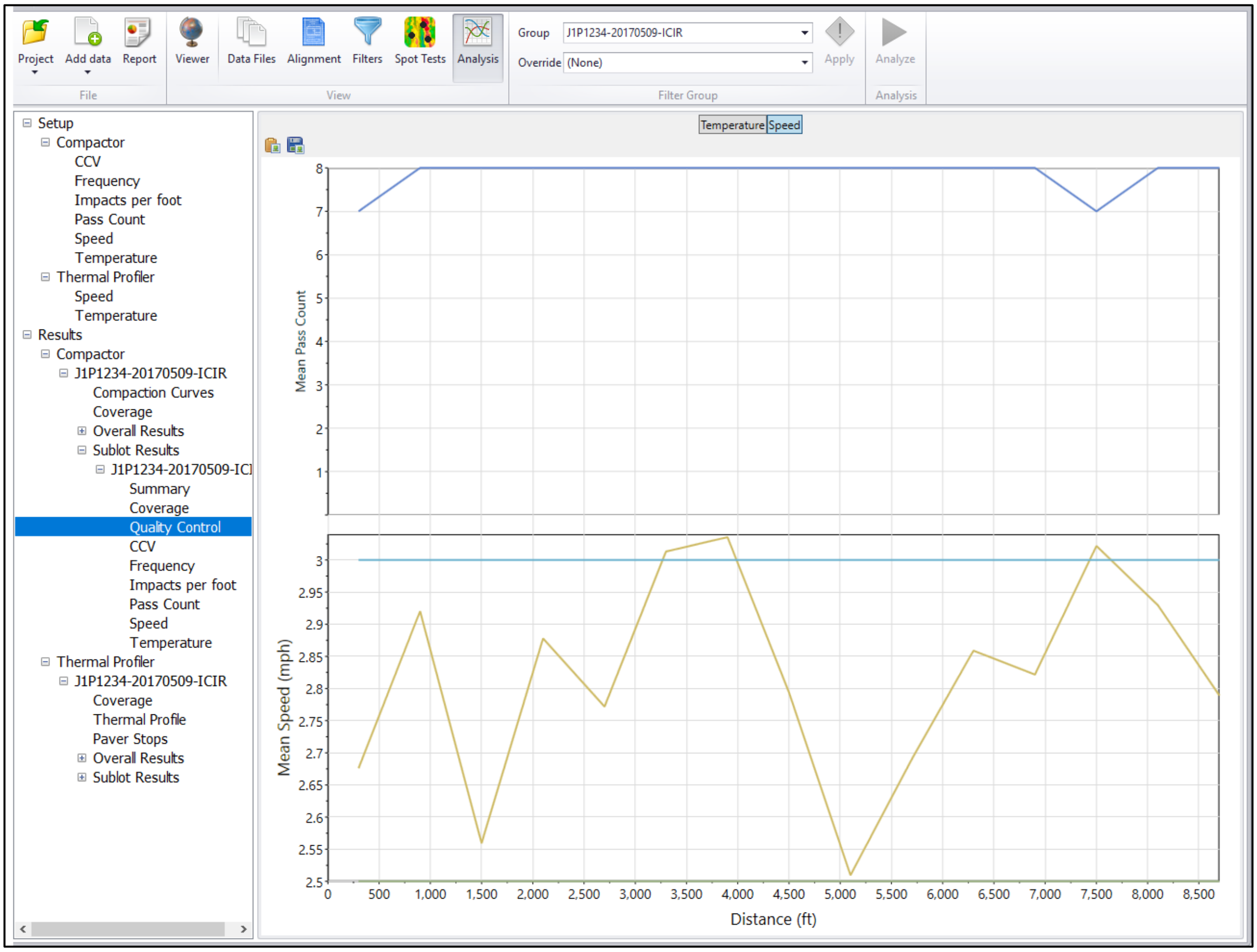


Figure 108. Sublot quality control results for the mean speed.

Data Details

Each data metric selected for analysis has sublot details. Users can click on the data metric to show the sublot details. There are up to three tabs displayed for each metric, including:

- The distribution shows the location and length of each sublot as well as the standard computed statistics in table form. An example of the distribution tab results using ICMV data is illustrated in Figure 109. Users can click on any data in the table to zoom to the sublot in the map.
- Mean displays the mean value of the selected metric in a bar chart format. An example of the mean tab results using ICMV data is illustrated in Figure 110.

- Acceptance is displayed when cumulative specifications are used. The cumulative percent is shown in a bar chart form, and a red line indicates the acceptance criteria. An example of the acceptance tab results using ICMV data is illustrated in Figure 111.

Location (m)	Length (m)	Acceptance	Acceptance (%)	Min	Mean	Max	Standard Deviation	Variance	CoV (%)	Sample Size
0.00	182.88	Passed	94.4	7.50	61.21	127.70	33.06	1,093.19	54	5,141
182.88	182.88	Passed	75.9	4.50	20.58	46.10	7.03	49.36	34	4,778
365.76	182.88	Passed	79.0	4.80	19.43	42.50	5.47	29.94	28	5,638
548.64	182.88	Passed	82.7	4.90	21.55	49.40	6.70	44.84	31	5,140
731.52	182.88	Passed	81.2	4.20	20.82	53.70	6.94	48.20	33	5,375
914.40	182.88	Failed	73.0	3.90	18.09	42.70	5.23	27.39	29	5,776
1,097.28	182.88	Failed	71.2	4.70	18.26	37.80	5.40	29.14	30	5,624
1,280.16	182.88	Passed	79.9	5.60	19.83	40.30	5.39	29.08	27	5,720
1,463.04	182.88	Failed	73.5	4.80	18.42	51.10	5.45	29.75	30	5,710
1,645.92	182.88	Failed	72.3	6.00	17.51	33.30	4.25	18.06	24	5,508
1,828.80	182.88	Failed	74.2	5.00	18.51	36.00	4.90	23.97	26	5,570
2,011.68	182.88	Failed	67.2	4.50	17.55	39.40	5.35	28.62	30	5,660
2,194.56	182.88	Failed	63.7	3.40	16.78	33.20	4.83	23.29	29	5,585
2,377.44	182.88	Failed	70.7	5.60	17.66	37.70	4.90	23.98	28	5,753
2,560.32	182.88	Failed	68.3	4.90	17.41	35.30	4.98	24.78	29	5,611
2,743.20	182.88	Failed	69.6	4.70	18.10	43.20	5.55	30.77	31	5,705
2,926.08	224.91	Failed	64.1	4.40	16.84	32.00	5.11	26.09	30	6,769

Figure 109. Distribution tab sublot data details.

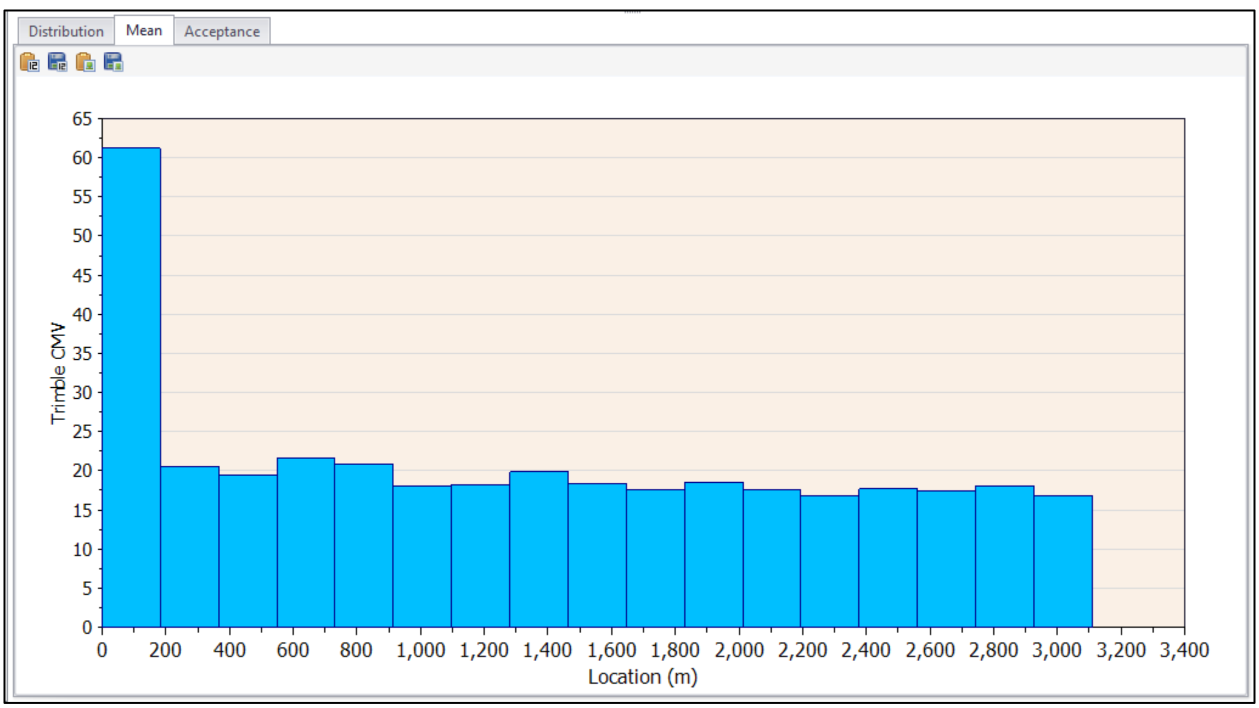


Figure 110. Mean tab sublot data details.

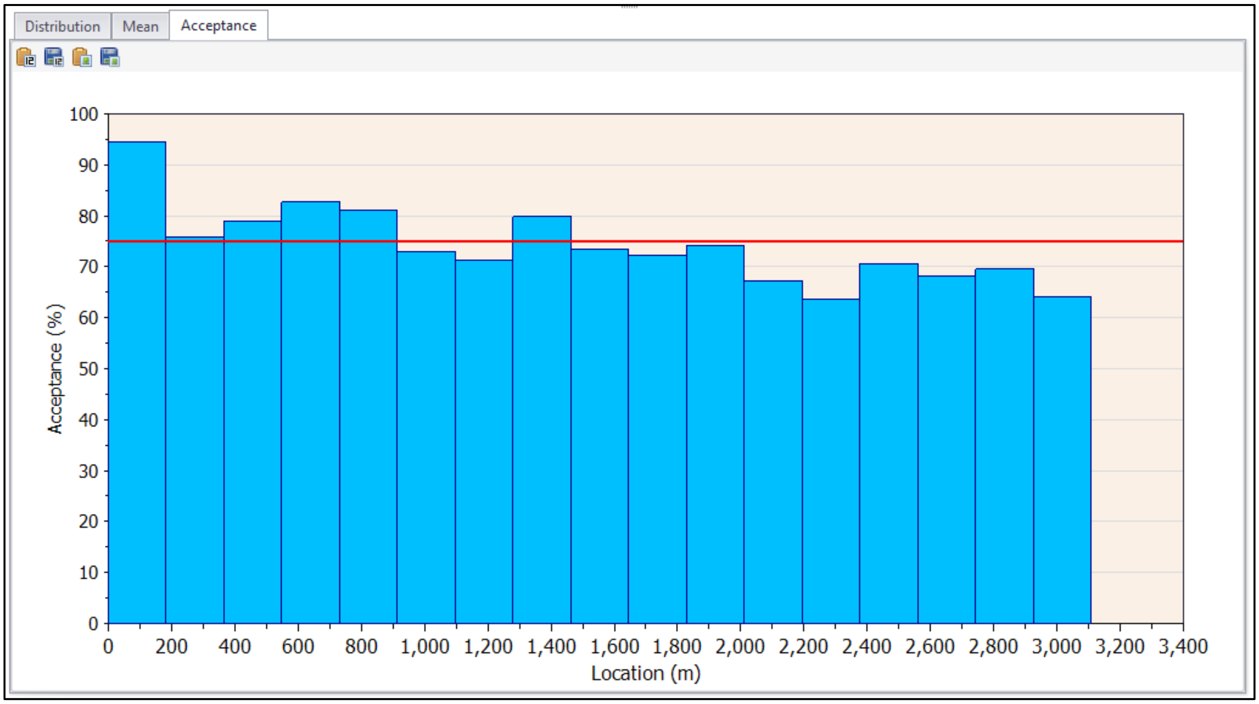


Figure 111. Acceptance tab sublot data details (used for the cumulative specification only).

Thermal Profiler

The following sections describe the analysis results for thermal profilers.

Data Lot

The data lot results show the thermal segregation classifications for all data lots in a project. Thermal classifications are based on the user's selection of DRS, TSI, or both. The legends and thresholds are customizable in the analysis setup (as previously described). Data lot results for DRS classifications are shown in Figure 112. A cumulative summary of price adjustments (if selected) is tabulated at the top of the screen.

Sublot

A table summary of sublot classifications and price adjustments (if selected) are included in the sublot temperature results, as shown in Figure 113.

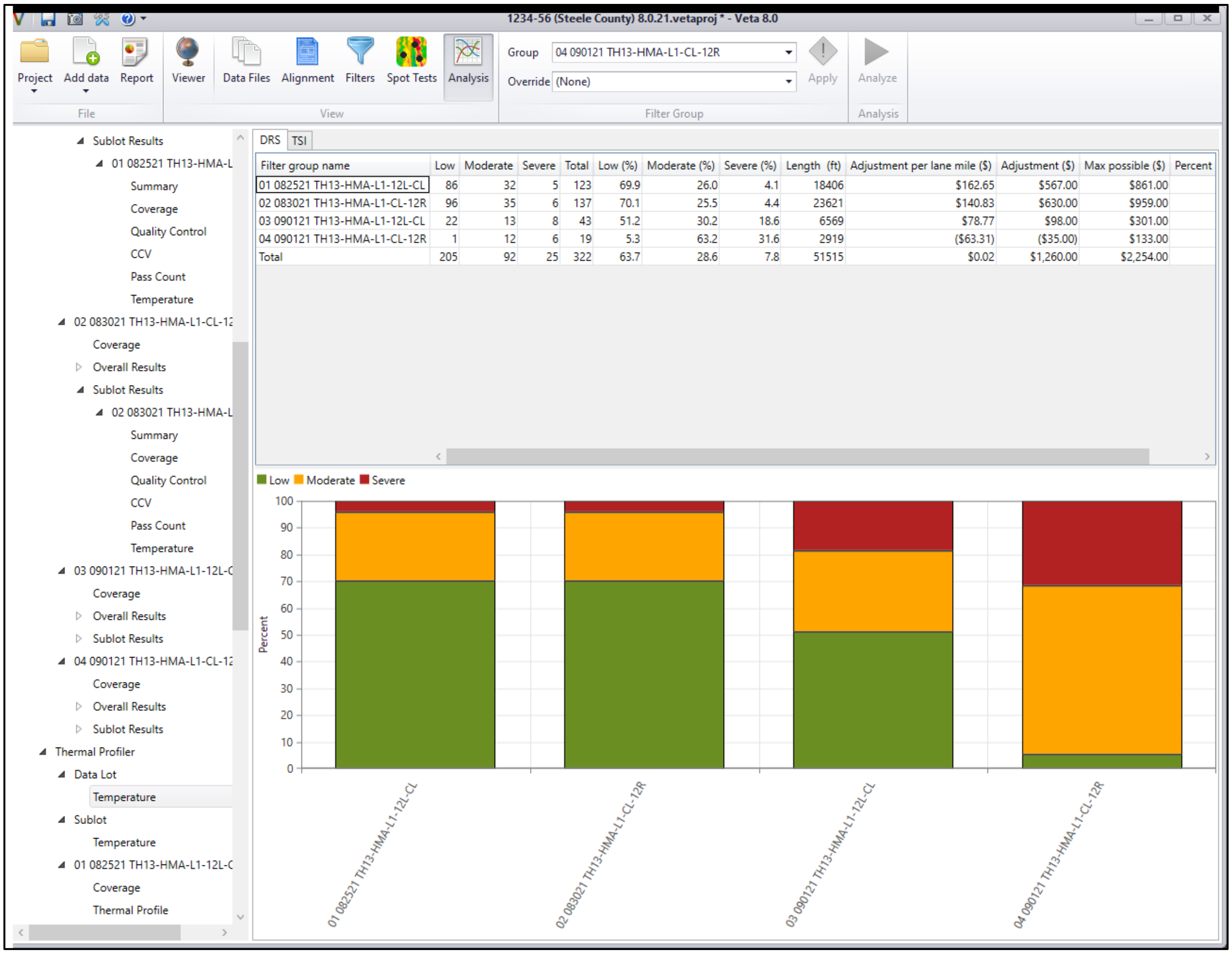


Figure 112. DRS thermal classification data lot results.

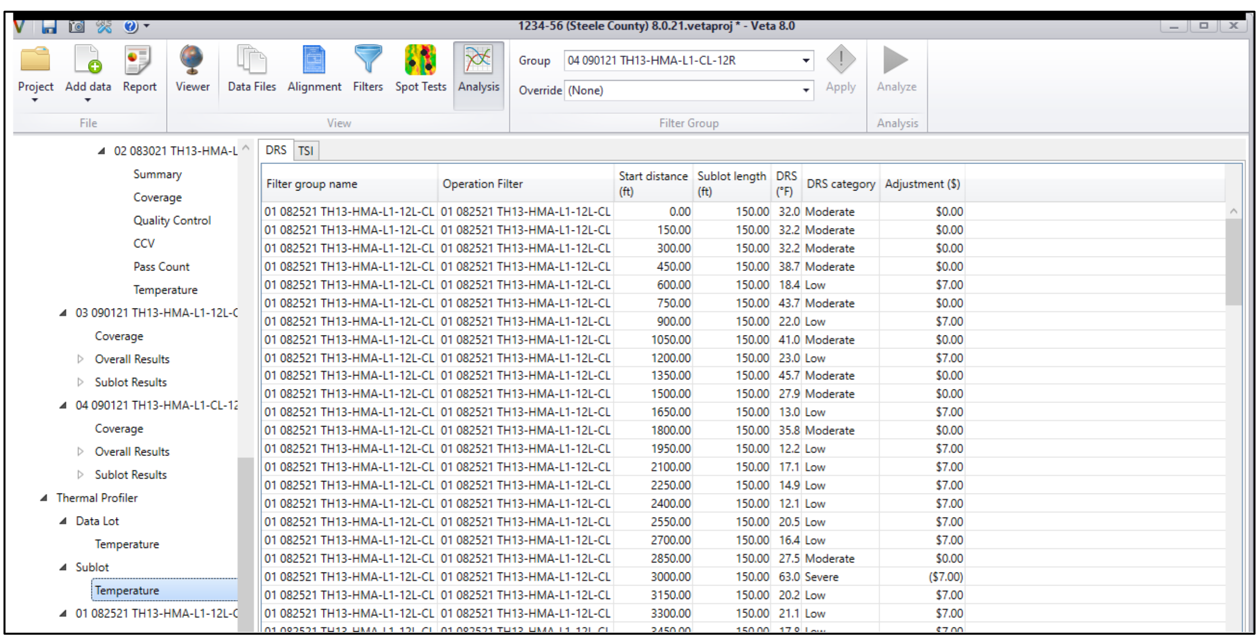


Figure 113. Sublot temperature results.

Coverage

The **coverage** results display a statistics table that includes the area covered in square feet or square meters (units may be changed in the **project properties box**). If the analysis includes a location filter, statistics are given for the area and percent covered.

Thermal Profile

The thermal profile results show a 2D color map of temperature data versus distance, the duration of paver stops versus distance, and speed versus distance. The minimum time duration for what Veta considers a "stop" is customized on the Setup screen. All three charts are synchronized. Users can zoom in by drawing a box around a selected area. Click **Zoom to Fit** to view the entire profile length. To pan, right-click and drag or use the horizontal scroll bar at the bottom of the screen. The legend can be displayed by clicking **legend**. Note that the legend for the thermal profile results is the same legend used for the mapped data. The legend can be customized to show more or fewer temperatures as described in chapter **Viewer**. An example of the thermal profile result screen is illustrated in Figure 114. Note that this example shows many paver stops.

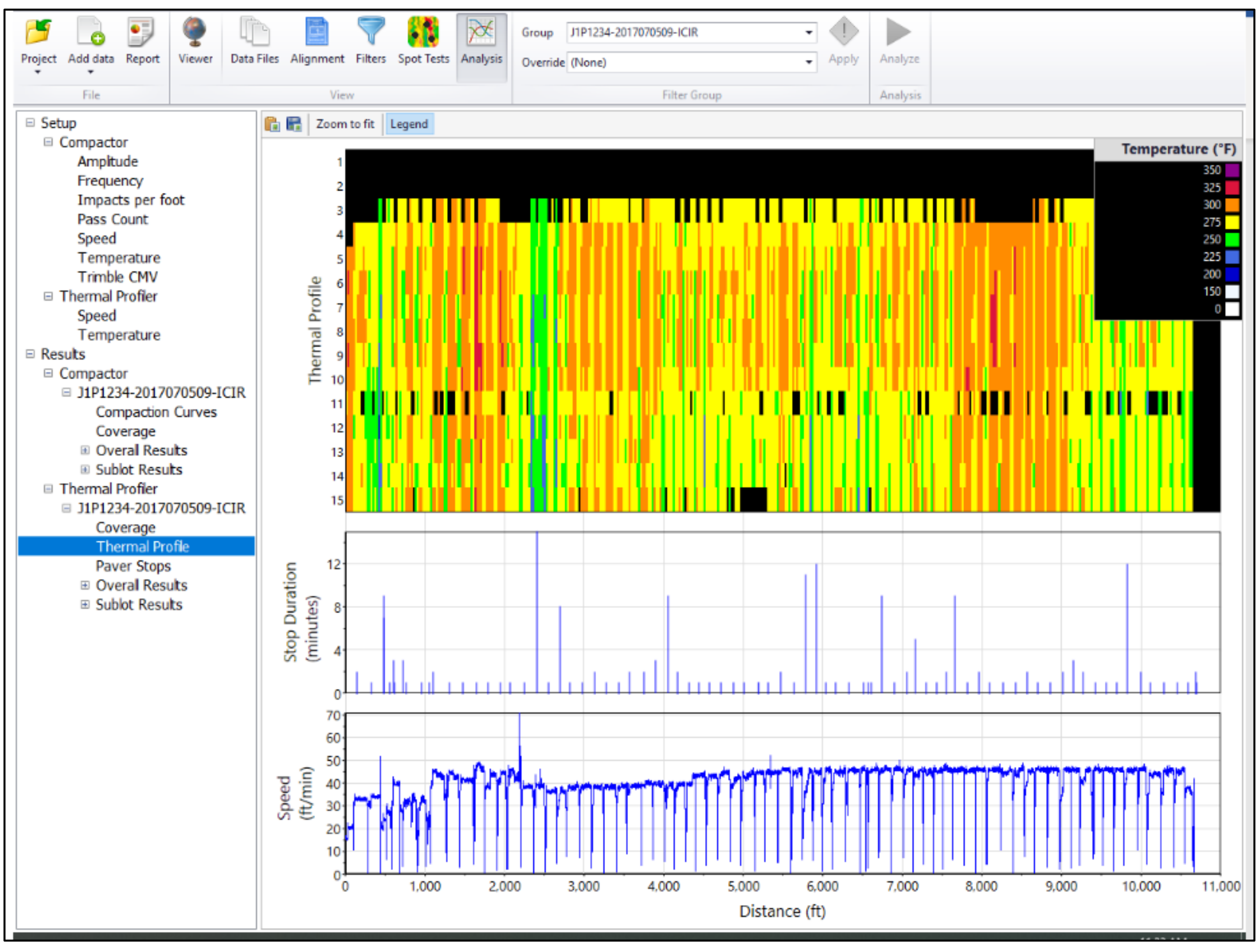


Figure 114. Thermal profile results.

Paver Stops

Paver Stops display a map of the thermal profiler data with paver stop locations circled on the map. The stop duration is shown next to each circle. The results are in table form above the map, as illustrated in Figure 115.

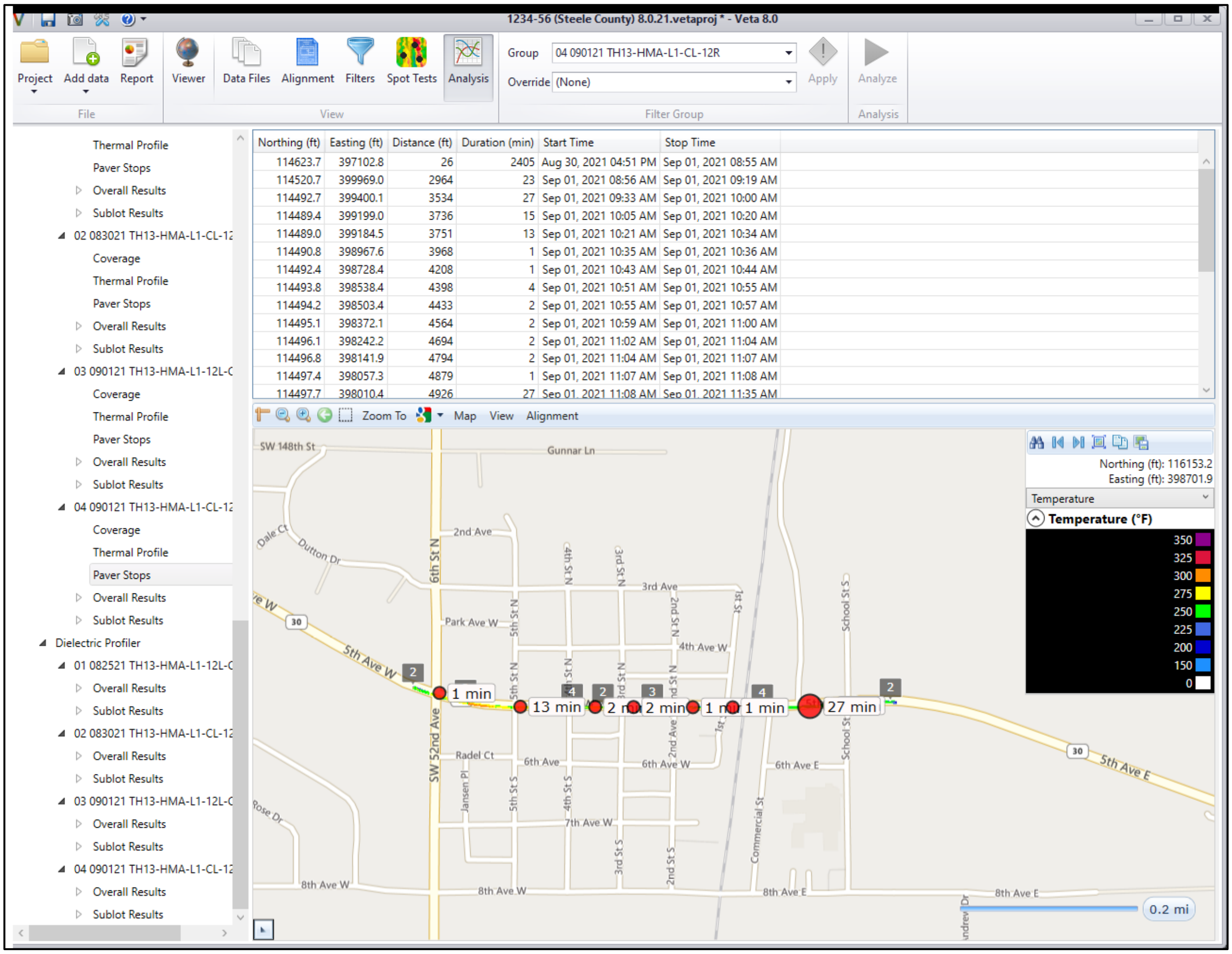


Figure 115. Paver stops results.

Overall Results

The overall results of speed and temperature display the same information previously described in section **Compactor**. The only applicable data source is the raw data (individual passes do not apply to thermal profiler data).

Sublot Results

The sublot results display the same information on the **Distribution** and **Mean** tabs previously described in section **Compactor.** Additional results include the optional DRS or TSI classifications, as previously described under the thermal profiler in section **Analysis**.

If either of these (or both) specifications are selected during the analysis setup, additional tabs with the specification results will be populated. Figure 116 shows the TSI results of some example thermal profiler data. The summary of low, moderate-high, moderate-low, and severe segregation are summarized. Details for each sublot are displayed in a chart or table format (toggled by selecting the ***Chart*** or ***Table*** tabs). Users can click on any data in the table to zoom to the sublot in the map. Example DRS results for the same sample project are illustrated in Figure 117. More information on these specifications can be found in AASHTO R 110.

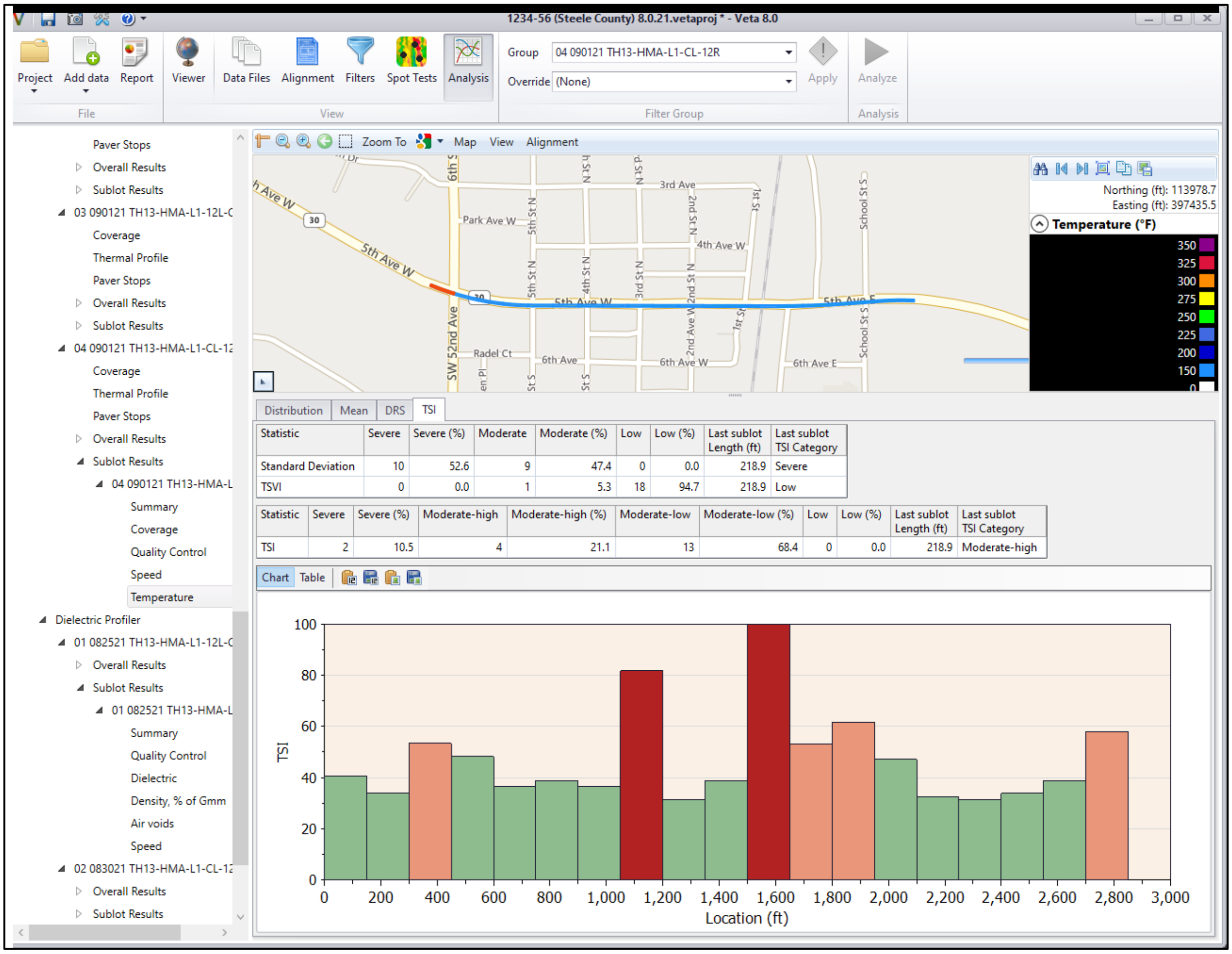


Figure 116. Thermal profiler TSI results.

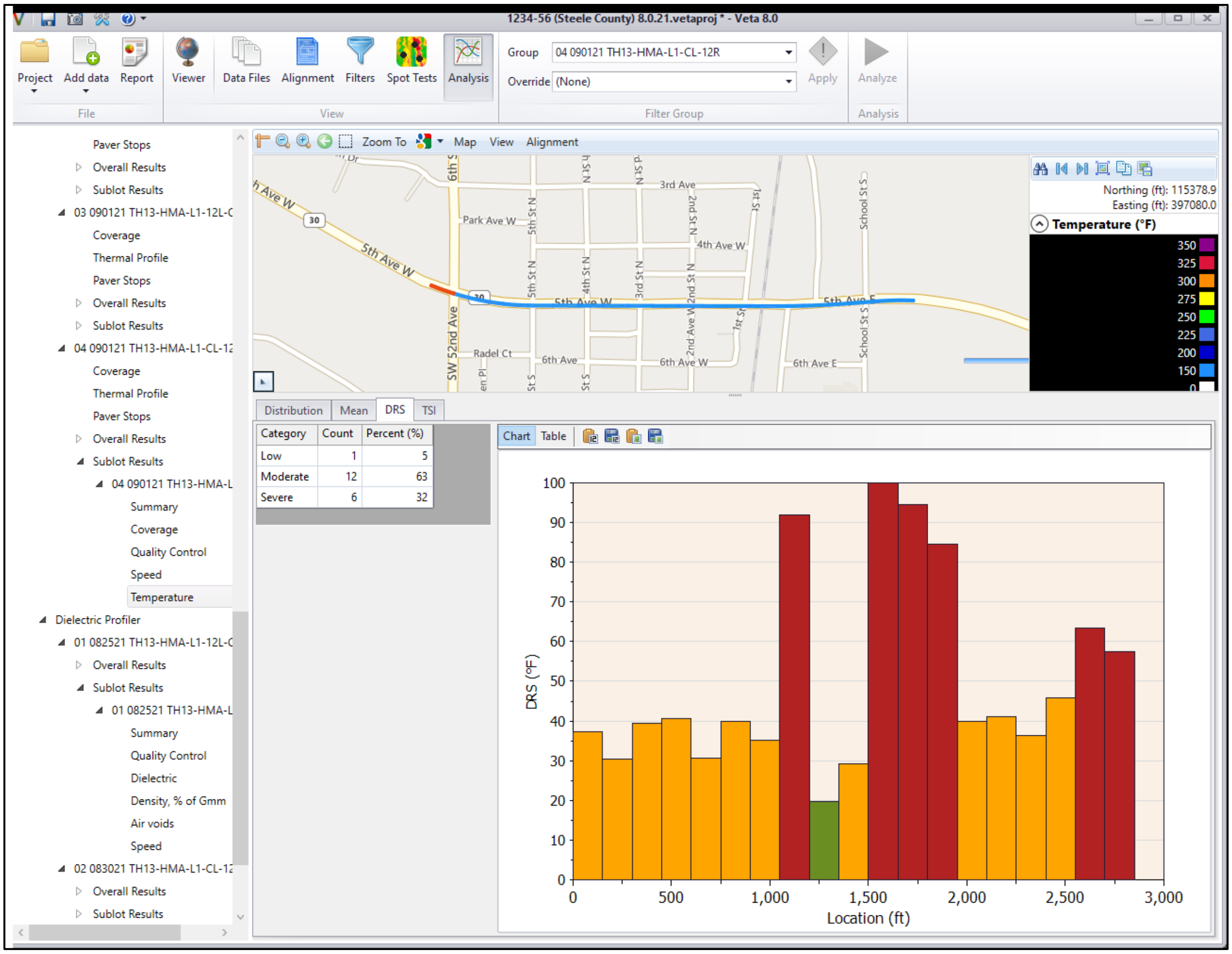


Figure 117. Thermal profiler DRS results.

Dielectric Profiler

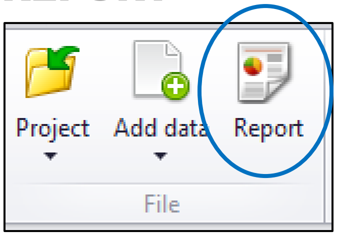
Overall Results

The overall results display the same information previously described in section **Compactor**. The only applicable data source is the raw data (individual passes do not apply to dielectric profiler data).

Sublot Results

The sublot results display the same information on the **Distribution** and **Mean** tabs previously described in section **Compactor.**

REPORT



The **Report** screen generates PDF or Excel reports or exports data to text files. Reporting options are summarized in the following sections.

Report Dialog Box

Figure 118 shows the report dialog box that appears when **Report** is selected from the **File** toolbar.

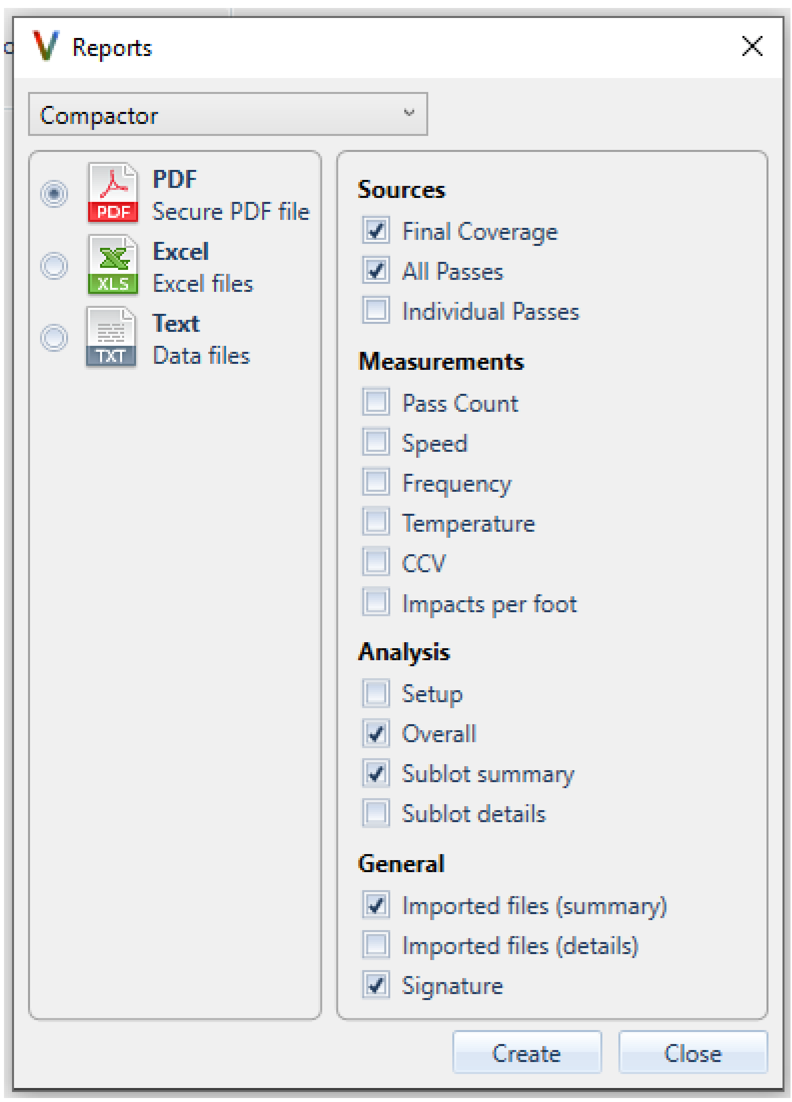


Figure 118. Report dialog box.

Users can select the equipment type using the dropdown menu. Figure 118 shows the options for **compactor** reports.

Users can select the type of report to generate by selecting **PDF**, **Excel**, or **Text**.

PDF Reports

The PDF (Secure PDF File) option is to produce a secured format with randomly generated password protection, ideal for permanent agency and contractor records.

The PDF report can be customized according to the users' requirements. The report includes the selected options in one complete report. Each customizable report section is described in the following sections.

Sources

Users can select final coverage, all-passes, and/or individual passes data for compactor data.

For thermal and dielectric profiler data, only raw data is applicable.

Measurements

All data measurements that were selected for analysis can be selected for reporting. If the analysis has not been performed, this option will not be available in the report dialog box.

Analysis

Users can select whether or not to include the setup details in the analysis results by selecting **Setup**. Different levels of results (summary or detailed) can be included for overall and sublot analyses. Users should consult agency specifications to determine the required results to include in the report. Selecting all options will generate a lengthy report. If the analysis has not been performed, this option will not be available in the report dialog box.

General

Users can select a summary table of imported data file names or include the details. The details include all general header information, which may vary by vendor. Users can select whether to include a signature line at the end of the report.

Excel Reports

Excel (Excel File) option is to generate Excel report files. They can also be customized using the same options as **PDF Reports**. Excel files are generated for each data metric (ICMV, Frequency, Pass Count, Temperature, etc.) and analysis type (Final Coverage, Individual Pass, All-passes, Coverage, Sublot). File names are automatically generated using the data file name, analysis description, date, and time.

Text Files

The Text (Data Files) option allows users to export raw or filtered data (if filtering was performed) in a text file format. Final coverage and all-passes data can be exported for compactor data.

Users can select **Text** and select the data to export. A dialog box will prompt users to navigate to a folder where the files will be saved. The text files are automatically named using a standard naming convention.

SUPPORT

The Transtec Group provides Veta support via a HelpDesk or training workshop.
Visit the support webpage for further details (https://www.intelligentconstruction.com/support/).

Veta License Agreement and Terms of Use

License Agreement

Veta (hereinafter the "SOFTWARE") is protected by Title 17 United States Code, Copyrights. The Transtec Group, Inc., 6111 Balcones Drive, Austin, TX, 78731, (hereinafter "TRANSTEC") grant you (hereinafter the "USER") a nonexclusive, nontransferable license to use the program, and any accompanying documentation (collectively referred to hereafter as the "SOFTWARE") in accordance with the terms and conditions of this License Agreement and Terms of Use.

The development of SOFTWARE has been funded by the Minnesota Department of Transportation (MnDOT) and the Transportation Pooled Fund Study, TPF-5(334) Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation.

The USER shall not copy or redistribute the SOFTWARE (or any part thereof) for any reason without the prior written permission of TRANSTEC.

TRANSTEC provide the SOFTWARE "as is" and "with all faults" without any express or implied warranties whatsoever. Because of the diversity of hardware and software configurations under which this SOFTWARE may be installed and used, no warranty of merchantability, performance or fitness for a particular purpose is offered. The USER shall test the software thoroughly before relying on it. The USER assumes the entire risk of using the software.

TRANSTEC and their affiliates and agents shall not be liable for any damages whatsoever (including but not limited to loss of money) resulting from the use of this SOFTWARE.

Terms of Use

End USER License Agreement

By installing or using the SOFTWARE, you (the USER) indicate your complete and unconditional acceptance of these terms and conditions. If you (the USER) do not agree to this agreement's terms and conditions, promptly remove the SOFTWARE from your computer and destroy the associated documentation.

Should there be any conflict between the terms and conditions of this agreement and the terms and conditions of any other agreement between you (the USER) and TRANSTEC or their agents about the SOFTWARE, the terms and conditions of this agreement shall apply.

If any provision of this agreement is found to be unlawful or void, then that provision shall be severed from this agreement and will not affect the validity of the remaining provisions.

Information contained in the SOFTWARE is subject to change without notice and does not represent a commitment or contracted obligation on the part of TRANSTEC.

This License Agreement (including the SOFTWARE) is not transferable. You (the USER) may not lend, loan, lease, rent, sell or distribute the SOFTWARE (or copies) in any form.

Limitations of Use

You (the USER) are expressly forbidden from making alterations or modifications to merge, adapt, decompile, disassemble, reverse engineer, or attempt to discover the source code.

You (the USER) cannot create a pooled fund study or agency-industry partnership regarding the SOFTWARE without approval from MnDOT and Transtec Group.

Limitations of Liability

Under no circumstances, including, but not limited to, negligence, shall TRANSTEC or their affiliates and agents be liable for any direct, indirect, incidental, special, or consequential damages that result from the use of, or the inability to use, the SOFTWARE. You (the USER) release TRANSTEC and its affiliates and agents from any damages you incur and agree not to assert any claims against them, arising from your use of the SOFTWARE.

Disclaimer

TRANSTEC may have provided links and pointers to Internet sites maintained by third parties. Neither TRANSTEC nor their affiliates and agents operate or control in any respect any information, products, or services on these third-party sites. The materials in this SOFTWARE and any third-party sites are provided "as is" and without warranties of any kind, either expressed or implied. To the fullest extent permissible pursuant to applicable law, TRANSTEC disclaims all warranties, expressed or implied, including, but not limited to, implied warranties of merchantability and fitness for a particular purpose. TRANSTEC does not warrant that the functions contained in the materials will be uninterrupted or error-free and that defects will be corrected.

Veta User's Guide

Version 8.0

6111 Balcones Drive

Austin, Texas 78731 USA

T: +1 (512) 451 6233

F: +1 (512) 451 6234

ICSupport@TheTranstecGroup.com

Minnesota Department of Transportation

THE TRANSTEC GROUP

The World's Pavement Engineering Specialists