VIII. E-CONSTRUCTION REPORTING

As part of the AID Demonstration Project, Ingios has created a project setup data collection form that is used to collect additional data about a project. The information is used to add context to measurement data that is created, calculated and reported via a web application. There are 5 main sections to the form: general project information, compaction materials used, compaction specification requirements, pavement layers and compaction reporting setup. Typically, a member of the DOT will fill out the project setup form with help from Ingios as needed. Most project information requested on the form is available in the DOT project plans.

As part of the AID Demonstration Project, Ingios has enhanced its COMP-Score CONNECT web application for use by the Iowa DOT. This application is hosted by Ingios and is available to users through a web browser and valid logon.

Modulus Verification Project Setup

Instructions: Select or enter values for cells in column C that are highlighted yellow. Additional cells may highlight based on information populated. Grayed out cells should be left blank. Do not alter any cells outside of those highlighted in column C. When saving the spreadsheet please append the Project Number to the filename.

Date Created	
Project Number	
Project Description	
County	
Work Type	
Bid Letting Date	
IA Coordinate System (See Plan Sheet G.1)	
Roadway Functional Classification	

Compaction Materials

Earthwork	
Will earthwork materials be used that require compaction?	
Subgrade Treatment (select all that may apply)	
Will subgrade treatment materials be used that require	
Subbases	
Will subbase materials be used that require compaction?	
Base Courses	
Will base course materials be used that require compaction?	
Surface Courses	
Will surface course materials be used that require compaction?	
Shoulders	
Shoulder Material Used on Project?	

Compaction Specification Requirements

Select applicable compaction specification requirements for Earthwork/Subgrade materials.	
2107.03E - Type A Compaction	
2107.03F - Type B Compaction	
2107.03I - Compaction with Moisture Control	
2107.03H - Compaction with Moisture and Density Control	
2109.03C - Special Compaction of Subgrade	
2107.03G - Compaction by other methods and equipment	
Select modulus verification improvements that will be used.	
Additional Compaction Effort	
Cement Treatment	
Geogrid Stabilization	
Overexcavation and Replacement	
Other	

Pavement Layers

2301-Portland Cement Concrete (PCC) Pavement	
Pavement Material Used on Project?	
2302-Portland Cement Concrete (PCC) Pavement Widening	
Pavement Material Used on Project?	

Figure 1. Example of project setup file template.

Introduction to COMP-Score® CONNECT

COMP-Score® CONNECT is an end-to-end IoT system designed to bring compaction quality information to the digital world. The COMP-Score CONNECT web application is used to:

- Track a project's compaction activities from anywhere using your desktop, tablet or mobile device.
- Access customized compaction reports for your project that provide quality analysis and metrics, display mapped area of compaction operations, show passes and materials compacted and serve as a record of compaction operations.
- Review reports by providing status and comments that are then documented directly in the report to aid in communication and decision support.
- Receive email notifications when new and updated reports are available.
- Save digital images directly to a report.
- View engineering control charts and monitor over time.
- Track equipment outfitted with COMP-Score™ on an interactive Google Maps interface.
- Identify materials mapped on projects.
- Scroll through compaction map visuals to see project performance over time or identify maps as a quick reference.
- View automated verification of calibration results for all maps.
- Integrate with external services to monitor camera feeds of your project site or live stream compaction operations during compaction (requires external site camera feed).

Customized compaction reports are generated and stored in COMP-Score CONNECT for every mapping run performed on a project. Available report pages are described in the sections below. Note: A fully detailed user guide for COMP-Score CONNECT is attached to this Appendix.
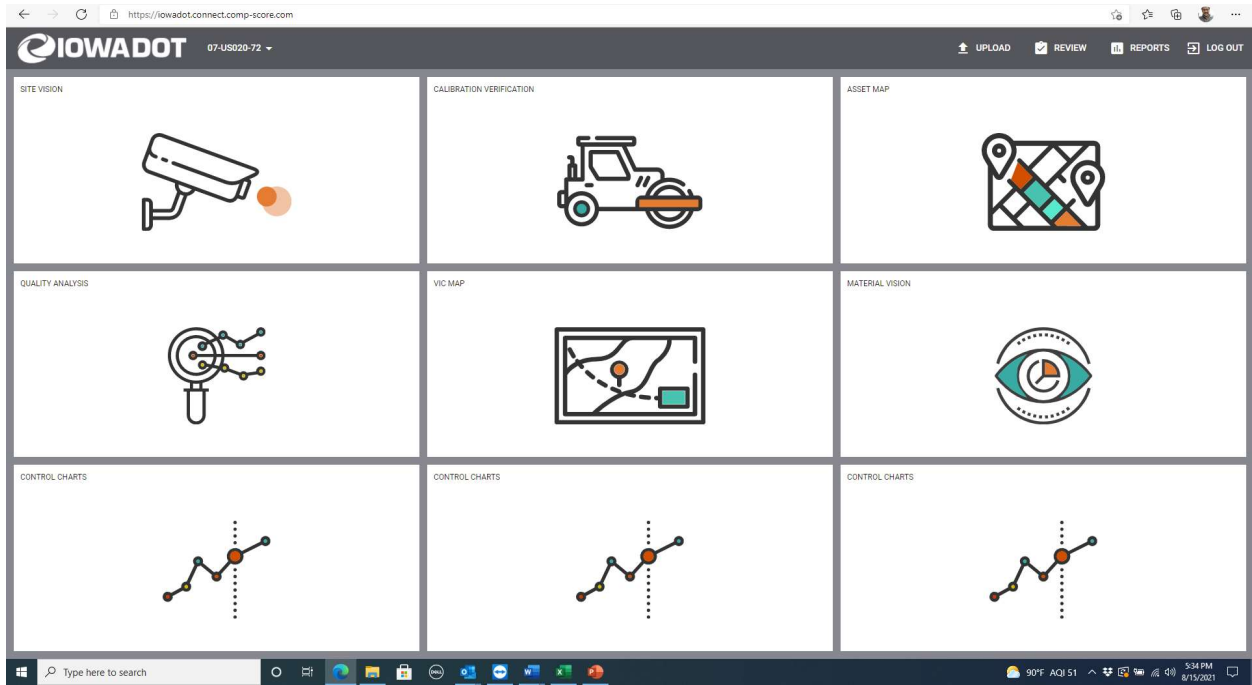
Figure 2. Screenshot of COMP-Score CONNECT web interface.

e-Compaction Report

Map Summary Page

The Map Summary page provides a summary of the data for the mapping. It shows metrics for each of the parameters measured on the project. Additional summary data is also displayed to provide additional context about the mapping performed.

E-Compaction Report

Project:	US52 Dubuque County	Mapping Duration (hrs):	0.45	Operator:	Ingios Geotechnics inc
Map ID:	iadot_31-us52_cs56-fcs00210_2020_08_12_114345a	No. of Measurements:	46670	Machine ID:	Ingios_FCS00210
Date and Time:	8/12/2020 11:43:45 AM	Location:	Dubuque County	State Plane:	1401 IOWA NORTH

Review Status: Review Required

Map Summary

Parameter	Measured	% Passing	CQI	CI	Calc. TV	min.	avg.	max.	std. dev.	cov(%)	min.-delta	avg.-delta	max.-delta
XMV	No												
Resilient Modulus	No												
k-value	Yes	58	70.31	0.46	150	35	156.3	370	55.28	35.38	-115	6.3	220
Moisture Content	No												

Mapped Area

square feet	acres
46670	1.07

Pass Count

min.	avg.	max.
1	1.3	6

Elevation (ft)

min.	avg.	max.
1018.06	1056.91	1102.68

Velocity (fps)

min.	avg.	max.
0.23	5.48	6.33

Materials

name	id	% of total	area-square ft	area-acres	tl-xmv	tl-Mr	tl-k value	tl-w%
Soil Cement_Subgrade	31001	100	46670	1.071	12	3000	150	40

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Figure 3. Map summary page.

Quality Analysis Summary Page

The Quality Analysis Summary page scores the area mapped across key metrics for each parameter identified for the project. A separate compaction map page will be generated for each compaction parameter measured for the project (examples: k-value, resilient modulus, xmv). These metrics score parameter performance of the area mapped for the report, giving the reader a quick summary of compaction quality achieved. Metrics are displayed in green if they meet or exceed the target value and shown in red if they do not meet the established target.

E-Compaction Report

Project: US52 Dubuque County	Mapping Duration (hrs): 0.45	Operator: Ingios Geotechnics inc
Map ID: iadot_31-us52_cs56-fcs00210_2020_08_12_114345a	No. of Measurements: 46670	Machine ID: Ingios_FCS00210
Date and Time: 8/12/2020 11:43:45 AM	Location: Dubuque County	State Plane: 1401 IOWA NORTH

QUALITY ANALYSIS SUMMARY - k-Value

Quality Value	Criteria
70.31	CQI > = 95
58	80% of k-Value MVs >= 150
35.38	COV <= 20
31.92	% i-Score Blob Area >= 200 ft^2
	80% of w% >= w% tv

Compaction Quality Index(CQI): Relative compaction quality index based on the percentage of the geospatial area that meets the minimum target values and accounts for the uniformity of compaction. The default minimum target CQI is 95% using a uniformity weight factor of 50%.

Percent Passing Target Values: Number of geospatial grid points from the output that meet or exceed the target value for the selected material. The default target % _Passing TV 80%.

Coefficient of Variation (COV): Calculated from the ratio of the standard deviation to the mean based on the MVs reported at each grid point of the mapping area. The default target COV is 30%. Description of COV ranges: 20% = Low Variability; 20 to 40% = Moderate Variability; and greater than 40% = High Variability.

i-Score Blob (%): Represents the percentage of the area within the map area that has been identified from i-Score Blob Analysis as a prioritized contiguous area that is > = 200 sq. ft, with MVs < target values. Description of i-Score Blob: 0% = No rework needed; 0 to 20% = Some rework needed; 20 to 30% = Moderate rework needed; > 30% = Signficant rework needed.

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Figure 4. Sample Quality Analysis Summary page showing k-value scores.

Compaction Map Page

Compaction Map pages geospatially display the results of compaction quality data overlaid on a static geo-referenced aerial image of the project site. Each data point measured is color-coded and displayed on the map. The color legend lets the viewer know how data points correspond to the parameter value and with respect to target. Summarized data can also be found at the top of the page. A compaction map page is available in the report for each parameter measured for a project. Potential compaction map pages include:

- k-Value
- Delta k-Value
- Blob Delta k-Value i-Score

E-Compaction Report

Map ID: iadot_31-us52_cs56-fcs00210_2020_08_12_114345a

Parameter	Measured	% Passing	CQI	CI	Calc. TV	min.	avg.	max.	std. dev.	cov(%)	min.-delta	avg.-delta	max.-delta
k-value	Yes	58	70.31	0.46	150	35	156.3	370	55.28	35.38	-115	6.3	220

Figure 5. Sample compaction map page showing k-value data overlaid on aerial imagery.

Pass Count Map

The Pass Count Map provides a visual to indicate the number of times a point was traveled over by the compaction machine during a mapped run. Each time a grid point is traveled over is considered a pass. The number of passes over each grid point is totaled and color-coded pass count data is overlaid on the project's geo-referenced image.
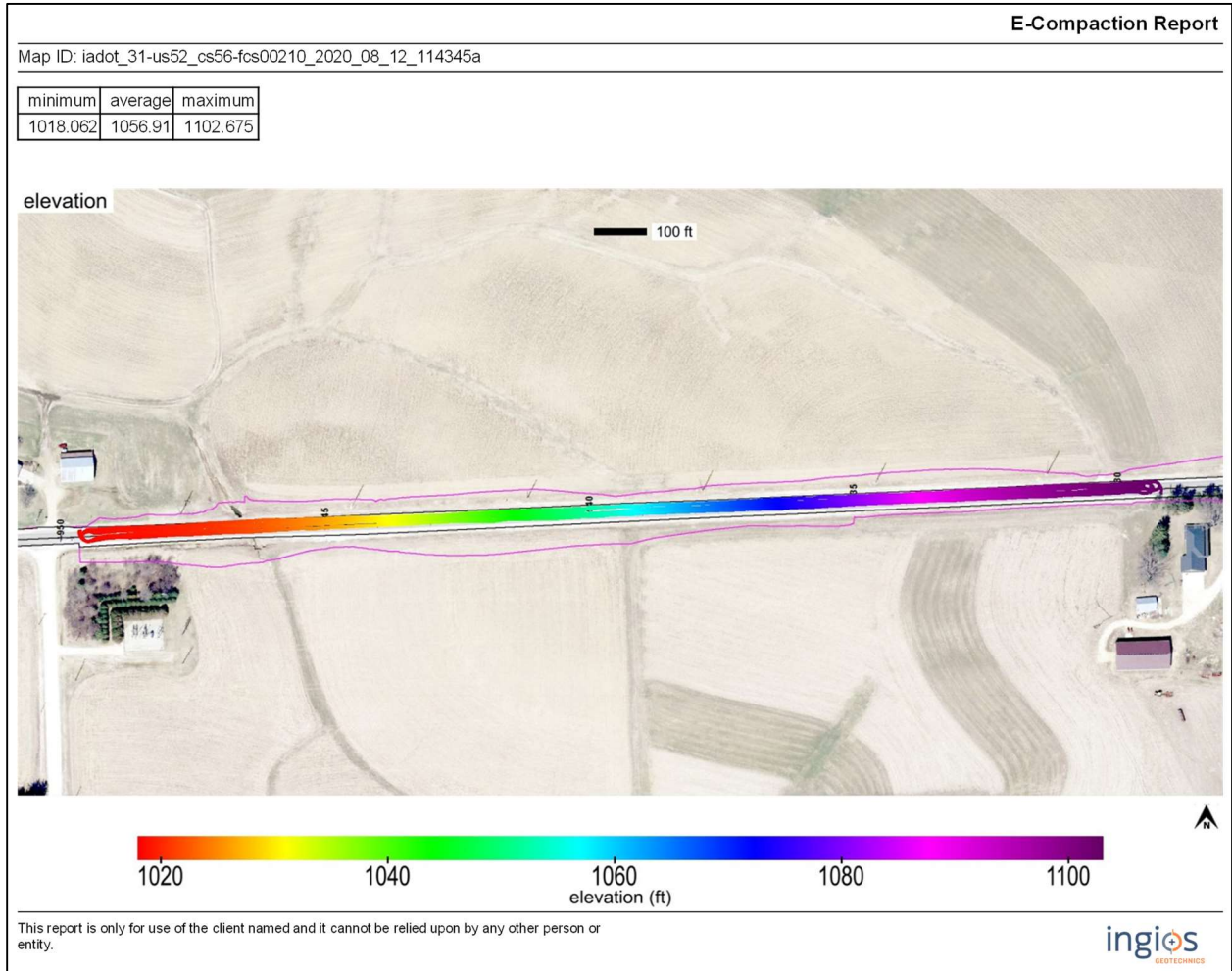

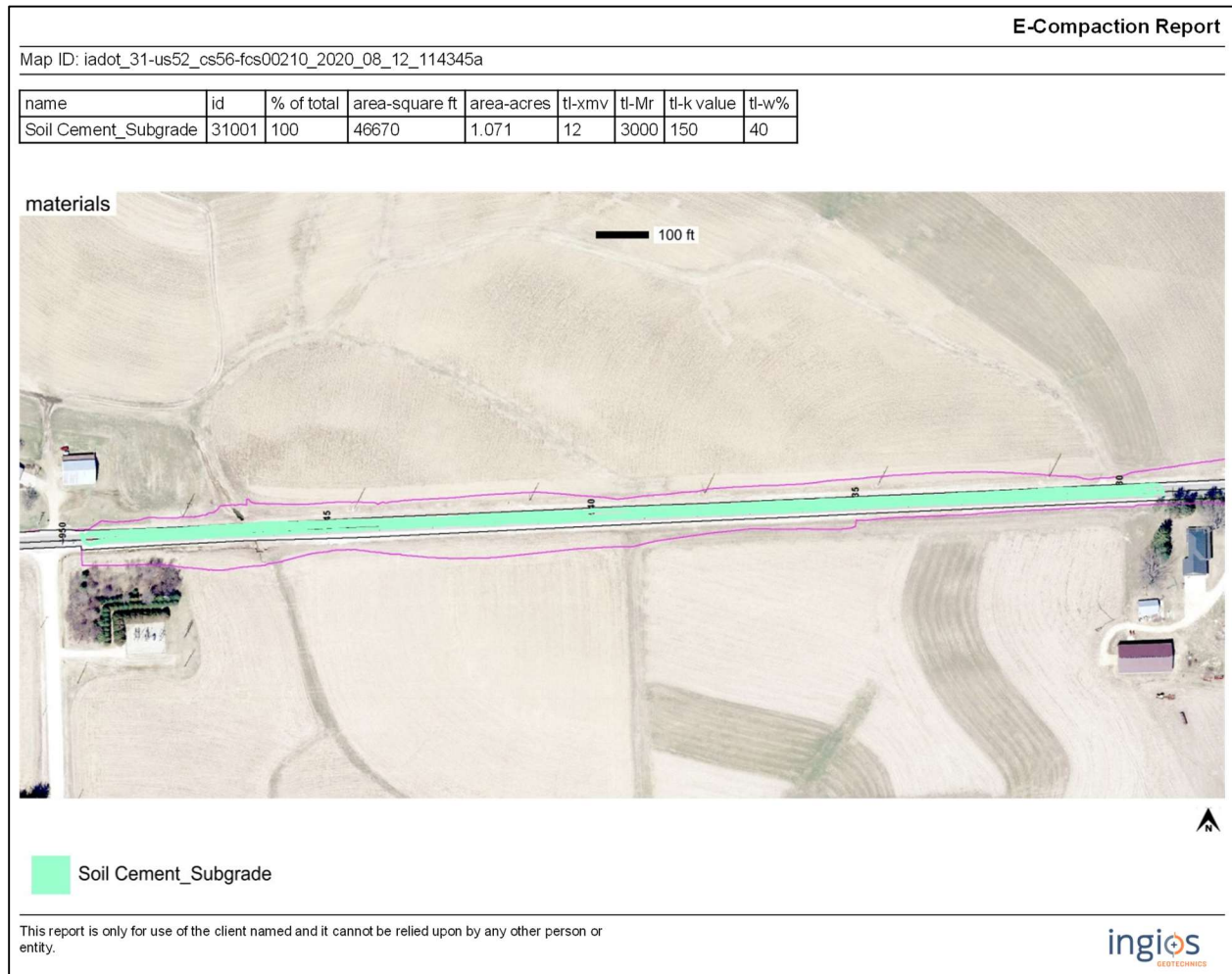**Figure 6. Sample pass count map.**

Elevation Map

The Elevation Map shows the elevation recorded at each point during a mapped run. Elevation is color-coded overlaid on the project's geo-referenced image.

Figure 7. Sample elevation map.

Material ID Map

The Material Map displays color-coded material data overlaid on a static geo-referenced image of the project site. One or more materials can be mapped on a single mapping and is controlled by the operator in real-time during the mapping.

name	id	% of total	area-square ft	area-acres	tl-xmv	tl-Mr	tl-k value	tl-w%
Soil Cement_Subgrade	31001	100	46670	1.071	12	3000	150	40

E-Compaction Report

Map ID: iadot_31-us52_cs56-fcs00210_2020_08_12_114345a

materials

100 ft

Soil Cement_Subgrade

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Figure 8. Sample material ID map.

The Digital Records page displays images that have been uploaded to the compaction report via the Upload functionality of COMP-Score CONNECT.

Figure 9. Sample digital records page.

Review Page

The Review Page displays information on reviews that have been performed for the compaction report. Each review consists of reviewer name, status and optional comments. Multiple reviews can be done on a single compaction report.

IOWA DOT   **E-Compaction Report**

Project:	29-US61-68	Mapping Duration (hrs):	0.54	Operator:	Ingios Geotechnics inc
Map ID:	iadot_29-us61-68_cs56-fcs00210_2020_05_11_155617	No. of Measurements:	63411	Machine ID:	Ingios_FCS00210
Date and Time:	5/11/2020 3:56:17 PM	Location:	Des Moines County	State Plane:	1402 IOWA SOUTH

REVIEW NOTES

2020-05-11 16:25
David White, P.E.
FINAL
Area mapped as part of calibration activity.

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Figure 10. Sample review page.

Future Enhancement Examples

It is Ingios' goal to continue to evolve the COMP-Score CONNECT web application to meet growing demand for additional features. Some examples of future enhancements that would likely benefit the DOT include:

- Adding the ability to export underlying data directly to csv.
- Provide a compaction map page that shows thickness of material placed at the project site by lift.
- Add a compaction report page that specifically identifies areas of concern where further testing for modulus verification may be warranted.
- Add a compaction report page that identifies blob areas on a map highlighting areas on that may be suffering from poor compaction quality.