



RPUG 2024
Road Profile Users' Group

April 29 - May 2



ST. AUGUSTINE
FLORIDA

New Technology For An Old World

From 2D to 3D Future of ProVAL

BY

GEORGE K. CHANG, PE, PHD

TRANSTEC GROUP

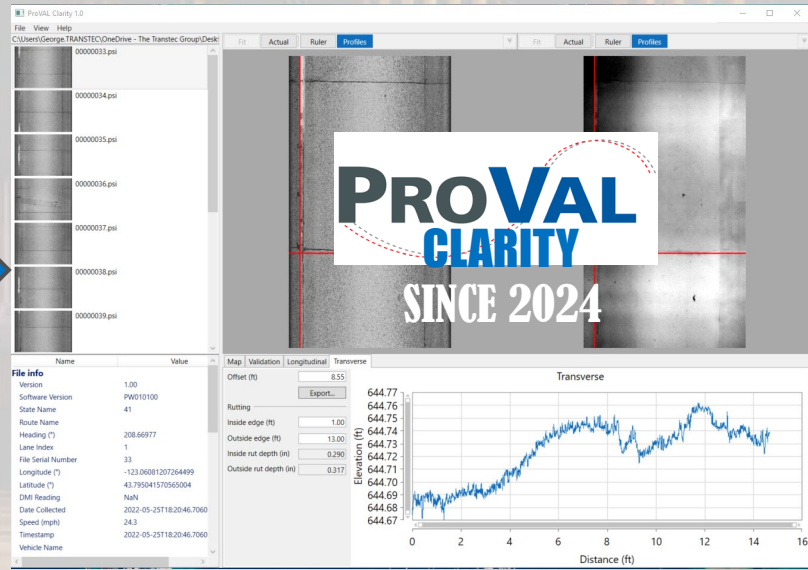
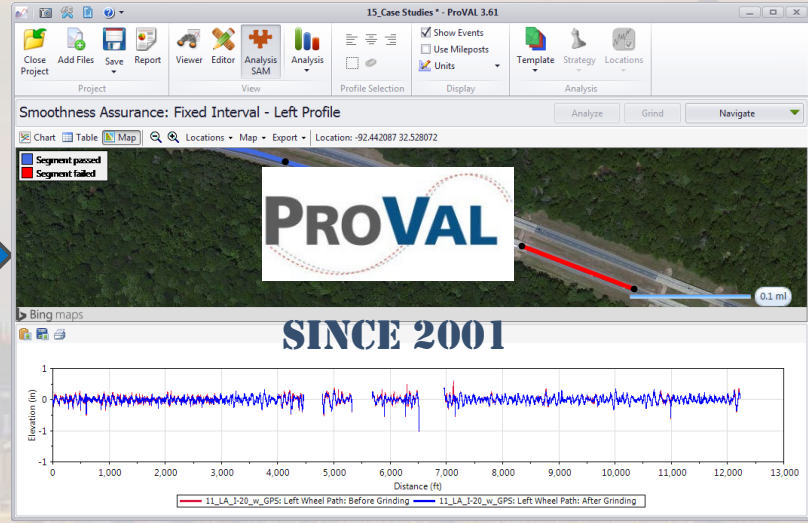
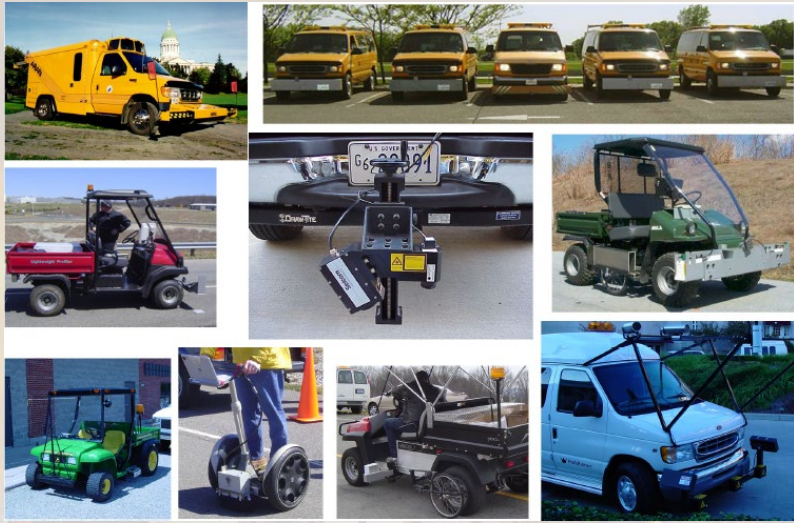


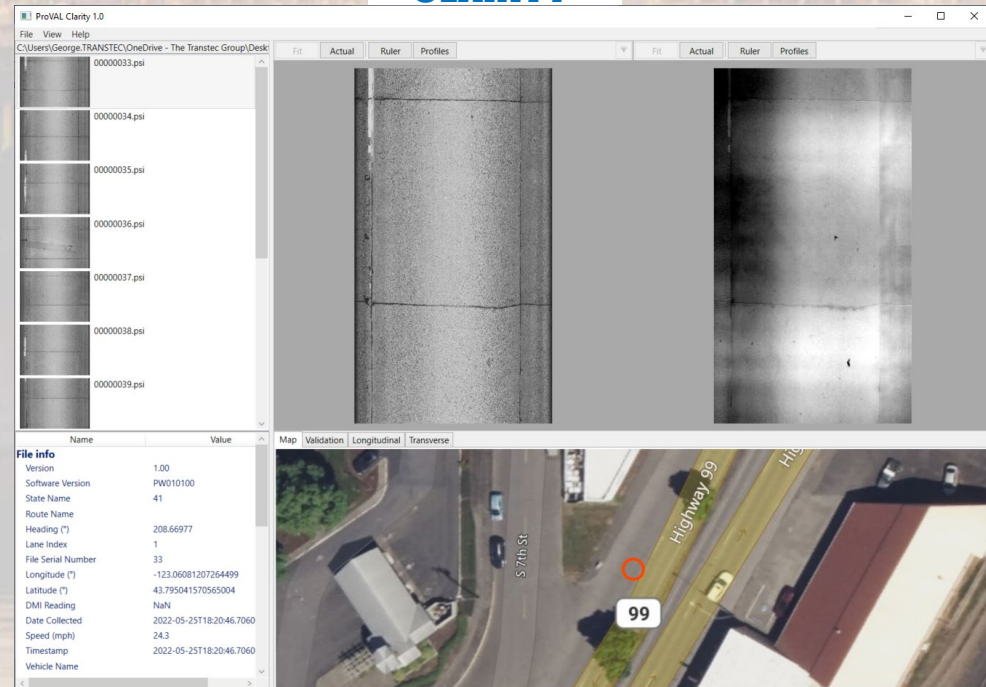
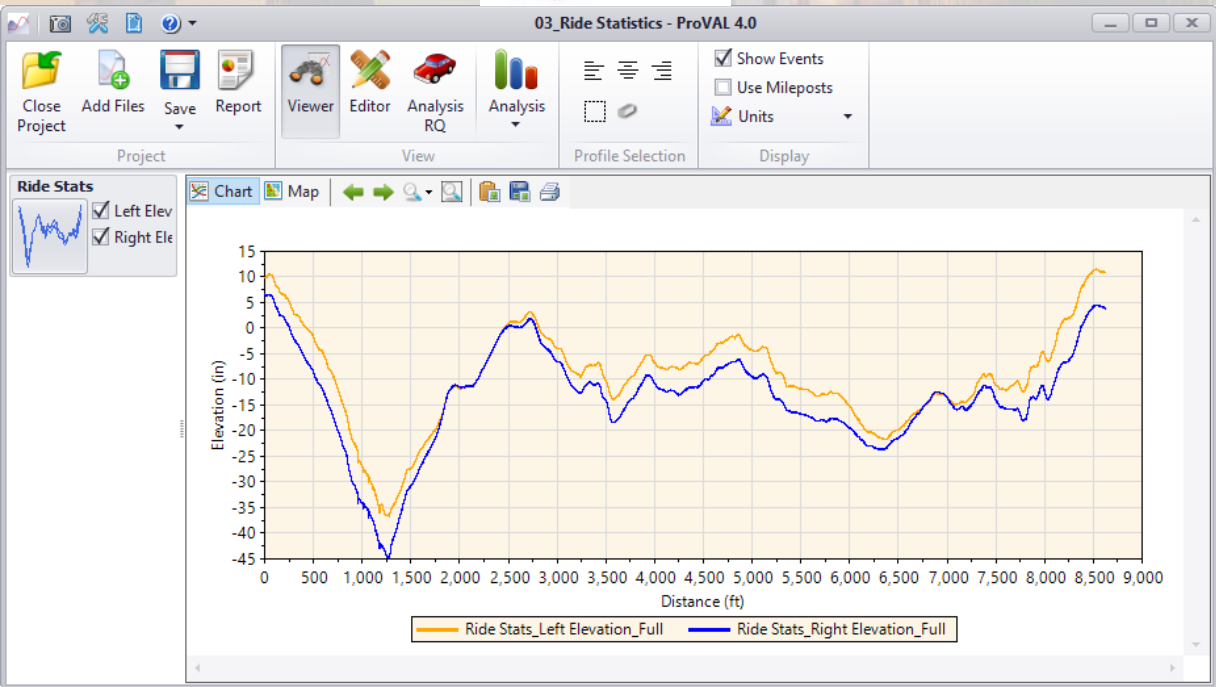
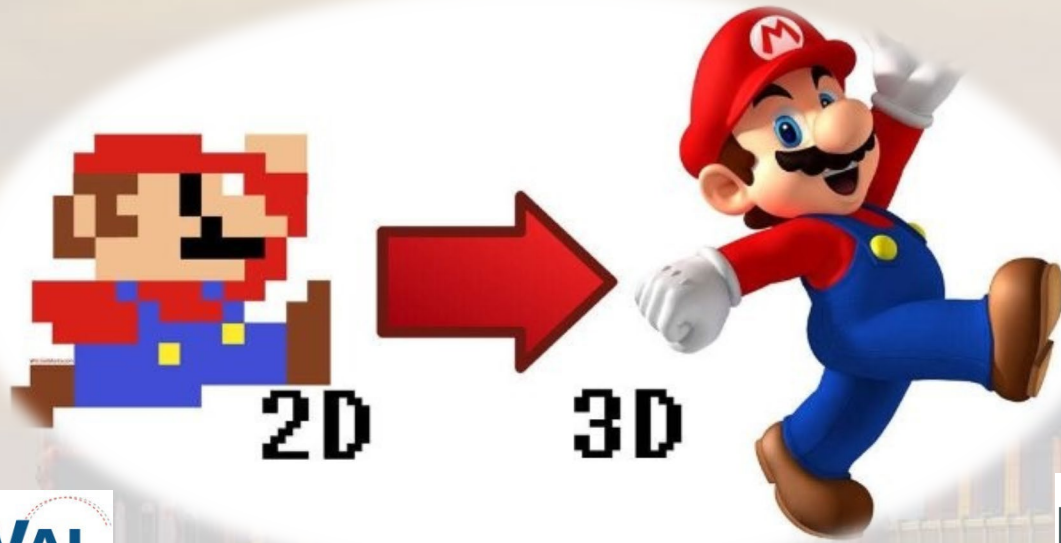
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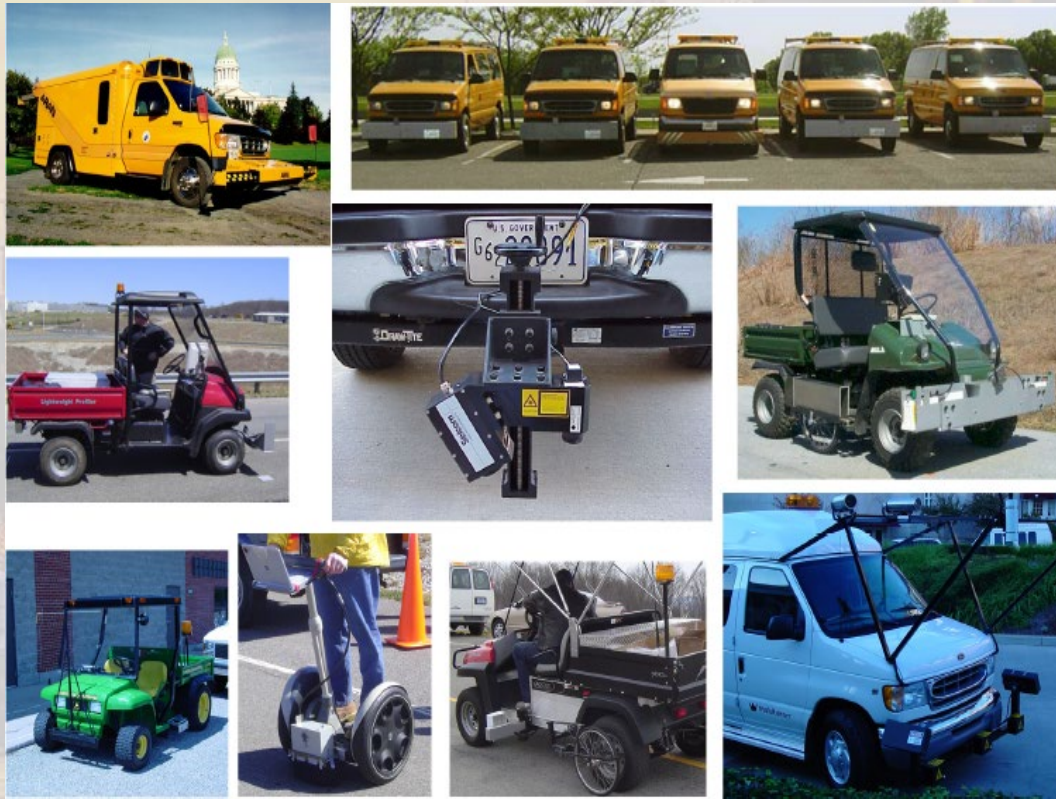
TPF TRANSPORTATION POOLED FUND



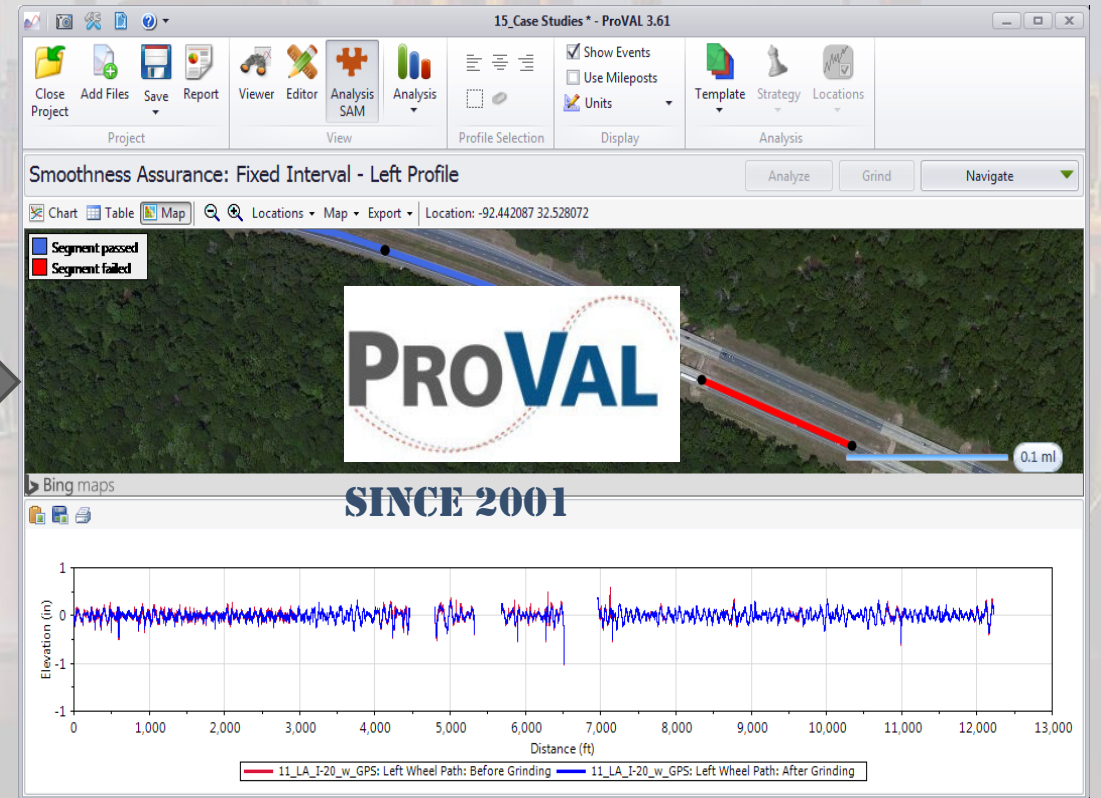


ProVAL 4.0

Many Different Profilers...



One Standard Software







Who Sponsors ProVAL ?

- **US DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION (FHWA)**
- **LONG TERM PAVEMENT PERFORMANCE PROGRAM (LTPP)**
- **PROFILE POOLED FUND STUDY – TPF-5(354)**





ProVAL Implements AASHTO/ASTM Standards

Standard Practice for Certification of Inertial Profiling Systems

AASHTO Designation: R 56-14¹

Standard Practice for Evaluating Faulting of Concrete Pavements

AASHTO Designation: R 36-17¹

Technical Section: 5a, Pavement Measurement

Release: Group 1 (April 2017)

Standard Specification for Smoothness of Pavement in Weigh-in-Motion (WIM) Systems

AASHTO Designation: M 331-17¹

Technical Subcommittee: 5a, Pavement Measurement

Release: Group 1 (April)



Designation: E2560 - 23

Standard Specification for Data Format for Pavement Profile¹

This standard is issued under the fixed designation E2560; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last approval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification describes a data file format for pavement profile.

1.2 This specification describes the variables and sizes of all data that will be stored in the file. The file is in binary format and is fully documented in this specification.

1.3 This specification is designed to be independent of hardware platforms, computer languages, and operating systems (OS).

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

- 2.1 *ASTM Standards:*²
- E867 Terminology Relating to Vehicle-Pavement Systems
- 2.2 *IEEE Standards:*³
- IEEE 754-2008 (2008) Floating-Point Arithmetic

3. Terminology

3.1 Definitions:

3.1.1 Terminology used in this specification conforms to the definitions included in Terminology E867.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *signed*—integer capable of representing negative values.

3.2.2 *unsigned*—integer only capable of representing non-negative values.

3.2.3 *int8*—data type for an 8-bit, unsigned integer.

3.2.4 *int32*—data type for a 32-bit, signed integer.

3.2.5 *single*—data type for a 32-bit, signed real number, such as single precision IEEE floating point.

3.2.6 *string*—data type for a variable-length ASCII string. No null character is included at the end of the string. A separate field defines the length of the string.

3.2.7 *3-byte string*—an ASCII string of three characters in length. No null character is included at the end of the string.

3.2.8 *4-byte string*—an ASCII string of four characters in length. No null character is included at the end of the string.

3.2.9 *8-byte string*—an ASCII string of eight characters in length. No null character is included at the end of the string.

3.2.10 *array (numeric data type)*—sequence of data of the specified numeric data type. Only the values are stored; no information about the array is stored.

3.2.11 *array (string)*—ASCII strings separated by a tab. There is no tab after the last string.

3.2.12 *double*—data type for a 64-bit, signed real number, such as double precision IEEE floating point.

3.3 *Symbols:*

3.3.1 *n*—total channels of elevation data.

3.3.2 *m*—total number of test locations (that is, data points).

4. Profile Data Specifications

4.1 File Structure:

4.1.1 The general file structure is divided into five sections: (1) File Header, (2) Metadata, (3) Longitudinal Profile Data, (4) Transverse Profile Data, and (5) File Trailer. The five sections are stored sequentially. (See Fig. 1.)

4.1.2 Each of these portions of the file is described in the following sections, as well as the data types and other descriptors that will be required by the file. The data will be written to the file sequentially, with the offsets listed in the file header as guides to find various portions of the file. It is



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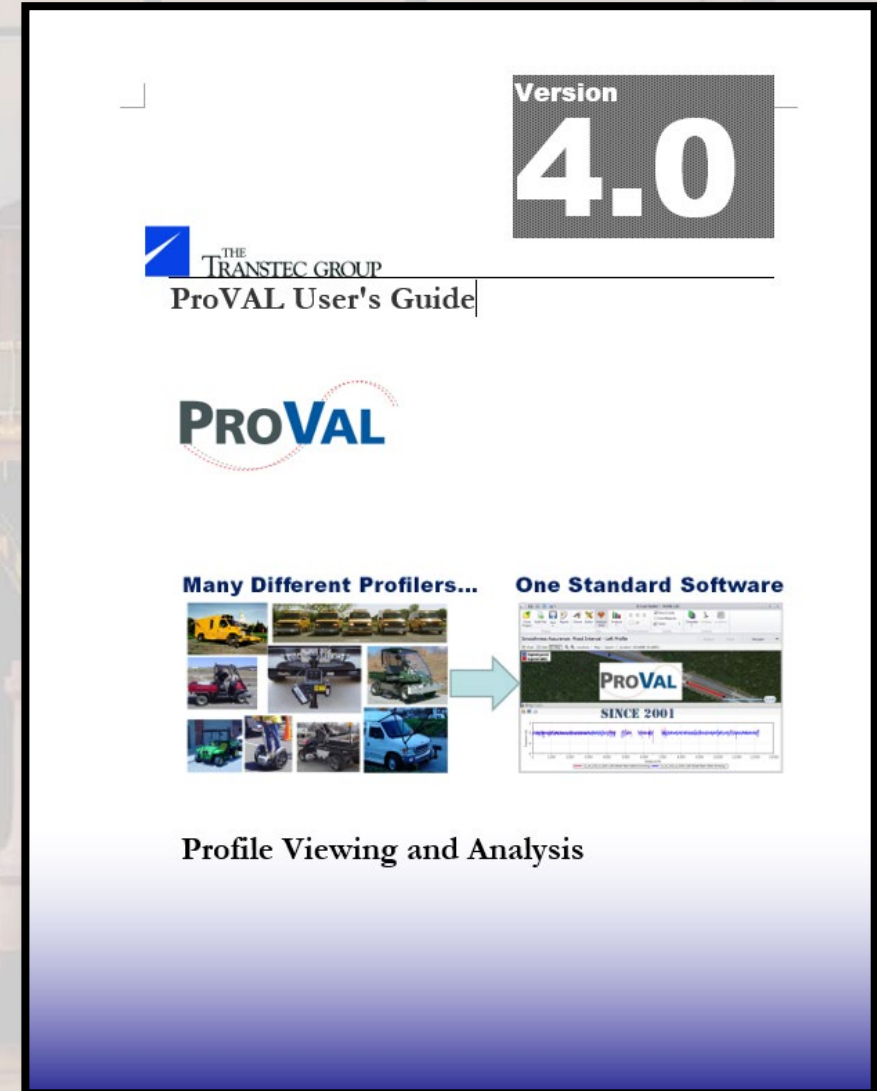
¹ This specification is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.31 on Methods for Measuring Profile and Roughness.
Current edition approved May 1, 2023. Published May 2023. Originally approved in 2007. Last previous edition approved in 2017 as E2560 - 17. DOI: 10.1520/E2560-23.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.


³ Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.


ProVAL Functions

- **IMPORT PROFILE DATA**
- **VIEW PROFILES/MAP**
- **EDIT/FILTER/ID JOINT LOCATIONS**
- **MANY ANALYSES**
- **REPORTING**




Version 4.0

 **THE TRANSTEC GROUP**
ProVAL User's Guide



Many Different Profilers... One Standard Software



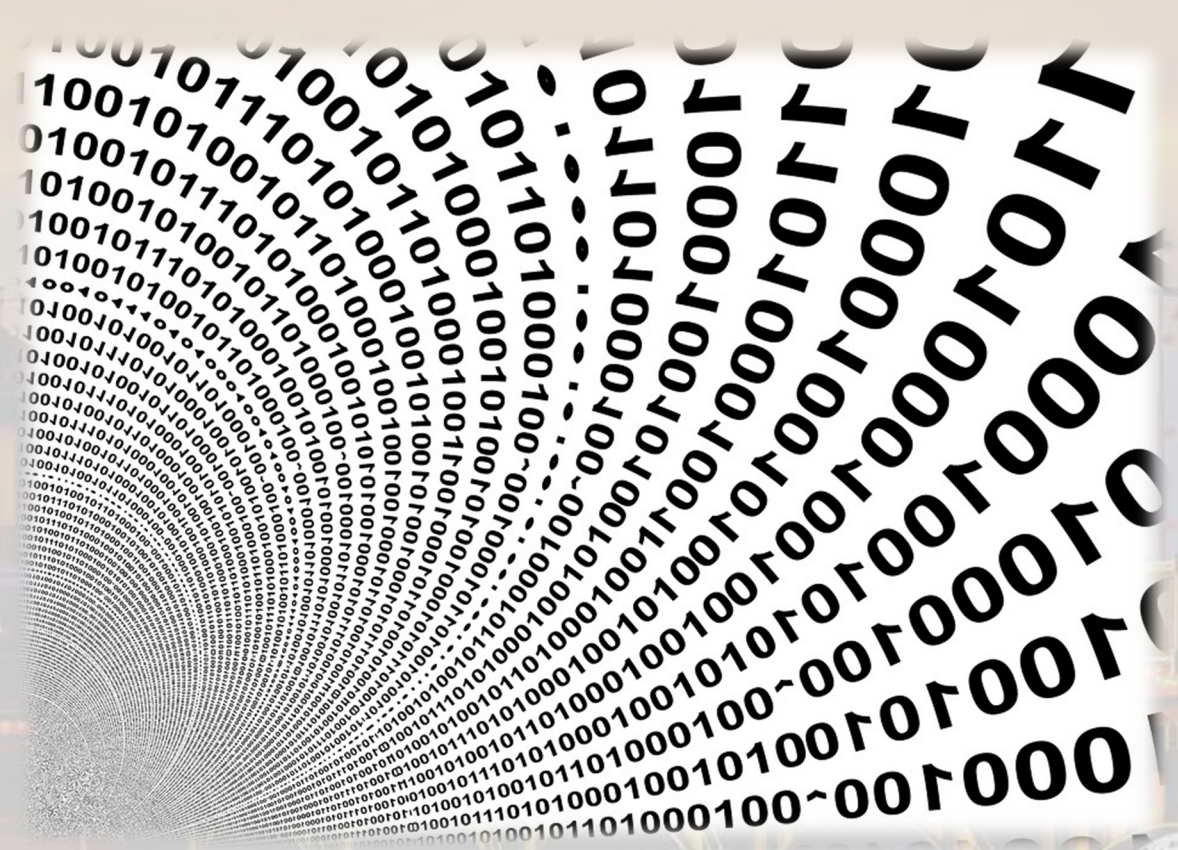
Profile Viewing and Analysis



ProVAL 4.0 Analyses

- **AUTOMATED FAULTING MEASUREMENTS (AFM)**
- **AUTOMATED PROFILE SYNCHRONIZATION (APS)**
- **CURLING AND WARPING**
- **POWER SPECTRAL DENSITY (PSD)**
- **PRECISION AND BIAS**
- **PROFILER CERTIFICATION MODULE (PCM)**
- **PROFILE SCREENER (SNIFFER)**
- **RADIOGRAPH SIMULATION**
- **RIDE QUALITY**
- **ROLLING STRAIGHTEDGE (RSE)**
- **SMOOTHNESS ASSURANCE MODULE (SAM)**
- **OPTIMAL WIM SITE LOCATOR (OWL)**

64-bit ProVAL 4.0





Close Add Files Save Report Viewer Editor Analysis PCM Analysis

Project View Profile Selection Display Analysis

Show Events Use Milepost: Units Template

Profiler Certification: Inputs

File	Sample Interval (in)	Profiles	Basis	Run
<input checked="" type="checkbox"/> Test 01	6.00	Left + Right	<input type="checkbox"/>	1

Use decimation

Use interval adjustment (%)

Use padding

Use upsampling

Basis Filter
[IRI \(without 250mm Filter\)](#)

Comparison Filter
[IRI \(with 250mm Filter\)](#)

Close Add Files Save Report Viewer Editor Analysis SAM Analysis

Project View Profile

Smoothness Assurance

Short Continuous

Ride Quality Index IRI

Segment Length (ft) 25.00

Threshold (in/mi) 90.00

Histogram

Long Continuous

Ride Quality Index (None)

Fixed Interval

Ride Quality Index MRI

Segment Length (ft) 528.00

Threshold (in/mi) 60.00

Comparison

Type Profile

Straightedge Length (ft) 10.00

Filter

[Butterworth High-pass \(100.00 ft\)](#)

Short Continuous

Ride Quality Index IRI

Segment Length (ft) 25.00

Threshold (in/mi) 90.00

Histogram

Long Continuous

Ride Quality Index (None)

Fixed Interval

Ride Quality Index MRI


Segment Length (ft) 528.00

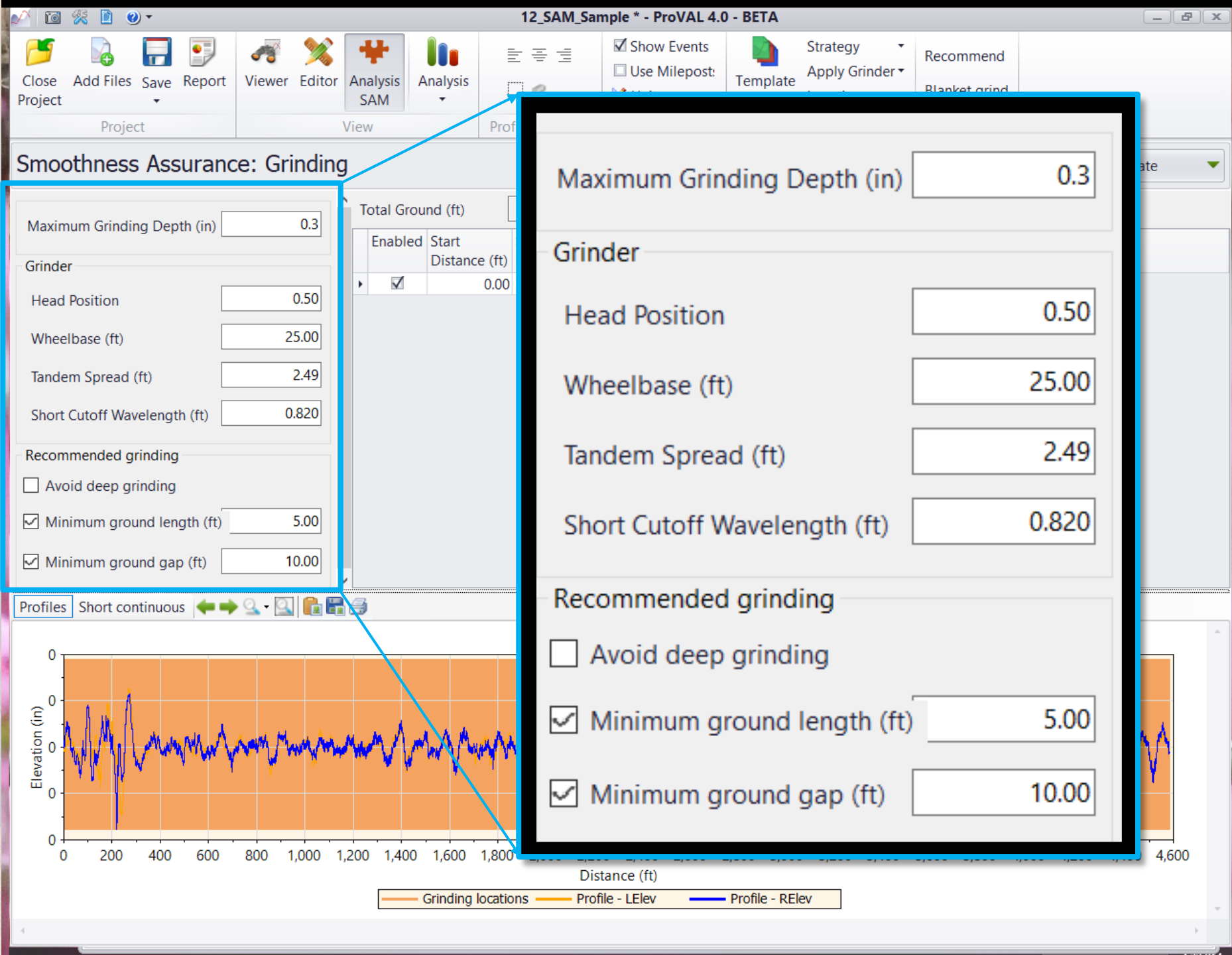
Threshold (in/mi) 60.00

Comparison

Type Profile

Analyze Grind Navigate



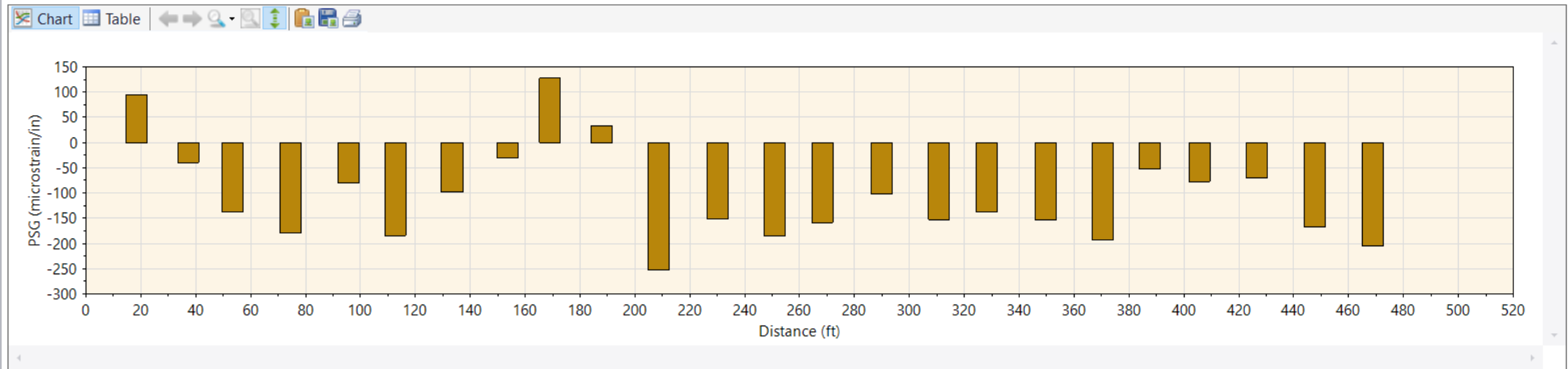
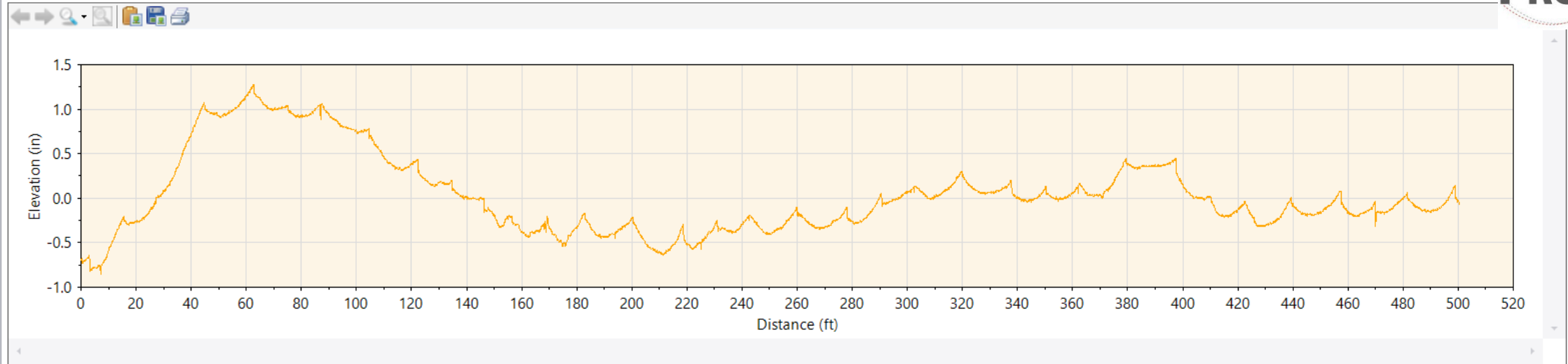


Close Add Files Save Report Viewer Editor Analysis CW Analysis Profile Selection Display Analysis

Curling and Warping: Results

Analyze Navigate

File PSDSample1_Left Elevation

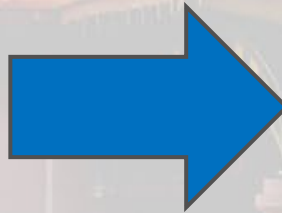




ProVAL Clarity 1.0

Different Transverse Profilers...

One Standard Software



ProVAL Clarity 1.0

File View Help

C:\Users\George\TRANSTEC\OneDrive - The Transtec Group\Desktop

00000033.psi
00000034.psi
00000035.psi
00000036.psi
00000037.psi
00000038.psi
00000039.psi

PROVAL CLARITY

Name	Value
Version	1.00
Software Version	PW010100
State Name	41
Route Name	
Heading (°)	208.66977
Lane Index	1
File Serial Number	33
Longitude (°)	-123.06081207264499
Latitude (°)	43.795041570565004
DMI Reading	NaN
Date Collected	2022-05-25T18:20:46.7060
Speed (mph)	24.3
Timestamp	2022-05-25T18:20:46.7060
Vehicle Name	

Map Validation Longitudinal Transverse

Offset (ft) Export...

Rutting

Inside edge (ft)

Outside edge (ft)

Inside rut depth (in)

Outside rut depth (in)

SINCE 2024

Elevation (ft)

Distance (ft)



Who Sponsors ProVAL Clarity?

- **2D/3D PAVEMENT IMAGE VIEWER PROGRAM**
- **PROFILE POOLED FUND STUDY – TPF-5(354)**
- **PROFILE POOLED FUND STUDY – TPF-5(399)**





ProVAL Clarity 1.0 Implements AASHTO Standards

Standard Specification for File Format of Two-Dimensional and Three-Dimensional (2D/3D) Pavement Image Data

AASHTO Designation: MP 47-24¹

Technically Revised: 2024

Technical Subcommittee: 5a, Pavement Measurement

AASHTO

American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

Standard Practice for Determining Pavement Deformation Parameters and Cross Slope from Collected Transverse Profiles

AASHTO Designation: R 87-18¹

Technically Revised: 2018

Technical Subcommittee 5a: Pavement Measurement

AASHTO

American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

ProVAL Clarity 1.0 Functions

- **IMPORT FILES IN MP 47 FORMAT**
- **VIEW 2D/3D INTENSITY/RANGE IMAGES**
- **RULERS**
- **MAP FILES**
- **VALIDATE FILES**
- **VIEW LONGITUDINAL PROFILES**
- **VIEW TRANSVERSE PROFILES AND RUTS**

Version **1.0**

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ProVAL Clarity User's Guide

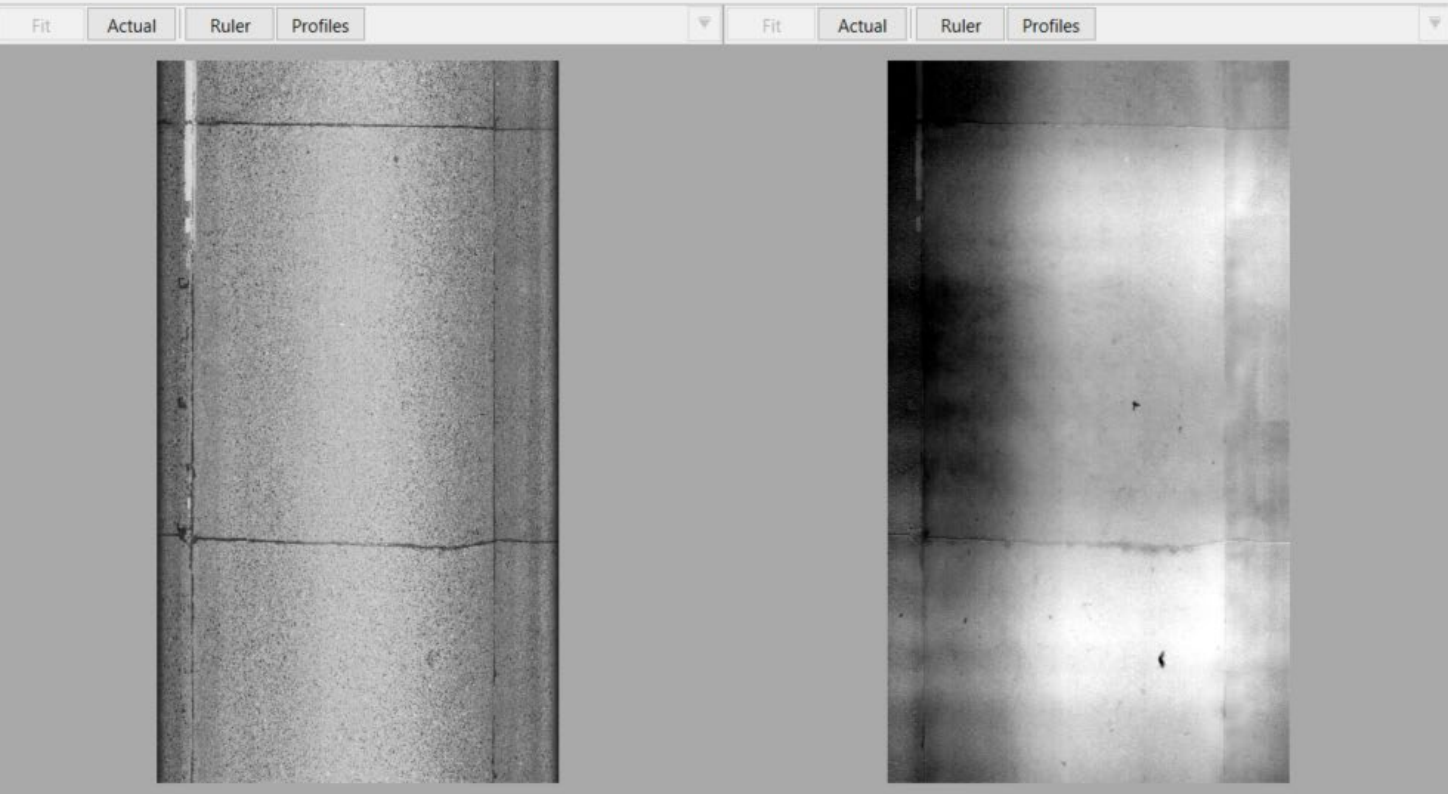
PROVAL CLARITY

Different Transverse Profilers... **One Standard Software**

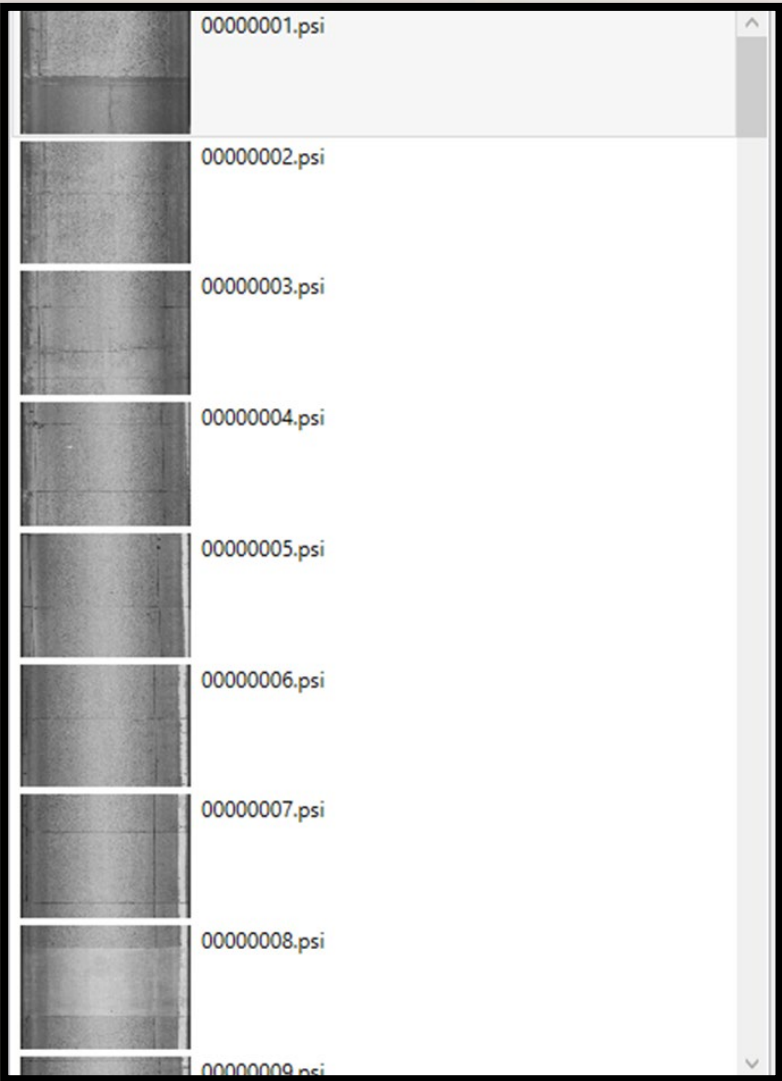
Transverse Pavement Profile Analysis

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	00000035.psi
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	00000038.psi
	00000039.psi

Name	Value
File info	
Version	1.00
Software Version	PW010100
State Name	41
Route Name	
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Lane Index	1
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Latitude (°)	43.795041570565004
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Speed (mph)	24.3
Timestamp	2022-05-25T18:20:46.7060
Vehicle Name	



Thumbnail and File Info



Name	Value
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Software Version	PW010100
State Name	41
Route Name	
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File Serial Number	1
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Speed (mph)	23.8
Timestamp	2022-05-25T18:20:23.1560000+00:00
Vehicle Name	
Operator Name	
Contractor Name	

View Intensity and Range Side-by-Side





Intensity

Name	Value
Intensity	
2D Pixel Storage Order	Row
2D Codec	BinUncompressed
2D Longitudinal Resolution (in)	0.171
2D Transverse Resolution (in)	0.069
2D Width (px)	2560
2D Length (px)	1855
2D Data Bit Depth	Depth8
2D Data Size	4748800
2D Compression Quality	0



Range

Range

3D Pixel Storage Order	Row
3D Codec	BinUncompressed
3D Longitudinal Resolution (in)	0.171
3D Transverse Resolution (in)	0.069
3D Vertical Resolution (in)	0.001
3D Width	2560
3D Length	1855
3D Data Bit Depth	Depth16
3D Data Size	9497600
3D Compression Quality	0
Baseline Range Value (ft)	643.38



Fit

Actual

Ruler

Profiles

Length (ft):

11.40

Clear



Ruler



Fit

Actual

Ruler

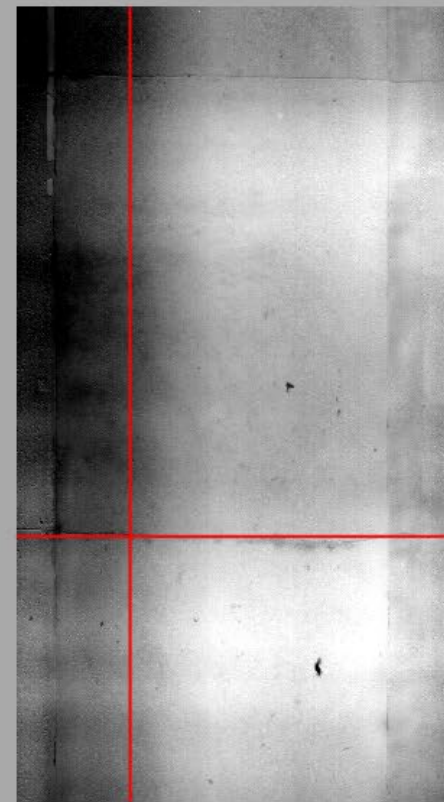
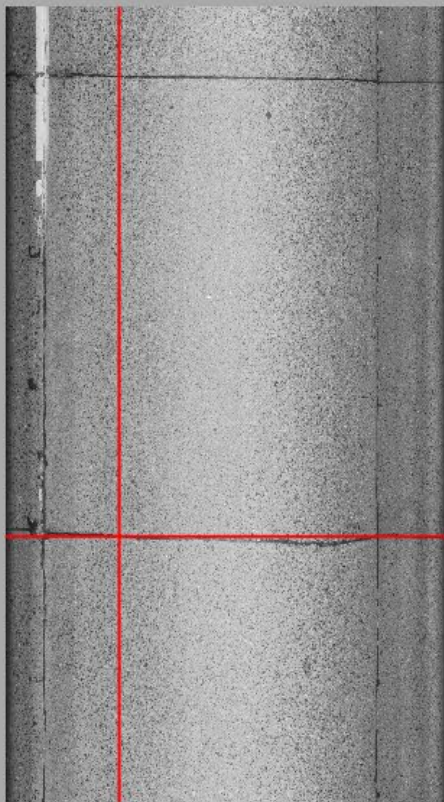
Profiles

Fit

Actual

Ruler

Profiles

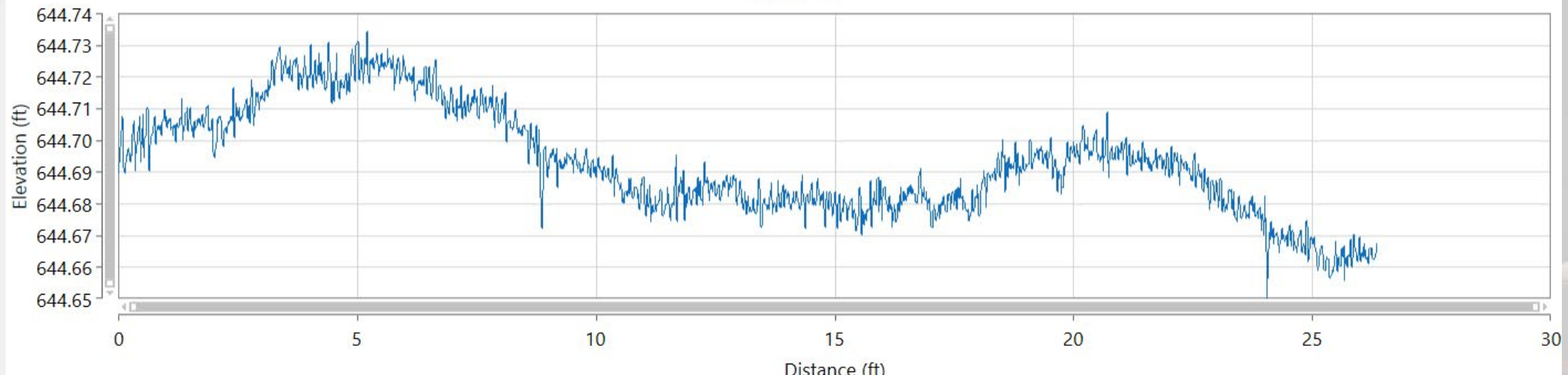


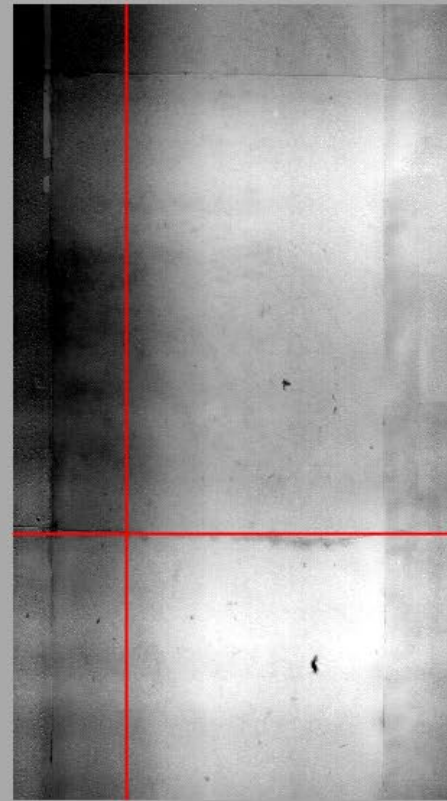
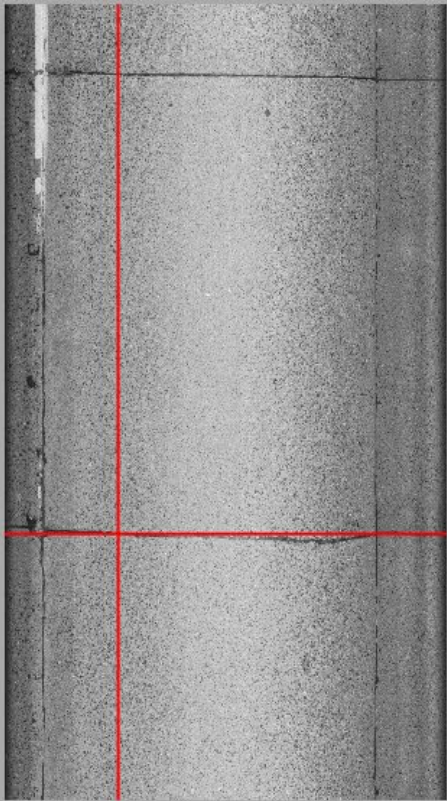
Map Validation Longitudinal Transverse

Offset (ft) 3.75

Export...

Longitudinal



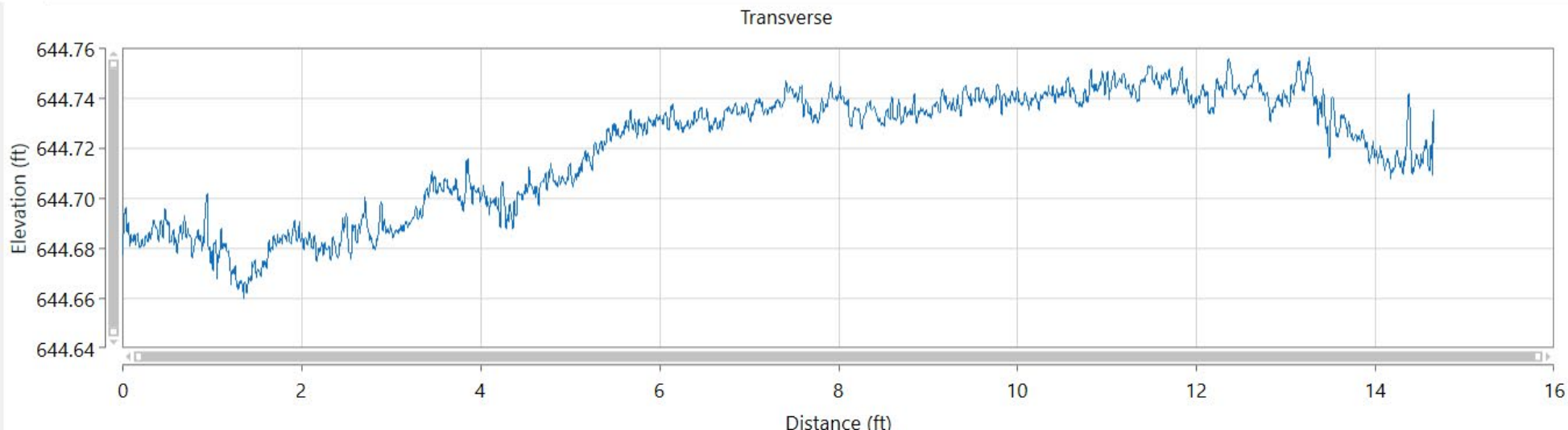


Map Validation Longitudinal Transverse

Offset (ft)

Rutting

Inside edge (ft)
Outside edge (ft)
Inside rut depth (in)
Outside rut depth (in)





ProVAL Clarity 2.0+ Expect to Implement AASHTO TPP Certification Standards

Standard Practice for Assessment of Static Performance in Transverse Pavement Profiling Systems

AASHTO Designation: PP 106-21¹
First Adopted: 2021
Technical Subcommittee: 5a, Pavement Measurement



American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

Standard Practice for Assessment of Body Motion Cancellation in Transverse Pavement Profiling Systems

AASHTO Designation: PP 107-21¹
First Published: 2021
Technical Subcommittee: 5a, Pavement Measurement



American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
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Standard Practice for Assessment of Navigation Drift Mitigation in Transverse Pavement Profiling Systems

AASHTO Designation: PP 108-21¹
First Published: 2021
Technical Subcommittee: 5a, Pavement Measurement



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Standard Practice for Assessment of Highway Performance of Transverse Pavement Profiling Systems

AASHTO Designation: PP 109-21¹
First Published: 2021
Technical Subcommittee: 5a, Pavement Measurement



American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
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Standard Practice for Assessment of Ground Reference Data for Transverse Pavement Profiling System Assessment

AASHTO Designation: PP 110-21¹
First Published: 2021
Technical Subcommittee: 5a, Pavement Measurement



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555 12th Street NW, Suite 1000
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Standard Practice for Definition of Terms Related to Transverse Pavement Profiling Systems and Ground Reference Equipment

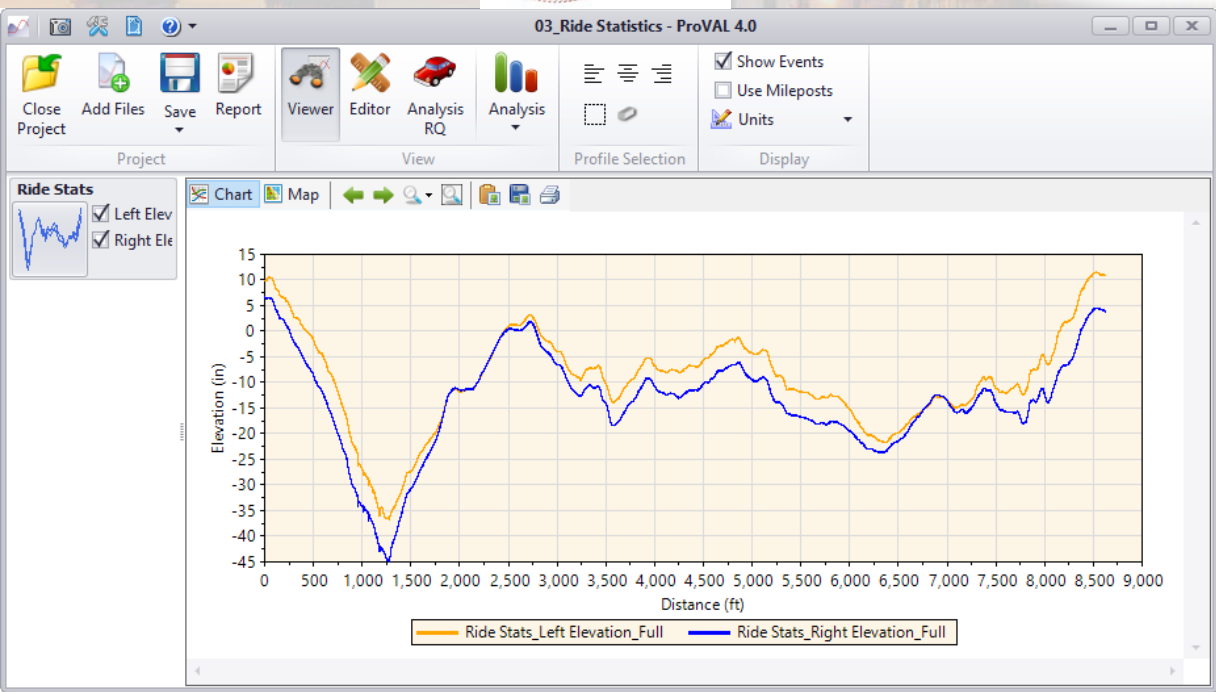
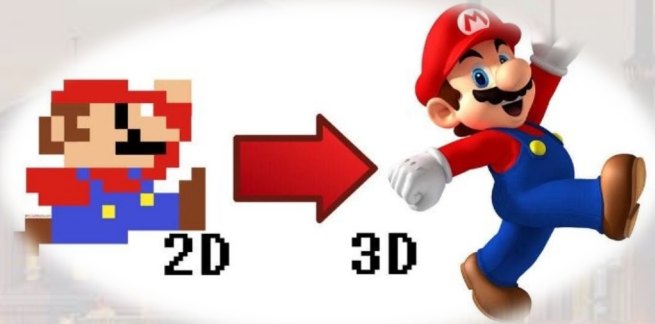
AASHTO Designation: PP 111-21¹
First Published: 2021
Technical Subcommittee: 5a, Pavement Measurement



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ProVAL Software Suite



ProVAL Clarity 1.0

File View Help

C:\Users\George\OneDrive - The Transtec Group\Desktop\MP47-1

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00000036.psi	
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00000038.psi	

File info

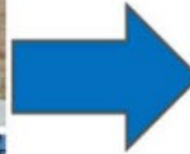
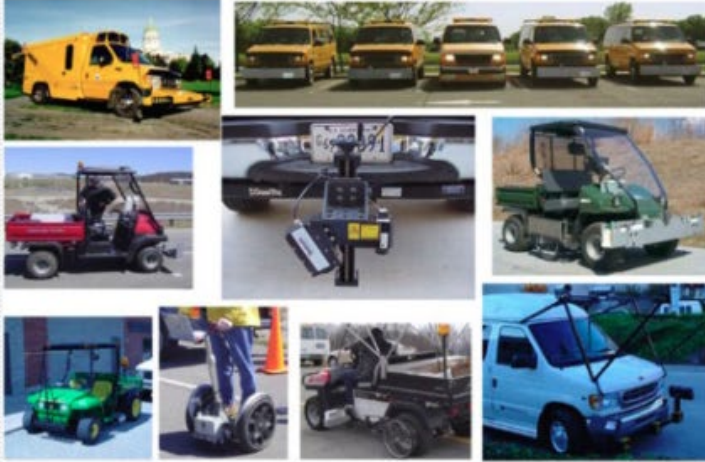
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Lane Index	33
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Longitude (°)	43.795041570565004
Latitude (°)	
DMI Reading	NaN

Fit Actual Ruler Profiles

Map Validation Longitudinal Transverse

S 7th St Highway 99

www.RoadProfile.com



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Transportation Pooled Fund - Solicitation Details

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Improving the Quality of Highway Profile Measurement

General Information

Solicitation Number:	1605
Status:	Solicitation posted
Date Posted:	Dec 04, 2023
Last Updated:	Mar 18, 2024
Solicitation Expires:	Dec 04, 2024
Partners:	AL, FHWA, GADOT, IL, IN, KY, MS, ND, NV, NY, OH, PADOT, TX
Lead Organization:	Illinois Department of Transportation

PROVAL

PROVAL
CLARITY

FUTURE
JUST AHEAD

Commitment Start Year:	2024
Commitment End Year:	2029
100% SP&R Approval:	Not Requested
Commitments Required:	\$2,250,000.00
Commitments Received:	\$2,060,000.00

Contact Information

Lead Study Contact(s):	John Senger
	John.Senger@Illinois.gov



RPUG 2024
Road Profile Users' Group

April 29 - May 2



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New Technology For An Old World

THANK YOU!

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