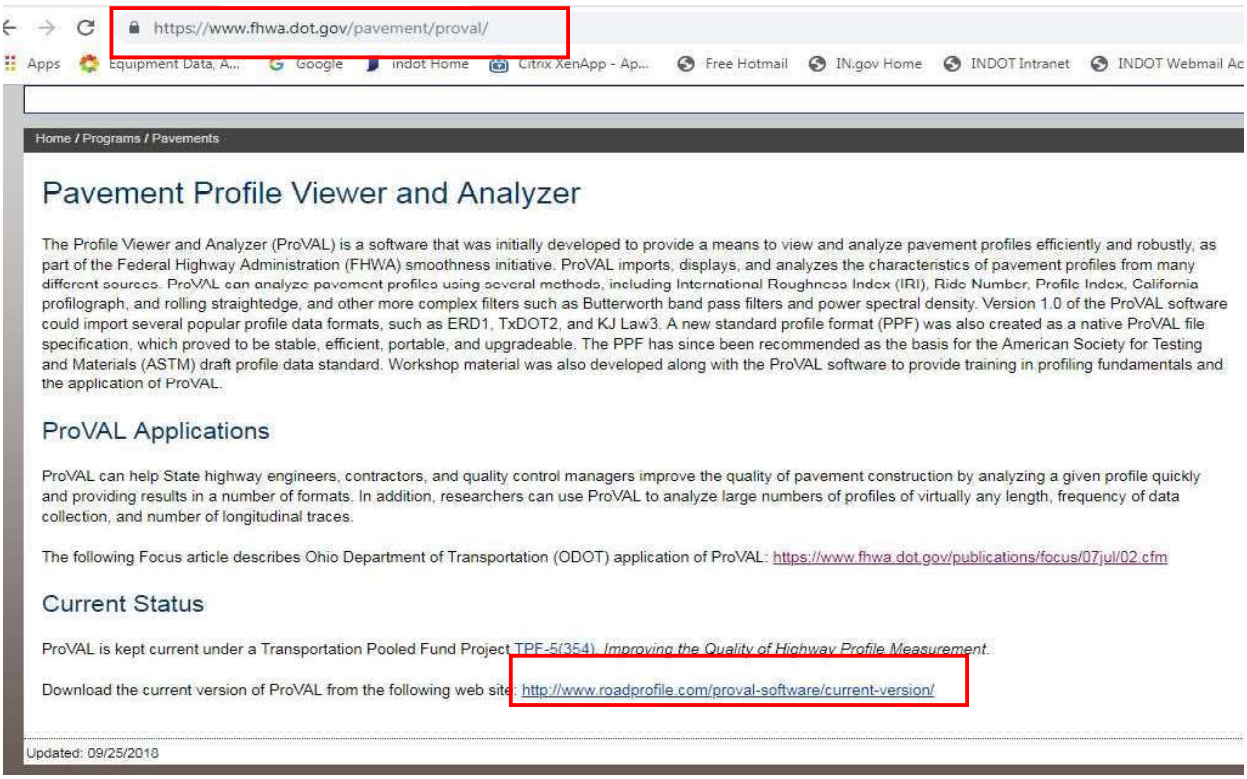
IRI Field Guide
for ProVAL 4.0

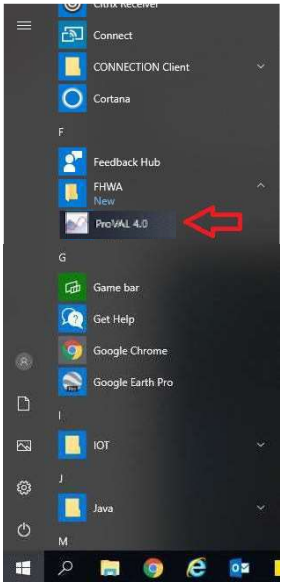
***The steps in this Field Guide are intended to be completed by the contractor performing the high-speed inertial profile data collection. After preparing the files, analyzing the data, and generating reports in ProVal, all files are to be submitted to the INDOT PE/S for review. The INDOT PE/S will review the ProVAL files and utilize the smoothness information to generate smoothness payment utilizing the Dept spreadsheets as shown in this guide. Any corrective action required for smoothness sections exceeding the contract thresholds will be performed in accordance with the contract documents, but only after a field review is completed by the PE/S. The guidance document in the appendix may be utilized as an aid to determine whether corrective action is necessary for each smoothness section or each ALR as applicable.**

ProVAL Applications can be downloaded from FHWA website:
https://www.fhwa.dot.gov/pavement/proval/

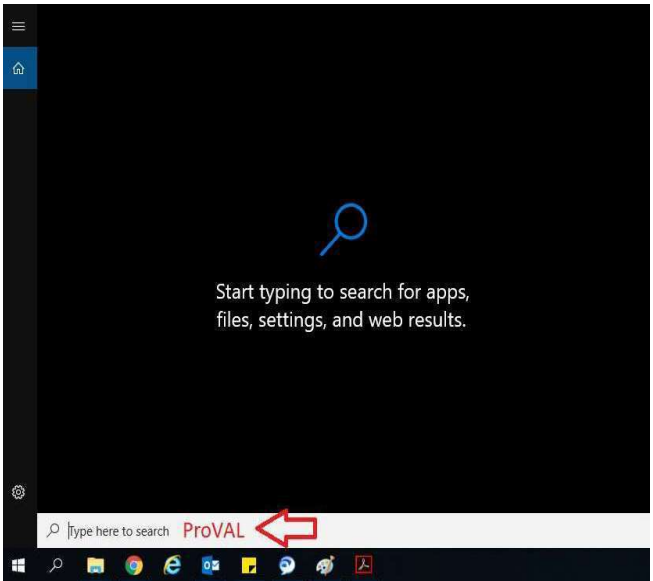


1) Open up ProVAL by either going to the Start button → All Programs → FHWA → ProVAL or typing ProVAL into the search bar located in the Start menu.

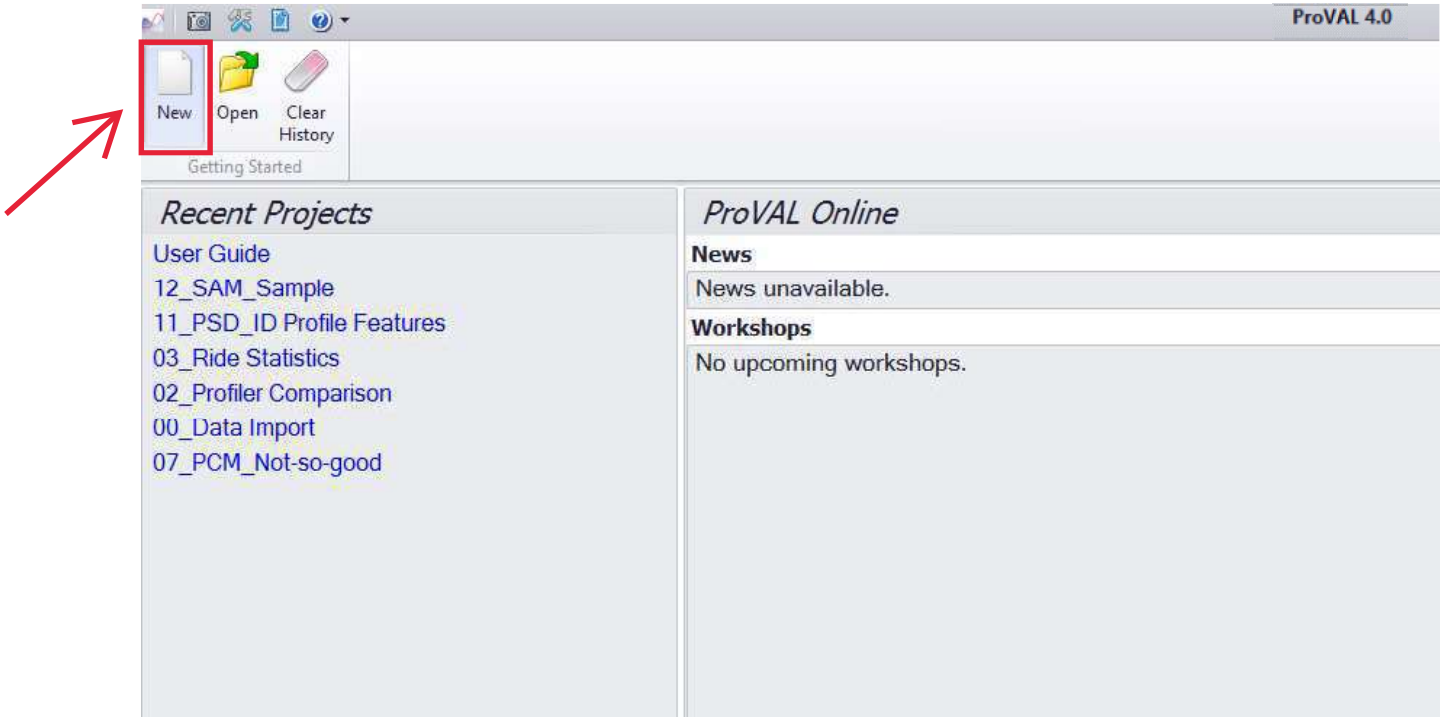
(Windows 10)



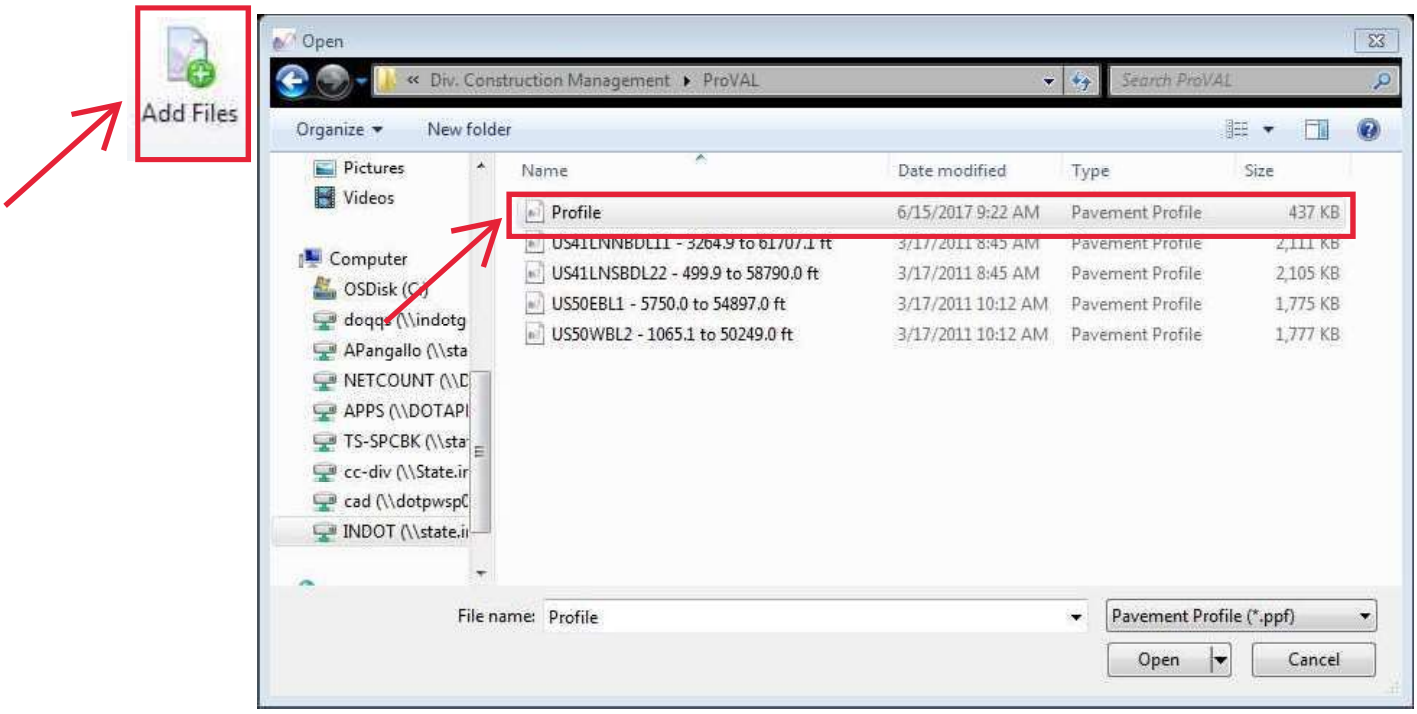
or



2) Select **New** to begin a new project file

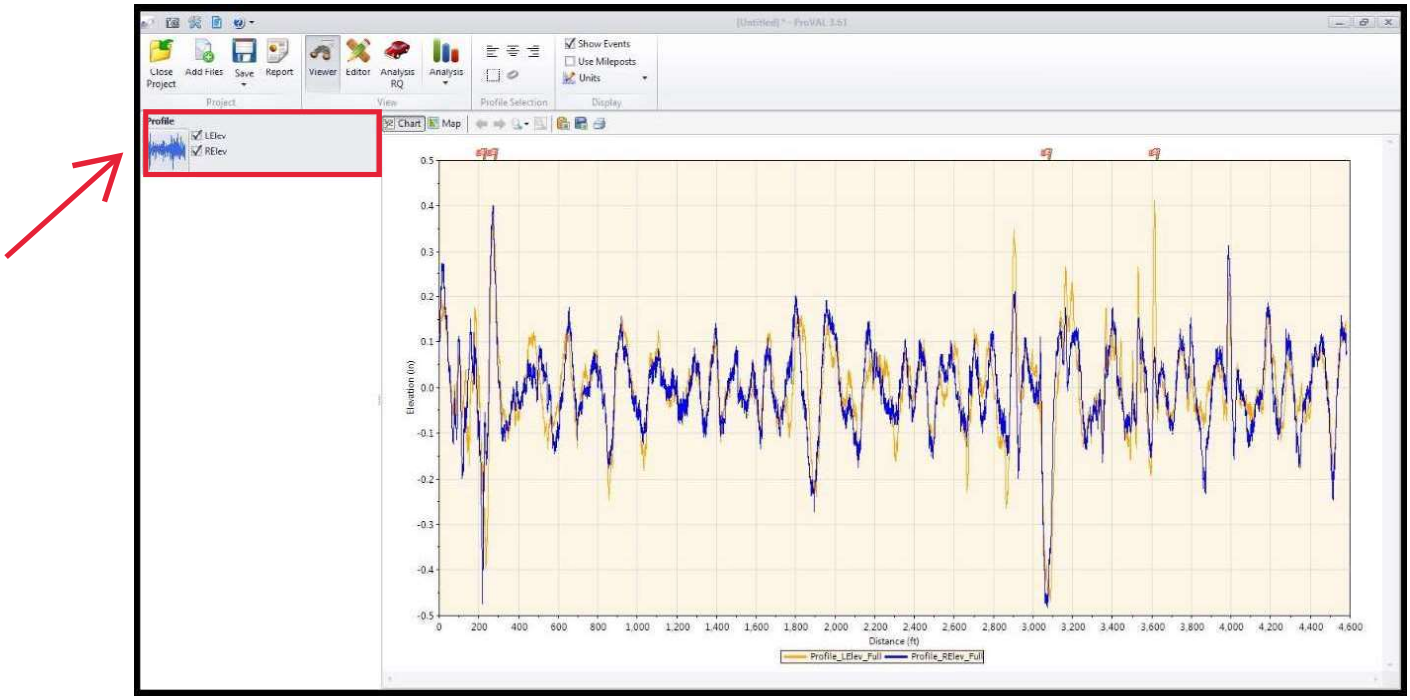


3) The data file the Contractor has sent needs to be downloaded onto this project file. Select **Add Files** and browse the folders where you placed the Contractor's data file (window below is only an example of a folder location) **select the file** and then select **Open**.

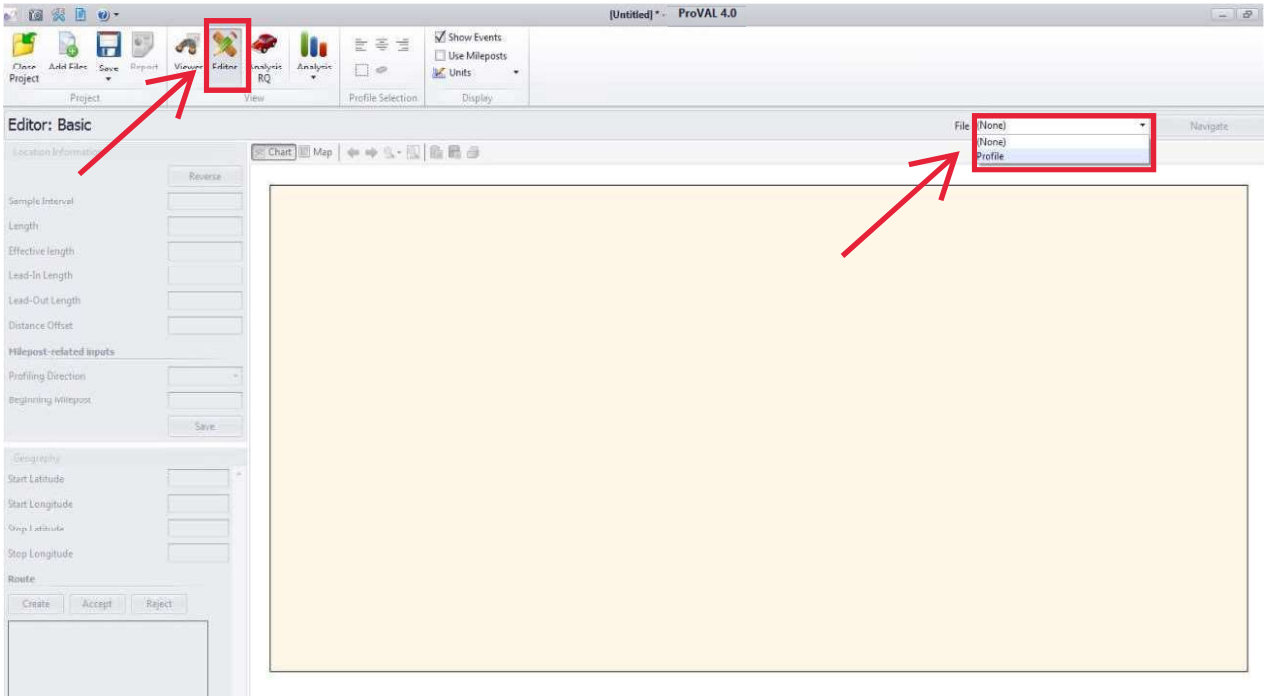


As more data is received, additional files should be added to this one project file to represent all the IRI testing for a contract.

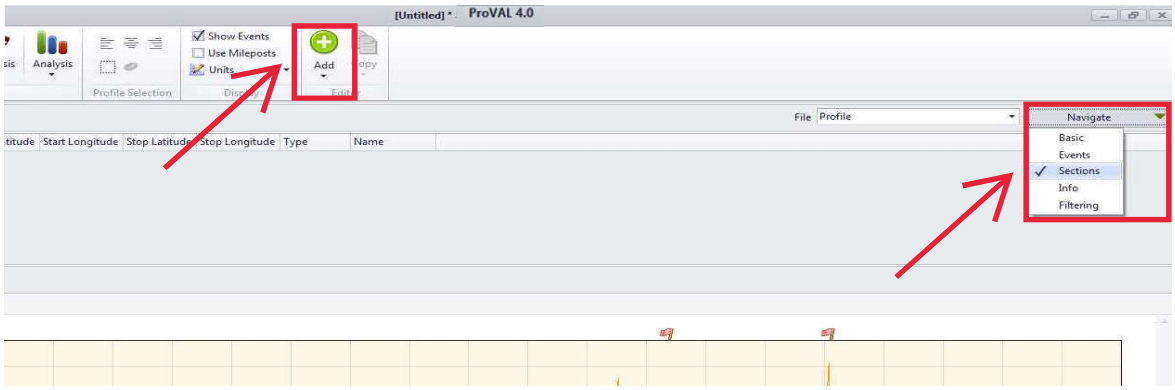
4) A data file will automatically begin in the Viewer pane. Each file will have two checkboxes for left and right wheel path readings. **Clicking** on these checkboxes will display the profile elevation and distance for the Section tested. The x-axis is listed in feet starting at 0 feet and up to the distance measured by the inertial profiler.



5) Next, the section needs to be identified for analysis. Not all sections start at 0 feet as can be seen above in the example. The starting location on this graph needs to correspond with a station that represents the start of paving. To identify the section, select the **Editor** icon. Now select which **file** you want to use from the File dropdown.



6) Once the file is selected, you will notice the profile results appear as they did on the Viewer pane. Click the **Navigate** dropdown to the right of File dropdown and select **Sections**. Next, click the **Add** button and provide a meaningful name that helps identify this exact section (Line/Direction/Lane/etc.).

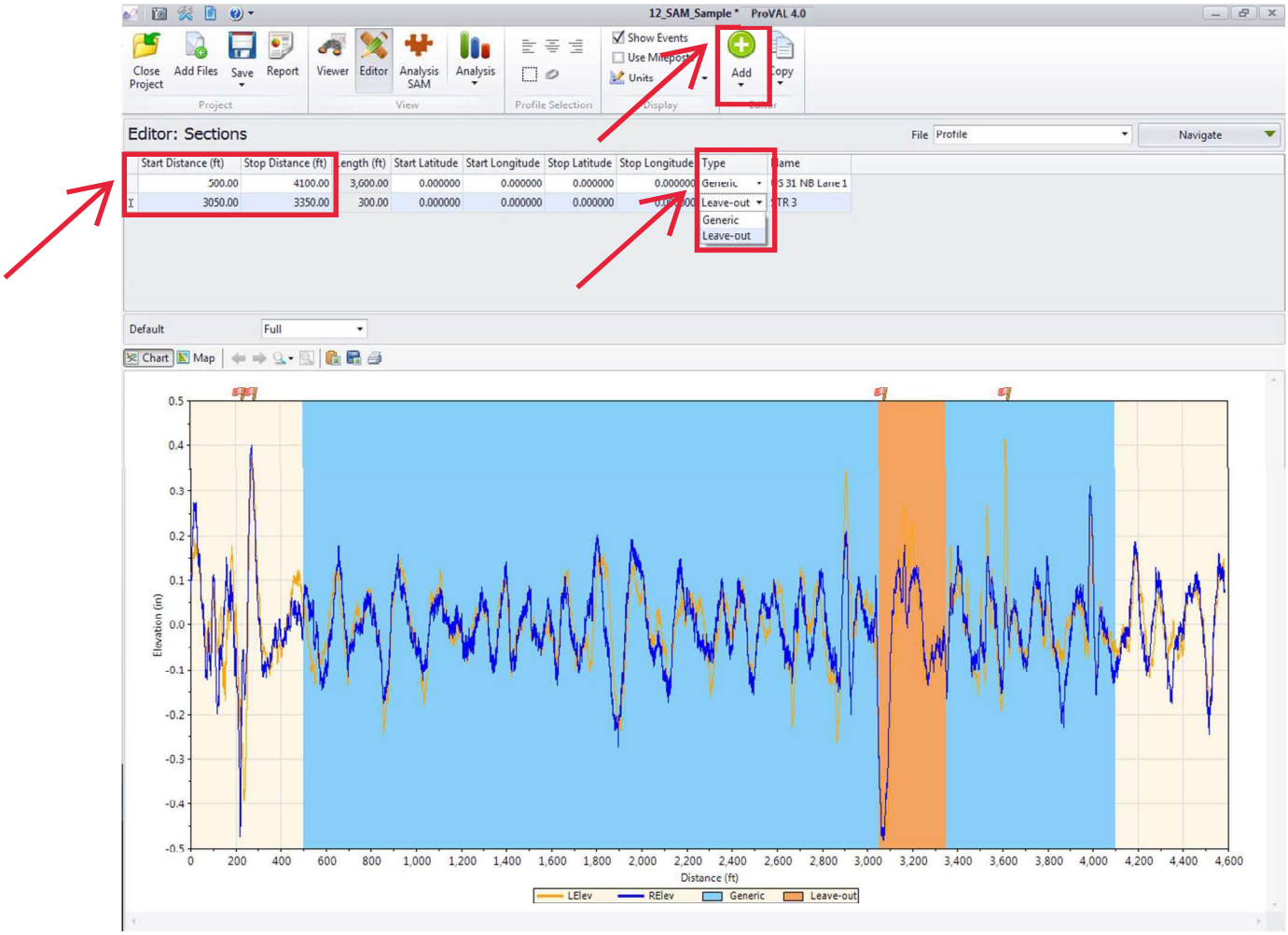


7) Provide the **Start Distance** and **Stop Distance** at which the Surface was measured for the contract. The distances will not always match up to your typical section stations. For example, the inertial profiler started taking measurements 500' before the construction limits and ended 500' past the construction limits on the other side of the contract. The total distance measured was 4600'. The starting station for paving is 0+00. That means distance 500' would be station 0+00 since the inertial profiler started measuring 500' before the paving limits. One of the exceptions for the inertial profiler is the first and last 50' of paving. Therefore, the Start Distance would be 550' and the Stop Distance would be 4050'. You will notice the **blue shaded area** will now shrink to the limits entered.

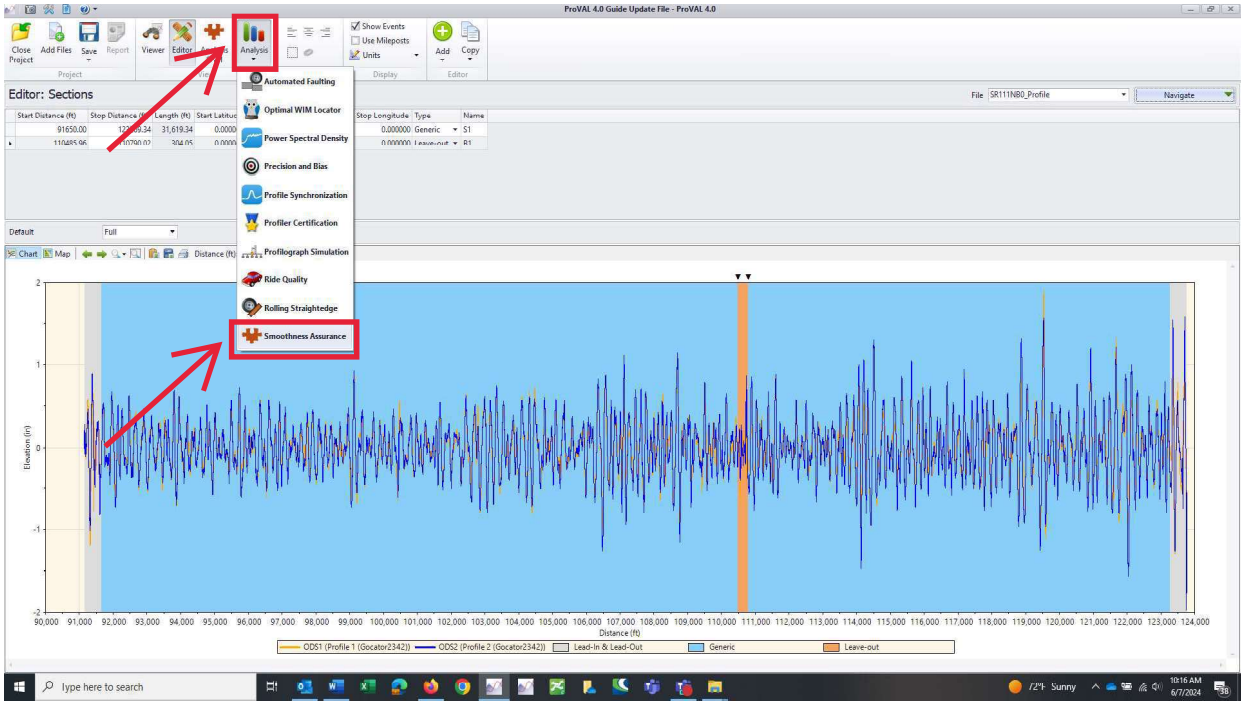
Red Flags can be seen right above the graph. These red flags represent **Events**. Events are usually accompanied by spikes in IRI because of a bridge, casting, railroad crossing or other feature that would cause a bump unrelated to the actual pavement. ITM 917 describes these and exempts 50' before through 50' after these features from measurement. The contractor should help identify these locations by marking them in the file before you receive it.

8) Once these exceptions are identified, these areas need to be excluded from measurement. Click **Add** button within Editor and provide a name that describes the exception such as STR 3 for a bridge. The **Start Distance** should be 50' before and then the **Stop Distance** should be 50' after the end of the feature. For example, there is a bridge that is 160' long with 20' approaches and the first approach begins at 3100'. The only difference between this section and the previous section is the selection for the dropdown under the Type column. Select **Leave-Out**.

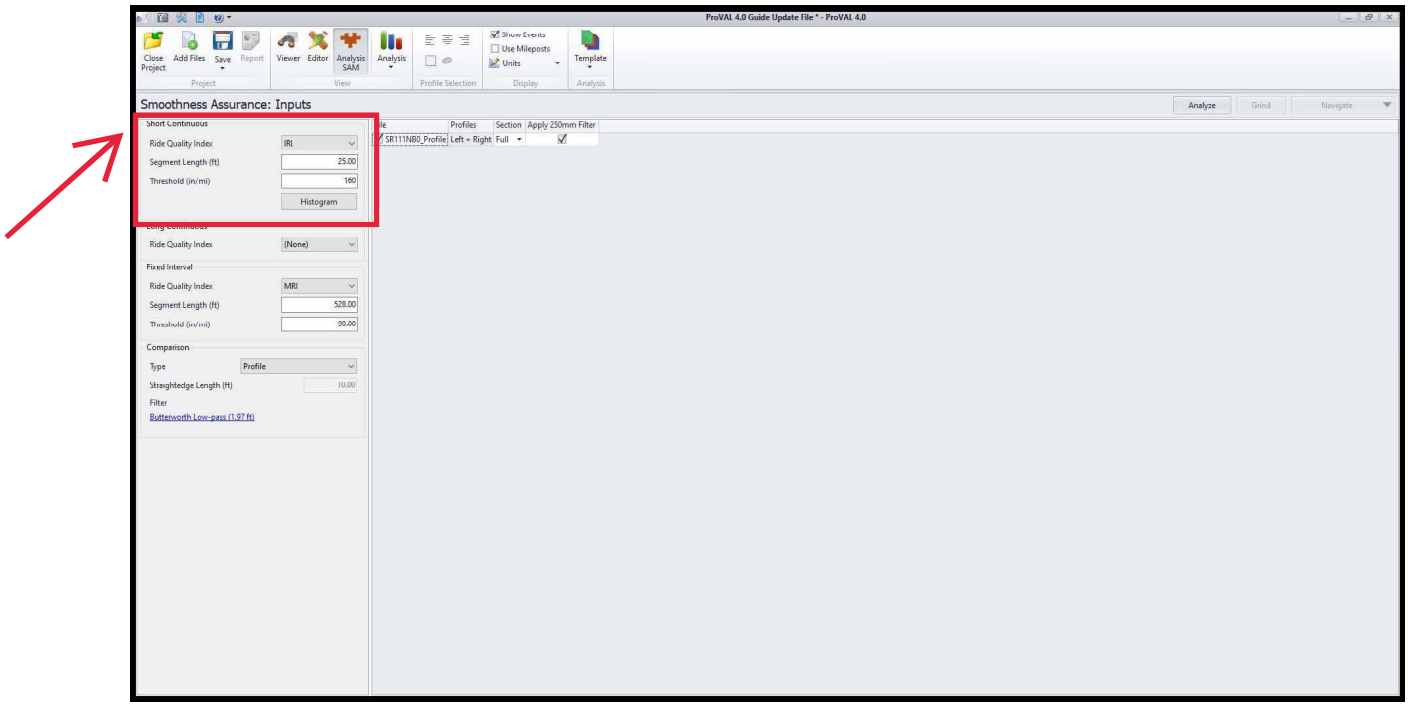
You will notice that the bridge can be seen as the **orange shaded** area. This area will now be excluded from IRI analysis. Repeat this process for all exceptions located within the section.



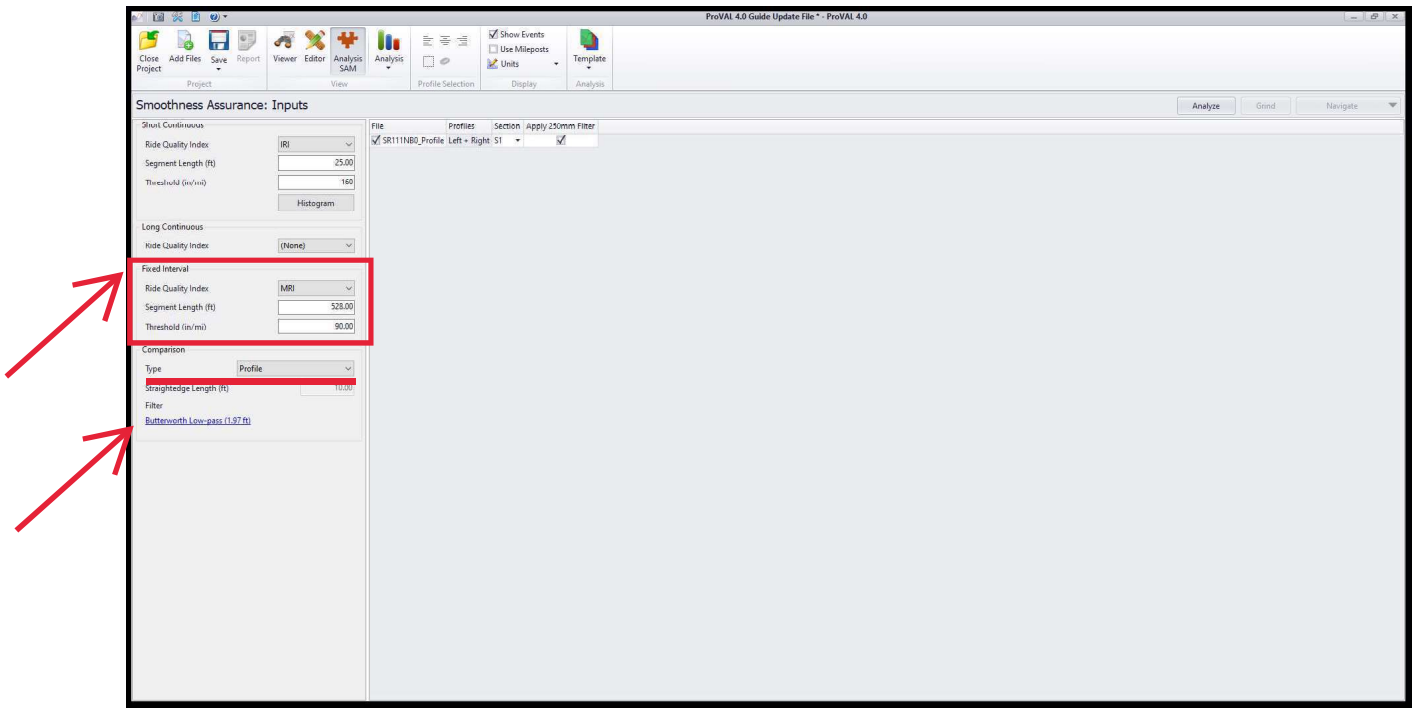
9) Now it is time to analyze the Section. Two analysis methods are required by specification, **IRI Segment Smoothness** and **Areas of Localized Roughness**. To start, click the **Analysis** button and select **Smoothness Assurance** from the dropdown.



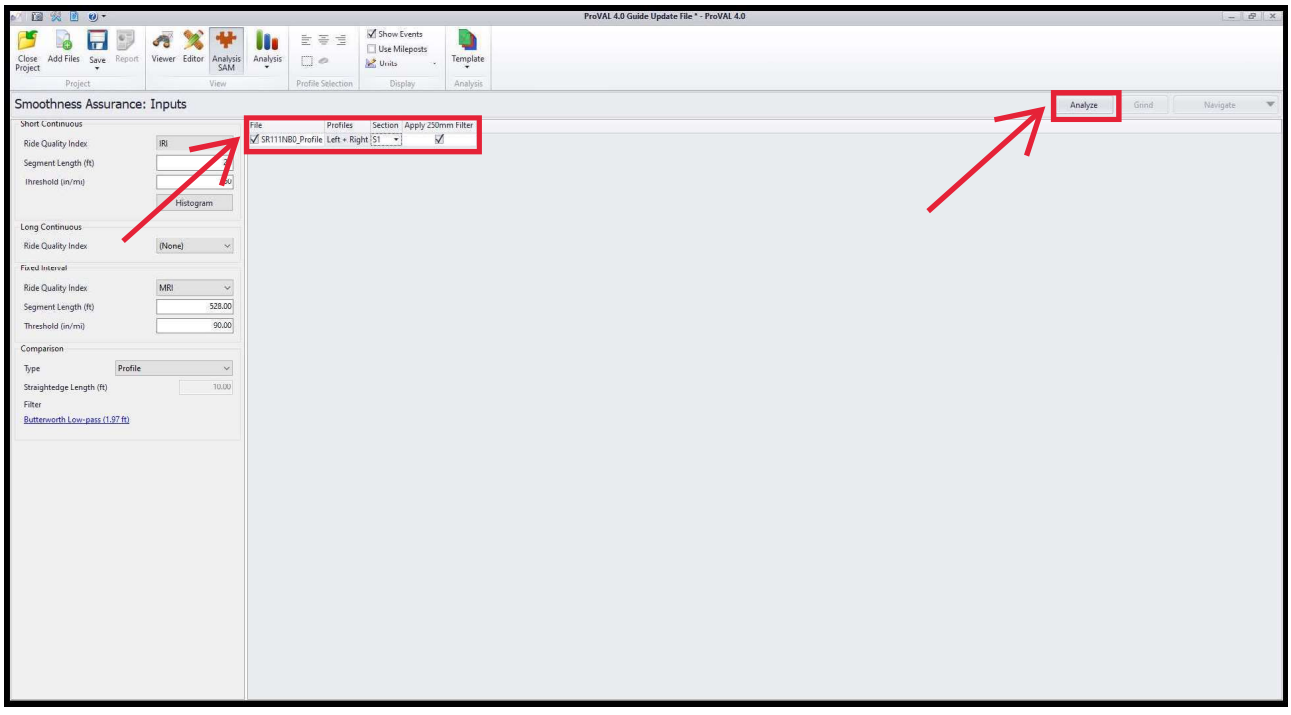
10) The Smoothness Assurance Module in ProVAL 4.0 enables calculation of both the Segment Smoothness and determination of the Areas of Localized Roughness (ALR) in a single analysis module. First, for the ALR review, in the **Short Continuous box** for ride quality index select **IRI**, then for segment length select **25.0 ft**, and finally for a threshold select **160 in/mi** for Type A or **170 in/mi** for Type B pavements. Then, in the **Long Continuous** box select **None** as this will not be part of our standard analysis.



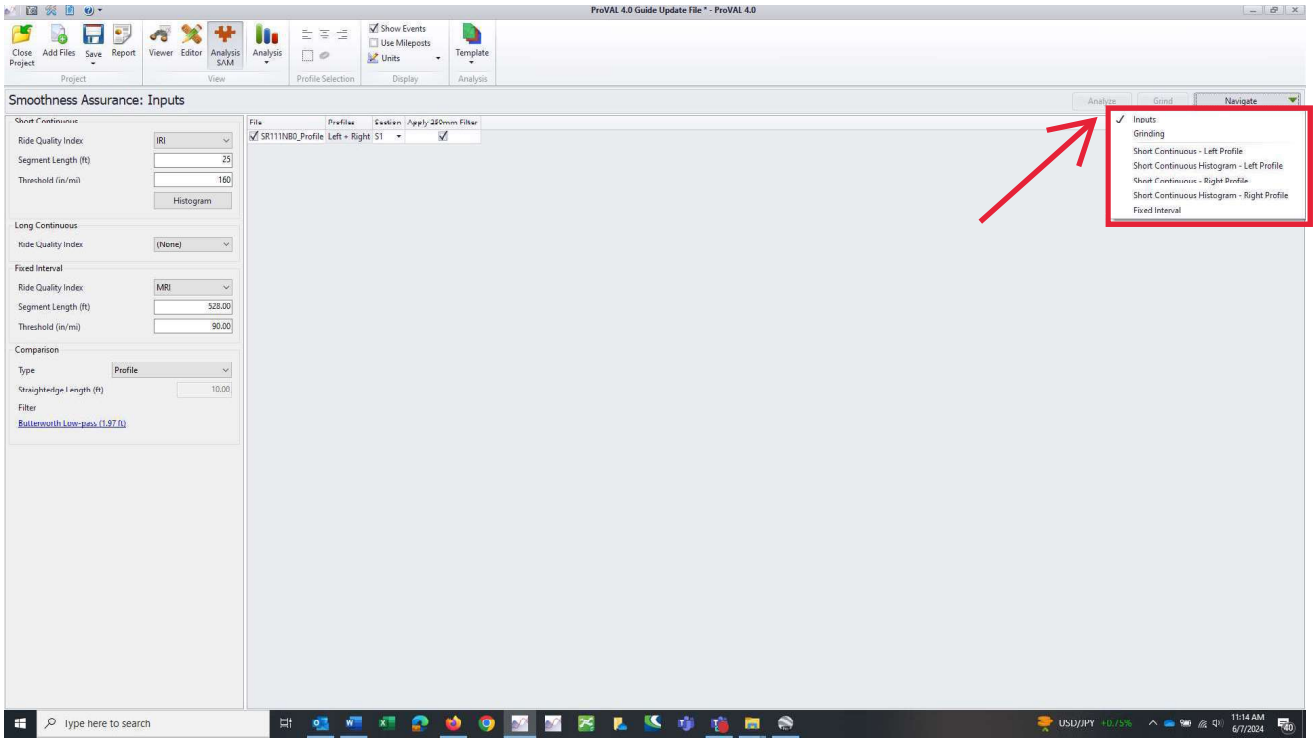
11) Now for the Segment Smoothness review, in the **Fixed Interval box** for ride quality index select **MRI**, then for segment length select **528 ft**, and finally for a threshold select **90 in/mi** for Type A or **110 in/mi** for Type B pavements. In the comparison box, it's not required but may be of interest to select **Profile** for the type then for filter select **Butterworth Low Pass** with Short Cutoff Wavelength of **1.97 ft**.



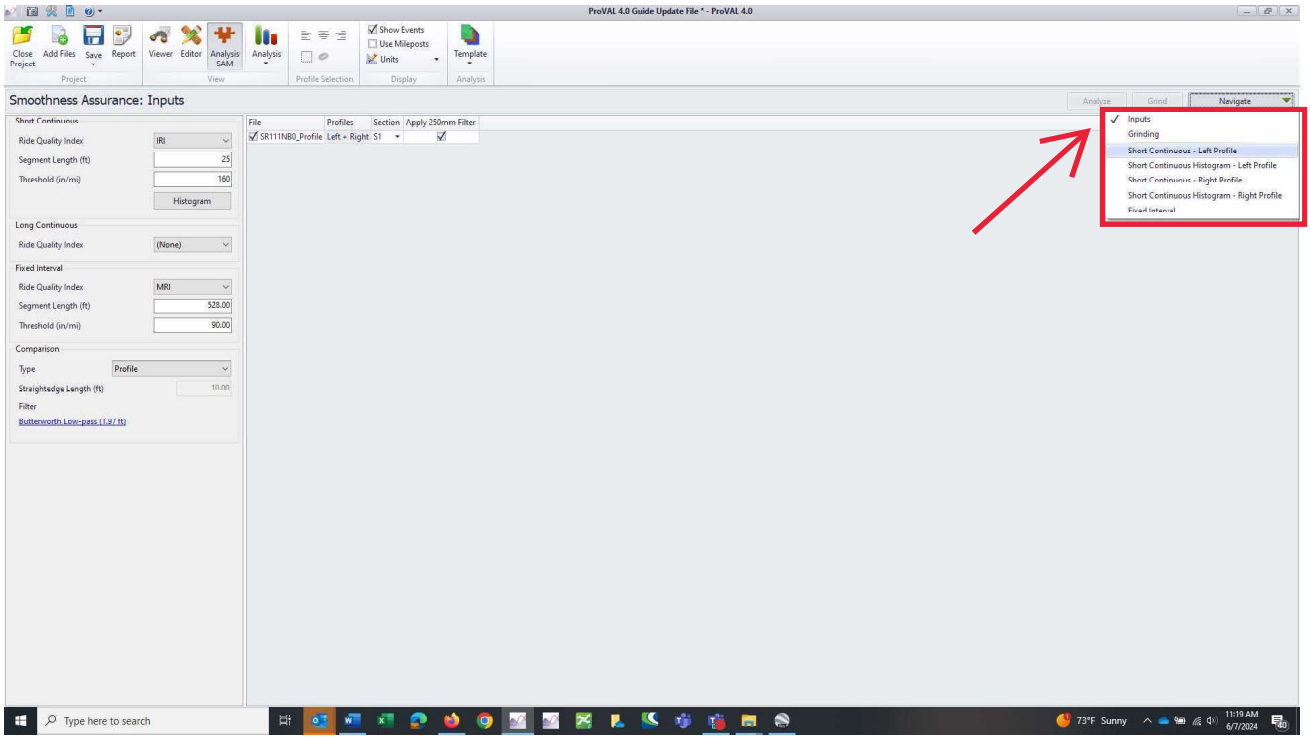
12) Now that all of the analysis boxes have been set to meet the specifications, select the **checkbox** for the file and select the **Section** from the dropdown box. Then click the **Analyze** button at the top right.



13) After the analysis is complete, select the **Navigate** button which will open up the dropdown to allow selection of **Short Continuous** results for both the left and right wheel paths along with **Fixed Interval** results for each segment.



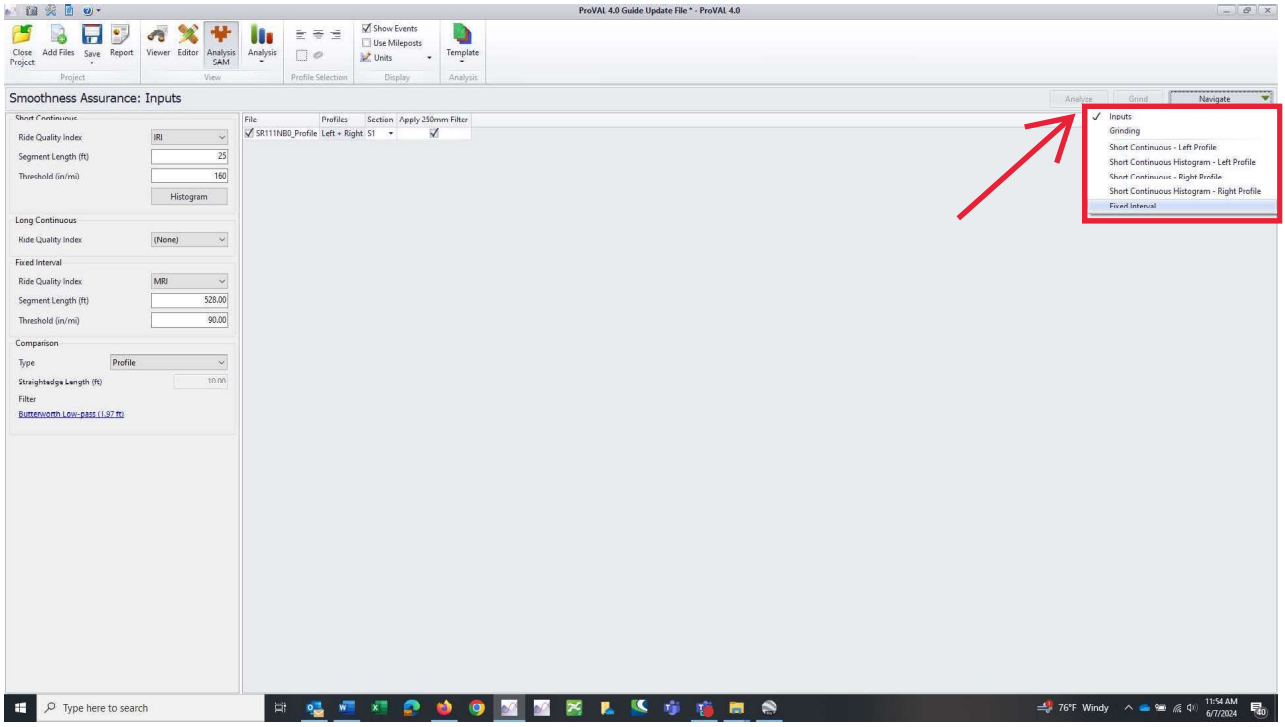
14) First, let's review the **Short Continuous** results by selecting the **left profile** and then repeat for the **right profile** on the navigation dropdown.



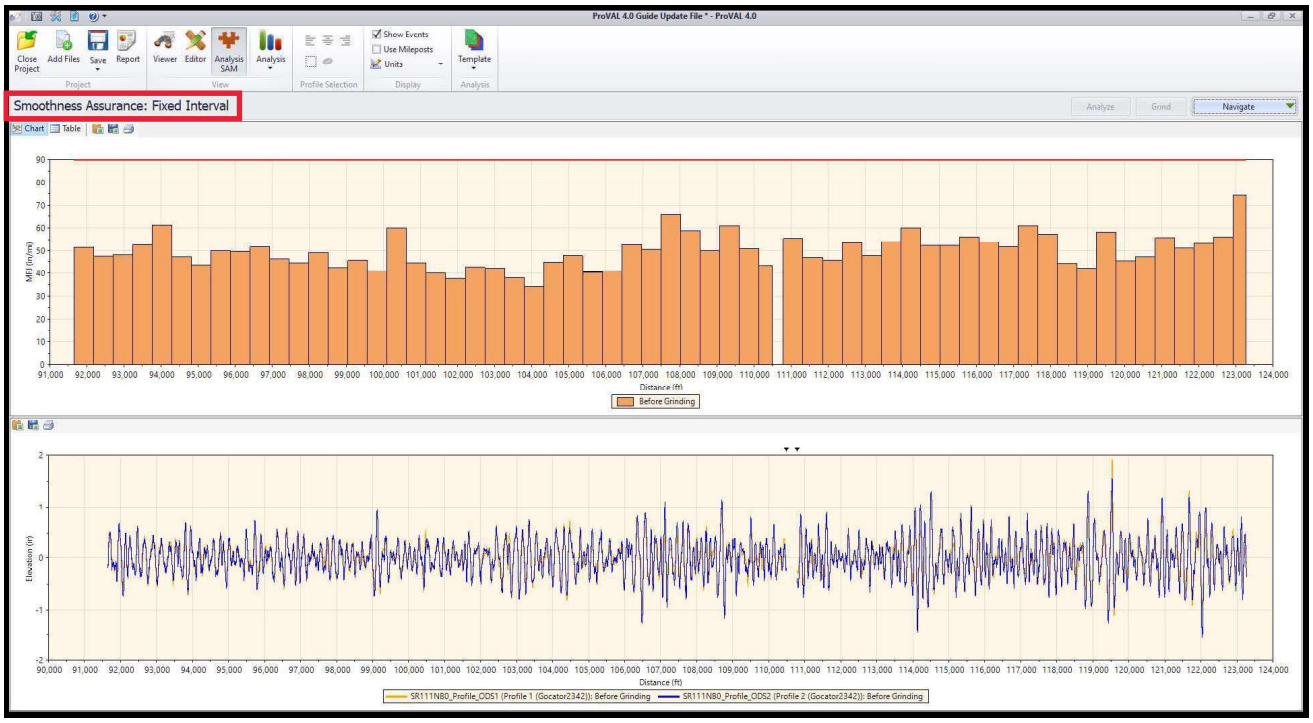
15) The **Smoothness Assurance: Short Continuous – Left or Right Profile** should be visible now as shown below. At this point the **upper window** of the IRI (in/mi) versus Distance (ft) gives a visual indication of every location that may require grinding which exceeds the red solid line threshold of 160 (in/mi) or 170 (in/mi) depending on pavement type. The **lower window** provides a comparison to the profile elevations of the pavement throughout the full length for the selected wheel path.

*Note: Specific locations of interest can be zoomed in on by selecting that function from the toolbar directly above the graph and then selecting the location on the graph and dragging a box over the area of interest.

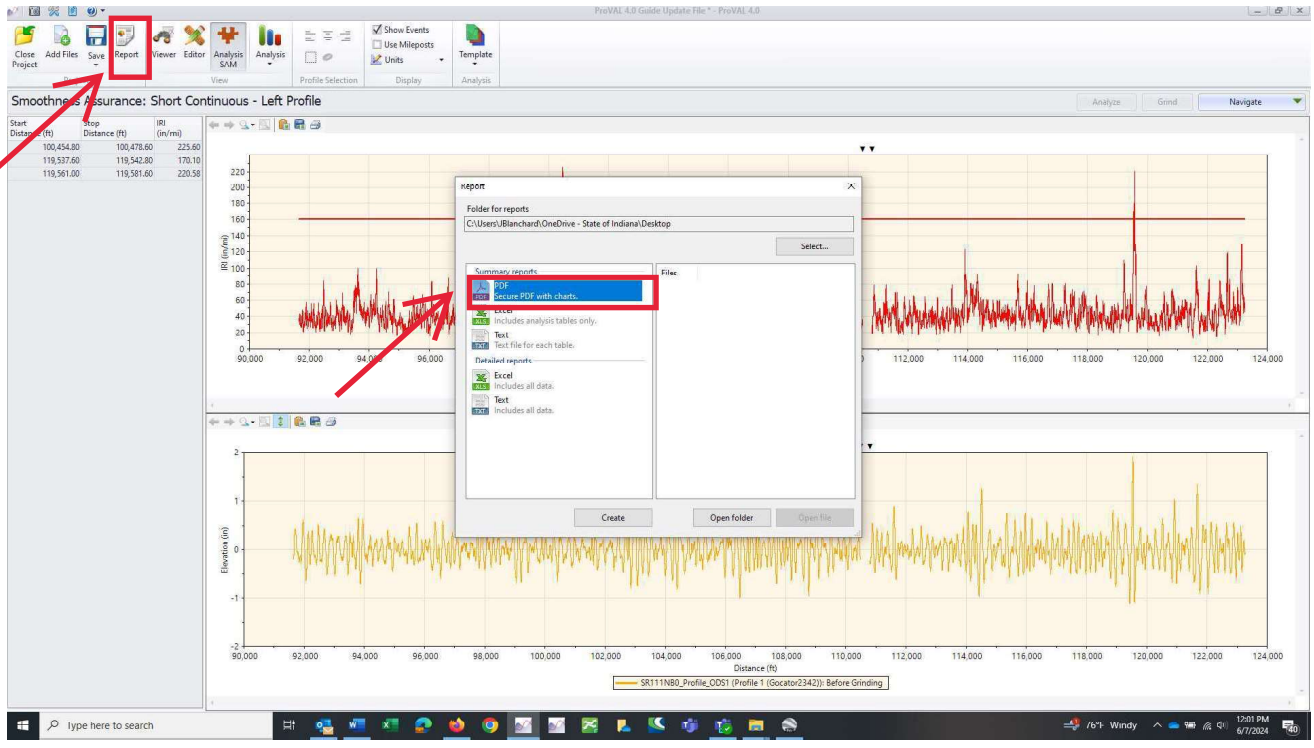
16) Next, let's review the **Fixed Interval** results by selecting fixed interval on the navigation dropdown.



17) The **Smoothness Assurance: Fixed Interval** analysis should be visible as shown below. At this point the **upper window** of the MRI (in/mi) versus Distance (ft) gives a visual indication of every tenth of a mile segment that requires grinding if exceeding the red solid line threshold located at 90 or 110 (in/mi) depending on pavement type. The **lower window** provides a comparison to the profile elevations of the pavement throughout the full length and includes both the right and left wheel paths.



18) Now that the analysis is complete, first let's generate the **Areas of Localized Roughness reports** to utilize in the field. The final report of the ALR results may be downloaded by selecting the **Report** button in the top right pane. A pdf of the report may be selected under Summary reports by clicking **PDF** or an excel version of the report may be selected by clicking **Excel**. Once PDF or Excel has been selected then click **Create** and the report will be generated and saved to your computer.



19) The below examples are information that should be shown in the **PDF report**, which can be used to determine ALR grinding locations. The **Defects before grinding** table is the summary information that should be utilized to locate grind locations in excess of 160 or 170 in/mi. Other information in the report may be useful to the PE/PS for review purposes.

Analysis: Smoothness Assurance

Selections

File	Section	Apply 250mm Filter
SR111NB0_Profile	S1	Yes

Leave-outs

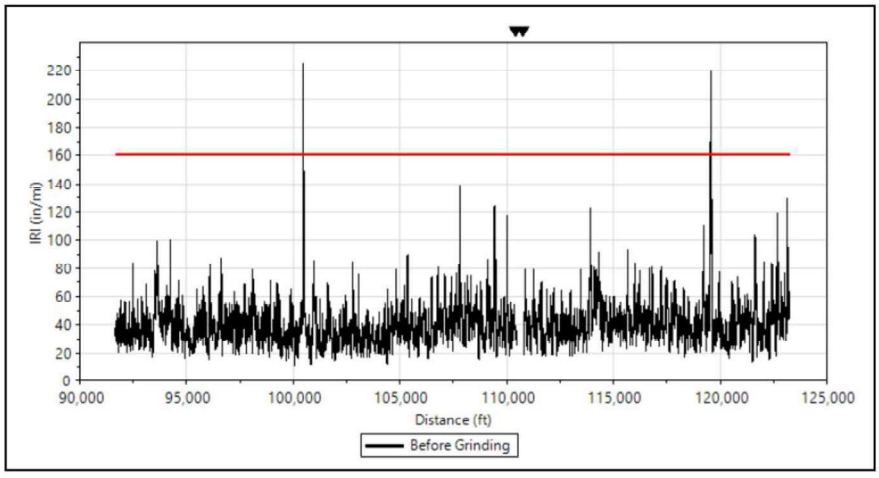
Start Distance (ft)	Stop Distance (ft)	Length (ft)	Name
110,485.961	110,790.016	304.055	B1

Results

Short Continuous - Left Profile
Segment Length (ft): 25.00
Threshold (in/mi): 160.00

Before Grinding
Total Percent Out of Spec (%): 0.16
Total Distance Out of Spec (ft): 50

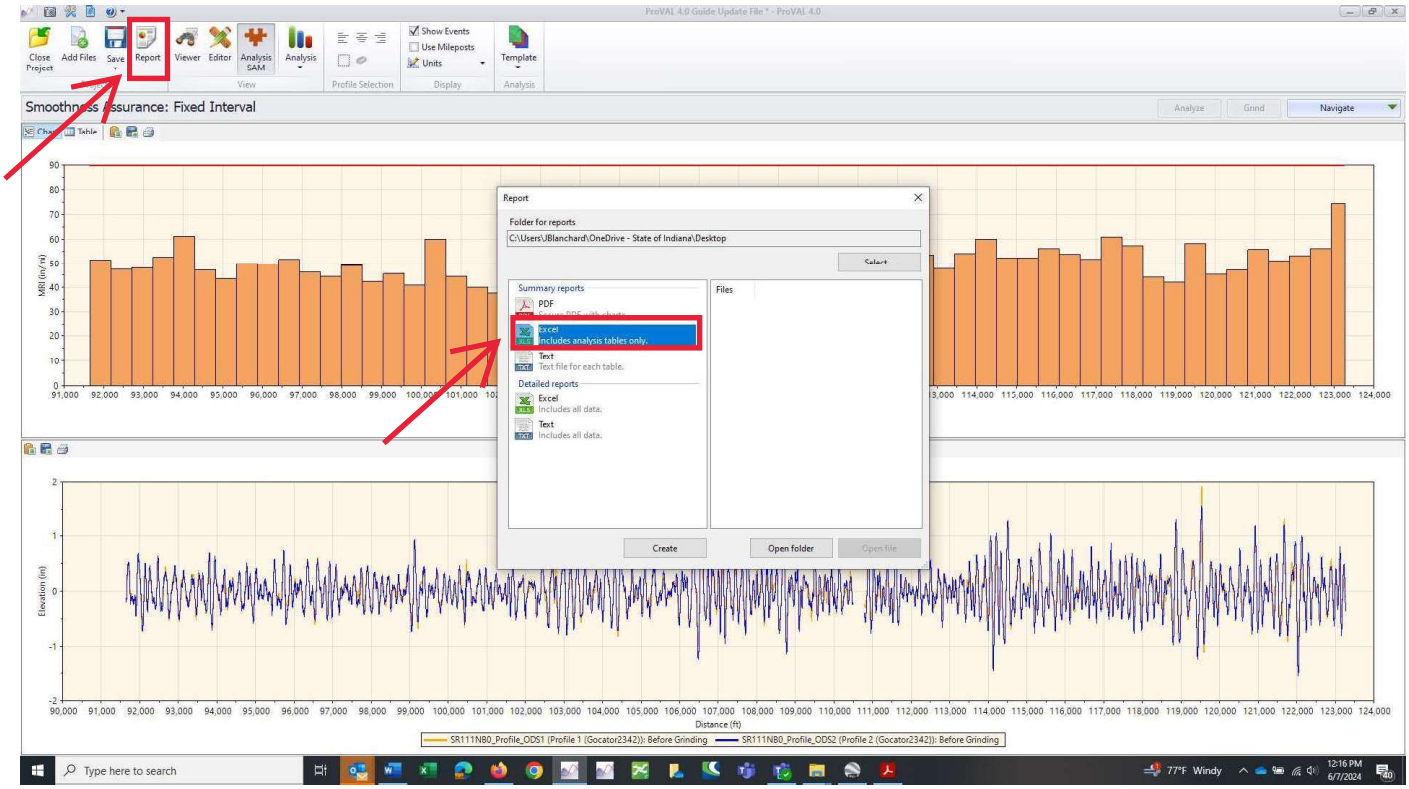
Max IRI (in/mi)	Min IRI (in/mi)	Before Grinding (%)	Before Grinding (ft)
∞	120.00	0.50	156
120.00	110.00	0.18	57
110.00	100.00	0.21	67
100.00	90.00	0.32	100
90.00	80.00	0.92	288
80.00	70.00	2.29	717
70.00	60.00	4.59	1,436
60.00	50.00	11.00	3,438
50.00	40.00	25.12	7,853
40.00	30.00	34.00	10,631
30.00	20.00	19.01	5,943
20.00	10.00	1.86	580
10.00	0.00	0.00	0



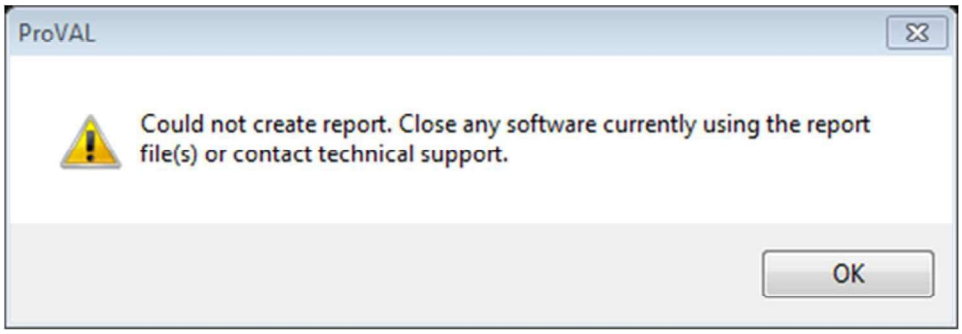
Defects before grinding

Start Distance (ft)	Stop Distance (ft)	IRI (in/mi)
100,454.80	100,478.60	225.60
119,537.60	119,542.80	170.10
119,561.00	119,581.60	220.58

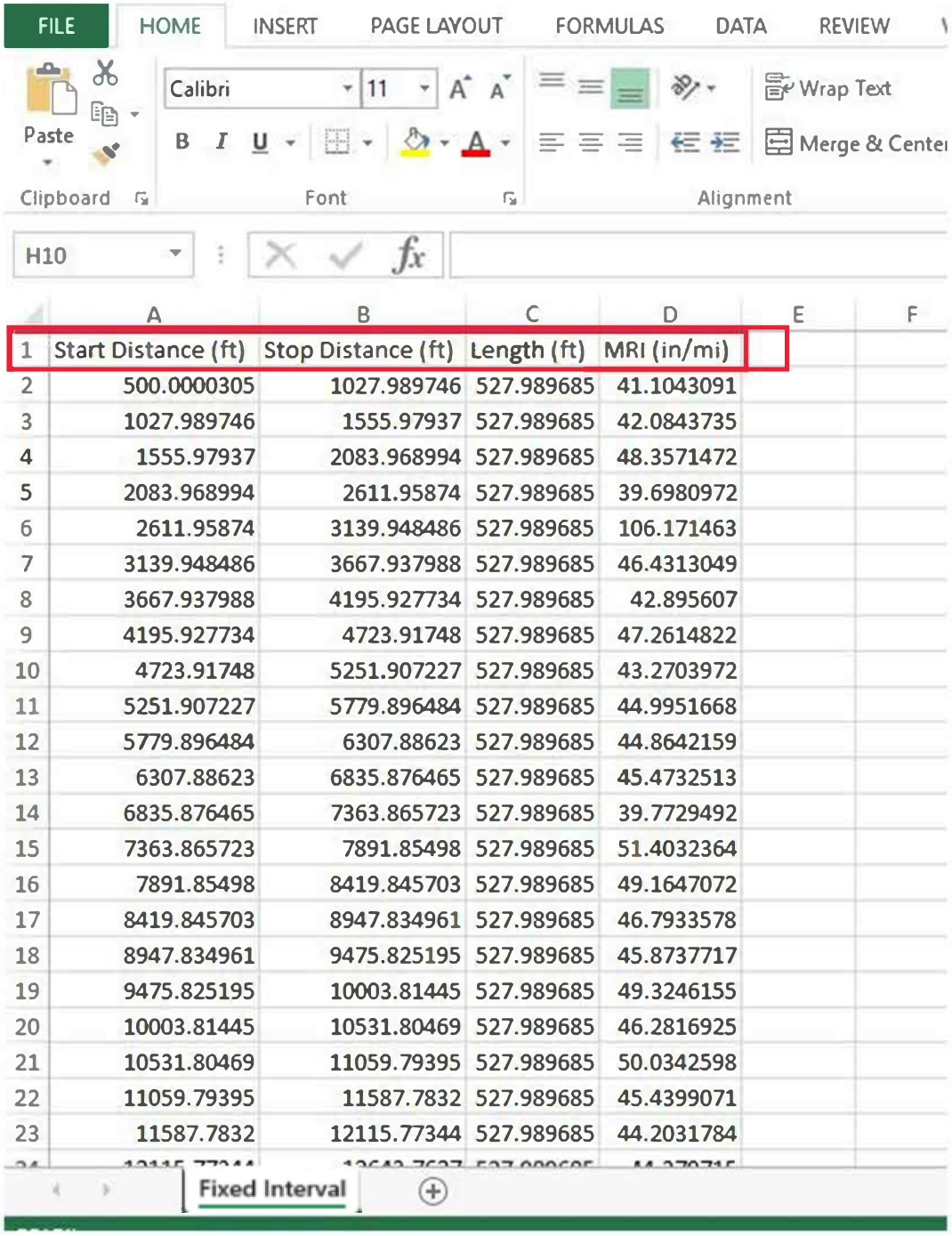
20) Next, let's generate a report to use for the **Fixed Interval segment smoothness** review. Select the **Report** button again in the top right pane. You can click **Select** to browse folders for the destination of the report download. Once a folder is selected, choose the **Excel** includes analysis tables only option on the left and then click **Create**.



***If you get this screen below, you may have a spreadsheet with the same exact name but by a different user. Either select a different folder or delete the old spreadsheets. ***



21) You are now ready to compute smoothness quality adjustments with the Department's Excel spreadsheet. First, open the **Fixed Interval** results spreadsheet you created from ProVAL. The spreadsheet should have the project file's name with columns of start distance, stop distance, length and MRI similar to the example shown below.



FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW

Paste Calibri 11 Wrap Text Merge & Center

Clipboard Font Alignment

H10

	A	B	C	D	E	F
1	Start Distance (ft)	Stop Distance (ft)	Length (ft)	MRI (in/mi)		
2	500.0000305	1027.989746	527.989685	41.1043091		
3	1027.989746	1555.97937	527.989685	42.0843735		
4	1555.97937	2083.968994	527.989685	48.3571472		
5	2083.968994	2611.95874	527.989685	39.6980972		
6	2611.95874	3139.948486	527.989685	106.171463		
7	3139.948486	3667.937988	527.989685	46.4313049		
8	3667.937988	4195.927734	527.989685	42.895607		
9	4195.927734	4723.91748	527.989685	47.2614822		
10	4723.91748	5251.907227	527.989685	43.2703972		
11	5251.907227	5779.896484	527.989685	44.9951668		
12	5779.896484	6307.88623	527.989685	44.8642159		
13	6307.88623	6835.876465	527.989685	45.4732513		
14	6835.876465	7363.865723	527.989685	39.7729492		
15	7363.865723	7891.85498	527.989685	51.4032364		
16	7891.85498	8419.845703	527.989685	49.1647072		
17	8419.845703	8947.834961	527.989685	46.7933578		
18	8947.834961	9475.825195	527.989685	45.8737717		
19	9475.825195	10003.81445	527.989685	49.3246155		
20	10003.81445	10531.80469	527.989685	46.2816925		
21	10531.80469	11059.79395	527.989685	50.0342598		
22	11059.79395	11587.7832	527.989685	45.4399071		
23	11587.7832	12115.77344	527.989685	44.2031784		

Fixed Interval

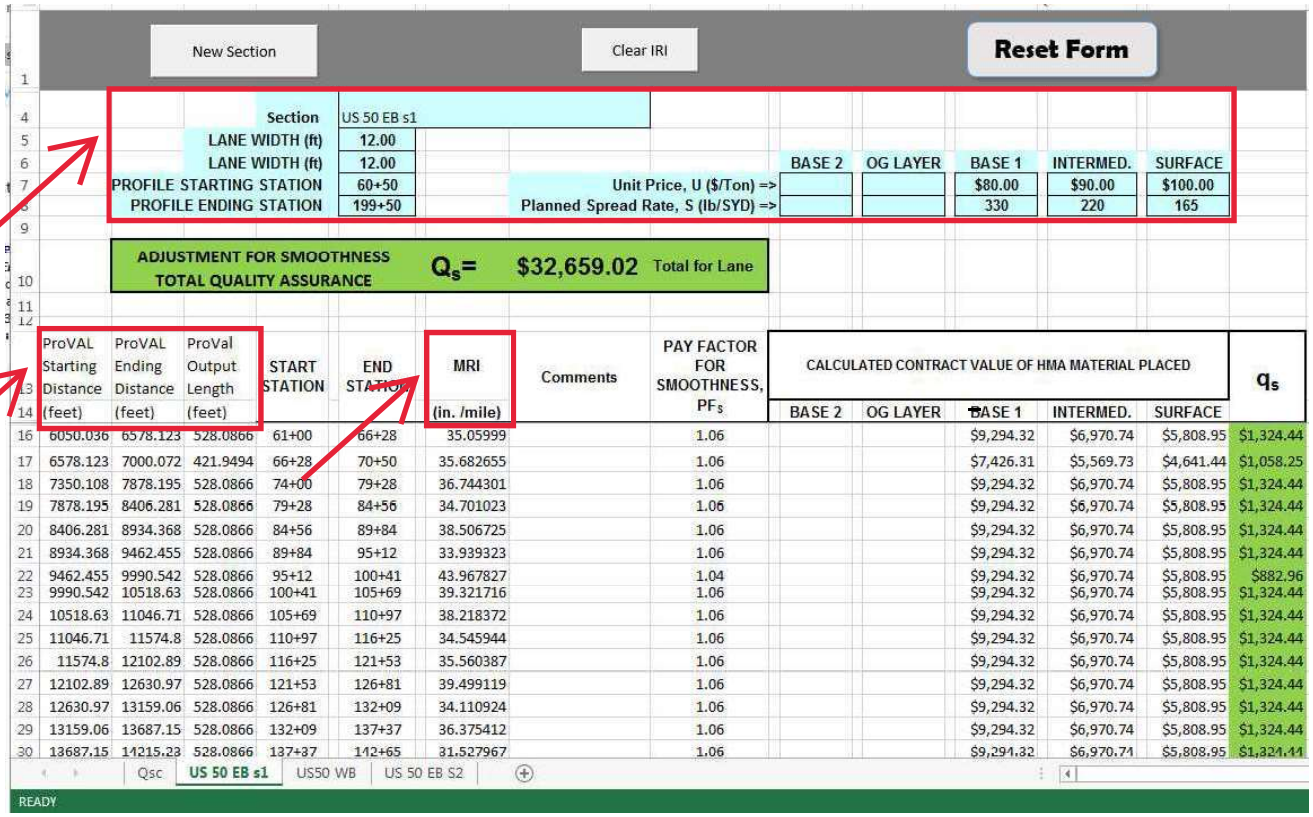
22) Now you can go to the Department's website: https://www.in.gov/indot/div/construction.htm

Select "IRI Payment Adjustment Spreadsheet – HMA (or PCCP)" from the website. Once you have this spreadsheet open, fill in all of the **Section Data** in the blue areas at the top, such as **profile starting station** and **profile ending station**, **lane widths**, all **planned spread rates** (if HMA), and all **unit prices** per pay item.

(Note: The information at the top of the spreadsheet must be completed prior to completing the next step in order for the spreadsheet to calculate as intended.)

Next, go to the **Fixed Interval spreadsheet** generated by ProVAL and **copy** the columns of **start distance**, **stop distance**, **length** and **MRI.** Then, **paste** these columns into the respective columns on the **IRI Payment Adjustment spreadsheet** as shown below.

(Note: the MRI column will have to be copied and pasted independently from the start/stop/length columns when transferring the data from Fixed Interval spreadsheet to the IRI Payment spreadsheet, since as shown below the stationing columns are in between and interfere with direct copy and paste of all four columns together at once.)



New Section | Clear IRI | Reset Form

		BASE 2	OG LAYER	BASE 1	INTERMED.	SURFACE
Section	US 50 EB s1					
LANE WIDTH (ft)	12.00					
LANE WIDTH (ft)	12.00					
PROFILE STARTING STATION	60+50	Unit Price, U ($/Ton) =>			$80.00	$90.00	$100.00
PROFILE ENDING STATION	199+50	Planned Spread Rate, S (lb/SYD) =>			330	220	165

ADJUSTMENT FOR SMOOTHNESS TOTAL QUALITY ASSURANCE Q_s= $32,659.02 Total for Lane

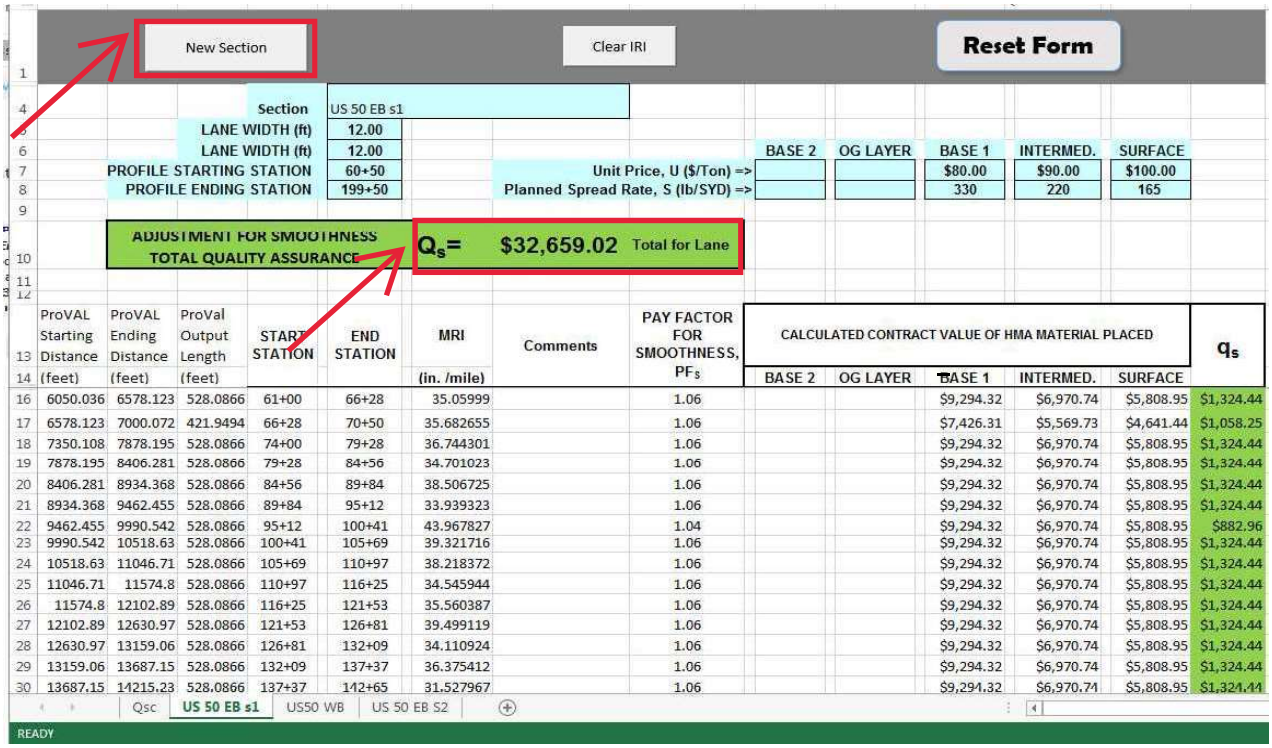
ProVAL Starting Distance (feet)	ProVAL Ending Distance (feet)	ProVal Output Length (feet)	START STATION	END STATION	MRI (in. /mile)	Comments	PAY FACTOR FOR SMOOTHNESS, PF_s	CALCULATED CONTRACT VALUE OF HMA MATERIAL PLACED					q_s
								BASE 2	OG LAYER	BASE 1	INTERMED.	SURFACE	
6050.036	6578.123	528.0866	61+00	66+28	35.05999		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
6578.123	7000.072	421.9494	66+28	70+50	35.682655		1.06			$7,426.31	$5,569.73	$4,641.44	$1,058.25
7350.108	7878.195	528.0866	74+00	79+28	36.744301		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
7878.195	8406.281	528.0866	79+28	84+56	34.701023		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
8406.281	8934.368	528.0866	84+56	89+84	38.506725		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
8934.368	9462.455	528.0866	89+84	95+12	33.939323		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
9462.455	9990.542	528.0866	95+12	100+41	43.967827		1.04			$9,294.32	$6,970.74	$5,808.95	$882.96
9990.542	10518.63	528.0866	100+41	105+69	39.321716		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
10518.63	11046.71	528.0866	105+69	110+97	38.218372		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
11046.71	11574.8	528.0866	110+97	116+25	34.545944		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
11574.8	12102.89	528.0866	116+25	121+53	35.560387		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
12102.89	12630.97	528.0866	121+53	126+81	39.499119		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
12630.97	13159.06	528.0866	126+81	132+09	34.110924		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
13159.06	13687.15	528.0866	132+09	137+37	36.375412		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44
13687.15	14215.23	528.0866	137+37	142+65	31.527967		1.06			$9,294.32	$6,970.74	$5,808.95	$1,324.44

Qsc | US 50 EB s1 | US50 WB | US 50 EB S2

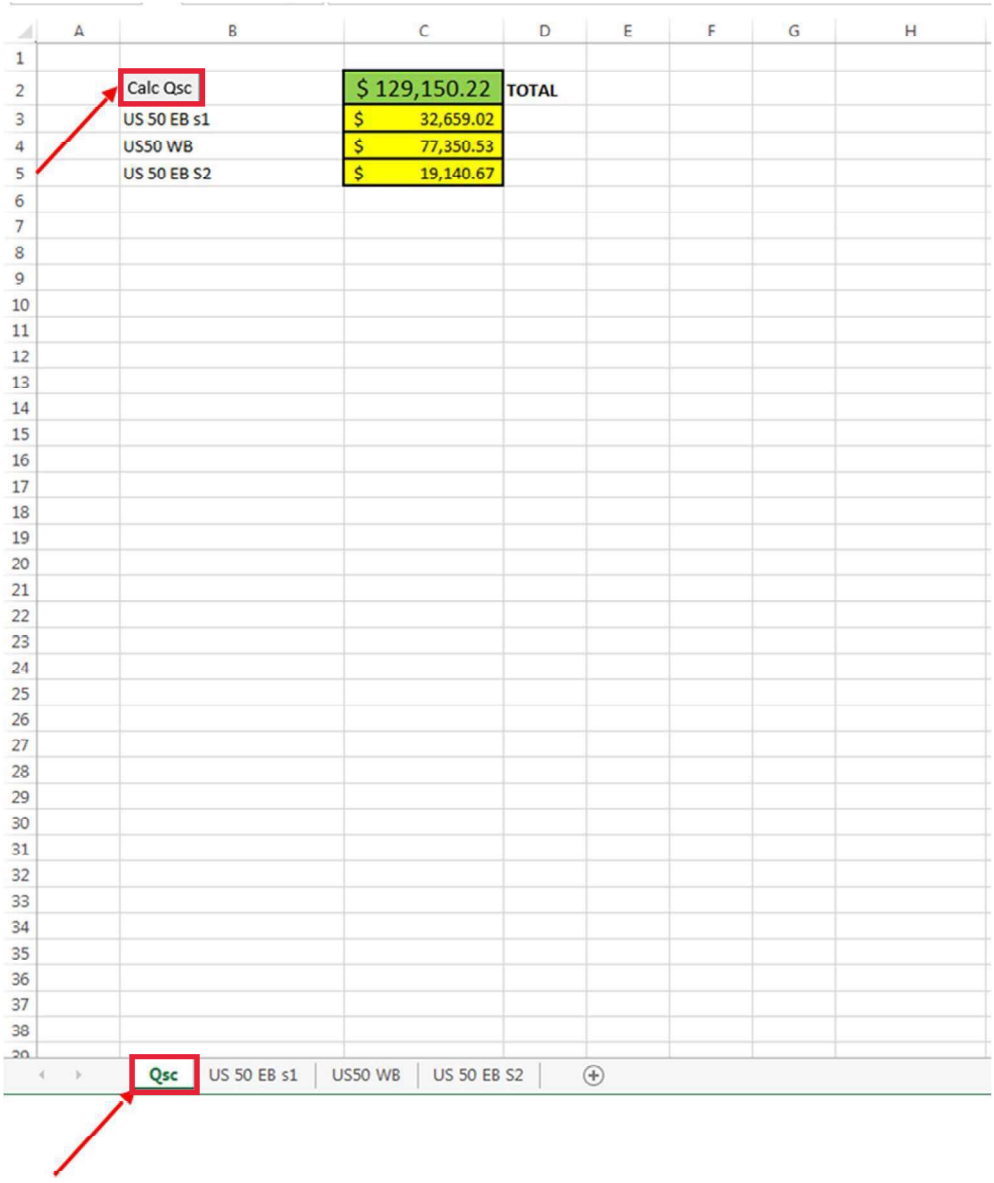
READY

23) Once all the information is entered, and the data from the ProVAL report is copied and pasted appropriately, you will notice the highlighted cell for variable **Qs** will show the **dollar amount** of the quality adjustment for the section.

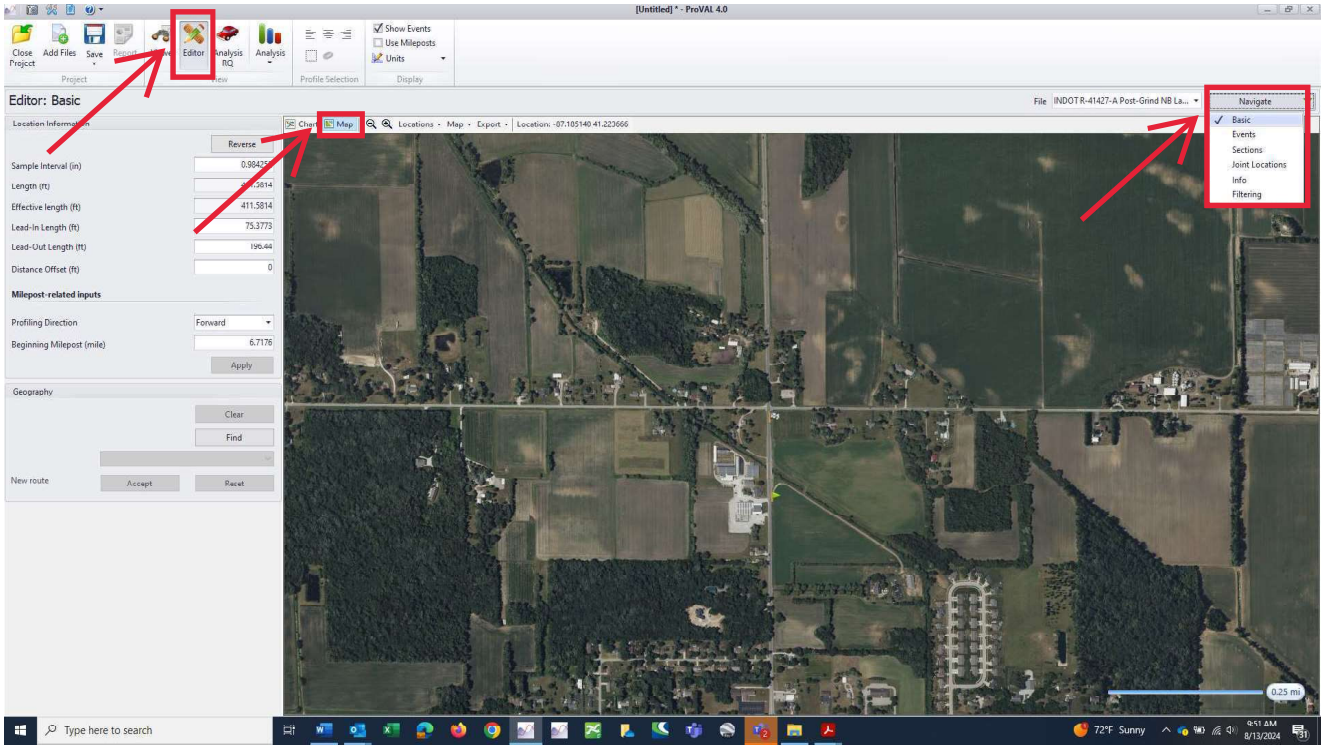
When the next Fixed Interval Section has been analyzed for MRI, simply click the **New Section** button. This action will save the current section spreadsheet results and will appear at the end of the spreadsheet tab shown at the bottom of the spreadsheet but maintain the profile stations, lane width, planned spread rates, and unit prices per pay item shown at the top of the spreadsheet. It will also clear out the ProVAL spreadsheet data so the next ProVAL section spreadsheet data can be copied to the Adjustment spreadsheet to calculate adjustments for the next section.



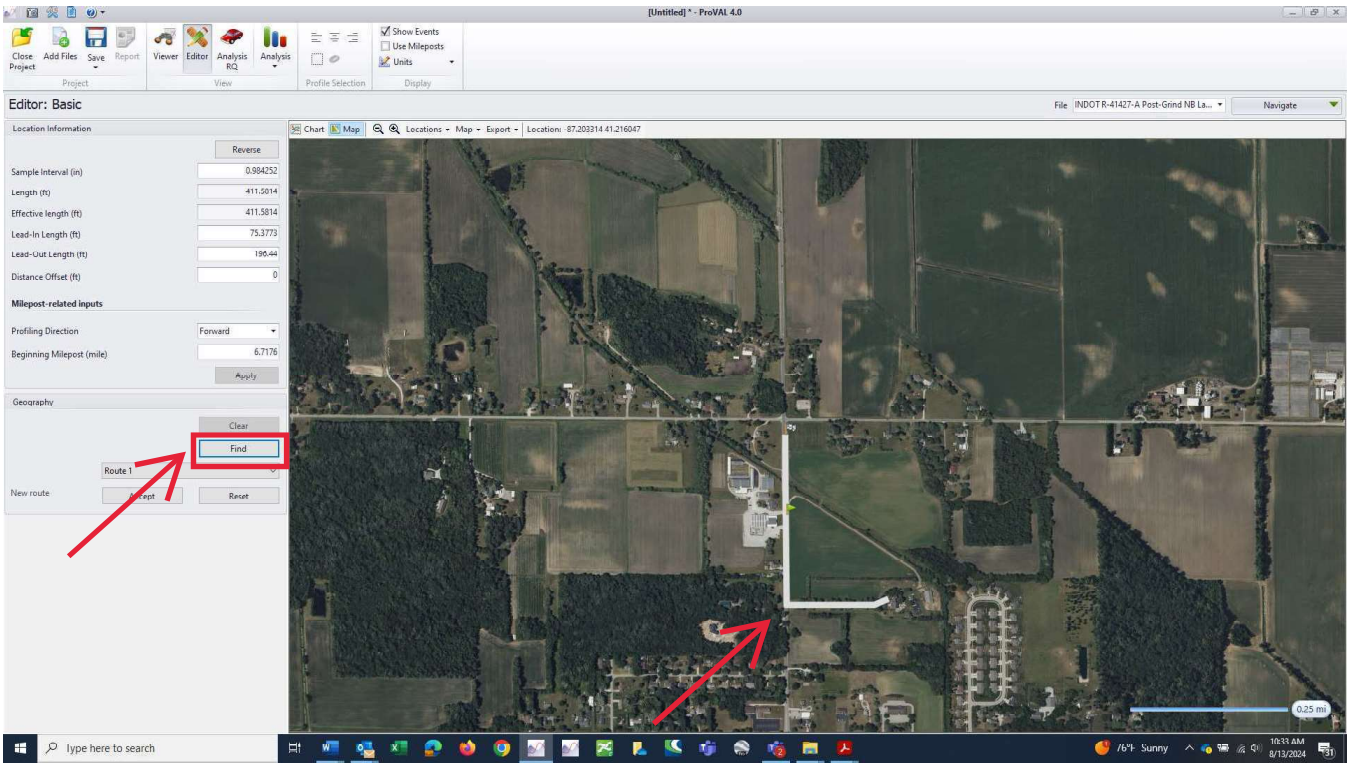
24) Once all Sections are completed, return to the first worksheet tab called **"Qsc"**. Simply press the **Calc Qsc** button to get the final quality adjustment for smoothness.



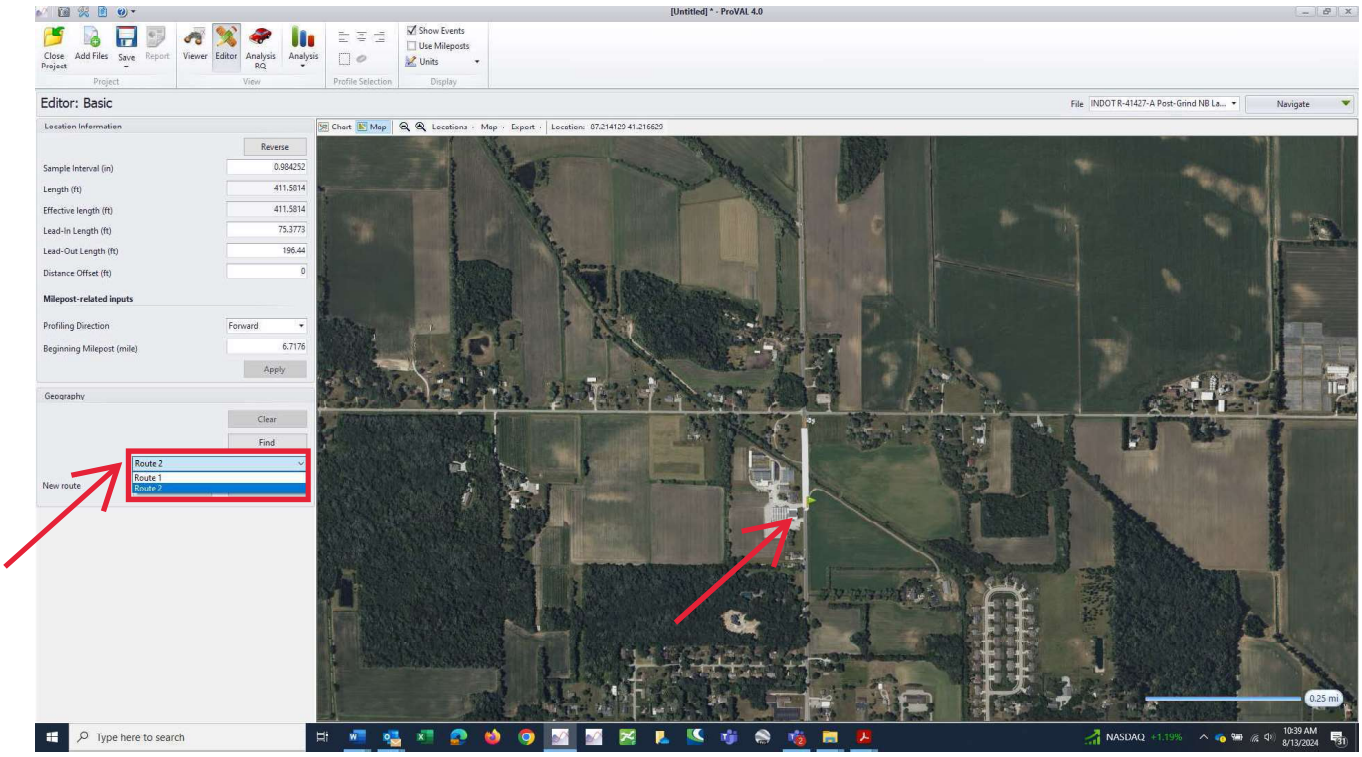
25) Locating corrective areas in the field may be aided by the use of the **map function** within ProVal. The map function is available in the **Viewer, Editor, and Analysis modules** of ProVAL. In order to access the map in the various modules, the map must first be created in the **Editor** module by selecting the **Basic** section of the module and then clicking on the **map button** to open up the mapped area as shown.



26) Next under the Geography portion of the module shown select **Find**, this will create a route for the profile data based on the GPS information in the file. Now a route should be visible on the screen as shown below.

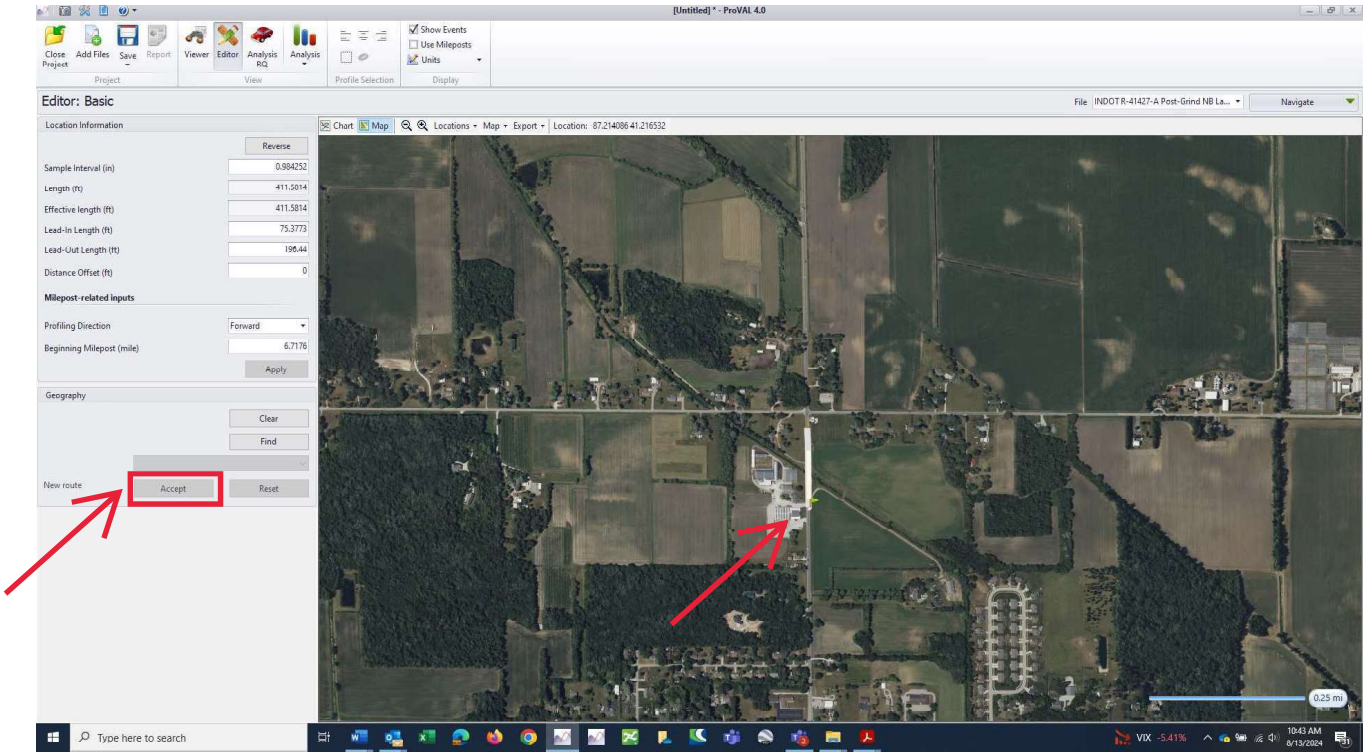


27) Check the route created by selecting the **Route dropdown** as shown, in this example Route 1 is incorrect for our location (the route shown in the previous step); however selecting Route 2 is correct for this project (the route shown below).



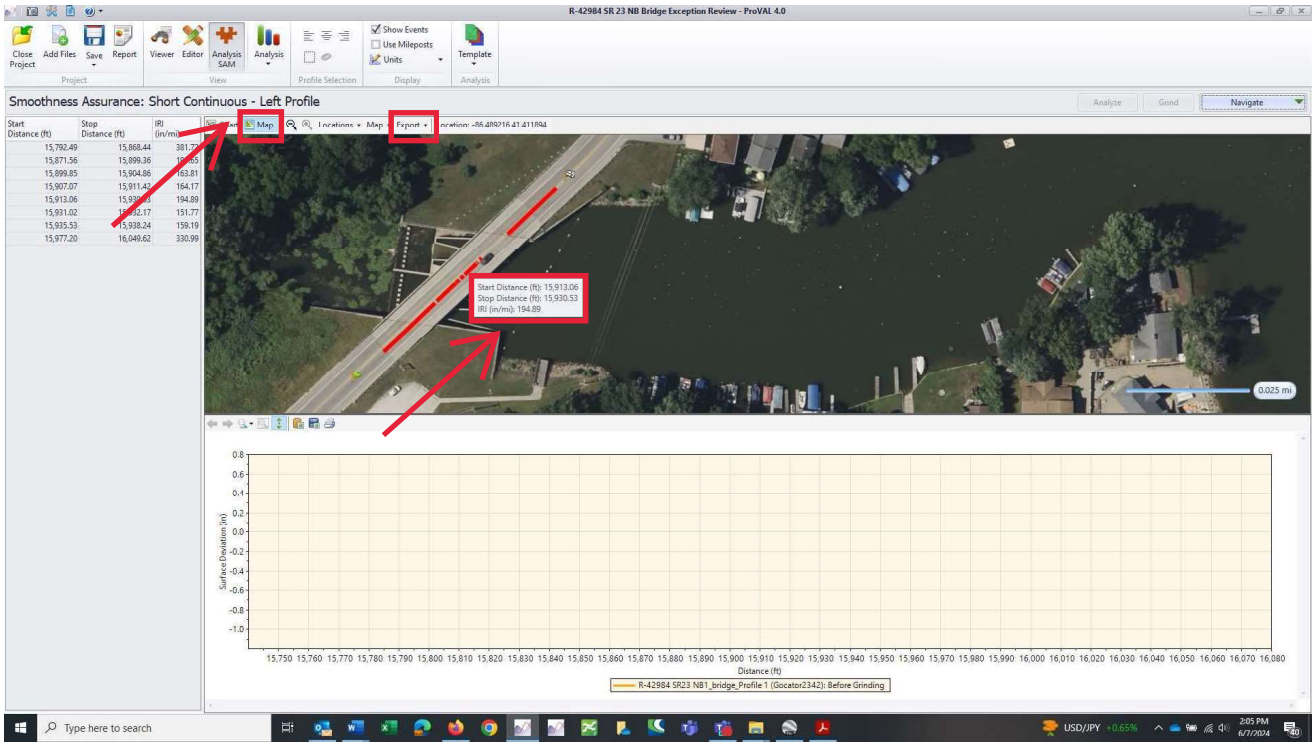
28) Once the route shown aligns with project work, select the **Accept button** as shown below. Now that you have generated an **accepted Route** in the Editor module, the **Map function** is now available in the **Viewer, Editor, and Analysis** modules.

(Note: if the incorrect route was accepted, select the reset button and repeat the route creation steps)



29) The example shown below shows utilizing the map function while in the analysis module, smoothness assurance. In all of these modules the map function is accessed by clicking on the **map button** on the tool bar just above the upper window as shown below. After you click on the map button, the chart view showing IRI vs distance will be replaced by the **map view** shown below. On the same toolbar just above the map, click on the **zoom button** to zoom in on the ALR locations which will be shown in red. Move the **mouse over** each location, and as you do notice the box that opens up with start and stop location as well as IRI roughness data. You can continue to move from location to location by zooming in and out and by clicking and holding with the mouse while at the same time moving the mouse forward or backward.

(Note: if the map button is not shown on your toolbar, it may be that the equipment the contractor used was not GPS enabled which means it is not meeting contract requirements)



Note: The map image shown in the window can be exported by clicking the export button on the same toolbar and selecting save image, the current zoomed view is what will be exported as an image. You could choose to zoom in on each location requiring ALR shown on the map in red and export an image file for each; then print each image to pdf and combine the pdf files into a single document for use in the field. Another option is to select copy image instead of save image, and then paste each image into a Microsoft Word document. Every Location could then be summarized in the Word document with start/stop distance and IRI data followed by a mapped location moving systematically from start of project to end of project. (There may be other ways to utilize the export data as well not explained here.) This information can then be printed and provided to inspectors and contractors involved in the locating and grinding corrective areas, or it could be utilized by sharing electronically only.

Note: The engineer may need to correlate the distances shown in the reports to project stationing prior to taking the information to the project site to review and locate corrective areas. The distances from the high-speed profiler are not automatically aligned to project station and the results on the report depend on the start station utilized during set up of the high-speed profiler and the ProVal editing of the files completed.

APPENDIX A

ALR Guidance for PE/PS – Data Confirmation & Engineer Decisions on Grinding (HMA Surface Level Review)

1. Receive ALR ProVal analysis and ProVal files from Contractor; ProVal analysis should include locations requiring corrective action.

2. Review Contractor ALR ProVal analysis to ensure completed in accordance with IRI Field Guide for ALR.

3. Review ALR locations utilizing GPS mapping function in ProVal in preparation for driving the project. Utilize the distances and lengths shown in the ProVal report tied to field located anchor points rather than project stationing in order to locate bumps. An anchor point is a known location that corresponds to the high-speed profile distances and lengths such as the start and end points of the run or known bridges, railroads, or intersections within the run. Anchor point data such as a bridge may be found in the ProVal software under the editor module as a "section" that has a "leave out" and is in orange.

4. Drive the project in a vehicle at the speed limit and check off whether or not each ALR location can be "felt" or "found" with the goal of deciding if ALR data is valid. (Note this is not to determine whether locations require corrective grinding but rather to confirm that the profile data is valid)

5. After review of all ALR locations in the field, determine how many locations could not be felt. If the % of locations that could not be felt is:
   a. Less than 10%; proceed to step six, or
   b. 10% or more; either consider the data bad and notify the contractor to run the same section again and repeat the overall process or contact the area engineer for further assistance. (Determination will need to be made as to the cause: equipment or operator error, filtering error, DMI or GPS error, etc.)

6. After ALRs have been validated as noted herein, a grinding simulation in ProVal should be performed by the contractor to see if the ALR can be corrected to an IRI value of less than 160 in/mi (Type A) or 170 in/mi (Type B) with no more than a ¼ in max grind depth at any spot. If the noted correction is not possible, then an ALR with an IRI value of less than 190 in/mi can remain uncorrected and an ALR with an IRI value of greater than 190 in/mi will require full depth removal and replacement of the surface course in accordance with the specification. However, if there is only one ALR in any two-lane mile section, then no smoothness correction will be required if the ALR does not exceed 190 in./mi and the overall segment smoothness of the two-lane mile section does not require any corrective action for segment smoothness in accordance with the specification. Contact the Area Engineer and Field Engineer for assistance as needed.

7. As a final check prior to performing corrective action, ensure that all exemptions noted in the specification and ITM 917 have been excluded.

8. Proceed with corrective action.

9. After completion of ALR corrective action, the contractor will perform a check run with the high-speed profiler and confirm that IRI values were brought to within an acceptable range. However, the check run will not be required if the overall segment smoothness for the contract was consistently at MRI of 90 in/mi or less and the total number of ALR corrective locations were less than 5 on the contract.

10. Prior to requesting multiple rounds of corrective action work of a Contractor, review the remaining ALR areas of concern with the Area Engineer to determine if further corrective action will achieve results.