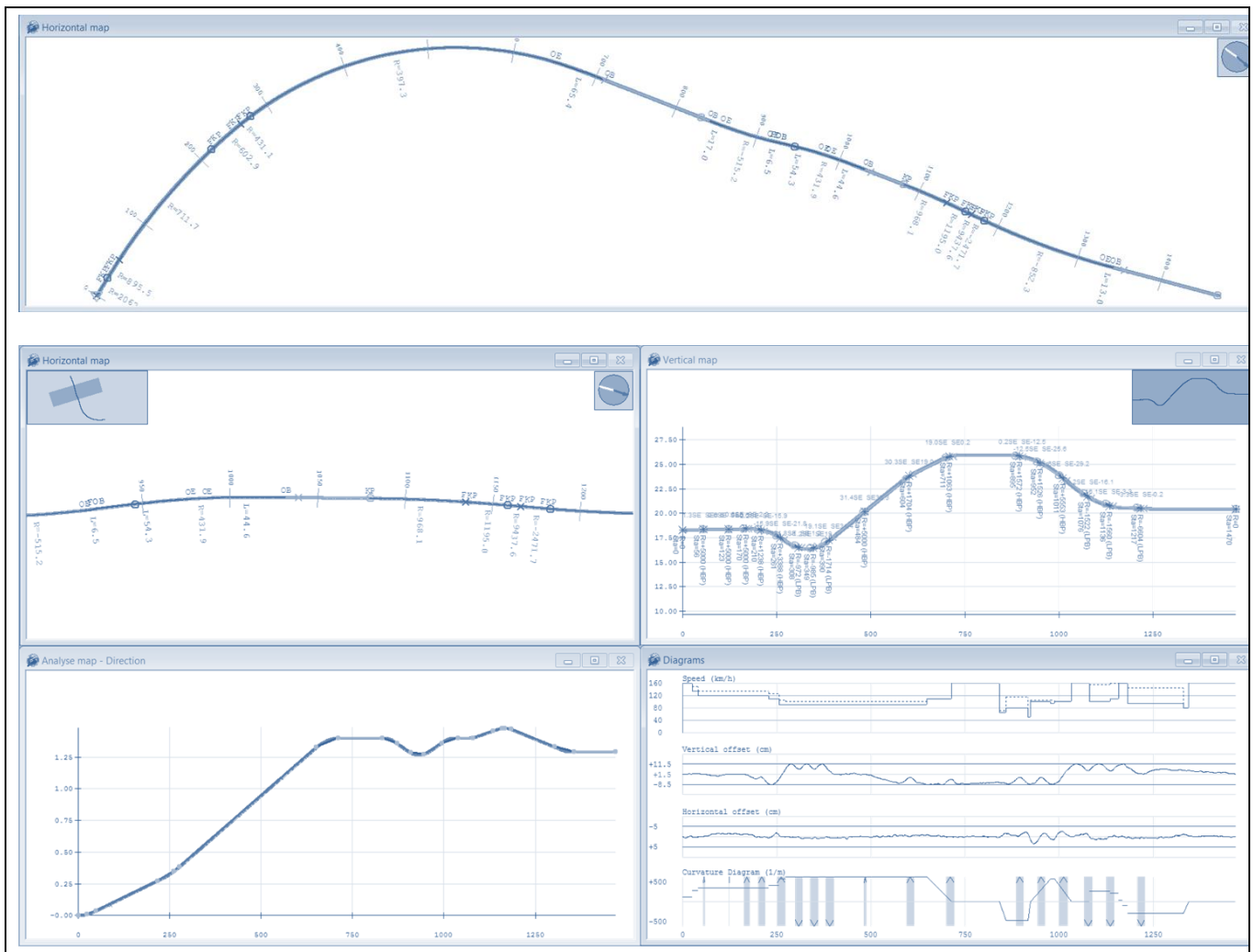




User manual

NovaTrack 2020



Version 2020
May 2020

This is 2020 release of the **Novapoint NovaTrack User Manual**, English language.
It applies to the TRIMBLE Novapoint NovaTrack software.

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1 Installation and licensing

- Novapoint Nova Track is a function included in Novapoint Railway.
- There is no separate installation of Nova Track. It is installed when Novapoint is installed.
- There is no separate license for Nova Track, it is included in Novapoint Railway.
- Novapoint Track is started from Novapoint AutoCAD menu Railway and button Alignment Design from Surveyed data...

2 Typical workflow

2.1 Alignment calculation using automatic smoothing

NovaTrack provides a functionality for automatic processing of measured track data into horizontal alignment elements, using 'NovaTrack 3.0' method.

The automatic processing workflow:

- Step 1.** Import track measurement data by clicking *Open -> (Survey point coordinate file)*.
- Step 2.** From the list select appropriate calculation profile (e.g. *'New tracks normal'*).
- Step 3.** If required, adjust *Main Calculation Constants* (depending on track and measurement quality): *'Min.straight line length'*, *'Minimum lift'* and *'Number of iterations'*⁽¹⁾.
- Step 4.** Press *'OK-Analyze'* to compute alignment.
- Step 5.** Review calculated offsets. If required, adjust scale for horizontal and vertical offset in *Tools -> Options*.
- Step 6.** Adjust individual horizontal alignment elements where offsets are beyond set tolerances.
- Step 7.** Adjust gradient lines and PVI from the *Vertical layout*, so vertical alignment elements are within the limits of minimum uplift and upper tolerance.
- Step 8.** Access the Cant calculation menu by double clicking *Cant Diagram*. Select method for cant calculation: *Get measured cant* – cant from coordinate file (if file contains left and right rail), *Calculate element speed only* – speed is calculated according to the measured cant values element by element. *Calculate element cant* – cant is calculated to give element speed element by element. *Calculate cant and speed* – cant is calculated as continuous cant throughout the alignment.
- Step 9.** If required, in the cant and speed calculation dialog adjust calculated cant/speed values. In the *Speed/Cant* table change *'h1'*, *'h2'* and *'v'* fields. Select checkbox *'K'* to lock edited values.
- Step 10.** Export alignment to a file format by selecting *File -> Save As.. -> and select an alignment format*.
- Step 11.** Save the project SPW file format to be able to open the project again.

⁽¹⁾ – In the NovaTrack 3.0 method it is recommended to adjust number of iterations between 1 and 10. Larger amount than 10 iterations will not have effect on final alignment result.

2.2 Alignment calculation using semi-automatic method

In the semi-automatic processing workflow, initial alignment measurement processing is done using 'Regression with Transition Curves' method. Further, using the Analysis Diagram tools, horizontal alignment elements are enhanced by extrapolating them based on track measurements. Semi-automatic workflow applies for tracks with poor geometry:

The processing workflow using Analysis tools:

- Step 1.** Import track measurement data by selecting *Open -> (Survey point coordinate file)*.
- Step 2.** From the list select appropriate calculation profile (e.g. 'New tracks minimum').
- Step 3.** If required, adjust *Main Calculation Constants* (depending on track quality): 'Error tolerance'⁽¹⁾, 'Min.straight line length', 'Max.radius for transition curves', 'Number of iterations'⁽²⁾.
- Step 4.** Press 'OK-Analyze' button to compute alignment.
- Step 5.** Review calculated offsets. If required, adjust scale for horizontal and vertical offset in *Tools -> Options*.
- Step 6.** Continue with further alignment adjustment in the *Analysis Diagram*. Depending on a track configuration, select *Curvature 7* or *Direction* diagram.
- Step 7.** In Analysis diagram activate continues calculation mode by selecting 'Calculate automatically'. Alignment/offsets will be updated continuously while editing split points.
- Step 8.** Adjust split point position by adding or removing redundant split points (e.g., to minimize offsets).
- Step 9.** Switch to *Horizontal layout*. If the horizontal offset values are still exceeding set limits, adjust individual horizontal alignment elements using element editing tools. Double-click element and adjust geometry parameters by observing offset trend.
- Step 10.** Adjust gradient lines and PVI from the *Vertical layout*, so vertical alignment elements are within the limits of minimum uplift and upper tolerance.
- Step 11.** Access the Cant calculation menu by double clicking *Cant Diagram*. Select method for cant calculation: *Get measured cant* – cant from coordinate file (if file contains left and right rail), *Calculate element speed only* – speed is calculated according to the measured cant values element by element. *Calculate element cant* – cant is calculated to give element speed element by element. *Calculate cant and speed* – cant is calculated as continuous cant throughout the alignment.
- Step 12.** If required, in the cant and speed calculation dialog adjust calculated cant/speed values. In the *Speed/Cant* table change 'h1', 'h2' and 'v' fields. Select checkbox 'K' to lock edited values.
- Step 13.** Export alignment to a file format by selecting File -> Save As.. -> and select an alignment format.
- Step 14.** Save the project SPW file format to be able to open the project again.

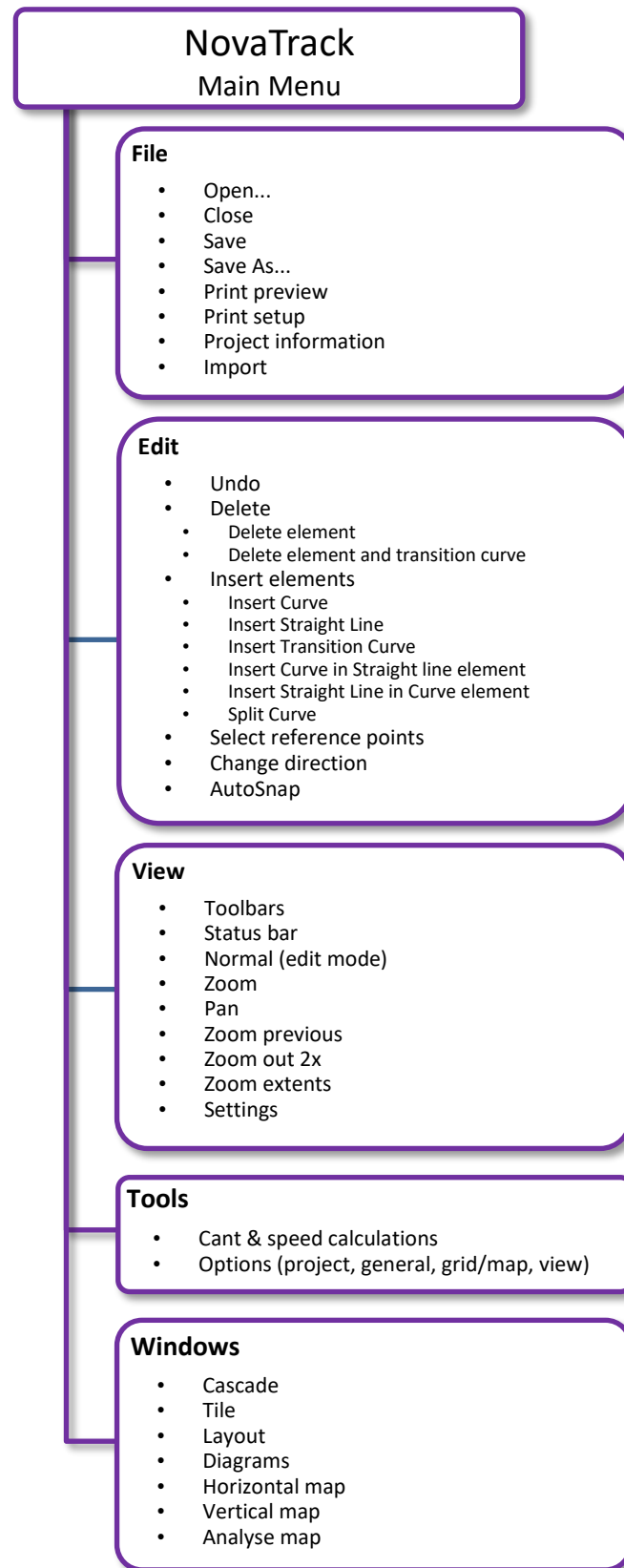
⁽¹⁾ – In the 'Regression with Transition Curves' method it is recommended to adjust 'Error tolerance' based on track geometry quality. The higher tolerance generates less precise alignment solution. It is recommended to use tolerance range between 0.5 and 30 meters.

⁽²⁾ – Setting 'Number of iterations' is directly related to 'Error tolerance' setting and defines with what step increment 'Error tolerance' will be increase. Calculation always starts with error tolerance 0.0 m and runs till it reaches maximum set value. At the end of the iteration process, software selects alignment solution which has smallest 'Sum of offset' value.

The higher iteration number can have effect on more precise alignment fitting.

3 Menu structure and user interface

3.1 NovaTrack menu structure



NovaTrack software menu structure

3.2 Toolbar items









NovaTrack has six different toolbars that gives access to the most frequently used command/functions. Holding the cursor on a toolbar button, a short description of the command is displayed. From the View menu, it is possible to choose which toolbars should be displayed, see Toolbars / Status line.

The toolbar buttons have colour codes; blue is Horizontal window, green is Vertical window, grey is the Diagram window and red square symbol is the Analysis window. The predefined layout makes it easy to move the window to desired position.

The toolbars can be moved as required.

3.2.1 Standard toolbar



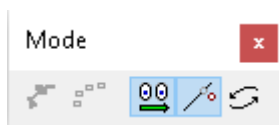
Icon	Function description
	Open existing project in .SPW or import new measurement data from coordinate file format
	Save project to .SPW or export data to alignment file format (.TIT/NYL, .LIN/PRF, .LandXML, .TDT, .HDT, .UDT)
	Alignment re-calculation based user selected settings and setting profile
	The Undo tool reverts back changes made in the process of calculation or editing. Undo function is affecting data changes made both in horizontal/vertical views, analysis diagrams and alignment changes due to recalculation process.
	The Redo tool reverts forward changes made in the process of calculation or editing. Redo function is affecting data changes made both in horizontal/vertical views, analysis diagrams and alignment changes due to recalculation process.
	Show Result File. Provides detail summary of alignment data input and calculation results.
	Print. Using this tool, it is possible to print out the data in the Horizontal, Vertical and Schematic windows. The data for the active window view will be printed. The information defined in the function 'Project Information' will be used for the printout headers.
	Help. Opens the NovaTrack help file.

3.2.2 View toolbar



Icon	Function description
	Normal (Edit Mode). Switching from zoom or pan mode to Edit mode. The Normal (Edit mode) is the standard mode and gives access to editing and pointing functions.
	Pan. Moves the zoomed area by pressing the left mouse button and dragging the zoomed area into place.
	Zoom Window. Zooms in an area between the chainages. The area is defined by clicking at the 'from chainage' and at the 'to chainage'.
	Zoom Previous. Zooms to the previous view.

3.2.3 Mode toolbar





Icon	Function description
	Mode Line (Not yet implemented)
	Mode Point (Not yet implemented)
	Left to Right Drawing. Rotates the drawing and the coordinate system so that the horizontal alignment is shown from left to right. By default this option is activated. When the option is not checked, the drawing is shown with the x-axis direction upwards. Left to right drawing can also be switched on or off from the toolbar.
	AutoSnap. Function is affecting element editing in horizontal, vertical and analysis diagram views. During element editing, when dragging existing tangent points or creating new, the function will automatically lock tangent point to a measured point.
	Change Horizontal Direction. When importing measurement data, the program will automatically start the chainage at the lowest X-coordinate, with increasing chainage northwards. This direction can be reversed using this tool.

3.2.4 Edit toolbar









Icon	Function description
	Delete measure point (Not yet Implemented)
	Delete Intersection Point. The function deletes the active vertical curve, and its initial and final straight lines (grades) are joined into one element.
	Insert Intersection Point. Inserts curve in vertical alignment. The program prompts for the position of curve and element radius.
	Delete Element Only. First active element is marked with a thicker line within the horizontal window. Then active element is deleted. <ul style="list-style-type: none"> - Before activating this tool, make sure that the correct element is selected by clicking on it in the window 'Horizontal Map'.
	Delete Element and Transition Curves. Deletes active element along with the transition curves. <ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' on status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Before activating this tool, make sure that the correct element is selected by clicking on it in the 'Horizontal Map' window.
	Insert Transition Curve. Inserts a transition curve (TC) after the active element. <ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to revert back to the last line calculation.
	Insert Curve. Inserts a curve (C) after the active element. <ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Straight Line. Inserts a straight line (SL) after the active element. <ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Curve in Straight Line Element. Inserts a curve (C) along with transition curves (TC) at either ends of the active straight-line element. <ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment is to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Straight Line in Curve Element. Inserts a straight line (SL) along with Transition curves (TC) at either ends in the active curve element.

	<ul style="list-style-type: none"> - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment is to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Split Curve. Splits the active curve element. The old curve is split, and two new curves are calculated from the measured data.
	Select Reference Point. The current start chainage reference point is replaced with a new reference point from the measurement data.


3.2.5 Layout toolbar



Icon	Function description
	Horizontal Map Diagram. Positions the Horizontal window above and the Schematic window below
	Vertical Map Diagram. Positions the Vertical window above and the Schematic window below.
	Vertical Map Horizontal Diagram. Positions the Vertical window to the left, Horizontal window to the bottom right and the Schematic window to the top right.
	Horizontal Map Vertical Diagram. Positions the Horizontal window to the left, Vertical window to the bottom right and the Schematic window to the top right.
	Hmap Vmap Diagram. Positions the Horizontal window above, the Vertical window in the middle and the Schematic window below.
	Vmap Hmap Diagram. Positions the Vertical window above, the Horizontal window in the middle and the Schematic window below.

3.2.6 Analysis toolbar



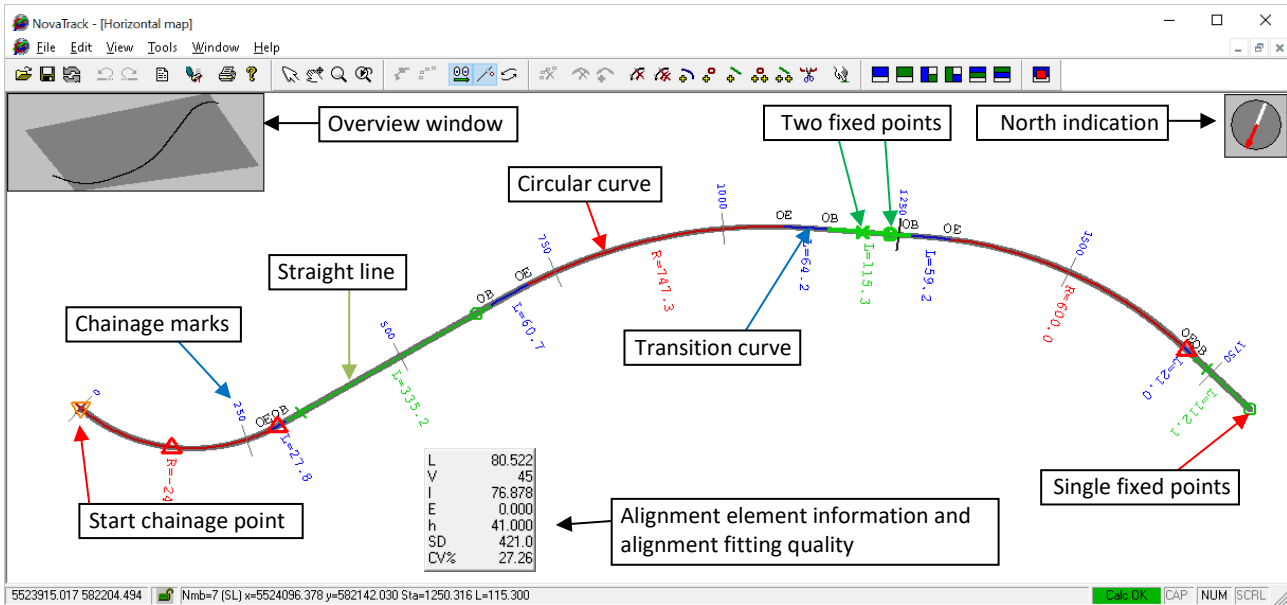
Icon	Function description
	Analysis Diagram. Opens new Analysis diagram window. Use mouse right-click to select appropriate measured point visualization method: Curvature 3, Curvature 7 or Direction.

3.3 Graphical User interface

NovaTrack uses three movable and re-sizeable windows: Horizontal Map, Vertical Map, and Analysis diagram windows. These windows can be arranged within the user’s preferences. NovaTrack also has pre-defined Layouts for these three windows.

3.3.1 Horizontal map view

The Horizontal window shows the Project’s horizontal alignment (current line calculation). The alignment can be shown in either a left-to-right direction or orientated with the North direction pointing upwards on the screen depending upon the current view settings (see paragraph 4.5 View settings).



The horizontal alignment elements are colour coded:

- green colour for straight line;
- blue colour for transition curves or spirals;
- red colour for circular curves;
- chainage is marked with a blue ticks.

With mouse ‘double click’ on the alignment element, the software opens quick information summary window containing information about the element, speed, cant and overall track offset summary. The summary window is floating and can be move using the mouse left key anywhere on the screen. The content of the window is dependent on the element type.

Element type - straight line	
L	157.633
V	120
SD	91.0
CV%	-3.92
L – element length, meters	
V – calculated speed for the specific element	
SD – calculated standard deviation for the alignment, mm	
CV% – calculated coefficient of variation for the alignment, %	

Element type - transition curve/clothoid		
L	33.624	<i>L</i> – element length, meters
V	45	<i>V</i> – calculated speed for the specific element
dl	25.241	<i>dl</i> – change in cant deficiency
dD	10.038	<i>dD</i> – cant change speed
dh	27.000	<i>dh</i> – change in cant
SD	91.0	<i>SD</i> – calculated standard deviation for the alignment, mm
CV%	-3.92	<i>CV%</i> – calculated coefficient of variation for the alignment, %

Element type - circular arc.		
L	416.281	<i>L</i> – element length, meters
V	65	<i>V</i> – calculated speed for the specific element
I	114.656	<i>I</i> – cant deficiency
E	0.000	<i>E</i> – excess of cant
h	27.000	<i>h</i> – design cant
SD	91.0	<i>SD</i> – calculated standard deviation for the alignment, mm
CV%	-3.92	<i>CV%</i> – calculated coefficient of variation for the alignment, %

With mouse free movement over the measured point element, the software opens point Tooltip window containing information about the selected point.

Element type - measured track point.		
Sta	= 934.147 m	<i>Sta</i> – point chainage (m)
Point#	= 471	<i>Point#</i> – point sequence number
Code	= TRK1	<i>Code</i> – point feature code from measurements
Name	= P510	<i>Name</i> – point name from measurements
Meas.cant	= -40 mm	<i>Meas.cant</i> – measured cant (mm)
H.Offset	= 0 mm	<i>H.Offset</i> – horizontal offset between measured track point and alignment
V.Offset	= -0 mm	<i>V.Offset</i> – vertical offset between measured track point and alignment

Cross marks and circle marks are fixed points (tangent points), necessary for the alignment calculation. The fixed point position can be modified in the graphical interface. However, fixed points cannot be deleted or created, since they are connected to the alignment elements.

The fixed points are colour coded, marked with different symbols and have the following meaning:

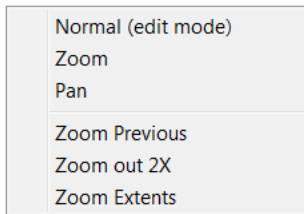
- green fixed points belong to elements which are locked with two fix points. The first point is a cross and the second is a circle.
- red fix points are locking the elements at one fixed position only.

For a description on calculation methods, see [5. Definition of calculation methods](#). For a description on editing the alignment calculation, see [7. Alignment data calculation and editing](#).

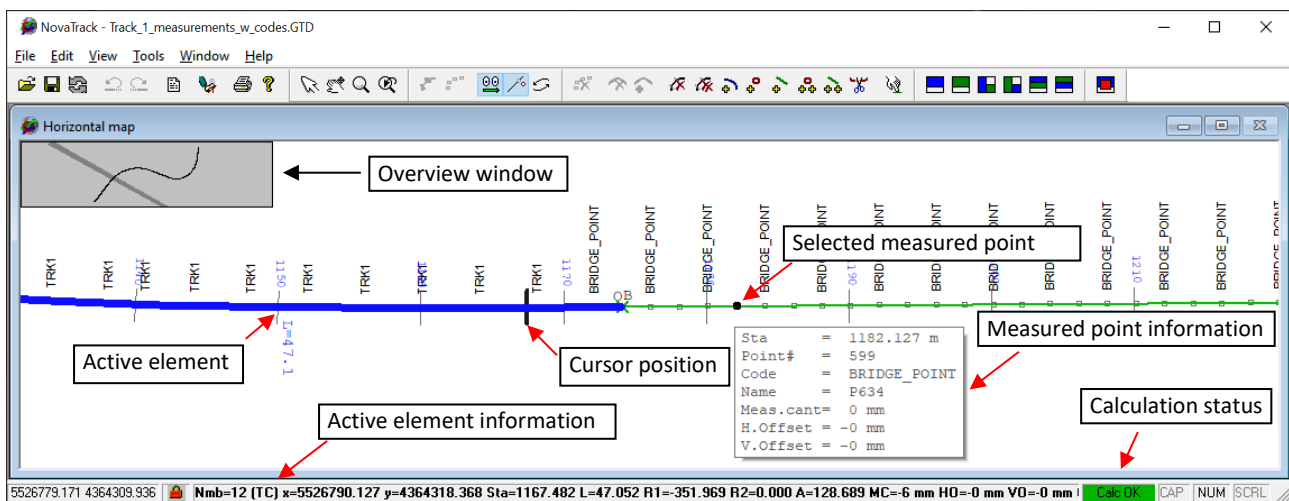
In the top left-hand corner of the *Horizontal* window, an aerial overview window of the complete alignment is shown, with the active view window marked in a darker color.



In the top right-hand corner, a north arrow is shown. (Only when viewed in left-to-right mode)

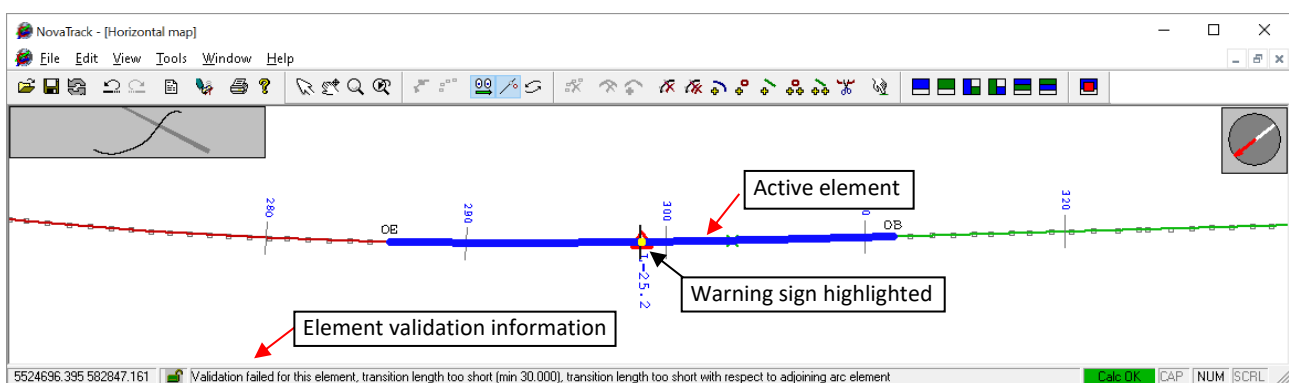
For viewing basic alignment element information, point the element using mouse left-click. A double left-click opens the element Editing dialog (see [7.3.1 Workflow for manual adjustment of horizontal alignment offsets](#)). A right-click opens a quick menu with appropriate commands:



When the cursor is moved along the alignment, the chainage marker is shown at the cursor's position. The active element is displayed using a bolder color. When the cursor is pointed at a fixed point, the fixed point is marked with a filled, yellow circle. When the cursor is moved over the measured point, the Tooltip shows detail information about the point.

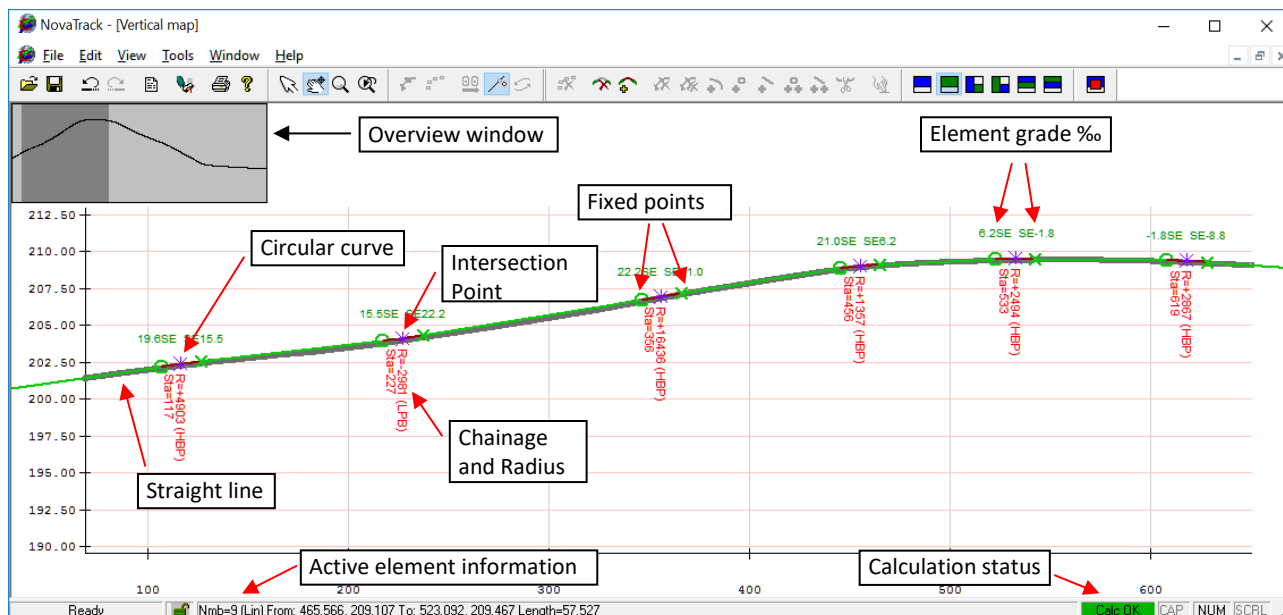


All calculated alignment elements which are outside the limits set in the selected user profile, are marked with a warning sign (triangle symbol) . When the mouse pointer is moved over the warning sign, the symbol is highlighted and the status prompts  with element validation information.



3.3.2 Vertical map view

In the *Vertical Map* layout window, the vertical alignment of the project is shown. The alignment is shown as a graph with the chainage on the X-axis and the height (elevation, Z-value) on the Y-axis. The alignment is colour coded: straight elements are green and circular curves are marked in red.



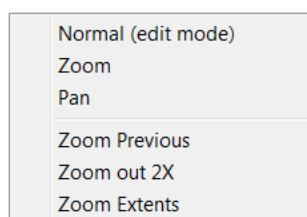
Cross marks and circles are fixed points necessary for the line calculation.


Green fixed points belong to straight elements, where the first fixed point is a cross, and the second is a circle. Blue crosses represent the vertical angular points for the circular curves.


For a description on editing the vertical alignment, please refer to chapter [7.3.3. Workflow for the manual adjustment of vertical alignment offsets](#).

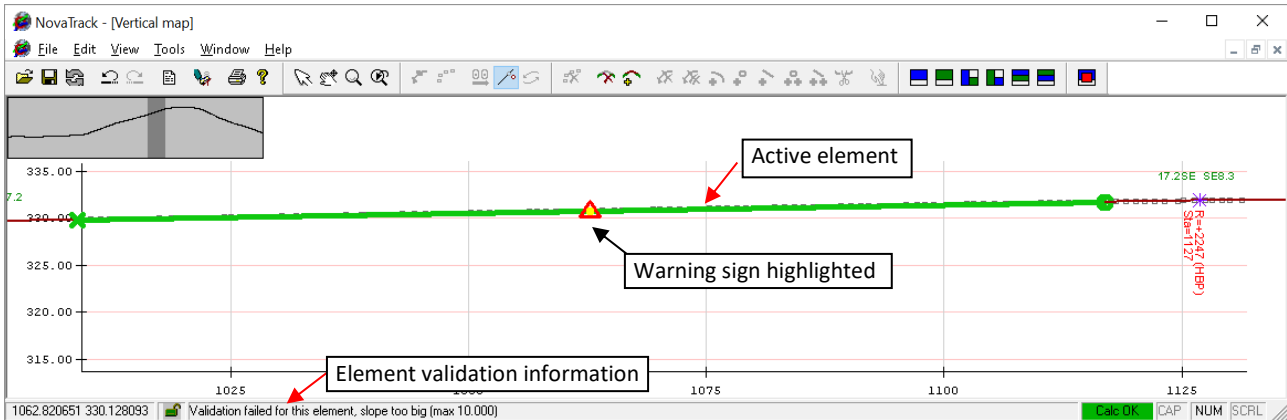
In the top left hand corner of the Vertical window, a view over the complete vertical alignment is shown, with the current view marked in a darker colour.

The user chooses an active element by clicking on it. Double-clicking an element opens the edit element dialogue box. A right-click opens a quick menu with appropriate commands:



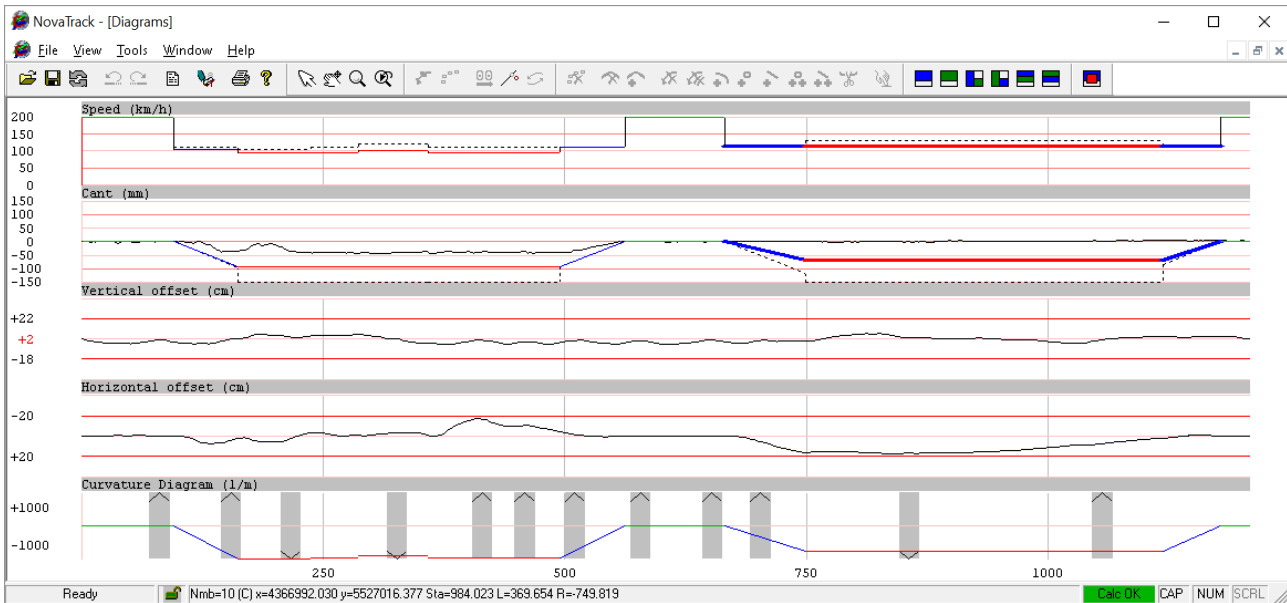
All calculated alignment elements which are outside the limits set in the selected user profile, are marked with a warning sign  (triangle symbol).

When the mouse pointer is moved over the warning sign , the  symbol is highlighted and the status prompts with element validation information.


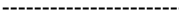



3.3.3 Diagram view

The Diagram window displays information about the calculated/set speed, measured/calculated cant, vertical offsets, horizontal offsets and horizontal/vertical alignment curvature.



- The Speed diagram (in km/h) shows calculated speed at each horizontal alignment element. The speed indication lines have different marking, which is dependent on element type (separated by colors) and calculated speed values (separated by line type).

	Calculated Vmax speed for individual element (colour coded)
	Calculated Vmax speed for individual element, considering neighbouring element speed (colour coded)
	User set Vmax speed for individual elements (colour coded)

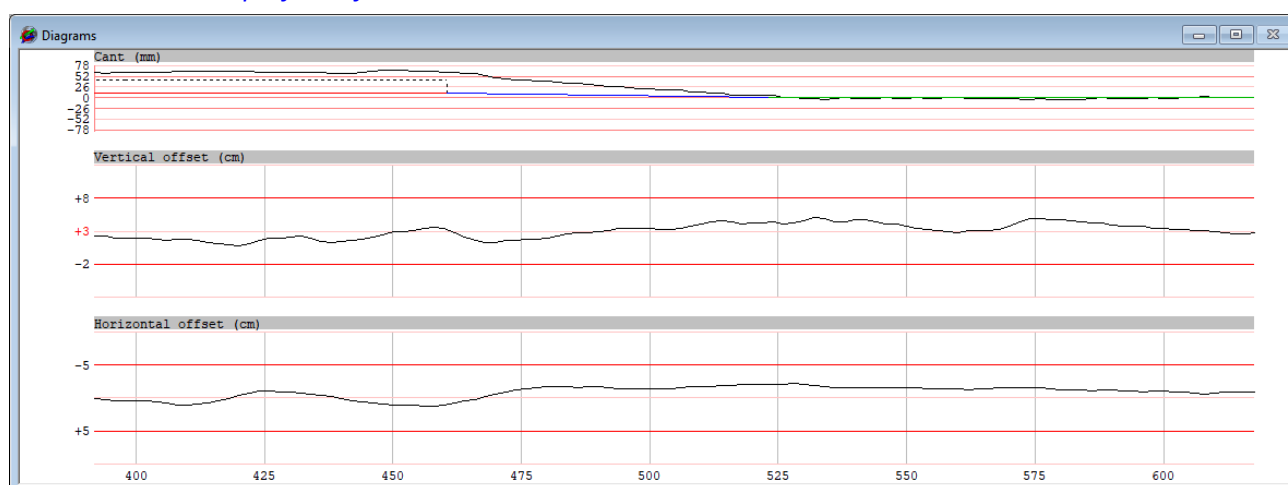
The speed calculation regulations can be set or edited in the [Calculation profile](#).

Calculation profiles can be accessed from the toolbar, by selecting the function [Re-analyse](#) or from the main menu Tools -> Options -> Calc.set. Use the same dialogue to define new or edit existing profile.

Vmax values are calculated based on the calculation profile table and can be over written with user define speed settings, in the [Tools -> Cant and Speed calculations – Speed](#).

- The Cant diagram (in millimeters) shows measured and calculated Cant values. Additionally, depending on the alignment element type, calculated Cant values are coloured accordingly. The maximum scale for calculated Cant is set in the [Calculation Profile](#) settings (variable *hmax*). The calculated Cant values for the whole alignment can be accessed for editing by double-clicking on the Cant graph.

For editing the [Calculation profile](#), please refer to chapter [4.4 Calculation profiles](#) and [Appendix 2. Calculation profile definition](#).



	Measured Cant (black colour)
	Calculated Cant for individual element (black colour)
	Calculated Cant for individual element, based on measured cant or based on calculation profile (colour coded depending on element type)
	Over written Cant by user (bold, colour coded depending on element type)

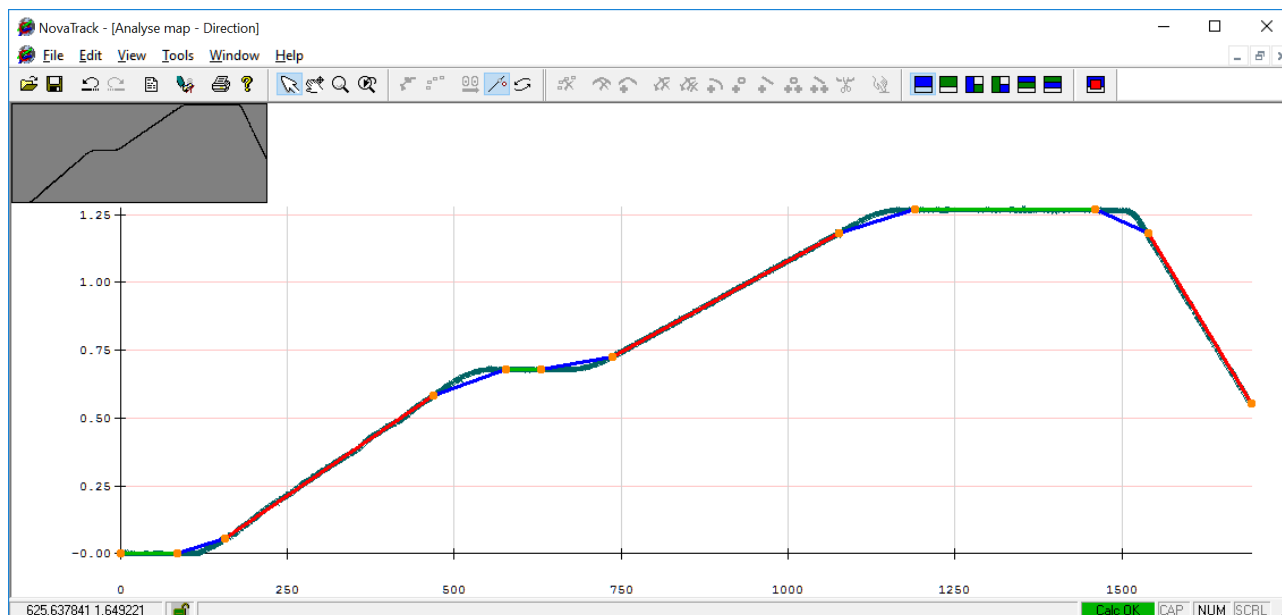
- The Vertical offset diagram (in centimetres) shows the offset between measured points and the vertical alignment calculation. Where the calculated line is above the measured point, the vertical offset is shown as above the [0-level](#) (positive offset). The scaling of the vertical offset diagram can be set in [Tools -> Options -> Project](#).
- The Horizontal offset diagram (in centimetres) shows the offset between measured points and the horizontal line calculation. Where the calculated alignment is always following the 0-level, and measured points as the continuous black line are displayed on both side of 0-level axis. Offsets on the left side [0-level](#) axis are 'positive', and on the right side - 'negative'. The scale of the horizontal offset diagram can be adjusted in [Tools -> Options-> Project](#) settings.
- The Curvature diagram (1/R) shows the curvature of the horizontal alignment. If the measured point view "[Show 3 \(and/or 7-\) point radius](#)" (in [View -> Settings](#) dialog) is activated, these

calculated points are visible in the *Curvature diagram*. The diagram also shows the vertical alignment, with its Intersection Points and vertical radii indicated with grey fields and arrowheads.

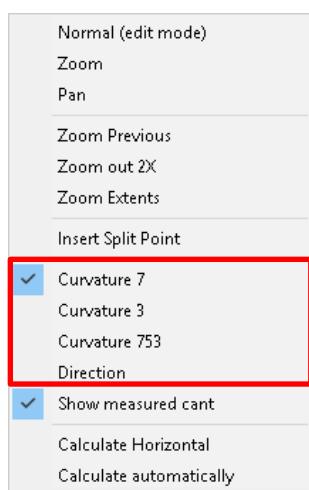
- At the bottom of the *Diagram* window, the chainage information is displayed.

3.3.4 Analysis diagram view

The **Analysis** window is used for semi-automatic analysis of the measured track data. Based on the measured points, the program calculates horizontal track curvature as $1 / \text{Radius}$ and **Direction** changes. Calculated values are displayed along the chainage axis in the form of diagram.



To switch between available Analysis diagram visualisation modes, in the **Analysis diagram** view use mouse **right-click** and select appropriate data visualization mode from short-cut menu:



Analysis diagram mode	Comment
Curvature 7	Inverse radius curvature diagram, average 7 point radius
Curvature 3	Inverse radius curvature diagram, 3 point radius
Curvature 753	Inverse radius curvature diagram, average of 7, 5 and 3 point radius
Direction	Directional diagram based on direction change along the measured points

Important!

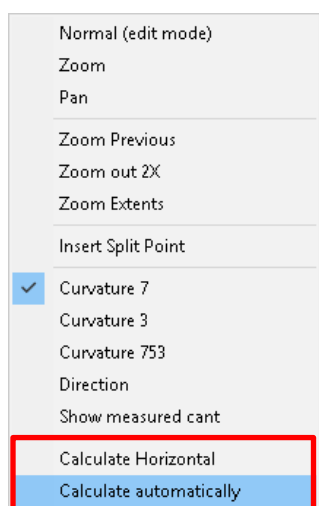
Analysis function only calculates horizontal alignment geometry. If the **Manual** or **Automatic** calculation function is activated, the available alignment geometry in the **Horizontal view** window will be replaced with the calculated alignment from **Analysis diagram**.

The *Analysis* calculation engine is relying on the user defined "*split*" points (in the *Analysis diagram*) which represent preliminary locations for element tangent points.

Each "*split*" point is connected with a horizontal alignment element and these elements are presented in the diagram view as preliminary guidelines for horizontal alignment calculation. The colour of the alignment elements has the following meaning:

Colour	Element type
Green	Straight line
Red	Circular curve
Blue	Clothoid/Spiral (transition curve)
Grey	No element inserted between split points

After the positions for the elements are identified and an alignment is calculated in the diagram view, the result is automatically synchronised with the Horizontal view. Diagram recalculation and synchronisation with the horizontal view can be set in Manual or Automatic mode. To switch between the modes in the Analysis diagram view *right-click* and select/deselect calculation mode to *Calculate automatically*:



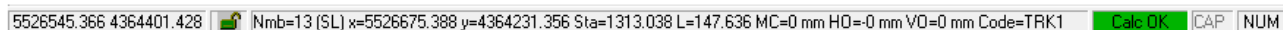
Important!



No element will be inserted between two '*split*' points that have fewer than 3 measured points between them.


If the diagram elements between the split points are coloured in 'magenta', it means that an alignment contains errors and therefore it cannot be calculated.

3.3.5 Status bar

The Status bar shows information about the position of the cursor, active element and calculation status. The type of visible information varies depending on what windows are open and the type of active element. When the user is editing an element, a brief description of what the user should do is displayed.



- To the left, the coordinates of the cursor are shown. When the cursor is in the *Horizontal* window, the coordinates are East-North. When in the Vertical window, the coordinates are Chainage-Elevation.
- The following symbol  is a *Padlock*. The lock is green when there is no element selected for editing. When an element is activated for editing, by clicking on it, the padlock changes to red .
- To the right of the *Padlock*, information about the current element is displayed - *Element number*, *Element type*, *Coordinates*, *Chainage*, *Length* and *Radius* (*Transitions* are displayed with Start and End radius). Displayed information about elements in the vertical alignment are *Element number*, *Element type*, *Chainage* for start and end, and *Element length*.
- Additionally, in horizontal and vertical alignment view, status bar contains information about the selected measurement point, including: *MC* – measured cant (mm), *HO* – horizontal offset (mm), *VO* – vertical offset (mm) and *Code* – selected point code.
- Further to the right, the status of the line calculation is displayed. When the calculation is successful, the text "*Calc OK*" is shown in green. When the calculation is not successful, the text "*Calc not OK*" is shown in red. Double-clicking this field opens the result text-file.
- Furthest to the right of the Status bar shows the current status for Caps Lock, Num Lock and Scroll Lock.

When the specific element warning sign  is selected in the Horizontal or Vertical view, a status bar prompts with element validation information.



3.3.6 Abbreviations used in horizontal and vertical alignments

NovaTrack is using following abbreviations for horizontal and vertical alignment elements:

- S** - Long fall gradient. Slope of the vertical alignment element in per-mil
- SE** - End of Slope. Marks the transition between gradient and vertical curve element.
- HBP** - High Break Point. Vertical intersection point where the slope decreases – PVI Crest.
- LBP** - Vertical Intersection Point. IP where the slope increases - PVI Sag.
- FKP** - Common circular curve point in a compound circular curve.
- FOB** - Common transition curve point at two connected transition curves.
- KP** - Circular curve with straight segment tangent point.
- OB** - Beginning of the transition curve.
- OE** - End of the transition curve.

- STA** - Chainage. Distance in metres along the track from a given reference point.
- Pr** - Chainage mark in metres.
- Km** - Kilometre. Similar to chainage, but the unit is in kilometres.
- L** - Straight element length. Used for horizontal elements. Unit in metres.
- R** - Radius for circular elements. Used for horizontal and vertical elements, in metres.
- A** - Transition curve (clothoid/spiral) A-parameter. Used for transition curve elements.

4 Settings and options

Settings and parameters in the NovaTrack software are grouped into the following groups:

- Project settings
- General settings
- Grid and Map settings
- Calculation profiles

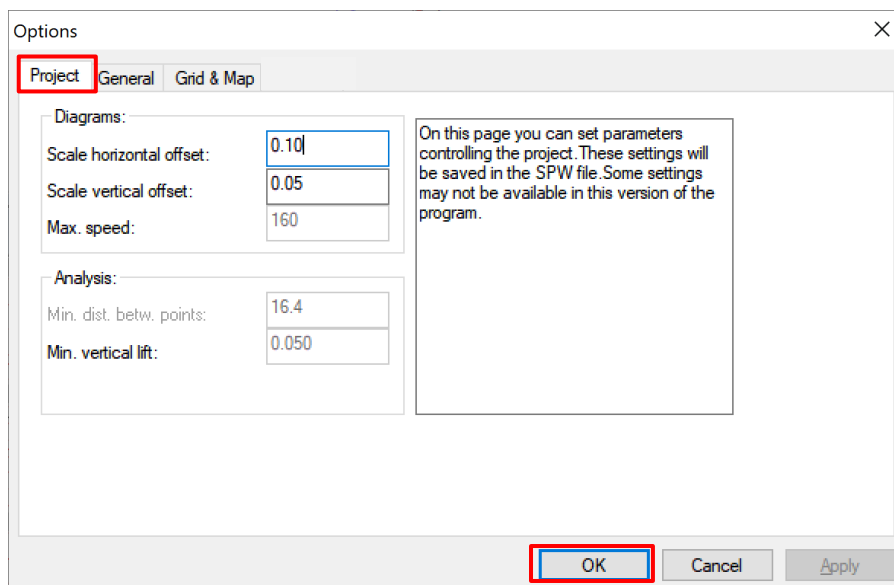
Important!

These settings are stored on a software configuration level and within the project .SPW files. Settings covering calculation profiles are stored in 'Profiles.ini' file (located in NovaTrack installation folder).

4.1 Project settings

To access the Project setting group:

- from the main menu select *Tools -> Options*
- select the *Project* tab.
- confirm changes by pressing *OK* button.

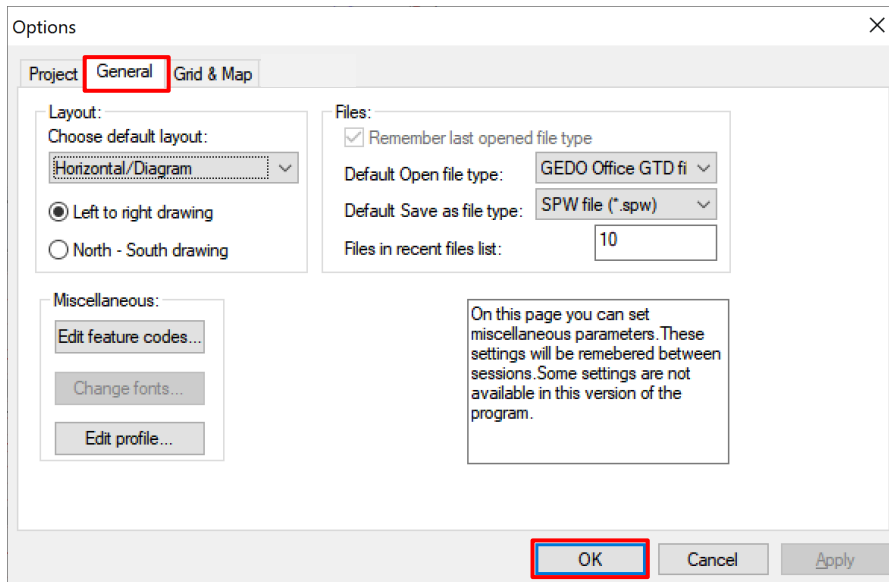


Settings	Comment
Scale horizontal offset	Scale for the Horizontal offset diagram values. Unit is metres
Scale vertical offset	Scale for the Vertical offset diagram values. Unit is metres

4.2 General settings

To access the General Settings group:

- from the main menu select **Tools -> Options**
- select the **General** tab.
- confirm changes by pressing **OK** button.

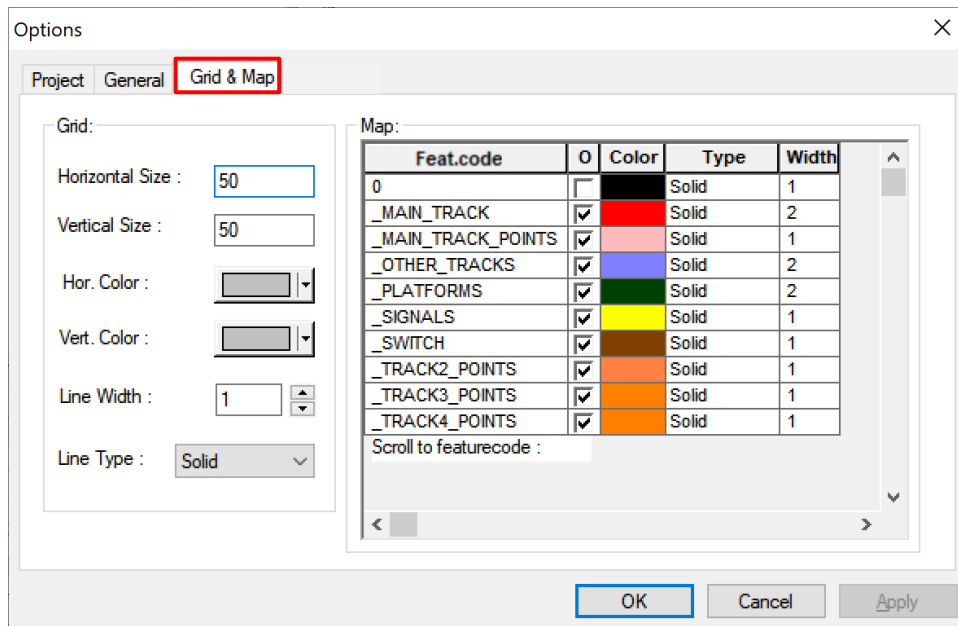


Settings	Comment
<i>Layout</i>	
Choose default layout	Sets the default layout window from the Predefined Window Layouts.
Left to right drawing	Sets the default orientation for the horizontal alignment from the left-to-right
North-south drawing	Sets the default orientation for the horizontal alignment from according to the coordinate grid
<i>Files</i>	
Remember last opened file type	Not implemented in this version.
Default load file type	Sets the default file type for opening a project.
Default Save as file type	Sets the default file type for saving a project.
Number of files in MRU list	Sets the number of recently used files shown in the File menu.
<i>Miscellaneous</i>	
Edit feature codes	Is used for changing or predefining feature codes for track centres or rails in in-data files.
Change fonts	Not implemented in this version.
Edit profile...	Create and edit calculation profiles

4.3 Grid and map settings

To access the Grid and Map Settings group:

- from the main menu select *Tools -> Options*
- select the *Grid & Map* tab.



Settings	Comment
<i>Grid</i>	
Horizontal Size/Vertical Size	Sets the grid size. Unit in metres.
Horizontal Colour/Vertical Colour	Sets the grid colour. Choose from the colour box.
Line Width	Sets the grid line width. Change using arrow-up or arrow-down.
Line Type	Sets the grid line-type. Choose available line-types from the drop-down list.
<i>Map</i>	
Feature code	Lists feature codes in the imported Map. The feature codes can be edited, but it is not possible to join feature codes.
On	Sets the feature code display status on/off.
Colour	Sets the feature entity display colour.
Type	Sets the feature entity display line-type.
Width	Sets the feature entity display line-type width.

4.4 Calculation profiles

There are two possibilities to access the Calculation profile settings:

- a) from the main toolbar, select [Re-analyse](#)

NovaTrack Analyze plug-ins

Calculation settings:

Selected profile:

- Existing tracks 2
- User specified tracks
- Plus_b
- Plus_c

Buttons: Create profile..., Edit profile..., Delete profile...

Selected Analyse Method : NovaTrack 3.0

Start & End Station : 0 810.08371710

Main calculation constants:

Constant	Value
Insert trans. curves	1
Min. straight line length	50
Min. lift	0.1

Number of iterations: 8

Measured data status:

Measured points read 2595

Duplicates - (x,y) 0

Assumed as measured error 0

Measured points deleted 0

Measured points to analyze 2595

☐ Include deleted points

OK - Analyze Cancel

- b) from the main menu, select [Tools -> Options -> General](#)

- press 'Edit profile...' button to view or edit calculation profiles.
- to delete selected profile, press 'Delete current profile' button.
- to create a new profile, press 'New (copy from existing)' button. The new profile will be always created based on a selected profile values.

Important!

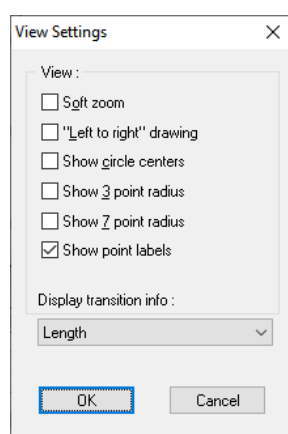
Detail description of constants used in calculation profiles is listed in the [Appendix 2. Calculation profile definition](#).

For the alignment re-calculation process, some of the most important constants are directly accessible from Re-analyse dialog:

Settings	Comment
Selected Analyse method	Regression method: <ul style="list-style-type: none"> - Novatrack 3.0: for track with good geometry quality - Regression with transition curves: for track with low-average track geometry quality - Regression without transition curves: for track with low geometry quality. Transition curves will not be used in alignment approximation.
Error tolerance	Setting which affects precision for alignment element approximation. The lower the value, the more 'constrained' the element fitting to the measured points. The error tolerance is iterated from zero to set error tolerance value.
Min. straight line length	Minimum length for the straight elements. The software will iterate the length from the set minimum length.
Max. radius for transition curve	Maximum radius for the transition curves. The software will iterate with transition elements (length, radius) starting from set radius value.
Min. lift	Applied minimum average vertical lift for vertical alignment elements
Number of iterations	Number of iterations for fitting horizontal alignment elements

4.5 View settings

There are two possibilities to access the Calculation profile settings:



Settings	Comment
Soft Zoom	Adds slow motion to the zoom
"Left to right" drawing	Changes alignment direction from left to right
Show circle centres	Shows radii centres in the horizontal view
Show 3 point radius	Shows 3 point radius values in the horizontal view
Show 7 point radius	Shows 7 point radius values in the horizontal view
Show point labels	Shows measured point feature codes

5 Definition of calculation methods

NovaTrack software contains two main methods for automatic alignment fitting with measured points. Each method has its own features and individual requirements for the measurement data.

5.1 Alignment smoothing using the NovaTrack 3.0 method

Horizontal alignment

The method is based on the analysis of the track measurement data in a curvature diagram, instead of trying to compute the elements (straights, curves and transition curves) directly from the coordinates of the measured data. In the diagram, the software assembles the points into groups of seven and transforms the coordinates, from X-Y to Chainage – Curvature. In a curvature diagram, all the elements that are straight lines or curves are represented as straight lines (constant curvature has parallel offset to the R axis), and the transition curves have linear increasing or decreasing functions. The elements are dissolved from a regression analysis to find best-fit lines. When the elements are identified, they are transformed back to X-Y coordinates and the result can be calculated.

Vertical alignment

The gradient lines are found by assuming a "corridor" either side of the straight line and then the software will compute how far the straight line can be extended without crossing the corridor with set vertical offset tolerance '[error_tolerance_vertical](#)'. The vertical intersection points are inserted at the intersection between straight lines. The radii are then calculated as having a tangent length of 20.0m.

Demands on track measurement data

The method is sensitive to the quality of the track measured data, but compared to the other methods, uses a more powerful algorithm for line calculation. With high quality on both track and measured data, the analysis will be capable of handling relatively complicated geometry.

Important !

Detail description of 'Novatrack 3.0' method specific calculation constants is listed in the [Appendix 2. Calculation profile](#) definition.

5.2 Alignment smoothing using 'Regression with transition curves' method

Horizontal geometry

This Analysis method is using the least squares method to find the straight lines in the alignment from the track measured coordinates and within user defined tolerances. Method is using measured data to calculate the "best" radius between straight elements. If a radius cannot be calculated, or calculated value exceeding 25000.0 meters, the radius is set to 10.0 m or 25000.0 meters.

Vertical geometry

Regarding vertical geometry, the least squares method is also used for establishing straight lines from the measured points, within the user given tolerance. From the measured data, software calculates the "best" radius between straight elements. If a radius cannot be calculated, or calculated to more than 50000.0 m, the radius is set to 50000.0 m.

Demands on track measurement data

The 'Regression with transition curves' analysis is less sensitive in detecting S-curves and combined curves, especially when the minimum straight line length is set too long. In those cases, connecting straight lines in between the S-curve are not detected.

The calculation of the transition curve parameter is also a relatively simple procedure and is done after the calculation of radii smaller than the radius given by the user. The analysis starts with the parameter A set to $A = R/3$, the length is reduced where there is no room for transition curves.

The 'Regression with transition curves' analysis has lower demands on the quality of the measured data, compared to the Novatrack 3.0, and will in most cases be able to find the straight lines. It is then up to the user to edit the geometry until a satisfying result is reached. The analysis will on the other hand have trouble with more complicated geometry, such as S-curves and combining spirals.

In most cases the 'Regression with transition curves' analysis will generate alignment geometry which can later be used for further optimization and adjustment.

Note.

Detail description of 'Regression with transition curves' method specific calculation constants is listed in the [Appendix 2. Calculation profile](#) definition.

5.3 Alignment smoothing using Analysis Diagram tools

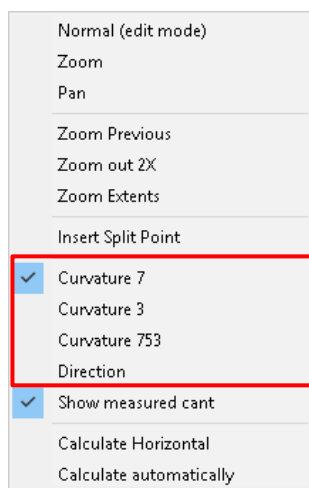
5.3.1 Analysis Diagram introduction

The Analysis diagram tool is used to manually or semi-automatically adjust horizontal alignment elements and overall horizontal alignment quality based on the track measured points.

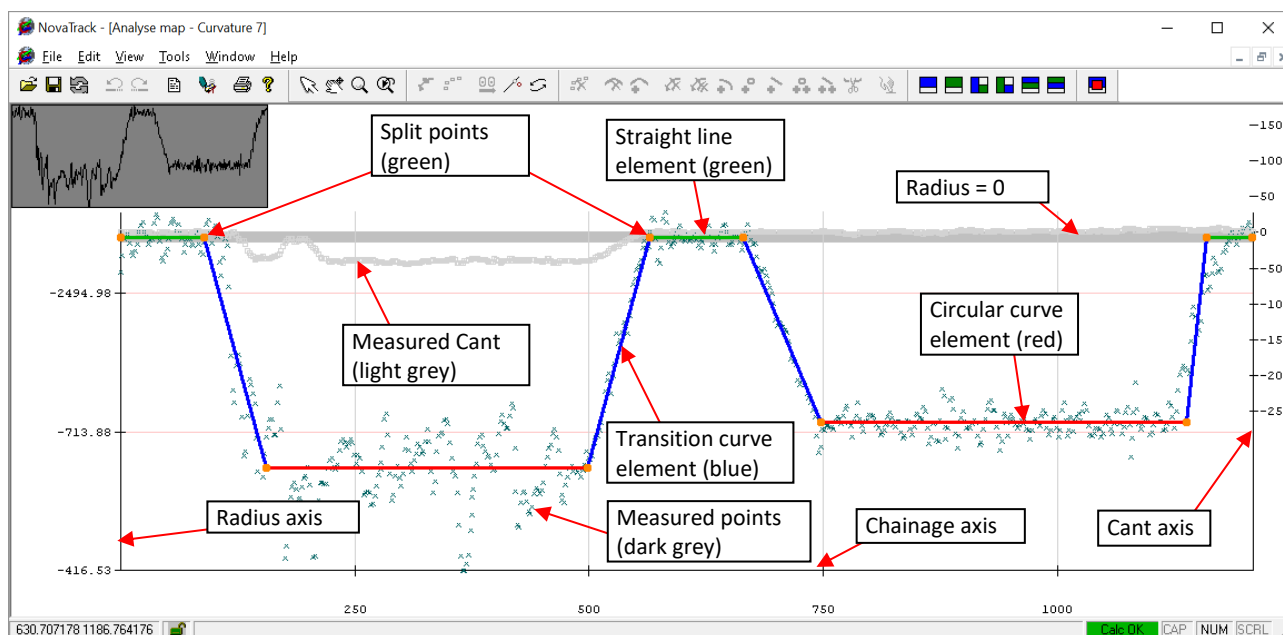
Once measured points are automatically processed within set number of iterations, using `Novatrack 3.0` or `Regression with transition curves` methods, elements can manually or semi-automatically be further adjusted in these two primary curvature Analysis diagrams:

- Curvature 7 (measured data is shown as 1/Radius, using 7 points)
- Direction (measured data is shown as direction change)

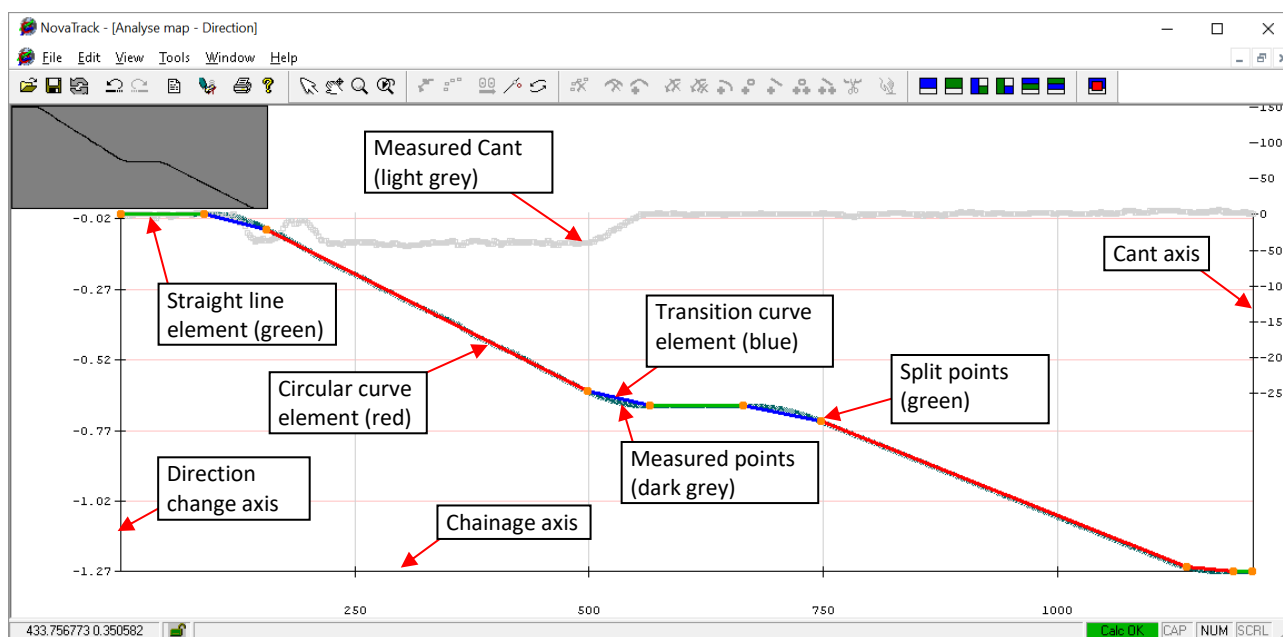
To switch between the available Analysis modes, in the Analysis diagram use mouse right-click to switch between Analysis mode:



Analysis mode	Comment
Curvature 7	Curvature diagram, based on 7 point radius - Diagram recommended to analyse track curvature with moderate-good geometry quality.
Curvature 3	Curvature diagram, based on 3 point radius - Diagram recommended to analyse track curvature with good geometry quality.
Curvature 753	Curvature diagram, based on average of 7, 5 and 3 point radius - Diagram recommended to analyse track curvature with good-very good geometry quality.
Direction	Direction diagram, based on measured points direction vector changes in a chainage direction: - Diagram recommended to analyse track curvature with low-very good geometry. The Diagram is a very efficient way to analyse track geometry on long straight and curve stretches. Direction diagram is also highly supportive when curvature pattern can't be recognized by Curvature 7, 3 or 753 analysis mode.



Analysis diagram - Curvature 7



Analysis diagram - Direction

Important!

Analysis diagram function calculates only horizontal alignment geometry. If the alignment is recalculated in *Automatic* mode, alignment geometry in the *Analysis diagram* will be overridden with new alignment result.

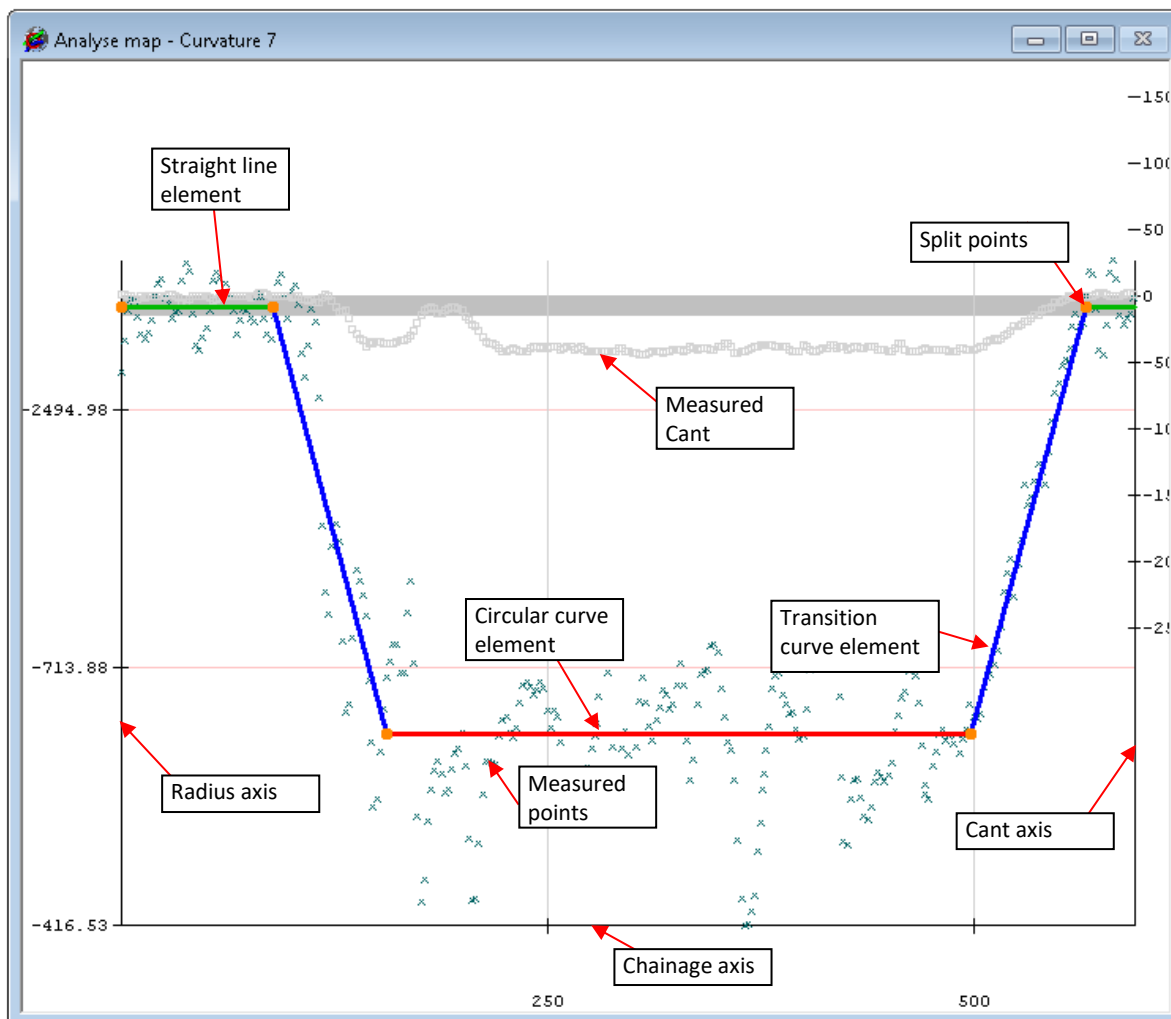
5.3.2 Analysis diagram editing and calculation

In the *Analysis diagram* view, calculation of horizontal alignment can be done in the following ways:

- right-click and select *Calculate Automatically* (continues real-time calculation)
- right-click and select *Calculate Horizontal* (single calculation)
- pressing *C key* (single manual calculation)
- pressing *V key* (single manual calculation, just visible part of alignment)

In the *Curvature 7*, *Curvature 3* and *Curvature 753* diagram the following rules apply:

- straight elements always follow the measured points along the chainage, with $R = 0$
- circular curve elements are parallel to chainage axis, with constant R offset
- transition curves are linearly ascending or descending relative to R and Chainage axis.
- split points are inserted at diagram locations, where the point sequence is starting to change the Radius.



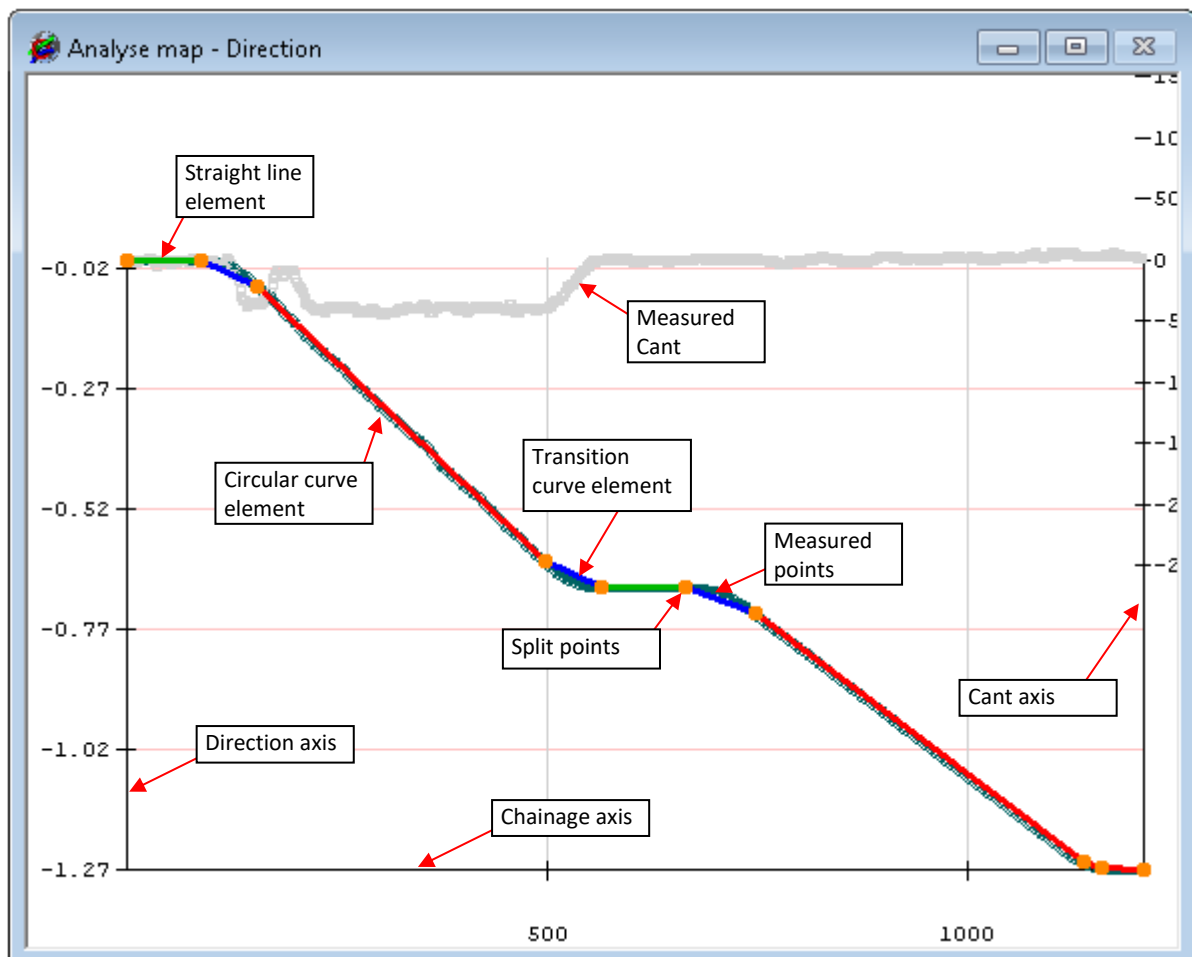
Split point positioning within Curvature 7 and Curvature 3 analysis diagram

Important!

Split points just indicate the preliminary position for element tangent points, however the precise position will be determined after element precise approximation process is completed.

In a *Direction diagram* the following rules apply:

- straight elements are always parallel to the Chainage axis, with Direction change = 0.
- circular curve elements are ascending or descending along measured points, relative to the Direction and Chainage axis.
- transition curves are established at diagram segments, where the direction of measured points starts to transition from '0 deg. to constant angle' or from 'constant angle to 0 deg.'.
- split points are inserted at the diagram locations, where the measured point sequence starts to change the Direction angle.



Split point positioning within Direction analysis diagram

Each "split" point is connected to an horizontal alignment element, and these elements are presented in the diagram as a 'guidelines' for horizontal alignment calculation. The colour of the alignment elements has the following meaning:

Color	Element type
Green	Straight line
Red	Circular curve
Blue	Clothoid/spiral (transition curve)
Grey	Connection between elements without transition

When the elements are identified and an alignment solution is calculated, the alignment elements from the [Analysis diagram](#) are transformed back to X-Y coordinates.

Important!

No element will be inserted between two "split" points that have fewer than 3 measured points in between them.



If the grey colour line is drawn between split points, it means that an alignment elements will be connected without transition curve (SL – C or C-C).

Split points just indicate the preliminary position for element tangent points, however the precise position will be determined after element precise approximation process is completed.

5.3.3 Analysis diagram short cut tools

In order to accelerate work process with element adjustment process in the Analysis Map, the software provides a set of commands and tools.

5.3.3.1 Commands valid for Curvature and Direction analysis diagrams

Short key	Command
Editing	
Left-click & drag	Pan diagram view along the chainage
Left-click 'split' point	Snap to 'split' and change position
Shift+ mouse cursor over 'measured point'	Snap to 'measured' point. Status bar will indicate information about the selected point
Mouse cursor over 'split' point + Delete	Deletes selected 'split' point Important! <ul style="list-style-type: none"> - Always move mouse cursor over a split point (turns RED) and then activate function.
Shift + Left click over 'split' point	Moves the split point to Radius = 0 and/or direction D = 0 Important!
Shift+ Delete	Delete selected measured point. Important! <ul style="list-style-type: none"> - Firstly, always move mouse pointed over measured point (turns into Circle). - While keeping the Shift key down and continue pressing Delete key, the function will continue to delete measured points, starting from the nearest to the previously deleted.
Ctrl-Z or  	Undo and redo changes
Double click or INS key	Inserts new split point by snapping to nearest measured point
A	Calculates an element's average radius to the next split point. Important! <ul style="list-style-type: none"> - Always move the mouse cursor over first split point of the element (turns RED) and then press A key. - In the Curvature 7 and 3 diagrams the averaging function applies to straight and circular curve elements. - In the Direction diagram averaging function applies to straight elements only.
Shift – A	Calculates average radius values for all curve elements at the same time. Important! <ul style="list-style-type: none"> - The function applies for 7, 3 and 753 curvature diagrams.

Short key	Command
B	Aggregate of multiple connected curve elements into single a continuous curve element to the next split point with a straight line or clothoid. Important! <ul style="list-style-type: none"> - Always move mouse cursor over the first split point of the element (turns RED) and then press B key. - The function applies for 7, 3 and 753 curvature diagrams.
Shift – B	Aggregates multiple connected curve elements into a single continues curve element. Important! <ul style="list-style-type: none"> - The function applies for 7, 3 and 753 curvature diagrams.
C	Calculates complete horizontal alignment
V	Calculates just visible horizontal alignment elements Important! <ul style="list-style-type: none"> - Prior to activating this function, make sure that the alignment is in the window area and not starting or ending with a Clothoid element (transition curve).
D	Changes alignment direction
E	Erases all split points
S	Turns snap to the measured points On/Off
X	Turns split points in the diagram On/Off
3	Turn 1/Radius Curvature 3 On/Off
O	Filter out measurement bias in Curvature 3, 7 and 753 diagrams Important! <ul style="list-style-type: none"> - Filtering function can be applied in the Curvature 3, 7 and 753 diagrams only.

Note.

The function behind the [Delete](#) key requires that the mouse pointer is placed over a "split" point and that the split point colour changes to red. A red colour indicates that the point is selected and active.

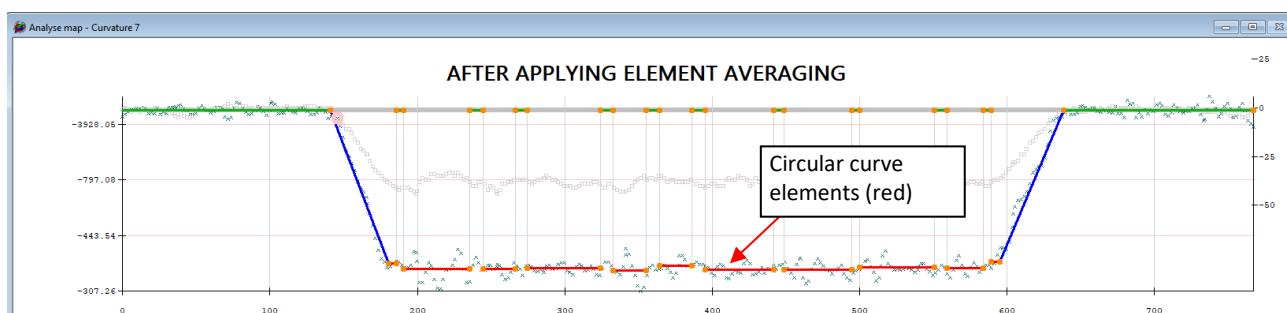
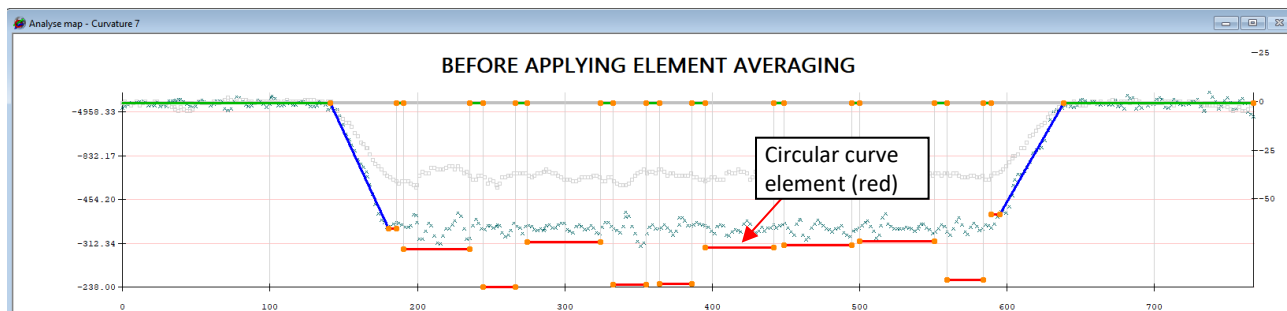
5.3.3.2 Curve averaging in the Curvature analysis diagram

Horizontal circular curve elements calculated using automatic smoothing can be further averaged to have a more coherent adjustment to the measured points. This averaging applies to all circular curve elements within the horizontal alignment.

To continue with the element averaging process, proceed as follow:

- calculate alignment in automatic mode and then open the Analysis diagram – Curvature 7 points.
- press [shift-A](#) to average all circular curve elements at once.

- if the automatic diagram re-calculation is not activated, press **C** key. With the automatic recalculation active, the Analysis diagram and alignment in the horizontal view will be updated automatically.

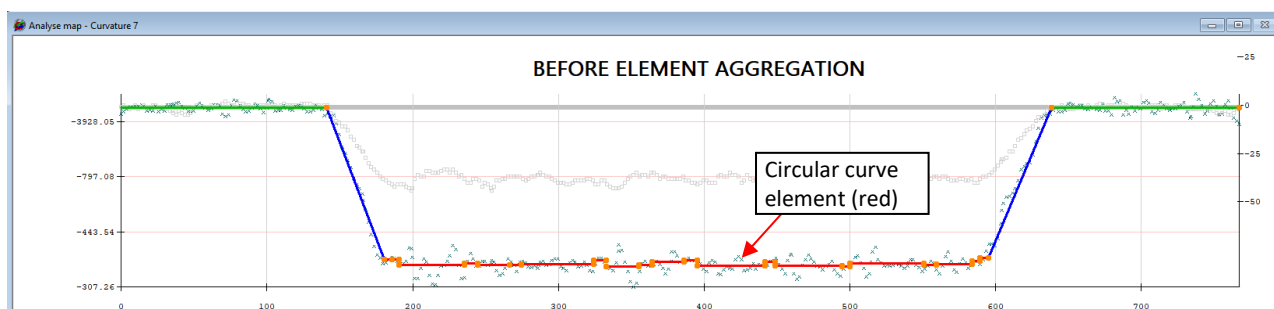


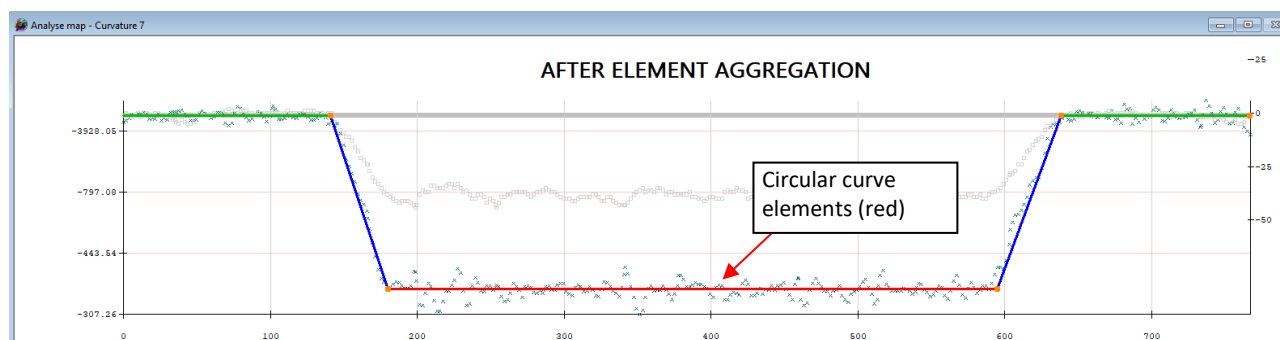
5.3.3.3 Curve aggregation in the Curvature analysis

The curve aggregation function is aimed at reducing the number of similar interconnected circular curve elements. This can be a standard result, when the alignment calculation in automatic mode is done using tight tolerances and fitting very short segments. The function checks the Analysis diagram for circular curve element similarities by radius and length and then connects them into one continuous circular curve element.

To continue with the element aggregation process, proceed as follow:

- calculate alignment in automatic mode and then open the Analysis diagram – Curvature 7 points.
- press **shift-A** to average all circular curve elements at once or use **A** key to average just selected elements.
- press **shift-B** to aggregate all circular curve elements at once or use **B** key to average circular curve elements to the next straight line/clothoid element.





5.3.3.4 Commands and tools valid for Direction Analysis diagrams only

Semi-automatic measurement data Analysis in the Direction diagram can be done in the following ways. These three analysis methods help to identify split point locations.

Short key	Command
Split point accelerator	(Commands are only valid in the Direction Analysis Map)
L	Insert split points using direction change. Measured point analysis is based on a graphical directional change.
P	Insert split points using radius alteration. Measured point analysis is based on the change of radius along the graph.
O	Insert split points using direction line regression. Measured point analysis is based on the fact that elements in the graph are calculated according to line regression.
Q	Calculation of direction and measured point data displayed as Curvature

Important!

At any given point, a manual adjustment of the analysis split point locations and their quantities may be required to achieve an alignment solution.

Analysis based on directional change along the graph (*L* key):

nPnt – number of points in a single analysis array

aPnt – number of points for calculating average direction

dD – maximum direction change between two vectors

The analysis assumes *nPnt* points at a time, calculates the average direction (y-value) at the first, middle and last *aPnt* point. These 3 values provide two directional vectors used to determine whether the graph changes direction. The parameter *dD* is the maximum directional change between the two vectors. The lower the *dD* value, the more exacting the analysis (will generate more split points).

A split point is automatically inserted when 3 subsequent calculations show the same directional change along the graph or if the directional change along the graph exceeds *dD*.

Analysis based on change of radius along the graph (*P* key):

nPnt – number of points in a single analysis array

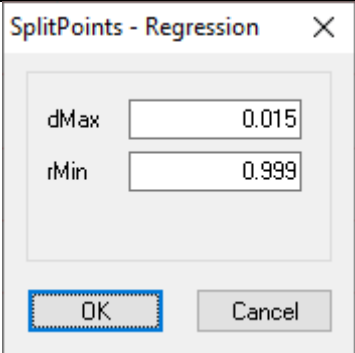
aPnt – number of points for calculating average direction

dR% – maximum radius change between two vectors

The analysis assumes *nPnt* point at a time, calculates the average direction (y-value) at the first, middle and last *aPnt* point. These 3 values provide two directional vectors used to calculate the radius at the beginning and at the end of these *nPnt*.

A split point is automatically placed when radians in 3 subsequent calculations show the same directional change along the graph or when the next radius deviates more than $\pm dR\%$ percent of the previous calculated radius. The lower the *dR%*, the stricter the analysis (will generate more split points).

Analysis based on line regression along the graph (O key):

 <p><i>dMax</i> – maximum difference between real direction and calculated direction <i>rMin</i> – minimum regression coefficient (must be between 0 and 1)</p>	<p>Split points are automatically inserted by finding straight lines using line regression analysis.</p> <p>The analysis starts by finding a line through the first 4 points. Based on the regression line cutting the y axis (direction axis) and the derivative line, one direction is calculated at each measured point. This value will probably differ from the real direction of the measured point, and this deviation is called delta. <i>rMin</i> is the least regression coefficient, and the greater <i>rMin</i> value, the tighter the analysis (will generate more split points).</p> <p>As long as delta is less than <i>dMax</i> and the regression coefficient is less than <i>rMin</i>, the regression line is assumed to be acceptable and the next point will be included in the next regression. If not, the new line is assumed, and a split point is placed at the end of the line.</p>
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Important!

The regression analysis is vulnerable to the measurement errors and requires extremely good data.

6 Data import and export

NovaTrack software supports data interoperability based on measured and design data in the following file formats:

Format	Read	Write	Map read	Description
SPW (.spw)	+	+		Native NovaTrack project file format
KOF (.kof)	+	+	+	Points, lines and alignment (space separated)
Lifting scheme (.lft)		+		Design geometry report (ASCII)
PXY (.pxy)	+		+	Point and line coordinate list (ASCII)
GPS (.gps)	+		+	Point coordinate list (comma separated)
Slew-lift report (.alc)		+		Design/as-build slew-lift offset report (space separated)
Design geometry report (.csv)		+		Complete alignment geometry report (semi-column, ASCII)
NovaPoint (.tit)	+	+		Horizontal alignment (ASCII)
Point file (.lin)	+	+		Alignment geometry (tabular, ASCII)
Intergraph (.dat)	+	+		Horizontal alignment (tabular, ASCII)
NYPL (.nyl)	+	+		Horizontal alignment (tabular, ASCII)
NADB (.ndb)	+	+		Alignment geometry (ASCII)
XRoad (.txt)	+	+		Alignment geometry (tabular, ASCII)
WinALC Geo (.geo)		+		Alignment geometry Plasser/Thuerer (ASCII)
WinALC Ver (.ver)		+		Alignment offsets Plasser/Thuerer (ASCII)
GEDO Track data (.gtd)	+			As-built track data (ASCII)
GEDO Office TDT (.tdt)	+	+		Horizontal alignment (tabular, ASCII)
GEDO Office HDT (.hdt)	+	+		Vertical alignment (tabular, ASCII)
GEDO Office UDT (.udt)	+	+		Cant alignment (tabular, ASCII)
LandXML (.xml)	+	+		Horizontal, vertical and cant alignment
LandXML cgPoints (.xml)	+			Point elements

6.1 Import of measurement data

Track measurement data for alignment re-establishment is imported from a coordinate file containing point representing centre of track or left and right track. For left and right track, each track needs to have a different point code:

- From the main menu select *File -> Open*
- Select file type and file to open.
- As part of the import process, a *NovaTrack Analyze* dialogue box will open. The dialogue box enables you to select already predefined *Calculation profile* for data analysis and alignment optimisation, set the start/end chainage for the calculation and which alignment type to be calculated.

During the measured data import, the software will perform data checks and error corrections, including:

- data sorting
- duplicate point removal
- non-track related points removal
- estimate of measured track length

Status for the sorted data is shown in the right hand side of the dialogue box.

- Choose an existing calculation profile or create a new. A Calculation profile is linked to the Analysis method, so 'Selected Analysis Method' option does not have to be selected separately.

Calculation profile contains both calculation constraints and alignment validation criteria.

NovaTrack Analyze plug-ins

Calculation settings:

Selected profile: **Re-alignment: Old_track**

General track geometry evaluation

Adjustment: New track

Selected Analyse Method: Regression with transition curves

Calculation applies to: Horizontal / Vertical Alignment

Main calculation constants:

Constant	Value
Error tolerance	8
Min. straight line length	25
Max. radius for trans. curves	3500
Min. lift	0

Number of iterations: 100

Start & End Station: 0 2403.784

Measured data status:

Measured points read: 2394

Duplicates - (x,y): 0

Assumed as measured error: 0

Measured points deleted: 0

Measured points to analyze: 2394

☐ Include deleted points

Buttons: Create profile..., Edit profile..., Delete profile..., OK - Analyze, Cancel

- Adjust the main calculation constants, so they correspond to the measured track quality and expected alignment result. The higher the iteration number will produce smaller steps with error tolerances

Main calculation constants:

Constant	Value
Error tolerance	1
Min. straight line length	20
Max. radius for trans.curves	20
Min. lift	0

Number of iterations:

Setting	Comment
Error tolerance	Setting affecting the precision for alignment element approximation. The lower the value, more 'constrained' the element fitting to the measured points. The error tolerance is iterated from zero to set error tolerance value.
Min. straight line length	Minimum length for the straight elements. The software will iterate the length from the set minimum length.
Max. radius for transition curve	Maximum radius for the transition curves. The software will iterate with transition elements (length, radius) starting from the set radius value.
Min. lift	Applied minimum average vertical lift for vertical alignment elements
Number of iterations	Number of iterations for fitting horizontal alignment elements

- Press [Ok – Analyze](#) button to proceed with the calculation.
- The software will run the iteration process by evaluating alignment options for the best available solution within set constraints:

Calculating results... [27%]

Analyzing result: 2
Tolerance: 97
Sum offset: 107.589m
Best sum offset: 107.589m (tolerance: 97)

Calculation finished!

Final analyze result:
Best result was achieved using tolerance=97%
This gave a sum offset, from each measured point, of 31.007m
Standard deviation=81.3, Coefficient variation=-2.57%

- At the end of the iteration process, the software selects an alignment solution which has the smallest 'Sum of offset' value.

Note.

If the alignment solution for a particular measurement data set cannot be calculated, it is recommended to re-adjust main constants.

Please refer to chapter [5. Definition of calculation methods](#) for a detailed method description and requirements for measurement data.

6.2 Import of measurement data from other file formats

Track measurement data (points) for alignment re-establishment can be also imported from the ASCII file formats, like .LandXML, .KOF, .GPS and .PXY. For the file format structure please refer to the appendix [Appendix 1. File formats](#).

Note.

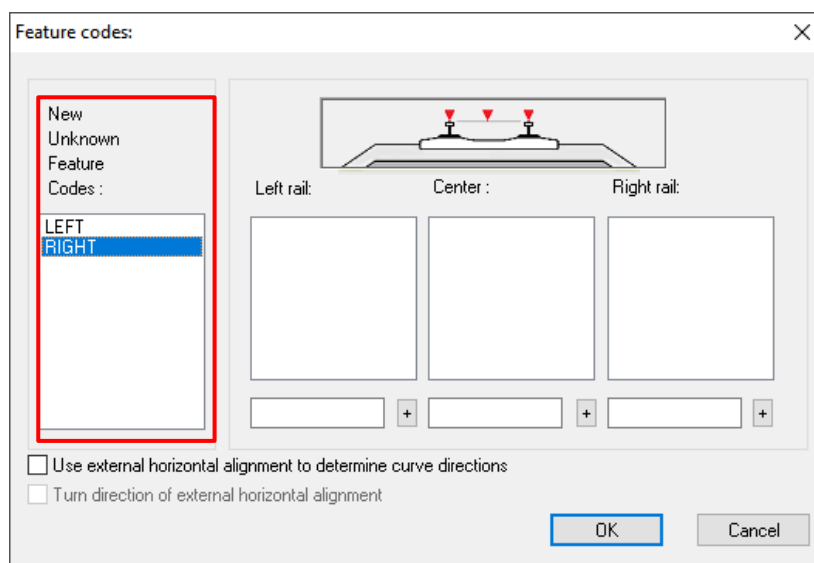
Import of the track coordinates for the centreline of the track only will not provide any cant information. This information will not be available during calculation and alignment definition face.

6.2.1 Import from the .LandXML file format

The import from the .LandXML file format additionally supports point feature codes, which makes it possible to assign individual feature codes to the left rail, right rail or track centre.

To continue with the .LandXML import, proceed as follows:

- From the main menu select *File -> Open*
- Select file type to **.LandXML* and confirm *OK*
- The software will scan the *.LandXML* file for available feature codes and show them in the next dialogue box:



- Drag & drop the available feature codes to the corresponding track field positions – *Left rail*, *Center* or *Right Rail*:

- Optionally, if required, select the *External horizontal alignment to determine curve direction* option to apply the existing alignment direction to the imported points.
- As part of the import process, the NovaTrack Analyze dialogue will open. The dialogue enables you to select a predefined *Calculation profile* for data analysis and alignment optimisation.

Note.

In cases where points are representing the left and right rail, the software will calculate track axis Easting, Northing coordinates and Cant. The elevation for the track axis will be taken from the low rail.

If the .LandXML input data contains only left, right or centreline coordinates, the cant data will not be calculated.

Point definition in the LandXML file should use the entity type CgPoint.

Point sequence in the LandXML file is not important. The file can contain unsorted point data.

6.2.2 Import from the .GPS file format

Import from the ASCII files in the **.GPS** format considering import track axis Easting, Northing coordinates and height information.

To continue with .GPS import, proceed as following:

- From the main menu select **File -> Open**
- Select file type to ***.GPS** and confirm **OK**
- As part of the import process, a dialogue box **NovaTrack Analyze** will open. The dialogue box enables you to select already predefined **Calculation profile** for data analysis and alignment optimization.

Note.

Each .GPS file can contain track axis points just from a single track.

Import or calculation of cant data is not supported.

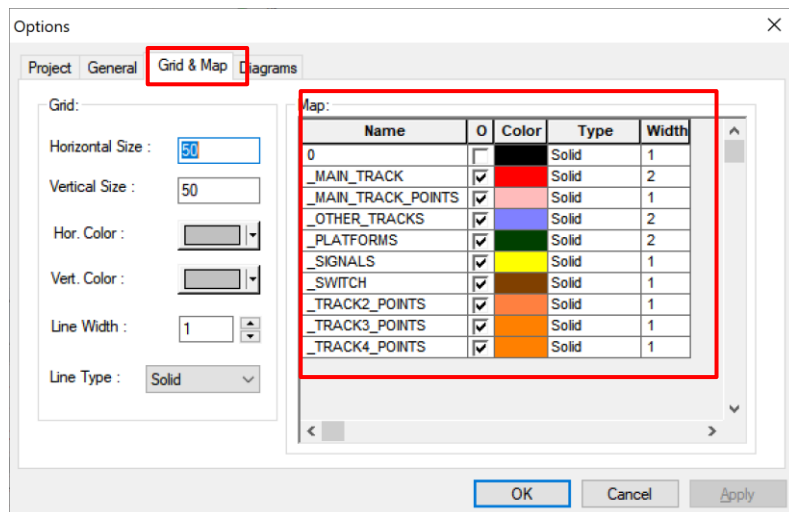
6.3 Import of background Map data

For geographical orientation within a project, point and line map data can be imported as background map datasets from .KOF, .PXY or .GPS file formats:

- From the main menu, select **File → Import Map...**
- From the drop down list select the suitable file format '**Files of Type**' of the dialog.

From the list, select the file for import and press **Open**.

- The dialogue '**Options**' with the tab '**Grid & Map**' will be opened.
- Check configuration of feature codes, colours and line-types. For a more detailed description of the settings please refer to section '**Grid and Map settings**'.

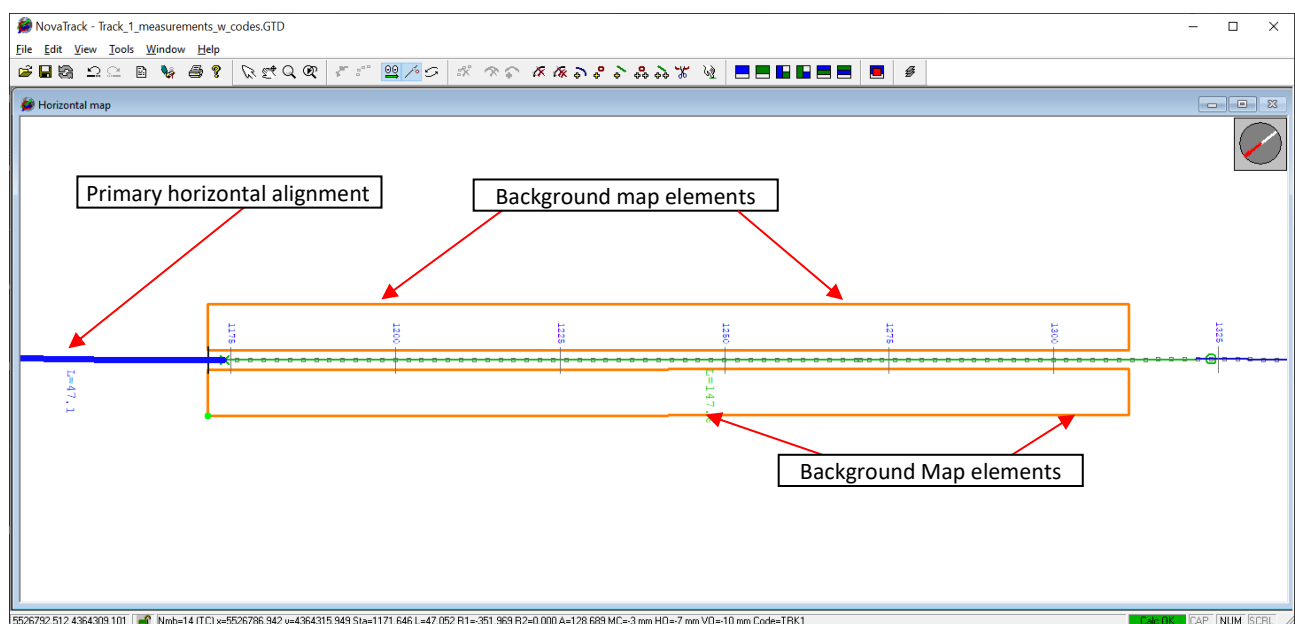


Name	O	Color	Type	Width
0	<input type="checkbox"/>		Solid	1
_MAIN_TRACK	<input checked="" type="checkbox"/>	Black	Solid	2
_MAIN_TRACK_POINTS	<input checked="" type="checkbox"/>	Red	Solid	1
_OTHER_TRACKS	<input checked="" type="checkbox"/>	Blue	Solid	2
_PLATFORMS	<input checked="" type="checkbox"/>	Green	Solid	2
_SIGNALS	<input checked="" type="checkbox"/>	Yellow	Solid	1
_SWITCH	<input checked="" type="checkbox"/>	Brown	Solid	1
_TRACK2_POINTS	<input checked="" type="checkbox"/>	Orange	Solid	1
_TRACK3_POINTS	<input checked="" type="checkbox"/>	Orange	Solid	1
_TRACK4_POINTS	<input checked="" type="checkbox"/>	Orange	Solid	1

Name – Layer name
O – activated/deactivated layer
Color – element colour
Type – element line/point type
Width – element line width

Press **OK** to accept grid and map settings.

- Once imported, the background Map data will be visible in the Horizontal Map layout along with measured point information and design alignment elements.



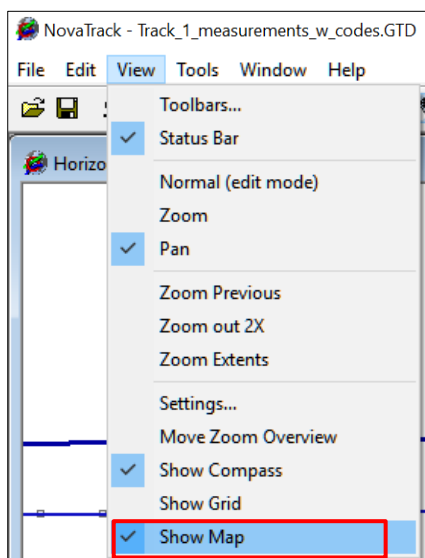
Background Map data along with horizontal alignment

Important!

Background Map elements are visible in the *Horizontal Map* view only.

The Background Map cannot be edited or stored in the NovaTrack project file (*.SPW).

To choose whether the Background Map(s) information should be visible or not, use the settings in the menu *File -> View -> Show Map*. For turning on/off single Background Map layers please use menu item *Tools -> Options -> Grid & Map*.



6.4 Alignment data export

NovaTrack software can export ('Save As') calculated alignment geometry and offset data to several file formats and reports. For more detail information on supported file formats please refer to [chapter 6 Data import and export](#).

To export complete alignment data for further use in Office/ Scan Office software:

- From the main menu select *File -> Save As...*
- Select file format – *All Office files (*.*)*. The alignment data will be exported into GEDO Office native alignment file formats:
 - *.TDT* - Horizontal Alignment data.
 - *.HDT* – Vertical Alignment data.
 - *.UDT* - Cant Alignment data.

Additionally, it is recommended to store processed measurement data and calculated alignment geometry in NovaTrack software (this will include measured points, analysis diagrams, cant data, design elements and speed information):

- From the main menu select *File -> Save As...*
- Select file format – *SPW file (*.SPW)*

6.5 Alignment data import and editing

NovaTrack software can import ('*Import*') calculated alignment geometry (horizontal, vertical and cant) from several file formats. For more detailed information on supported file formats please refer to [chapter 6 Data import and export](#).

7 Alignment data calculation and editing

7.1 Automatic calculation of horizontal and vertical alignments

7.1.1 Automatic calculation of horizontal alignment

To continue with the automatic calculation of horizontal alignment elements, proceed with the following steps:

- From the main menu select **File -> Open** (select measurement data file)
- Select start-end chainage for the calculation. All measured points outside defined range will be ignored by the calculation engine. During the measurement data import, the start chainage is always reset to 0.000 value.
- Select the calculation scope: horizontal/vertical alignment, horizontal alignment, vertical alignment or validation only. By the Validation scope, the horizontal/vertical alignment geometry remains unchanged, only new profile settings for geometry validation and speed/cant calculation are applied.
- Select the calculation profile based on '*Regression with transitions curves*' or '*NovaTrack 3.0*' method

NovaTrack Analyze plug-ins

Calculation settings:

Selected profile: **Adjustment. New track**

General track geometry evaluation

Re-alignment. Old track

Adjustment. New track

Create profile...

Edit profile...

Delete profile...

Selected Analyse Method: NovaTrack 3.0

Start & End Station: 0 1405.653

Calculation applies to: Horizontal / Vertical Alignment

Measured data status:

Measured points read: 713

Duplicates - (x,y): 0

Assumed as measured error: 0

Measured points deleted: 0

Measured points to analyze: 713

Include deleted points: ☐

Main calculation constants:

Constant	Value
Insert trans. curves	1
Min. straight line length	5
Min. lift	0

Number of iterations: 8

OK - Analyze Cancel

- In the calculation method dialogue press **Configure** to set the calculation constants:

'Regression with transition curves'

Main calculation constants:

Constant	Value
Error tolerance	1
Min. straight line length	20
Max. radius for trans.curves	3500
Min. lift	0

'NovaTrack 3.0 regression'

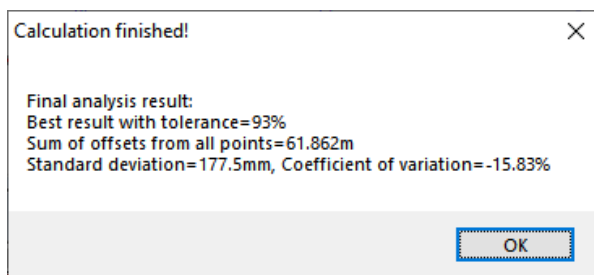
Main calculation constants:

Constant	Value
Insert trans. curves	1
Min. straight line length	10
Min. lift	0.02

Recommended setting 'Regression with transition curves'	Value
Error tolerance	range 0.5 – 30
Min. straight line length (m)	range 5 – 20
Max. radius for transition curve (m)	range 2500 – 4500
Number of iterations	range 50 – 200

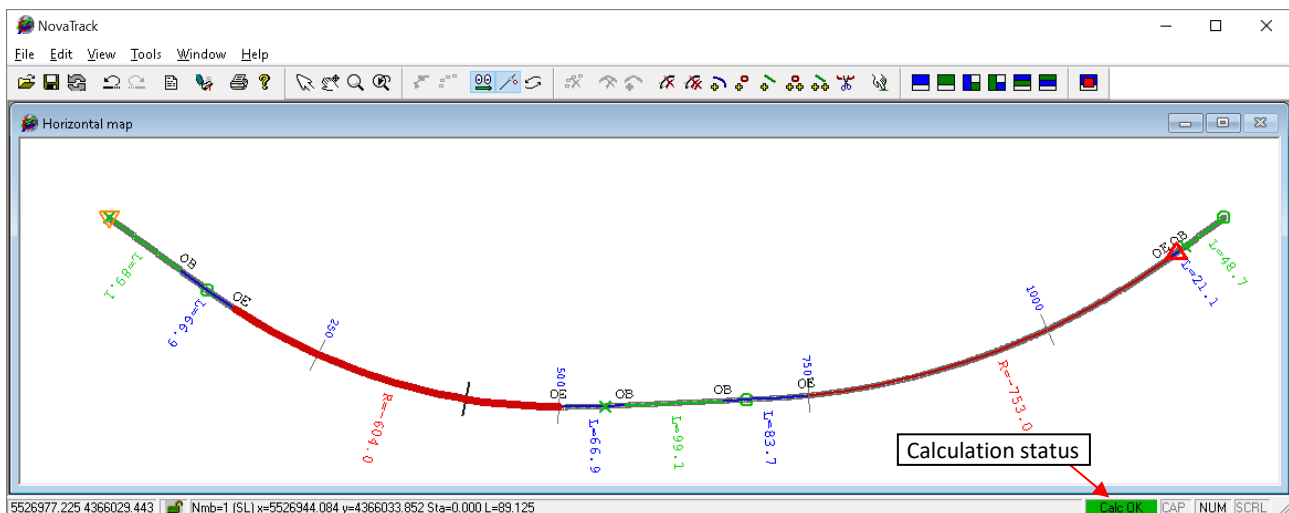
Recommended setting 'NovaTrack 3.0'	Value
Number of iterations	range 1 – 10 (recommended 8)
Error_tolerance_offset_pnts	82
Nt3_remove_split	range 97 – 102 (recommended 102)
Nt3_remove_split_step	1
Nt3_remove_split_lines	8
Nt3_merge_split_segments	range 0.12 – 0.20 (recommended 0.12)

- Press **OK-Analyze** button to start the calculation.
- After the calculation with the set number of iterations, the software will display a dialogue box with summary of results:

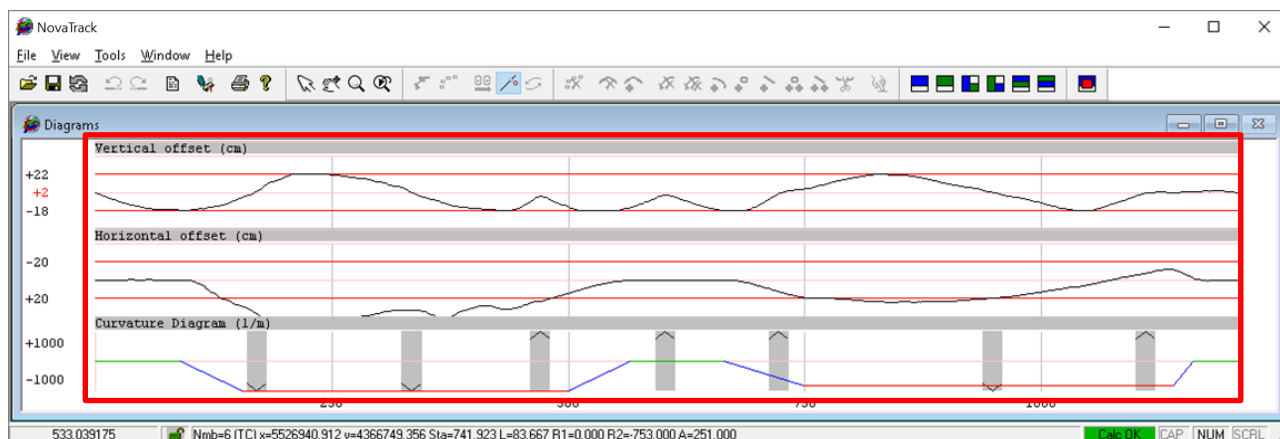


- Press **OK** button to confirm the calculation result.

At the same time the status bar will indicate a green message 'CALC OK'.




- Check the calculated offsets in the *Diagrams* → *Horizontal Offset*.



If the software fails to compute an alignment solution within the set limitations, the alignment status is indicated in red, displaying the message **'CALC not OK'**.



To re-calculate an alignment with different settings (i.e. with a smaller error tolerance):

- From the main toolbar select the *Re-analyse*  command.
- The command will open the initial *NovaTrack Analyze* dialogue. Adjust the settings by editing the selected calculation profile '*Edit profile*' or by changing the calculation profile '*Main calculation constants*'.
- Press '*OK-Analyze*' to recalculate the result.

NovaTrack Analyze plug-ins

Calculation settings:

Selected profile:

- General track geometry evaluation
- Re-alignment. Old track
- Adjustment. New track

Buttons: Create profile..., Edit profile..., Delete profile...

Selected Analyse Method:

NovaTrack 3.0

Start & End Station:

0 17137.275

Calculation applies to:

Horizontal Alignment

Measured data status:

Measured points read 3539

Duplicates - (x,y) 0

Assumed as measured error 0

Measured points deleted 0

Measured points to analyze 3539

☐ Include deleted points

Main calculation constants:

Constant	Value
Insert trans. curves	1
Min. straight line length	5
Min. lift	0.01

Number of iterations: 8

Buttons: OK - Analyze, Cancel

- The new results will be directly updated on the screen.

Important!

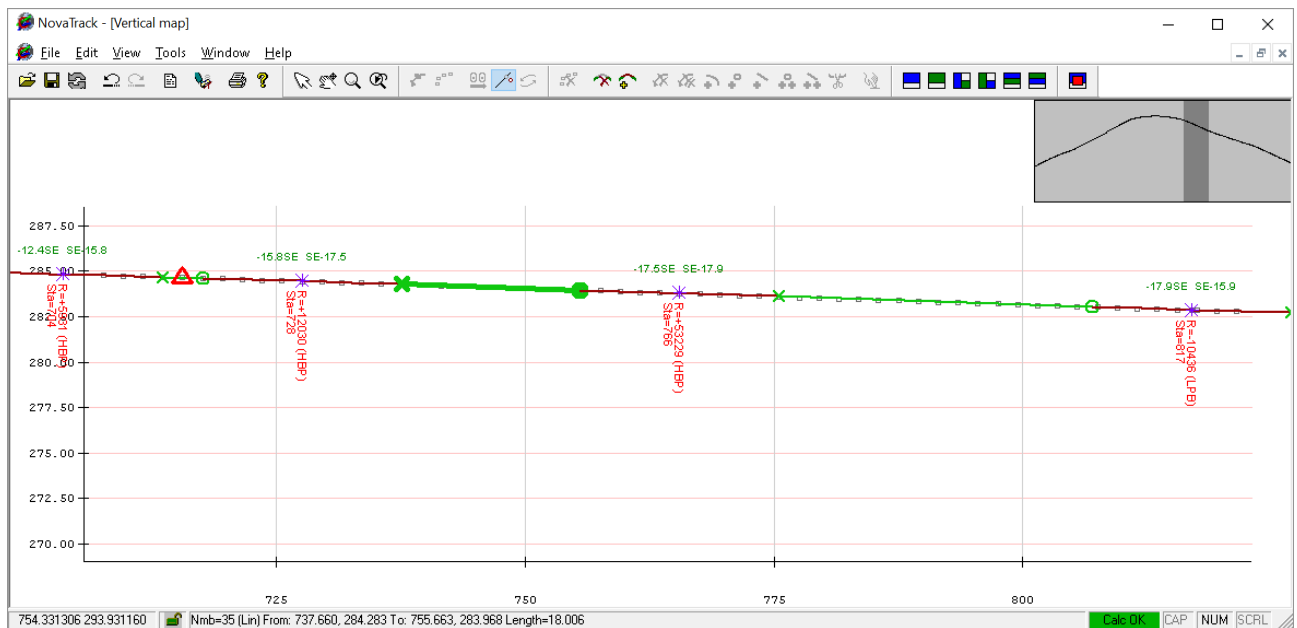
The re-calculation process will use the last edited version of measured data. Thus, all measured points which were deleted before recalculation, will not be considered in the consecutive calculations.

Re-calculation process can be restored to a previous versions using [UNDO](#) or [REDO](#) commands.

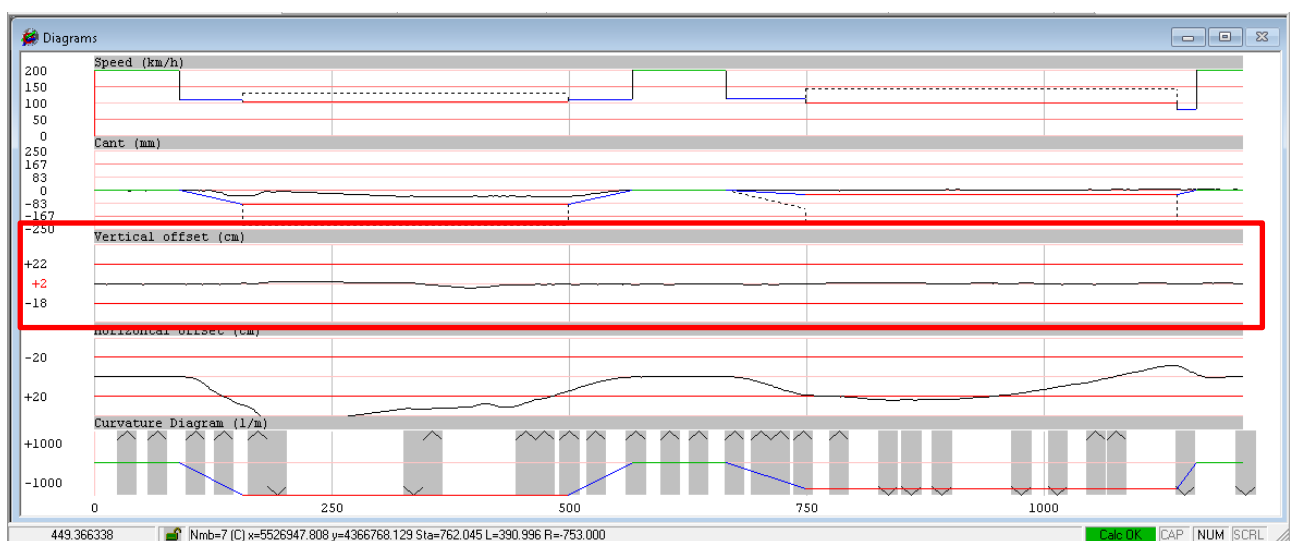
7.1.2 Automatic calculation of vertical alignment

Automatic calculation of vertical alignment uses the same selected *Calculation profile* as the horizontal alignment. Calculation for vertical alignment is completed simultaneously with the calculation of horizontal alignment. Vertical alignment smoothing is directly dependent on set '*error_tolerance_vertical*' value in the Calculation profile.

- To view and verify the vertical alignment, switch the layout view to *Window -> Vertical Map*:



- In the *Diagram view*, check that the vertical alignment offsets (lifts) from the measured points are within the set tolerance limits:



- If the vertical alignment offsets from the measured points are below the 'min. lift tolerance' or above the maximum lift limits, adjust the Vertical alignment approximation settings (*min_lift* and *error_tolerance_vertical*) in the Calculation profile and re-run calculation.

If the new result is still outside the requirements, continue with alignment manual editing and adjustment using manual editing tools, as described in chapter [7.3 Manual alignment editing and fine-tuning](#).

Note.

Vertical alignment minimum uplifts can be adjusted in the Calculation profile (*min_lift*). The software will re-calculate the vertical gradients to fit within the new calculation settings.

Reduction of the '*error_tolerance_vertical*' value will increase the amount of gradient elements and decrease vertical offsets between measured points.

To increase the visibility of the vertical offset value in the vertical offset diagram, adjust the '*Scale vertical offset*' parameter in the dialogue *Tools -> Options -> Project*. Save values as User Default, so they can be recalled at any time.

The screenshot shows the 'Options' dialog box with the 'Project' tab selected. The 'Diagrams' section contains three settings: 'Scale horizontal offset' (0.10), 'Scale vertical offset' (0.05), and 'Max. speed' (160). The 'Scale vertical offset' field is highlighted with a red rectangular box. Below this, the 'Analysis' section shows 'Min. dist. betw. points' (16.4) and 'Min. vertical lift' (0.050). At the bottom left are buttons for 'Save as user default' and 'Get user default values'. At the bottom right are 'OK', 'Cancel', and 'Apply' buttons. A text box on the right side of the dialog states: 'On this page you can set parameters controlling the project. These settings will be saved in the SPW file. Some settings may not be available in this version of the program.'

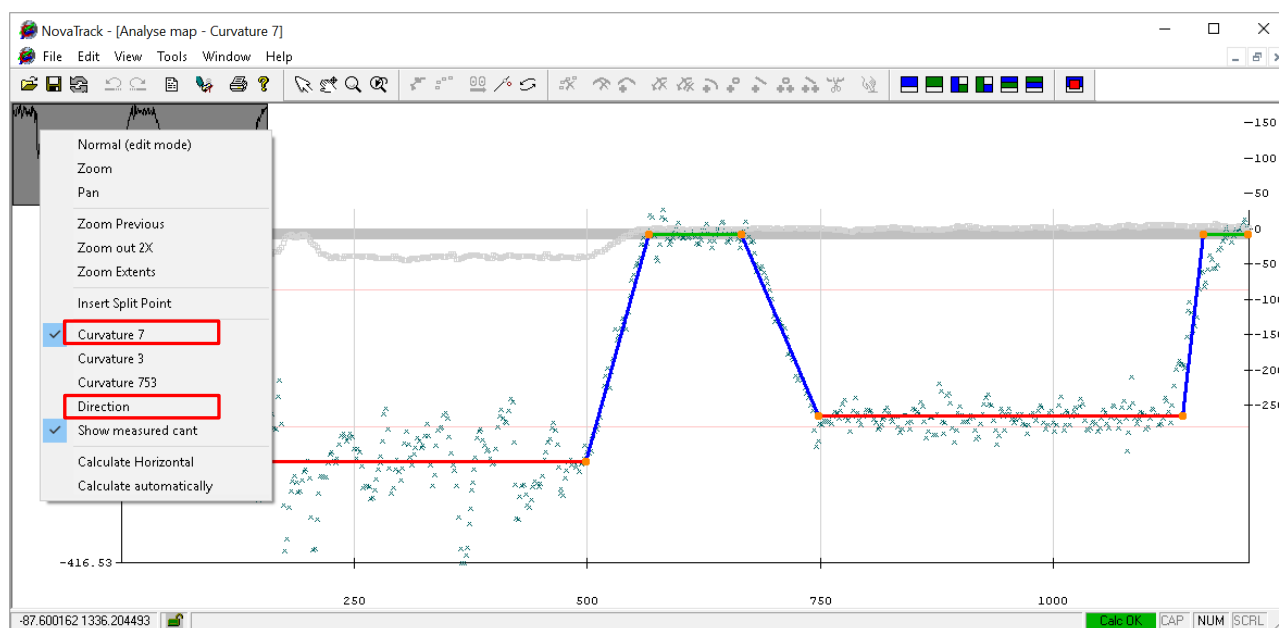
7.2 Calculation of horizontal alignment using the Analysis diagram

Measurement data from track with poor geometry quality, can have a negative influence on the automatic calculation results. This circumstance can prevent the automatic process from finding the right element configuration within the set tolerance limits. As a result, the calculated alignment can have significant offsets, which are beyond the set tolerance limits. To overcome this issue, it is recommended to use the alignment editing in the Analysis diagram mode.

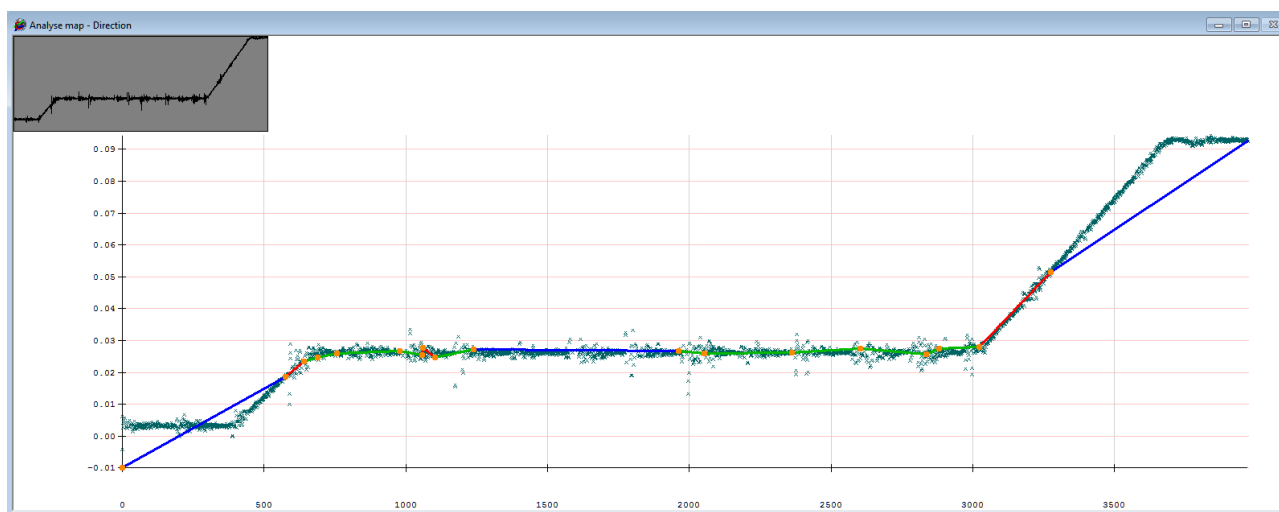
To switch to the Analysis diagram mode:

Switch the Layout view to the Analysis Diagram, from the menu selecting Window -> Analyse map.

- Right-click on the diagram and select either the diagram type: *Curvature 7* or *Direction*.
- To ensure that the Analysis diagram has the latest calculation result, in the *Horizontal view* press 'S' key. The data between views will be synchronised.

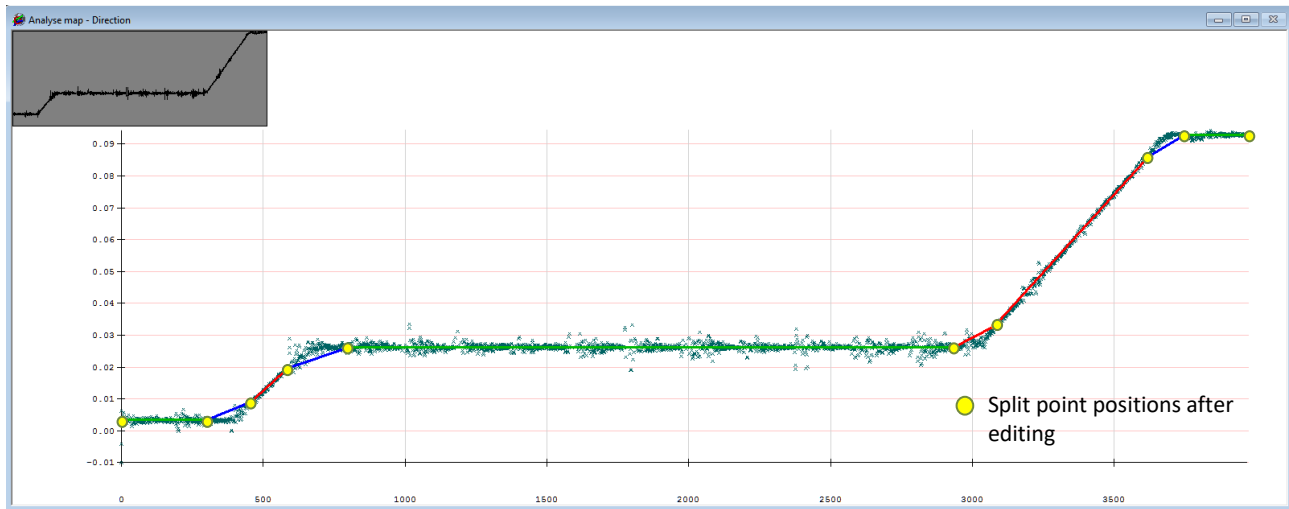


In the Analysis diagram, each horizontal alignment element is limited by two split points.



Direction diagram. Before editing split points

- Adjust alignment elements by adding or removing split points. Check the chapter [5.3.2 Analysis diagram editing and calculation](#) for split point insertion rules.

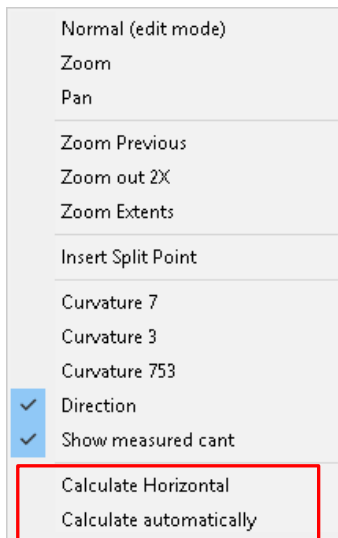


Direction diagram after editing

- Once the diagram editing is completed, re-calculate the alignment with new definitions.

To perform single alignment recalculation, press mouse [right-click](#) and from the short-cut menu select [Calculate Horizontal](#).

Alternatively, from the short-cut menu select '[Calculate automatically](#)' to activate 'real-time' recalculation option.




Note.

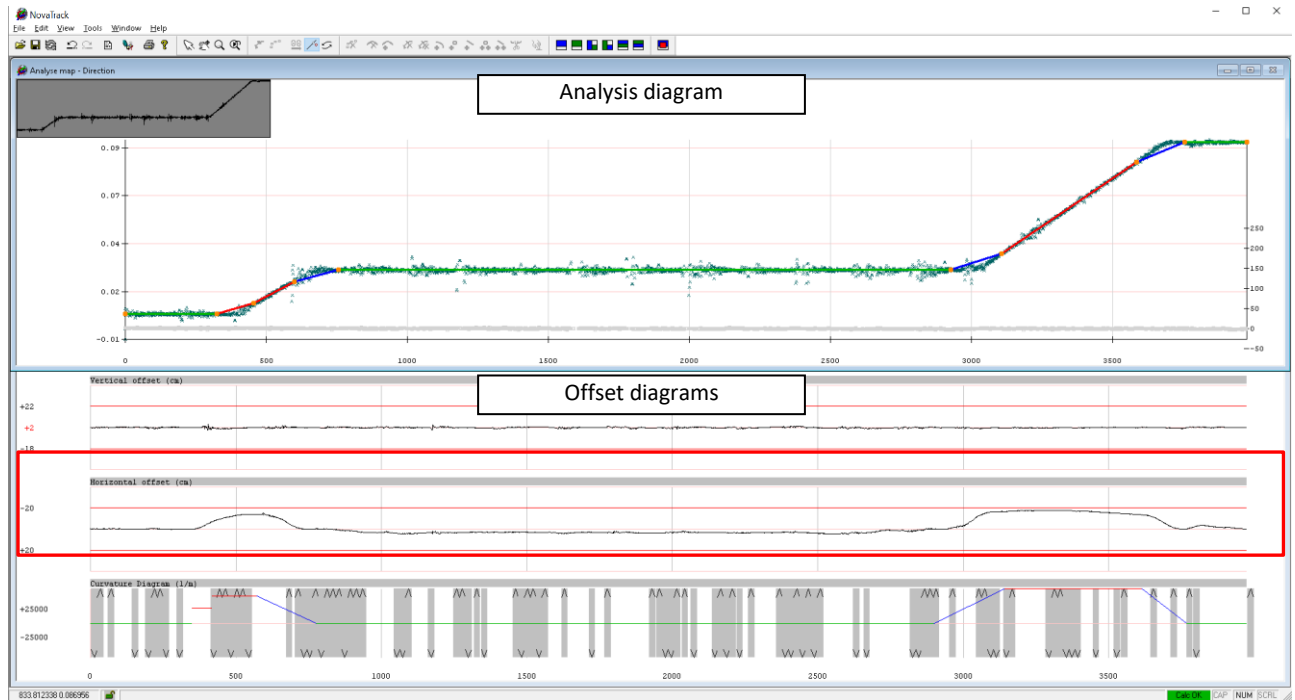
To insert a new split point, double click with your mouse and a new split point will be added.

To delete split point, move the mouse cursor over the split point and press Delete key.

To move the split point, press left mouse key on the split point and drag the cursor.

To activate a split point snap to measured point, in the main toolbar select button .

As a result, the elements from the Analysis diagram are transformed to the absolute alignment position. To view the horizontal alignment offsets while editing the diagram, arrange the windows in a way that both analysis and offset diagrams are in the same view.



Note.

Scale for horizontal offsets can be adjusted in the [4.1 Project settings](#).

Manual alignment element fine-tuning procedure is described in the chapter [7.3 Manual alignment editing and fine-tuning](#).

Important!

Editing of alignment elements in the Analysis diagram can cause alignment calculations to fail because the element configuration and position is no longer mathematically solvable. This is then indicated on the status bar - **Calc not OK**.

To diagnose the calculation error or review calculation results in the numeric form, double-click the **Calc OK/not OK** indication. This will open the calculation protocol. The calculation report is updated with every new calculation. For more detailed information about the calculation report, please refer to chapter [8 Calculation report data](#).

7.3 Manual alignment editing and fine-tuning

The alignment geometry editing tools are accessible from the Horizontal Map and Vertical Map views.

Alignment and geometry elements can be edited and fine-tuned in three different ways:

- by adjusting the position of fixed (tangent) points
- by adjusting the parameters of geometry elements
- by adding/splitting/deleting geometry elements
- by changing alignment chainage information

7.3.1 Workflow for manual adjustment of horizontal alignment offsets

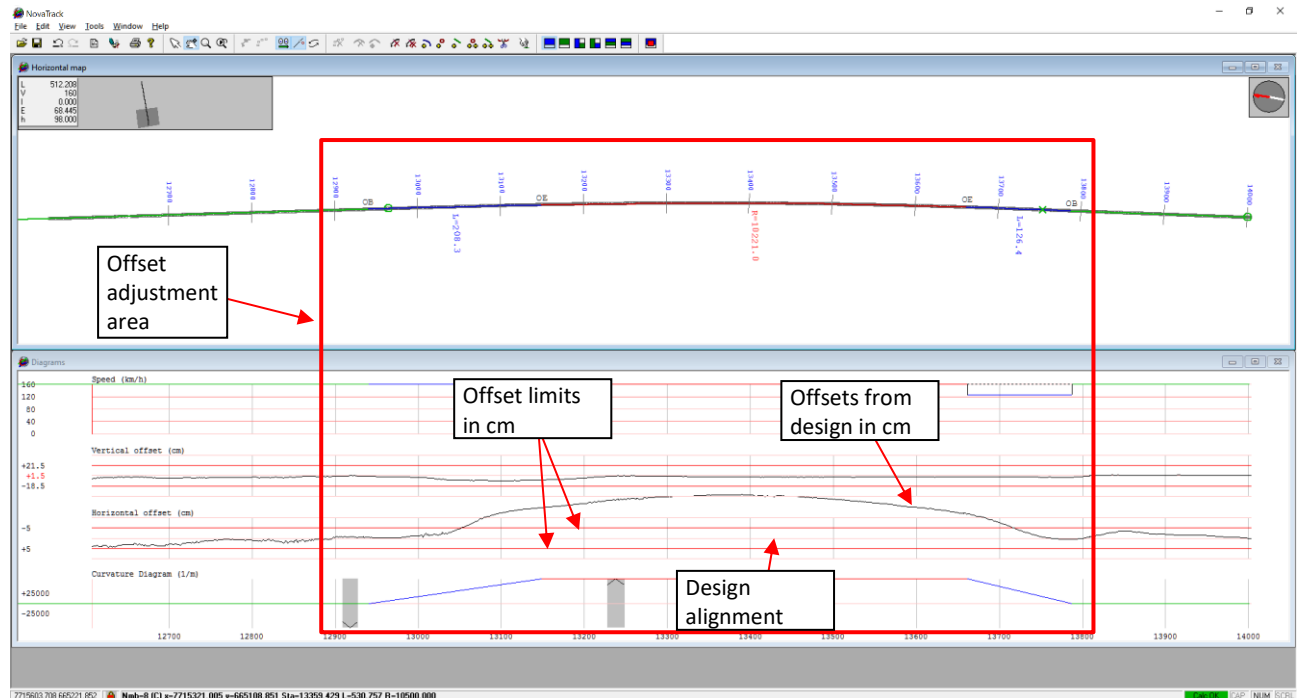
After the horizontal alignment calculation is completed using the automatic method or semi-automatic approach with the Analysis diagram, there can still be residual horizontal offsets that are exceeding the maximum track tamping limit. Further precise adjustment of the offsets can be done directly by editing the parameters of the individual alignment elements:

- for straight line: fixed point coordinates (start, end);
- for transition curve: length and/or A-parameter;
- for circular curve: radius, length, start point coordinate (if element is Partly fixed).

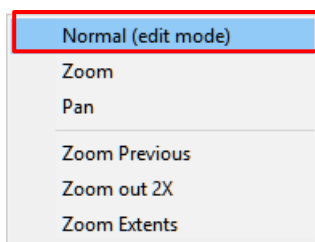
Each element position is controlled by a maximum of two fixed points. Depending on the element order, the software requires none (Approximate), one (Partial) or two (Fixed) fixed points per element. The software automatically determines how many fixed/tangent points are needed for each element. For the horizontal alignment fixed points are given with X- and Y- coordinates.

To manually adjust horizontal offsets, proceed as follows:

- Identify alignment elements where the horizontal offsets are exceeding the pre-set limits.
- **Zoom in** to the *Diagram window* or *Horizontal Map* window, so the screen is covering principal element and two adjacent elements.



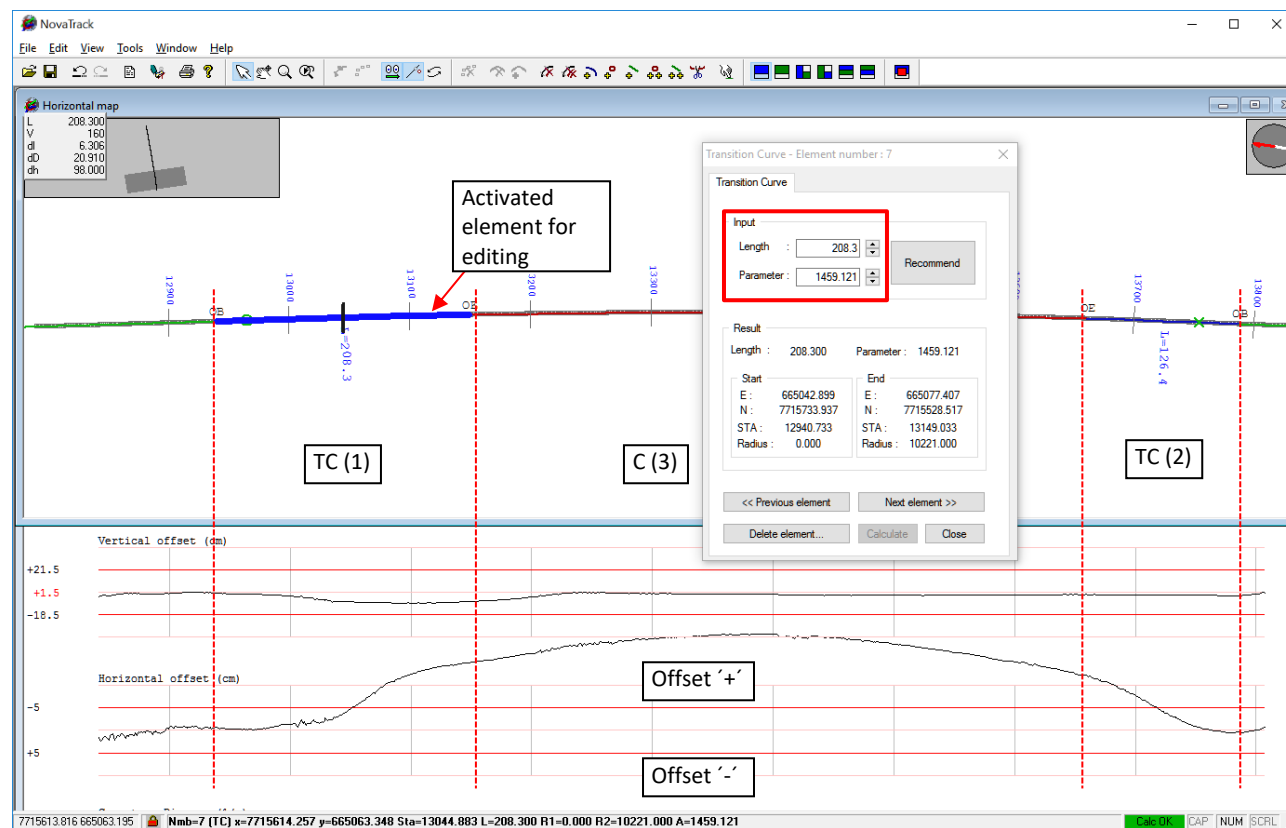
- **Right-click** on to the *Horizontal Map* layout. From the command list activate *Normal (edit mode)*. When *Normal (edit mode)* is activated, the mouse cursor follows the element geometry and allows them to be selected for detail editing.



- Use the left mouse click to select the geometrical element for editing. Selected element information is displayed in the *Status bar*.

Note.

If the offset values on the Circular curve element are largest, it is recommended to start editing from the connecting transition curve elements (*TC1*) and (*TC2*), and only after that switch to the circular curve (*C3*) editing.



- Open the geometry editing dialogue box by making a double *left-click* on the activated element.

Transition curve editing dialogue

Input data: length or A-parameter

Circular curve editing dialogue

Input data: radius and a

Fixed point status (auto selected): fixed, partly, approx., appr. radius


Greyed out fields cannot be edited and are selected by the software to automatically compute a best solution

Straight line editing dialogue


Input data: Start and end fixed point coordinates

Fixed point status (auto selected): fixed, partly, approx.

Greyed out fields cannot be edited and are selected by the software to automatically compute a best solution

- Change an element's parameters by using the up/down arrows  for each field. During editing, the alignment and offsets are automatically updated. When values are entered directly, press 'Calculate' to update geometry and offsets.

Note.

if an offset is positive '+' (on the left side of alignment), the element radius/length has to be decreased;
 if an offset is negative '-' (on the right side of alignment), the element radius/length has to be increased;
 by changing element coordinates using up/down arrows  both 'X' and 'Y' coordinates are affected simultaneously, with a step of 7 cm;
 by changing individual 'X' or 'Y' element coordinate, will have affect to element direction.

- If further editing is required, switch to the next element by selecting '[Next element](#)' or double [left-click](#) on the element and the dialogue box information will be updated.

Important!

If the alignment solution cannot be calculated **Calc not Ok**, press the [Undo](#) key (Toolbar) to return the parameter value to its previous state;

Redundant or faulty elements can be deleted directly using the element editing dialogue, by selecting the element and pressing the '[Delete element](#)' button;

To diagnose the calculation error or review calculation results in numerical form, double-click on the **Calc OK/not OK** indication. This will open the calculation protocol. The calculation report is updated with every new calculation. For more detail information about the calculation report, please refer to the chapter [8 Calculation report data](#).

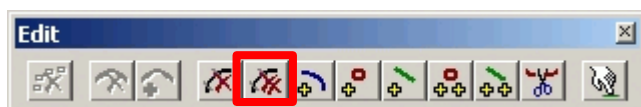
7.3.2 Functions for horizontal alignment editing

7.3.2.1 Delete element only



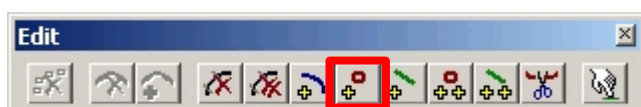
Icon/Key	Function description
	<p>To Delete Element Only:</p> <ul style="list-style-type: none"> Select alignment element using mouse <i>left-key</i>. Selected element will become a thicker line. Press mouse <i>right-key</i> and choose <i>Delete</i>. If the alignment calculation is <i>Calc not Ok</i>, it has to be edited manually until the line calculation turns to <i>Calc Ok</i> or apply <i>UNDO</i> command to cancel changes.

7.3.2.2 Delete Element with Transition Curves



Icon	Function description
 DEL	<p>To delete an element and the connected Transition Curves:</p> <ul style="list-style-type: none"> Select the alignment element using mouse <i>left-key</i>. Selected element will become a thicker line. Press <i>DEL key</i> to delete the element. The activated element and connected transition curves will be deleted. <p>If the alignment calculation is <i>Calc not Ok</i>, it has to be edited manually until the line calculation turns to <i>Calc Ok</i> or apply <i>UNDO</i> command to cancel changes.</p>

7.3.2.3 Insert Curve (Circular)

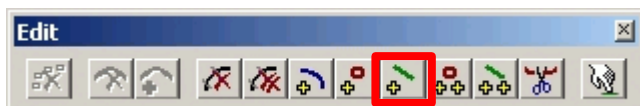


Icon	Function description
	To insert a Curve after the active element:

- Use the mouse *left-key* to mark the element after which you want to insert a circular curve element. Selected element will become a thicker line and marked with a red padlock symbol on the status bar.
- Press *Insert Curve* icon to insert new element.

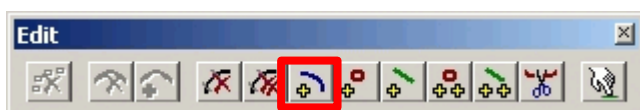
If the alignment calculation is '**Calc not Ok**', it has to be edited manually until the line calculation turns to '**Calc Ok**' or apply *UNDO* command to cancel changes.

7.3.2.4 Insert Straight Line



Icon	Function description
	<p>To insert a straight line after the active element:</p> <ul style="list-style-type: none"> • Use the mouse <i>left-key</i> to mark the element after which you want to insert a straight element. The selected element will contain thicker line and marked with red padlock on the status bar. • Press <i>Insert Straight line</i> icon to insert new element. <p>A straight element cannot be inserted after a straight element and cannot be connected to another straight element.</p> <p>If the alignment calculation is 'Calc not Ok', it has to be edited manually until the line calculation turns to 'Calc Ok' or apply <i>UNDO</i> command to cancel changes.</p>

7.3.2.5 Insert Transition Curve



Icon	Function description
	<p>To insert a Transition Curve after the active element:</p> <ul style="list-style-type: none"> • Use the the mouse <i>left-key</i> to mark the element after which you wish to insert a transition curve element. Selected element will contain a thicker line and marked with red padlock on the status bar. • Press <i>Insert Transition Curve</i> icon to insert new element. <p>If the alignment calculation is 'Calc not Ok', it has to be edited manually until the line calculation turns to 'Calc Ok' or apply <i>UNDO</i> command to cancel changes.</p> <p>Choose 'Undo' to revert back to the last line calculation.</p>

7.3.2.6 Insert Curve in Straight Line Element



Icon	Function description
	<p>To insert a Circular Curve element together with transition curves at either end into an active straight line element:</p> <ul style="list-style-type: none"> Use the mouse <i>left-key</i> to mark a straight line element, which will be split with the curve. Run the function to insert a curve. The program prompts for the location of a horizontal angular point of curvature (follow the messages in the status bar). Pick the intersection /angular point. By default, the program will insert a Circular Curve with a radius of 55.0 m and two transition curves at both ends with lengths of 15.0 m each. When it is not possible to insert a Circular Curve in conjunction with transition curves, the transition curves will be discarded. <p>When <i>AutoSnap</i> is active, the reference point will automatically snap to nearest measured point. <i>Autosnap</i> is switched on/off with the <i>key F9</i>.</p> <p>If the alignment calculation is 'Calc not Ok', it has to be edited manually until the line calculation turns to 'Calc Ok' or apply <i>UNDO</i> command to cancel changes.</p> <p>Choose 'Undo' to resort back the last line calculation.</p>

7.3.2.7 Insert a Straight Line in to Curve Element



Icon	Function description
	<p>To insert a Straight Line with Transition Curves into a Circular Curve Element:</p> <ul style="list-style-type: none"> Use the mouse <i>left-key</i> to mark the Circular Curve element, into which will be inserted a straight line and transition curves at both ends. Run the function to insert a straight line. The program prompts for two tangent points (end points) for the straight line element (follow the messages in the status bar). Pick the end points of the straight line. The selected point coordinates are displayed on the status bar. By default, the program will insert Straight line element and two transition curves at both ends with the length of 15.0 m each.

- When it is not possible to insert a straight line with transition curves, the transition curves are discarded.


When *AutoSnap* is active, the reference point will automatically snap to the nearest measured point. *Autosnap* is switched on/off with the *key F9*.

If the alignment calculation is '**Calc not Ok**', it has to be edited manually until the line calculation turns to '**Calc Ok**' or apply *UNDO* command to cancel changes.

Choose 'Undo' to revert back the last line calculation.


7.3.2.8 Split Curve

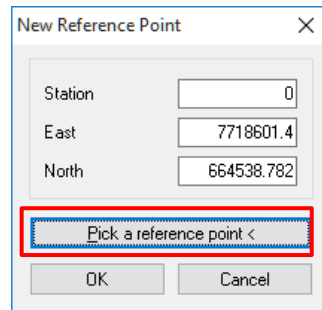


Icon	Function description
	<p>To split the active Circular Curve element into two new Circular curves:</p> <ul style="list-style-type: none"> Use the mouse <i>left-key</i> to mark the Circular Curve element, which will be split. Run the function to split the active curve. The program prompts for two points (observe the status bar). One point is desired split point for the curve and the second point - fix point on one of the new curves. The old circular curve is split and two new circular curves are calculated from the measured data. <p>When <i>AutoSnap</i> is active, the reference point will automatically snap to nearest measured point. <i>Autosnap</i> is switched on/off with the <i>key F9</i>.</p> <p>If the alignment calculation is 'Calc not Ok', it has to be edited manually until the line calculation turns to 'Calc Ok' or apply <i>UNDO</i> command to cancel changes. Choose 'Undo' to bringing back the last line calculation.</p>

7.3.2.9 Select Reference Point (change alignment chainage)



Icon	Function description
	<p>To change chainage a reference point (start chainage):</p> <ul style="list-style-type: none"> From the toolbar run the function <i>Select Reference Point</i> In the function dialogue box press the button '<i>Pick a reference point</i>' and select the new reference point in the window '<i>Horizontal Map</i>'



New Reference Point

Station: 0

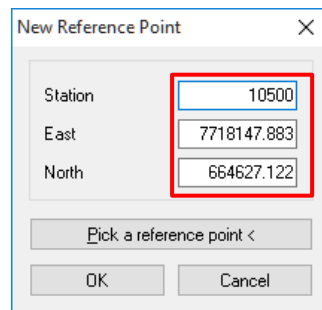
East: 7718601.4

North: 664538.782

Pick a reference point <

OK Cancel

- The function will read the current chainage and coordinates of selected point.
- Using the same dialogue box, type in the new chainage for selected point or alternatively, override the coordinates and chainage with known values.



New Reference Point

Station: 10500

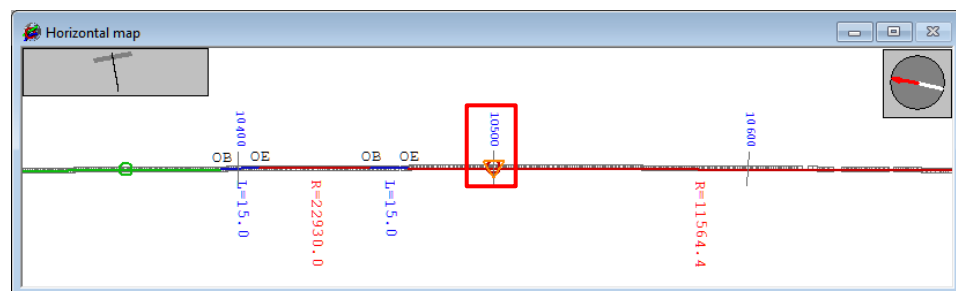
East: 7718147.883

North: 664627.122

Pick a reference point <

OK Cancel

- Press **OK** button to accept changes. In case changes were made to the reference point coordinates only, the overall alignment chainage will not be affected.
- The new reference point position will be marked with the a 'triangle' symbol.




7.3.3 Workflow for the manual adjustment of vertical alignment offsets

The vertical alignment is automatically calculated together with the horizontal alignment either during track measurement data imported or at the re-calculation. Further, precise adjustment of the offsets can be done directly by editing the parameters for individual alignment elements:

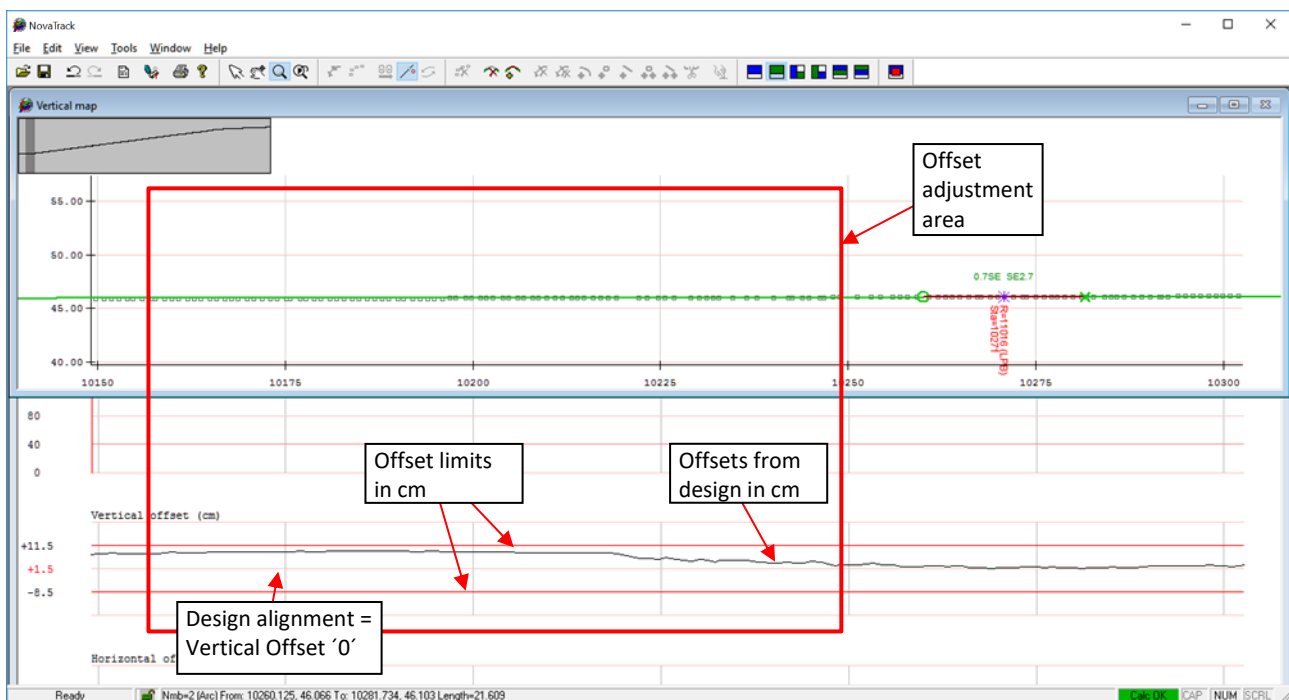
- for circular curve: radius, length, angular point elevation (PVI – point of vertical intersection), PVI chainage;
- for gradient line: start/end point chainage and elevation.

The vertical curve radius can be edited, either by changing the radius or its length. The correlation between curve radius R and length L is $L=R*SD$, where SD is change in grade along the vertical curve.

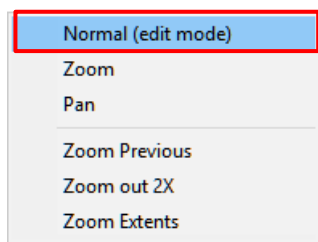
Alternatively, the fixed element and PVI position can be adjusted using the mouse cursor. It is recommended to use Snap (F9) function, so the  mouse cursor is locked to the measured points.

To manually adjust vertical elements and offsets, proceed as follows:

- Identify the alignment location (or elements) where the vertical offsets are exceeding set limits or element parameter is incorrect.
- **Zoom in** on the *Diagram window* or *Vertical Map window*, so the focus is over the area where vertical alignment offsets need to be adjusted.



- In the *Vertical Map* layout use the mouse *right-click* to select *Normal (edit mode)* command. When the *Normal (edit mode)* command is activated, the mouse cursor follows the alignment and enables the user to select individual elements for detail editing.



- Select the element for editing by using the left mouse click. Selected element information is displayed in the *Status bar*.

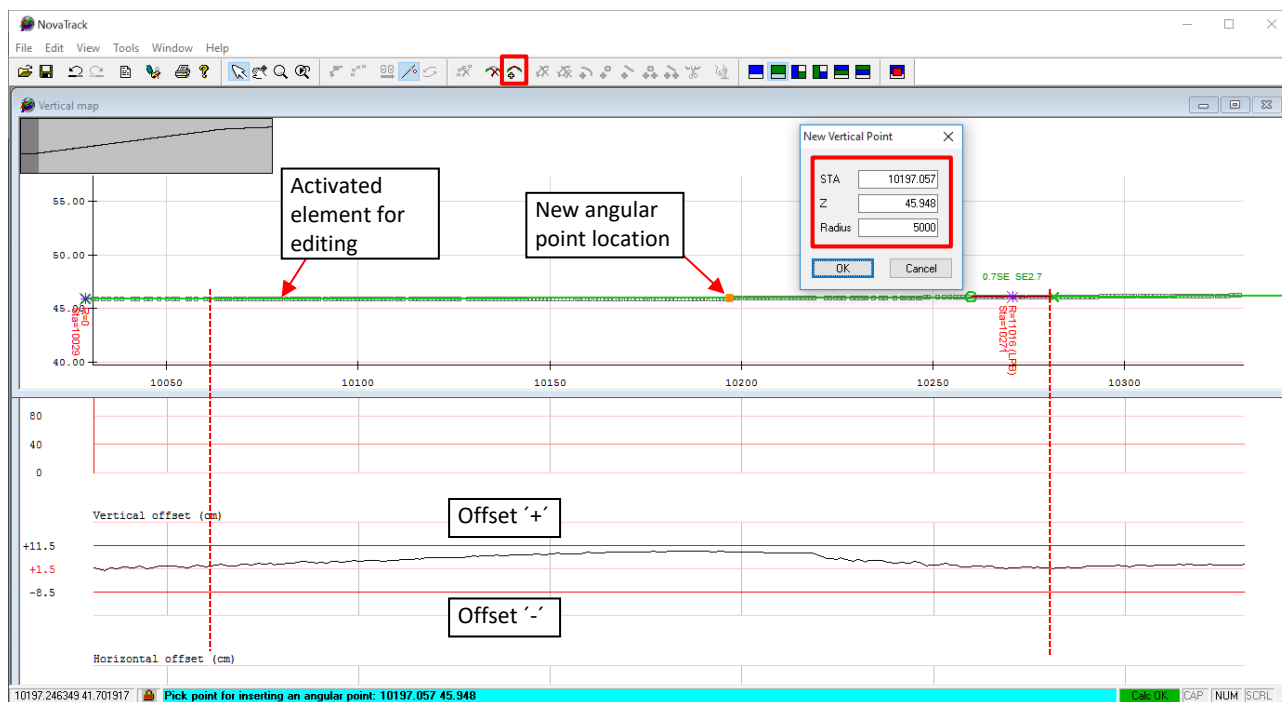
10240.865165 62.451069 Nmb=1 (Lin) From: 10029.191, 45.898 To: 10260.125, 46.066 Length=230.934

Calc OK CAP NUM SCRL

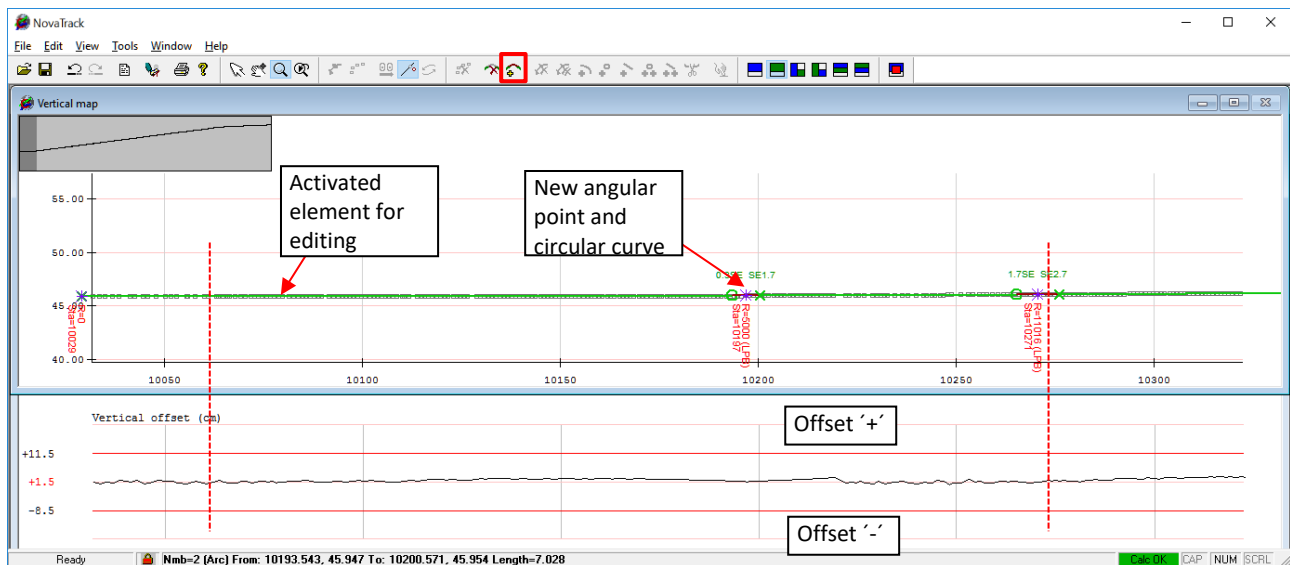
Note.

It is recommended to start the adjustment of vertical offsets at the chainages where offsets are at their peak (above or below) the design alignment.

- From the toolbar, select the '*Insert angular point*' function to insert an IP. Use the mouse *left-click* to select the element (chainage) where the angular (IP) point should be inserted.



- In the 'New vertical point' dialogue box, chainage (STA) and elevation (Z) data is automatically extracted from the measured points. The default radius value is set to 5000.0 m. The circular curve length will be calculated based on the radius value and incoming/outgoing gradients.



- Further, open the element editing dialogue by double clicking the element. Element editing dialog is transparent, so it's stays active with selection of next element.

Vertical Alignment - Element number : 1

Input - Line

Start	End
STA : 10029.191	STA : 10193.543
Z : 45.898	Z : 45.947

Result

Start	End
STA : 10029.191	STA : 10193.543
Z : 45.898	Z : 45.947

Length : 164.352 Slope : 0.298

<< Previous element Next element >>

Calculate Close

Gradient element dialogue box

Input data: fixed point chainage (STA) and elevation (Z)

Vertical Alignment - Element number : 2

Input - Arc

Radius	Angular point
5000	STA : 10197.057
Length : 7.028	Z : 45.948

Result

Start	End
STA : 10193.543	STA : 10200.571
Z : 45.947	Z : 45.954


Length : 7.028

<< Previous element Next element >>

Delete element Calculate Close

Vertical curve dialogue box

Input data: element radius, length, PVI point chainage (STA) and elevation (Z)

- Adjust the radius by manually typing between 3000 m and 5000 m, so the circular curve element is extended in length. Press 'Calculate' to update changes.
- Press *Next element* to continue with the adjustment of the neighbouring element. Modify elevation, chainage or radius using the up/down  arrows for each field. Whilst editing, alignment recalculation and offset update is done automatically. When values are entered directly, press 'Calculate' to update geometry and offsets.
- If there are still residual offsets, switch to neighbouring element by pressing 'Next element' or 'Previous element' button.
- First minimise offsets by adjusting the elevation (Z) value, and then adjust the chainage for further offset reduction.

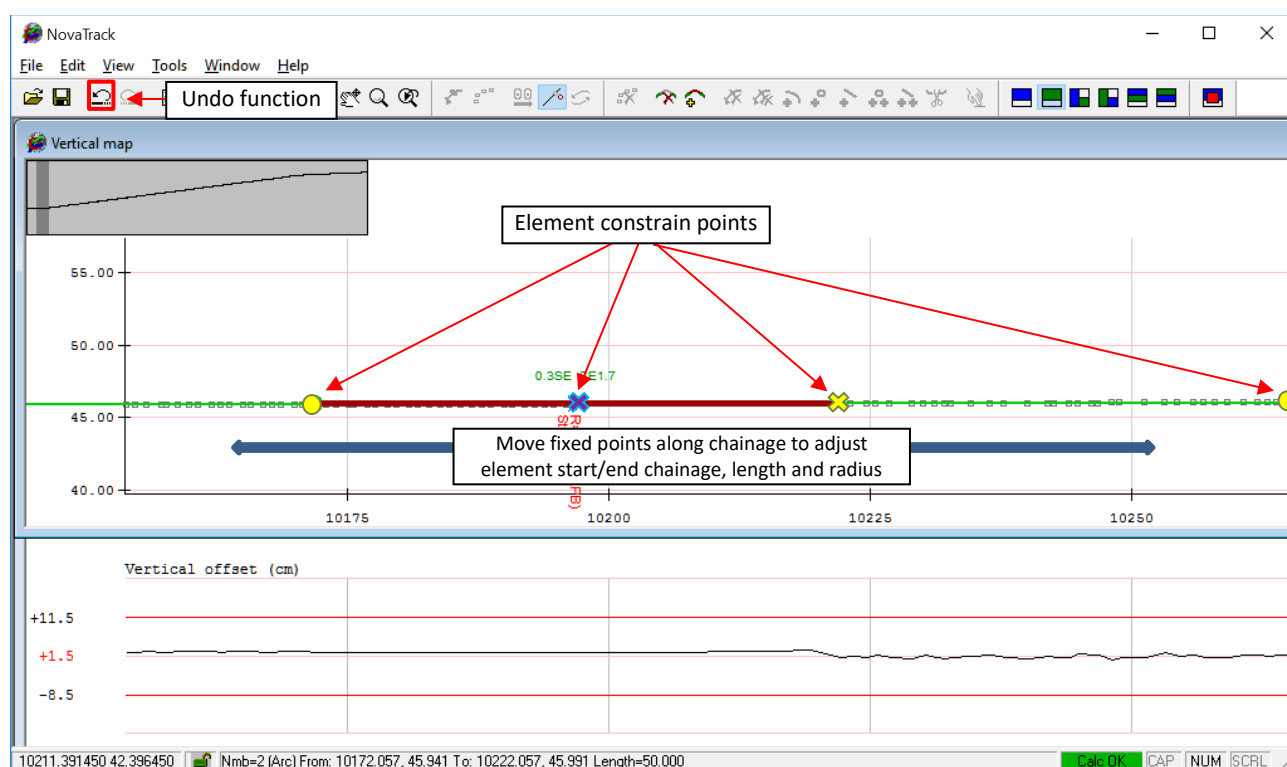
Note.

element radius/length modification has less of an impact to vertical offset;

first adjust the PVI elevation and then adjust the radius/length;

for Gradient – Gradient element connection use Radius of 1.0 metre;

to accelerate the editing of the PVI (angular) and fixed point chainages, use the mouse *left key* to select a fixed point and move in a chainage direction. It is recommended to activate *AutoSnap (F9)*, so fixed points are following measured points. If *AutoSnap* is deactivated, fixed points can be moved unconstrained, in both chainage and elevation direction.



- When the PVI (angular) and fixed points are moved using the mouse cursor, follow the status bar information about current point position and delta chainage/elevation from previous:

3007.840918 53.614382



Dragging a break point: Sta=3007.931 z=53.596 dSta=+0.722 dz=-0.019

PVI (angular) point


3018.765096 53.496616




Dragging a fix point: Sta=3018.642 z=53.626 dSta=+0.164 dz=+0.130

Fixed point

Important!

the 'Undo'  function will undo all changes made after the last project save;

if a vertical alignment solution reports element overlap, press the 'Undo'  key to return parameter values to their previous state;

'Circular curve' elements can be deleted directly from element editing dialog, by pressing 'Delete element' button;

'Straight' elements can be deleted from the Vertical Map view, by selecting element and pressing keyboard 'DEL' key.

7.3.4 Functions for vertical alignment editing

7.3.4.1 Insert Vertical Angular Point (Intersection Point)



Icon	Function description
	<p>To insert curves into a vertical alignment:</p> <ul style="list-style-type: none"> • Activate the layout window '<i>Vertical Map</i>' • From the toolbar run the function '<i>Insert Angular Point</i>' (<i>INS</i> key) • The program prompts for the curve insertion point. Use the mouse left-click to insert a point or alternatively use '<i>INS</i>' key • The program will prompt with the dialogue box '<i>New Vertical Point</i>' for the new curve settings (observe the status bar): <div data-bbox="365 896 675 1207" data-label="Form"> </div> <ul style="list-style-type: none"> - Position of the vertical angular (IP) point (chainage). - Elevation of the curve. - Radius of curve. The default radius is 5000.0m. <ul style="list-style-type: none"> • Click the button <i>OK</i> to calculate the new vertical alignment. If the calculation fails, the vertical alignment is to be edited by the user until the calculation is successful.

7.3.4.2 Delete a Vertical Angular (Intersection Point) Point



Icon	Function description
	<p>To delete a Vertical Angular (IP) Point.</p> <ul style="list-style-type: none"> • Switch layout to '<i>Vertical Map</i>' • Select the vertical alignment angular element (curve) using the mouse <i>left-key</i>. Selected element will be highlighted with a thicker line. • Press the <i>Delete</i> key to remove the marked element. • After deleting the angular element (curve), the start and end grading lines will be joined into one element.

If the calculation fails after deleting a curve, the vertical alignment elements has to be edited until the calculation is successful.

7.4 Calculation of Cant and Speed

Software functionality allows the calculation of the Cant and Speed in four different ways:

- **Cant averaging** - with this approach the software calculates the average design cant values based on the measured cant at each individual horizontal alignment element.
- **Design element cant** - with this approach the software calculates design cant values for each element individually, based on horizontal alignment element geometry and Speed/Cant settings in the *Calculation profile*.
- **Design element speed** – with this approach the software calculates design speed values for each individual element, based on horizontal alignment element geometry and Speed/Cant settings in the *Calculation profile*.
- **Design cant & speed** – with this approach the software calculates both design speed and cant values based on the complete horizontal alignment geometry and Speed/Cant settings in the *Calculation profile*.

To view and recalculate the speed and cant in a tabular view, proceed as follows:

- Double click on **Cant Diagram** or alternatively, from the main menu select **Tools -> Cant and Speed calculations**.
- The function will open a new dialogue box, containing two tabs:
 - Given speed – speed limit indicator marking in the *Diagram* view.
 - Speed and Cant – cant and speed calculation

Cant and speed calculation

Given speed: **Speed**

Nr	From	To	R1	R2	L	H1	H2	V	h1	h2	v	K
1	-0.000	103.103	0.000	0.000	103.103	0.000	0.000	160	0.000	0.000	160	
2	103.103	135.388	0.000	222.302	32.285	0.000	55.000	40	0.000	12.000	30	
3	135.388	175.866	222.302	222.302	40.477	61.000	61.000	40	12.000	12.000	30	
4	175.866	235.739	272.067	272.067	59.873	86.000	86.000	50	12.000	12.000	55	
5	235.739	247.847	202.710	202.710	12.108	51.000	51.000	40	12.000	12.000	50	
6	247.847	247.917	202.710	198.389	0.071	51.000	50.000	15	12.000	12.000	15	
7	247.917	375.757	198.389	198.389	127.839	49.000	49.000	35	12.000	12.000	30	
8	375.757	397.899	184.428	184.428	22.142	42.000	42.000	35	12.000	12.000	45	
9	397.899	460.451	187.035	187.035	62.551	43.000	43.000	35	12.000	12.000	45	
10	460.451	523.209	187.035	0.000	62.759	12.000	0.000	35	12.000	0.000	35	
11	523.209	680.849	0.000	0.000	157.640	0.000	0.000	160	0.000	0.000	160	

- To calculate design cant as an average of the measured cant values, press the **Cant averaging** button. The values in the fields "h1"/"h2" will be updated.
- To calculate the element's design cant based on definitions in the calculation profile and calculated design speed, press **Design element cant** button. The values in the field "h1"/"h2" will be updated.
- To calculate the element's design speed based on definitions in the calculation profile and calculated design cant, press **Design element speed** button. The values in the field "v" will be updated.

- To calculate the overall design speed and cant based on definitions in the calculation profile and calculated design alignment geometry, press **Design cant and speed** button. The values in the fields "h1", "h2" and "v" will be updated.

Note.

All settings for the speed and cant calculation are accessible from the main menu **Tools -> Options -> General -> Edit profile...** Alternatively, the calculation settings and corresponding values can be edited in the **profiles.ini** file, located in the NovaTrack program directory. File format definition is listed in the **Appendix 1. File formats**. In the **'Speed and Cant'** tab, the **'grey'** and **'white'** fields are calculated automatically, however it is possible to overwrite the proposed values in the **'white'** fields.

The table columns have the following meaning:

Name	Description	Name	Description
No.	Hor. alignment element number	V	Calc. Vmax speed based on element
From	Element start chainage	h1	Element start Cant value based on element group
To	Element end chainage	h2	Element end Cant value based on element group
R1	Element start radius	v	Calculated Vmax speed based on element group
R2	Element end radius	K	Check mark to keep user defined values
L	Element length		
H1	Element start Cant value		
H2	Element end Cant value		

- To store user defined cant and speed values in the **'h1'**, **'h2'** and **'v'**, select the checkbox in the column **'K'**.

Cant and speed calculation

Given speed Speed and Cant

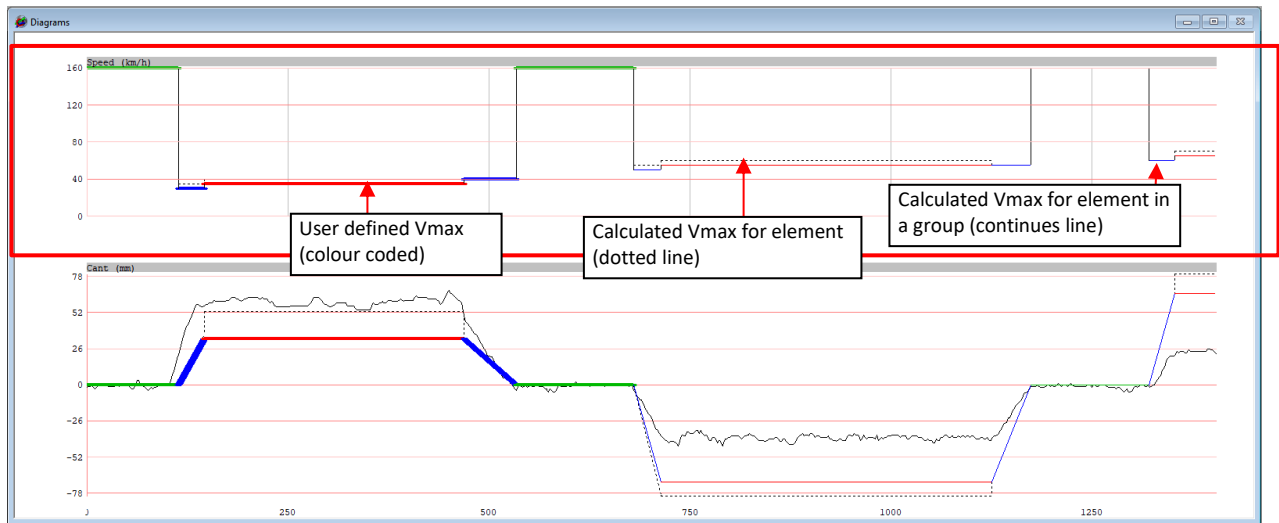
No	From	To	R1	R2	L	H1	H2	V	h1	h2	v	U
1	1448.148	1847.856	0.000	0.000	399.708	0.000	0.000	160	0.000	0.000	160	<input checked="" type="checkbox"/>
2	1847.856	1935.796	0.000	972.507	87.940	0.000	76.000	95	0.000	76.000	95	<input checked="" type="checkbox"/>
3	1935.796	2317.421	972.507	972.507	381.625	80.000	80.000	100	76.000	76.000	100	<input checked="" type="checkbox"/>
4	2317.421	2476.314	972.507	0.000	158.893	79.000	0.000	105	76.000	0.000	100	<input checked="" type="checkbox"/>
5	2476.314	2559.668	0.000	0.000	83.355	0.000	0.000	160	0.000	0.000	160	<input checked="" type="checkbox"/>
6	2559.668	2659.380	0.000	-1487.785	99.711	0.000	74.000	115	0.000	71.000	110	<input checked="" type="checkbox"/>
7	2659.380	3122.509	-1487.785	-1487.785	463.130	80.000	80.000	125	71.000	71.000	120	<input type="checkbox"/>
8	3122.509	3198.745	-1487.785	0.000	76.235	71.000	0.000	110	71.000	0.000	110	<input type="checkbox"/>
9	3198.745	3359.369	0.000	0.000	160.624	0.000	0.000	160	0.000	0.000	160	<input type="checkbox"/>
10	3359.369	3528.228	0.000	693.623	168.859	0.000	70.000	90	0.000	66.000	85	<input type="checkbox"/>
11	3528.228	3965.293	693.623	693.623	437.064	80.000	80.000	85	66.000	66.000	80	<input type="checkbox"/>

Design cant and speed Design element speed Design element cant Cant averaging

OK Cancel Help

- Press **OK** to store settings.


- To evaluate speed calculations graphically, switch to the *Diagram* layout. Speed information is shown in the *Speed (km/h)* chart.

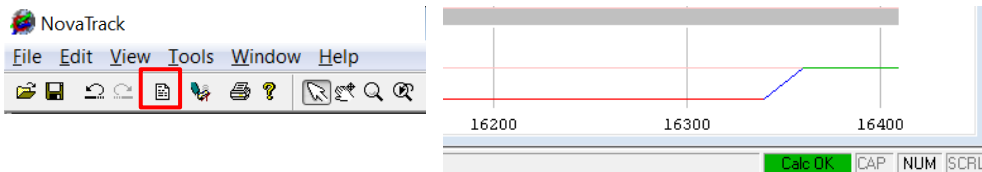


8 Calculation report data

The software produces calculation reports based on horizontal alignment input and output results. The calculation log is automatically updated each time the horizontal alignment geometry is affected or after manual element editing.

To access the calculation result log:

- From the toolbar select icon **Show Result File**  or in the status bar double click message box 'Calc **Ok**' / 'Calc not Ok'.



- The input and calculation result data will be separated by two individual headings - 'Horizontal Alignment Input Data' and 'Horizontal Alignment Main Points - Result'.

X10_realignment_NT_1.RES - FileView

File Edit View Help

HORIZONTAL ALIGNMENT INPUT DATA

PROJECT NO.	CALC.NO.	ACCOUNT	REG.DATE	CALC.DATE
Track_X10	X10	-	-	17- 1-2019
CHAINAGE PARAMETERS				
STARTPT.	DIRECTION	CHAINAGE		
0.	1.	15200.000		
EL. NO.	R-START R-END	PARAM. I LENGTH	N E	L-START L-END O-START O-END I
1	0.000 0.000	0.000 05526944.0844366033.852		0.000 0.000 3
	0.000 0.000	5526910.2474366117.249		0.000 0.000 3
2	0.000 -600.000	198.997 0 0.000		0.000 0.000 3
3	-600.000 -600.000	0.000 15526870.5554366515.754	0.000 0.000	0.000 0.000 1
		0.000 0.000	0.000 0.000	0.000 0.000 0
4	-600.000 0.000	201.990 0 0.000		

X10_realignment_NT_1.RES - FileView

File Edit View Help

HORIZONTAL ALIGNMENT MAIN POINTS RESULTS

CERO NOVATRACK

PAGE 1

AB

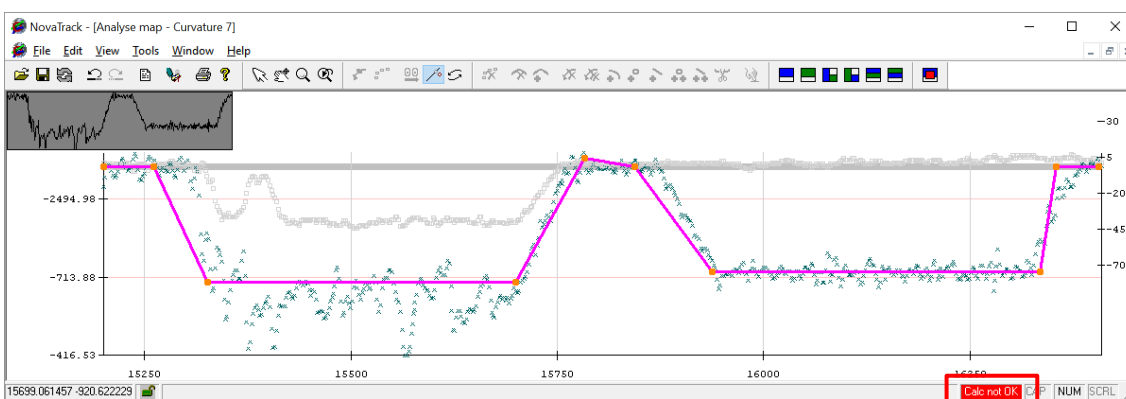
Re-alignment after ballast cleaning.

15200 - 16500

PROJECT NO.	CALC.NO.	ACCOUNT	REG.DATE	CALC.DATE
Track_X10	X10	-	-	17/ 1-2019
EL. NO.	STATION-ST. LENGTH	R-START R-END	PARAM. COORDINATES N E	BEAR-ST. BEAR-END
1	15200.000 90.933	- -	B5526944.0844366033.852 S5526909.8974366118.113	124.538 124.538
2	15290.933 66.000	- -600.000	198.997 B5526909.8974366118.113 S5526886.2114366179.707	124.538 121.037
			V5526893.3524366158.892	
3	15356.933 340.100	-600.000 -600.000	- B5526886.2114366179.707 S5526870.4374366514.901	121.037 84.951
			V5526878.6114366745.007	

Important!

In the case where a solution for an horizontal alignment cannot be found within the set constraints, the status bar indicates 'Calc not Ok' and the Analysis Diagram is coloured in 'magenta'. Please check the calculation **Result file** for possible errors in element connections.



To check result file for errors:

- Open the results file and scroll to the header '*Horizontal Alignment Main Points - Result*'.

Each element causing an error in the element connectivity and therefore preventing an alignment solution, has only a few parameters listed. The parameters which cannot be calculated are marked with error codes or are not listed at all.

- Under the header 'Control and Error Messages', check the error records indicating erroneous elements where the calculation was aborted.

Alignment_RES1.res - FileView

File Edit View Help

CONTROL- AND ERROR-MESSAGES GEDO NOVATRACK

PROJECT NO.	CALC.NO.	ACCOUNT	REG.DATE	CALC.DATE
Track_X10	X10	-	-	17/ 1-2019

ELEMENT 7. FIXED POINT WITHIN ADJOINING ELEMENT -750.52

ELEMENT 7. NO SOLUTION WITHIN CONNECTING ELEMENT

CALCULATION STOPPED AT ELEM.NO. 3.

HORIZONTAL ALIGNMENT PAGE 1
MAIN POINTS
RESULTS GEDO NOVATRACK

Calculated by: A.B.
Re-alignment after ballast cleaning
CH 15200 - 16500

PROJECT NO.	CALC.NO.	ACCOUNT	REG.DATE	CALC.DATE
Track_X10	X10	-	-	17/ 1-2019

EL. NO.	STATION-ST. LENGTH	R-START R-END	PARAM.	COORDINATES N E	BEAR-ST. BEAR-END
1	0.000 91.824	-	-	B5526943.3324366035.705 S5526908.8134366120.794	124.535 124.535
2	91.824 64.000	- -594.597	195.075	B5526908.8134366120.794 S5526885.8244366180.514 V5526892.7714366160.337	124.535 121.109 121.109
3	155.824 665.288	-594.597 -594.597	-	B5526885.8244366180.514 S5527028.3974366795.323 V5526764.6224366532.556	121.109 49.878 85527448.0744366373.978
4	-	-594.597	212.578	-	-
5	-	-	732.276	-	-
6	-	-	7055.643	-	-
7	-	-	-	-	-

Result protocol.
Error detection in Element No.4

Alignment_RES1.res - FileView

File Edit View Help

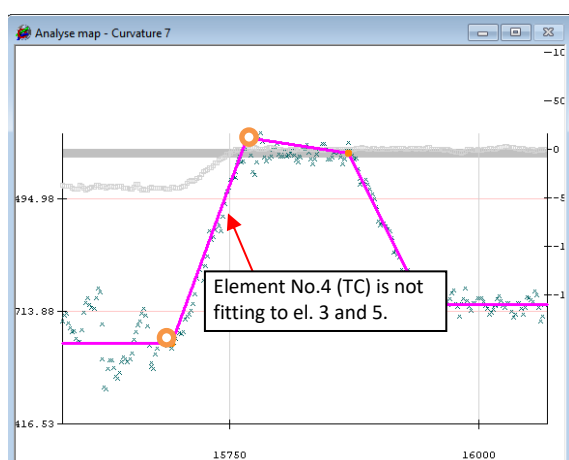
HORIZONTAL ALIGNMENT PAGE 1
MAIN POINTS
RESULTS GEDO NOVATRACK

Calculated by: A.B.
Re-alignment after ballast cleaning
CH 15200 - 16500

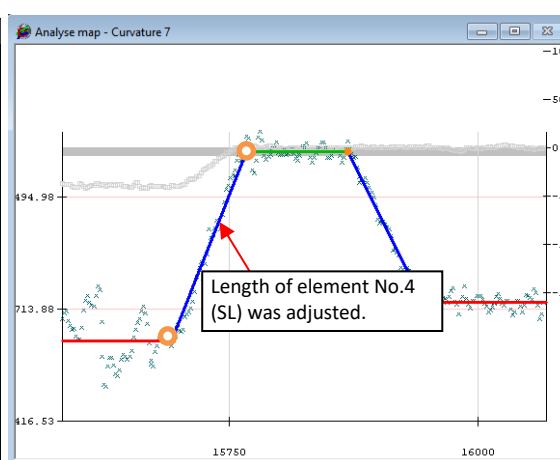
PROJECT NO.	CALC.NO.	ACCOUNT	REG.DATE	CALC.DATE
Track_X10	X10	-	-	17/ 1-2019

EL. NO.	STATION-ST. LENGTH	R-START R-END	PARAM.	COORDINATES N E	BEAR-ST. BEAR-END
1	0.000 91.720	-	-	B5526943.3324366035.705 S5526908.8524366120.698	124.535 124.535
2	91.720 64.000	- -594.597	195.075	B5526908.8524366120.698 S5526885.8644366180.418 V5526892.8104366160.241	124.535 121.109 121.109
3	155.720 333.409	-594.597 -594.597	-	B5526885.8644366180.418 S5526869.0204366509.045 V5526830.1284366342.306 C5527448.0744366373.978	121.109 85.411 81.343 81.343
4	489.129 76.000	-594.597	212.578	B5526869.0204366509.045 S5526889.4174366582.242 V5526874.7774366533.725	85.411 81.343 81.343
5	565.129 102.801	-	-	B5526889.4174366582.242 S5526919.1154366680.660	81.343 81.343
6	667.931 76.000	- -748.396	238.491	B5526919.1154366680.660 S5526942.2974366753.030 V5526933.7544366729.173	81.343 78.110 78.110
7	743.931 369.855	-748.396 -748.396	-	B5526942.2974366753.030 S5527146.2684367057.048 V5527005.9374366930.765 C5527646.8864366500.741	78.110 46.649 43.842 43.842
8	1113.786 66.000	-748.396 -	222.248	B5527146.2684367057.048 S5527196.6004367099.732 V5527162.6244367071.767	46.649 43.842 43.842
9	1179.786 26.186 1205.972	- -	-	B5527196.6004367099.732 S5527216.8184367116.374	43.842 43.842

Result protocol.
Result after error in Element No.4 corrected.



Analysis diagram.
Error detection in Element No.4



Analysis diagram.
Result after error in Element No.4 corrected.

9 Alignment geometry verification

Each alignment recalculation and editing activity is automatically followed by the alignment element verification against user defined settings. Settings for alignment element verification are defined and stored in the same table as Calculation settings. Please refer to the chapter [Appendix 2. Calculation profile](#) definition for more detail information

To edit existing or to define new calculation profiles with alignment validation values, proceed as follows:

- From the menu select **Tools -> Option-> General** and press button **'Edit profile...'**.
- To edit existing profile, select profile and edit appropriate values.

New calculation profile

Profile name:

Comment:

Created by:



Variable	Value	Description
CRmin	300	Minimum radius for curve (m)
CRmax	5000	Maximum radius for curve (m)
SLCmin	10	Minimum Straight line length between two Circul
CLmin	20	Minimum length for curve (m)
TCLMin	0.5	Minimum length transition curve (m)
RminTCmin	300.0 40.0 400.0 45.0 500.0 50.0	Minimum Transition curve length @ radius
VCRmax	70000.0	Maximum vertical crest radius (m)
VSRmax	70000.0	Maximum vertical sag radius (m)
VELmin	10	Minimum vertical element length (m)
VESmax	10	Maximum vertical element slope (per-mille, ‰)

OK Cancel

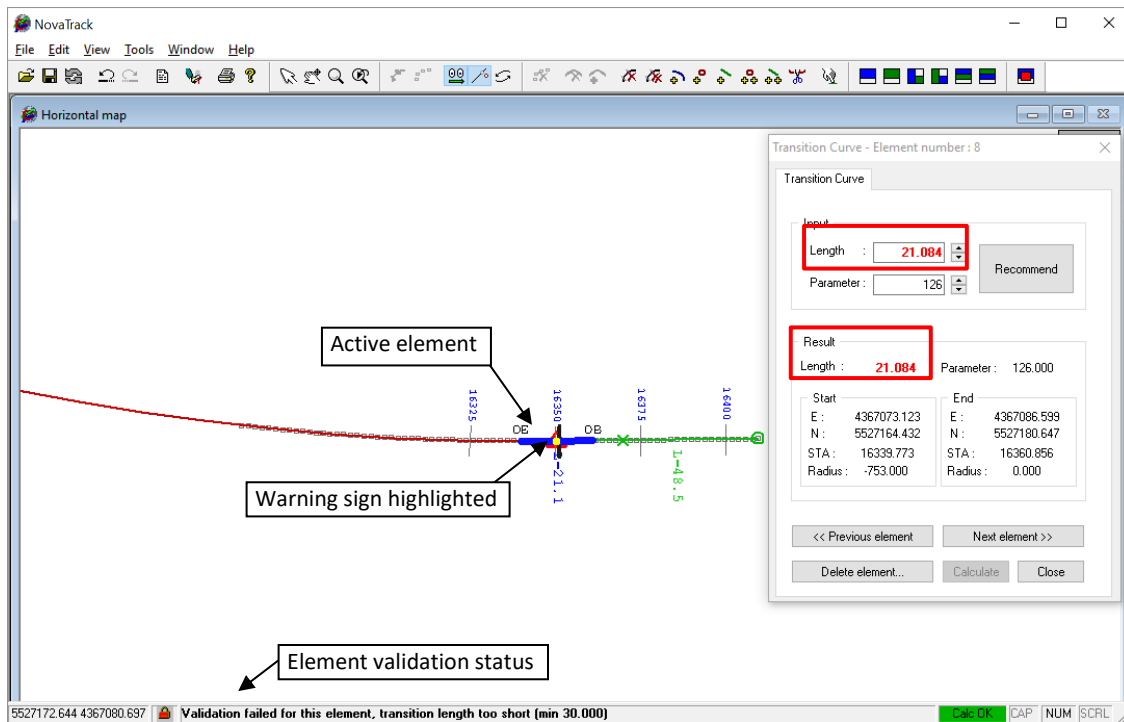
- To delete a profile, first select the profile and then press 'Delete current profile' button.
- To create a new profile, first select the reference profile and then press 'New (copy from existing)' button. All variable values will be transferred from reference profile to the new profile and can be modified.
- When profile editing is completed, press 'OK' button to store changes.

Note.

For the complete list of alignment verification variables, please refer to the chapter ['Appendix 2. Calculation profile'](#) definition.

- To apply new settings to the active alignment and to run the element validation, press 'Apply' button. The validation process will be performed both for horizontal and vertical alignments. Alignment elements which do not correspond with set verification criteria are marked with a warning symbol .
- To visualise an approximate validation, move the mouse over the warning  symbol. The status bar line will show the primary issue with the element.

- To achieve more precise information with validating issues, double click the element. The element editing dialogue box will show the 'highlighted' parameter which is beyond the set criteria limits.



- Once the element is adjusted (from the editing dialogue box or using the Analysis Diagram) to comply the set requirements, warning information will be automatically removed.

Appendix 1. File formats

GEDO Track data file format (*.gtd)

Data: track trajectory, cant, gauge

Field delimiter: comma

Decimal separator: dot

Example:

```
[Header]
FormatVersion = 1.0                ; file format version
Name = 34.6 to 38.5 140913         ; file name
ReferenceGauge = 1.435             ; reference gauge
CantBase = 1.5096                  ; cant base
[TrackData]                        ; detail track data
[Point_no;E-coord_C(m);N-coord_C(m);H-elev_C(m);Gauge(m);Incl(rads);Chainage(m);Prism_side;Ref_H_Rail]
34550R->34714L_1;;664538.782187441;7718601.40019557;45.8830243763602;1.434716544;-0.000818998017437332;34548.9312164998;Right;Left
34550R->34714L_2;;664538.889472634;7718600.88728717;45.8840264333605;1.434628768;-0.00108607569285843;34549.9164060877;Right;Left
34550R->34714L_3;;664539.108236682;7718599.73199802;45.8807265808121;1.434907288;-0.00118400417384616;34552.5435993232;Right;Left
34550R->34714L_4;;664539.335100111;7718598.56973668;45.8854532262065;1.43510816;-0.00168254916796553;34552.985992017;Right;Left
34550R->34714L_5;;664539.665681707;7718596.8885067;45.8919555278645;1.435060896;-0.00159352327615851;34553.919607927;Right;Left
34550R->34714L_6;;664539.911129619;7718595.6141894;45.8842067348748;1.4338506;-0.00147778961680936;34556.3216059077;Right;Left
34550R->34714L_7;;664540.305065043;7718593.62403868;45.8899238025968;1.434178072;-0.000925829087605769;34557.0148760155;Right;Left
34550R->34714L_8;;664540.576357108;7718592.19784344;45.880942453584;1.435855944;-0.000605335877100458;34560.5892768363;Right;Left
```

KOF file format (*.kof)

Data: points, lines, alignments

Field delimiter: space

Decimal separator: dot

Example:

```
-00 FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF *
-01 OOOOOOOOOOOO DDDDDDDDDDD VVVVVVVVVVVV KKKKKKKKKKKK OOOOO0000000 *
-02 SSSSSSSSSS KKKKKKKK NNNNNNNN TTTTTTTT TTTTTTTT II.III Bk MMMMMMMM *
-03 TTTTTTTTTT KKKKKKKK HHH.HHHH VVV.VVVV AAAA.AAA SS.SSS Bk MMMMMMMM *
-04 TTTTTTTTTT KKKKKKKK HHH.HHHH DDDD.DDD AAAA.AAA SS.SSS Bk MMMMMMMM *
-05 PPPPPPPPPP KKKKKKKK XXXXXXXX.XXX YYYYYYY.YYY ZZZZ.ZZZ Bk MMMMMMMM *
-06 PPPPPPPPPP KKKKKKKK PPPPPPPP.PPP AAAAAAA.AAA ZZZZ.ZZZ Bk MMMMMMMM *
-09 FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF Pi MMMMMMMM *
```

-Pno	Chain.	Fcode	N-coord.	E-coord.	H-Elev.	0	*
09_91							
05 300		12700	6595748.607	163951.272	11.548		
05 302		12700	6595748.473	163950.606	11.553		
05 303		12700	6595748.425	163950.361	11.554		
09_99							
09_91							
05 900		12701	6595749.483	163951.097	11.549		
05 904		12701	6595749.249	163949.928	11.557		
09_99							

VER file format (*.ver) (Plasser & Theuer, offsets for tamping)

Data: chainages, horizontal and vertical offsets

Field delimiter: space

Decimal separator: dot

Example:

```
VerschHoehe      1.0Vorw_____====EndOfFileHeader===
===== BeginOfTab =====
15202.000 -1.062e+000 1.448e+001 0.000e+000
15204.000 -7.132e-001 9.719e+000 0.000e+000
15206.000 -5.048e-001 4.378e+000 0.000e+000
15208.000 -1.076e+000 6.838e-001 0.000e+000
===== EndOfTab =====
```

GEO file format (*.geo) (Plasser & Theuer, alignment for tamping)

Data: chainages, horizontal and vertical alignments

Field delimiter: space

Decimal separator: dot

Example:

```
SollGeom          1.0Vorw_____====EndOfFileHeader===
===== BeginOfTab =====
15200.000 -0.000e+000 0.000e+000 449 464
15200.000 -0.000e+000 0.000e+000 449 464
15289.523 6.600e+001 6.600e+001 451 465
15355.523 6.040e+002 0.000e+000 450 464
15698.343 6.800e+001 6.800e+001 451 465
15766.343 -0.000e+000 0.000e+000 449 464
15869.050 7.800e+001 7.800e+001 451 465
===== EndOfTab =====
```

LIN file format (*.lin)

Data: horizontal alignment

Field delimiter: comma

Decimal separator: dot

Example:

```
6
1,5526944.08450,4366033.85216, 15200.00000, 0.00000,124.537926, 0.00000, 0.00000, 89.52254,
2,5526910.42692,4366116.80667, 15289.52254, 0.00000,124.537925, 199.65970, -604.00000, 65.99999,
3,5526886.73403,4366178.39799, 15355.52253, -604.00000,121.059705, 0.00000, -604.00000, 342.82051,
4,5526870.83824,4366516.26160, 15698.34304, -604.00000, 84.926209, 202.66226, 0.00000, 67.99999,
5,5526889.25546,4366581.71007, 15766.34303, 0.00000, 81.342589, 0.00000, 0.00000, 102.70668,
```

GPS file format (*.gps)

Data: points

Field delimiter: space

Decimal separator: comma

Example:

1	4366118,24909854	5526911,24741448	277,69031134
2	4366120,10299811	5526910,49704092	277,72766083
3	4366121,95690843	5526909,74669538	277,76451828
4	4366123,80934050	5526908,99271899	277,80215430
5	4366125,66213876	5526909,23962918	277,83786697
6	4366127,51624900	5526910,48978106	277,87329802
7	4366129,36890285	5526915,73633363	277,90791061
8	4366131,22185912	5526914,98364677	277,94311873
9	4366133,07479519	5526914,23088918	277,97703579
10	4366134,92729626	5526918,47707744	278,01101642
11	4366136,78144995	5526910,72732526	278,04613538
12	4366138,63572410	5526917,97787617	278,08146977

LandXML point file format – Import (*.xml)

Data: points

Field delimiter: not applicable

Decimal separator: not applicable

Example:

```
<?xml version="1.0" encoding="utf-8"?>
<LandXML xmlns="http://www.landxml.org/schema/LandXML-1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.2 http://www.landxml.org/schema/LandXML-1.2/LandXML-
1.2.xsd" version="1.2" date="2019-08-29" time="15:52:45" readOnly="false" language="English">
  <Project name="" desc="">
    <Feature name="projectExt">
      <Property label="id" value="8fd6e5a57b6e41ff9523b7a7f91a8342" />
    </Feature>
    <Feature code="trimbleLayers">
      <Feature code="trimbleLayer">
        <Property label="name" value="Points" />
        <Property label="color" value="255,255,255" />
        <Property label="lineStyleName" value="Solid" />
        <Property label="lineWeight" value="0" />
      </Feature>
    </Feature>
  </Project>
  <Units>
    <Metric linearUnit="meter" widthUnit="meter" heightUnit="meter" diameterUnit="meter" areaUnit="squareMeter"
volumeUnit="cubicMeter" temperatureUnit="celsius" pressureUnit="HPA" angularUnit="decimal degrees"
directionUnit="decimal degrees" />
  </Units>
  <Application name="Trimble Business Center" manufacturer="Trimble" version="31.0.7088.19172" timeStamp="2019-08-
29T15:52:45">
    <Author createdBy="Lmaciul" timeStamp="2019-08-29T15:52:45" />
  </Application>
  <CgPoints>
    <CgPoint name="IX_track_points_10m_2_1" featureRef="Points">5065125.54200 465821.32800 63.05700</CgPoint>
    <CgPoint name="IX_track_points_10m_2_2" featureRef="Points">5065115.08200 465821.26300 62.97800</CgPoint>
    <CgPoint name="IX_track_points_10m_2_3" featureRef="Points">5065135.82900 465821.24000 63.14100</CgPoint>
    <CgPoint name="IX_track_points_10m_2_4" featureRef="Points">5065108.57600 465821.15400 62.92700</CgPoint>
    <CgPoint name="IX_track_points_10m_2_5" featureRef="Points">5065145.90100 465821.00600 63.21300</CgPoint>
    <CgPoint name="IX_track_points_10m_2_6" featureRef="Points">5065098.38100 465820.83800 62.84500</CgPoint>
    <CgPoint name="IX_track_points_10m_2_7" featureRef="Points">5065156.38900 465820.65100 63.30200</CgPoint>
    <CgPoint name="IX_track_points_10m_2_8" featureRef="Points">5065088.34800 465820.38300 62.76500</CgPoint>
    <CgPoint name="IX_track_points_10m_2_9" featureRef="Points">5065166.22700 465820.22000 63.39100</CgPoint>
  </CgPoints>
</LandXML>
```


LandXML alignment file format – Import/Export (*.xml)

Data: horizontal/vertical alignment geometry

Field delimiter: not applicable

Decimal separator: not applicable

Example:

```

<?xml version="1.0" encoding="utf-8"?>
<LandXML xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.1 http://www.landxml.org/schema/LandXML-1.1/LandXML-1.1.xsd"
date="2019-08-29" time="13:54:43+02:00" version="1.1" xmlns="http://www.landxml.org/schema/LandXML-1.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Units>
    <Metric areaUnit="squareMeter" linearUnit="meter" volumeUnit="cubicMeter" temperatureUnit="celsius"
pressureUnit="mmHG" angularUnit="radians" directionUnit="radians"/>
  </Units>
  <Application name="NovaTrack" manufacturer="Trimble Railway GmbH" version="2.0.1 (822)" manufacturerURL="www.trimble-
railway.com">
    <Author createdBy="User1"/>
  </Application>
  <Project name=""/>
  <Alignments name="">
    <Alignment name="From NovaTrack" staStart="0.000000" length="4551.273194">
      <CoordGeom>
        <Line staStart="0.000000" length="191.457445" dir="3.090229">
          <Start>6065346.847000 465808.873000</Start>
          <End>6065155.642053 465818.702624</End>
        </Line>
        <Spiral staStart="191.457445" constant="156.000" radiusStart="INF" radiusEnd="467.000000"
spiType="clothoid" length="52.111349" rot="cw" dirStart="3.089971" dirEnd="3.145764">
          <Start>6065155.642053 465818.702624</Start>
          <PI>6065120.941312 465820.486549</PI>
          <End>6065103.565881 465820.409574</End>
        </Spiral>
        <Curve staStart="243.568794" rot="cw" length="88.439274" radius="467.000000"
chord="88.307176" dirStart="3.145764" dirEnd="3.335981">
          <Start>6065103.565881 465820.409574</Start>
          <Center>6065105.634737 465353.414157</Center>
          <End>6065015.692139 465811.670994</End>
        </Curve>
        <Spiral staStart="332.008068" constant="78.000" radiusStart="467.000000" radiusEnd="INF"
spiType="clothoid" length="13.027837" rot="cw" dirStart="3.335981" dirEnd="3.349349">
          <Start>6065015.692139 465811.670994</Start>
          <PI>6065011.430749 465810.834606</PI>
          <End>6065002.932204 465809.043133</End>
        </Spiral>
        <Line staStart="345.035905" length="33.253699" dir="3.349349">
          <Start>6065002.932204 465809.043133</Start>
          <End>6064970.393585 465802.184069</End>
        </Line>
        <Spiral staStart="378.289604" constant="84.000" radiusStart="INF" radiusEnd="501.000000"
spiType="clothoid" length="14.083833" rot="cw" dirStart="3.348763" dirEnd="3.363404">
          <Start>6064970.393585 465802.184069</Start>
          <PI>6064961.206172 465800.247384</PI>
          <End>6064956.626491 465799.214563</End>
        </Spiral>
        <Curve staStart="392.373437" rot="cw" length="88.586484" radius="501.000000"
chord="88.471127" dirStart="3.363404" dirEnd="3.540481">
          <Start>6064956.626491 465799.214563</Start>
          <Center>6065066.845151 465310.488825</Center>
          <End>6064872.378444 465772.207029</End>
        </Curve>
        <Spiral staStart="480.959921" constant="167.000" radiusStart="501.000000" radiusEnd="INF"
spiType="clothoid" length="55.666667" rot="cw" dirStart="3.540481" dirEnd="3.595779">
          <Start>6064872.378444 465772.207029</Start>
          <PI>6064855.272741 465765.002440</PI>
          <End>6064821.918629 465748.717993</End>
        </Spiral>
        <Line staStart="536.626588" length="257.162205" dir="3.595779">
          <Start>6064821.918629 465748.717993</Start>
          <End>6064590.827995 465635.892824</End>
        </Line>
        <Spiral staStart="793.788793" constant="227.000" radiusStart="INF" radiusEnd="681.000000"
spiType="clothoid" length="75.666666" rot="ccw" dirStart="3.595779" dirEnd="3.540224">
          <Start>6064590.827995 465635.892824</Start>
          <PI>6064545.490370 465613.757677</PI>
          <End>6064522.238905 465603.964613</End>
        </Spiral>
      </CoordGeom>
      <Profile staStart="0.000000">
        <ProfAlign name="From NovaTrack">
          <PVI>0.000000 64.327000</PVI>
          <Curve length="5803.772065" radius="19.999653">117.482044 63.868000</Curve>
          <Curve length="17619.465580" radius="19.999369">238.655032
62.977000</Curve>
          <Curve length="49377.012293" radius="19.999244">583.011244
60.054000</Curve>
          <Curve length="-9319.133311" radius="19.999377">758.759932
58.491000</Curve>
          <Curve length="-2894.169894" radius="19.999772">1085.862110
56.284000</Curve>
          <Curve length="-29449.176512" radius="19.999996">1349.032818
56.327000</Curve>
          <Curve length="-9677.417063" radius="19.999954">1927.054907
56.814000</Curve>
          <Curve length="-17774.090069" radius="19.999876">2056.987410
57.192000</Curve>
          <Curve length="7511.580248" radius="19.999909">2258.997610
58.007000</Curve>
        </ProfAlign>
      </Profile>
    </Alignment>
  </Alignments>
</LandXML>

```

```
58.513000</CircCurve>
60.454000</CircCurve>
61.180000</CircCurve>
62.365000</CircCurve>
62.933000</CircCurve>
64.972000</CircCurve>
65.012000</CircCurve>
<CircCurve length="-3371.480888" radius="19.999724">2627.835957
<CircCurve length="47250.286616" radius="19.999497">2893.577200
<CircCurve length="4730.701206" radius="19.999728">2999.088210
<CircCurve length="27378.521810" radius="19.999946">3445.752466
<CircCurve length="-5547.843172" radius="19.999829">3741.201724
<CircCurve length="3683.032329" radius="19.999847">4110.081210
<CircCurve length="60998.297990" radius="20.000000">4521.605683
<PVI>4551.950955 65.005000</PVI>
</ProfAlign>
</Profile>
</Alignment>
</Alignments>
</LandXML>
```

Appendix 2. Calculation profile definition

The calculation profiles are stored in file Profiles.ini, located in

[AppData]\Vianova\Novapoint\18.10\NovaTrack

If the file is removed, a standard Profiles.ini will be restored from the Novapoint installation next time NovaTrack is started.

List of user defined calculation variables

Calculation profile header	
[TRACK CAT 2]	Profile header (name)
description=Profile description	Profile description
created_by=User1	Created by name or initials
HA Alignment regression variables	
analyse method=2	Selected analysis method
error tolerance=5.0	Error tolerance for horizontal geometry (m)
error tolerance vertical=0.2	Error tolerance for vertical geometry (m)
error tolerance offset pnts=85	Minimum % of measured points on resulting alignment (%)
nt3 remove split=97	Initial percentage value for removing split points (%)
nt3 remove split step=3	Step size when iterating
nt3_remove_split_lines=7	Remove split point if less measure points than number since previous split point
nt3 merge split segments=0.2	Merge split points if tolerance is below value
min straight line=50.0	Minimum length of straight line in result alignment
min radius for trans curves=3500.0	Maximum radius when inserting transition curves (m)
min lift=0.100	Average min. vertical lift for vertical geometry (m)
number of iterations=1	Number of iterations. Set to 1 to disable.
VA Alignment calculation variables	
error tolerance vertical=0.2	Error tolerance for vertical geometry (m)
min lift=0.100	Minimum vertical lift for vertical geometry (m)
CANT / SPEED calculation variables	
hmax=130	Maximum cant value (mm)
a=1.05	Minimum length for element with constant curvature (0.5V) (normal)
n=400	Maximum value for Cant change ratio (1:n)
MaxSpeedConstant=0.295	Maximum design speed constant
Imax=9999999.0 160	Maximum values for Cant deficiency @ R
ImaxKP=100	Maximum Cant for circular curves
dImax=100	Maximum value for Cant variation
dDmax=9999999.0 69	Limit value for Cant ramp incline speed
Emax=600.0 90 9999999.0 110	Limit value for Cant Excess @ R
Vg=80	Maximum speed of the freight trains, km/h
b=0.5	Minimum length for element with constant curvature (0.25V) (minimum)
c=2.6	Coefficient for Rv calculation (2.6 normal, 3.6 minimum)
Vmax=200	Maximum speed (km/h)
GEOMETRY verification variables	
CRmin=500	Minimum radius for curve (m)
CRmax=5000	Maximum radius for curve (m)
SLCmin=0.25	Minimum Straight line length between two Circular curves
CLmin=20	Minimum length for curve (m)
TCLmin=0.5	Minimum length transition curve (m)
RminTCmin=300.0 40.0 400.0 45.0 500.0 50.0	Minimum Transition curve length @ radius
VCRmax=70000.0	Maximum vertical crest radius (m)
VSRmax=70000.0	Maximum vertical sag radius (m)
VELmin=10	Minimum vertical element length (m)
VESmax=10	Maximum vertical element slope (per-mille, ‰)

Calculation profile settings (profiles.ini)**Example:**

```
;*****
[Adjustment. New track]
created_by=GEDO
description=Adjustment of new track. High quality geometry and measurements
;Selected analyse method
analyse_method=1
;Error tolerance for horizontal geometry (m)
error_tolerance=5.000
;Error tolerance for vertical geometry (m)
error_tolerance_vertical=0.05
;Minimum % of measured points on resulting alignment (%)
error_tolerance_offset_pnts=82
;Initial percentage value for removing split points (%)
nt3_remove_split=103
;Step size when iterating
nt3_remove_split_step=1
;Remove split point if less measure points than number since previous split point
nt3_remove_split_lines=8
;Merge split points id tolerance is below value
nt3_merge_split_segments=0.12
;Minimum length of straight line in result alignment
min_straight_line=5.000
;Maximum radius when inserting transition curves (m)
min_radius_for_trans_curves=7000.000
;Minimum vertical lift for vertical geometry (m)
min_lift=0.05
;Number of iterations. Set to 1 to disable.
number_of_iterations=8
;Maximum Cant value (mm)
hmax=140
;Minimum length for element with constant curvature (0.5V) (normal)
a=0.5
;Maximum value for Cant change ratio (1:n)
n=400
;Maximum values for Cant deficiency @ R
Imax=9999999.0 45
;Maximum Cant for circular curves
ImaxKP=140
;Maximum value for Cant variation
dImax=10
;Limit value for Cant ramp incline speed
dDmax=999999.0 70
;Limit value for Cant Excess @ R
Emax=600.0 40 999999.0 50
;Maximum speed of the freight trains, km/h
Vg=120
;Maximum design speed constant
MaxSpeedConstant=0.295
;Minimum length for element with constant curvature (0.25V) (minimum)
b=0.5
;Coefficient for Rv calculation (2.6 normal, 3.6 minimum)
c=2.6
;Maximum speed (km/h)
Vmax=160
;Minimum radius for curve (m)
CRmin=500
;Maximum radius for curve (m)
CRmax=5000
;Minimum Straight line length between two Circular curves
SLCmin=0.25
;Minimum length for curve (m)
CLmin=20
;Minimum length transition curve (m)
```

```
TCLMin=0.5
;Minimum Transition curve length @ radius
RminTCmin=300.0 40.0 400.0 45.0 500.0 50.0
;Maximum vertical crest radius (m)
VCRmax=70000.0
;Maximum vertical sag radius (m)
VSRmax=70000.0
;Minimum vertical element length (m)
VELmin=10
;Maximum vertical element slope (per-mille)
VESmax=40
;*****
```

Document revisions

Rev. no.	Date	Latest changes
Novapoint 21.Fp4	24.05.2019	Bug fixing
Novapoint 2020	19.05.2020	Support for LandXML CgPoint format. Support for LandXML Alignment format. Point code, name and number visible in horizontal and vertical view.

Notes.

