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Scene External Import

CarSim, TruckSim, and BikeSim use paths to define road surfaces, specify motions of moving objects, and provide a target for the built-in driver/rider model to control the path taken by the ego vehicle. Road surface information is needed by the vehicle models to determine the interface between tire and road and to vertically locate moving objects representing traffic vehicles and pedestrians. Animator assets are used by VS Visualizer to provide visual content for the simulation. If used in a driving simulator, the visual environment is essential for enabling a driver to navigate the simulated environment. If the VS Visualizer shared buffer is used (see the Technical Memo "Example: Camera Sensors"), the visual environment is essential for simulating camera sensors used in some ADAS scenarios.

Two options are available for defining the road surface: VS Roads and VS Terrain. VS Roads use a form that is well-defined where the vehicle tires are likely to travel, and sparse or nonexistent where the tires are unlikely to be. To do this, a VS Road represents the road surface using a coordinate system based on a 2D VS Reference Path — a continuous line that exists in a horizontal plane with continuity in position and gradient. VS Roads may be created using multiple built-in GUI screens and tools.

VS Terrain is the second option, and is usually used for 3D data from external sources that were converted to the `vsterrain` file format. It is well suited for driving simulators and simulations involving high-quality visual rendering using graphics engines such as Epic Unreal.

In addition to the built-in GUI tools for creating paths and roads, three other tools are available for use in CarSim, TruckSim, and BikeSim:

1. **Atlas** is web application hosted at https://atlas.carsim.com that can provide X-Y coordinates for a route, along with matching elevation data.
2. **VS Scene Builder** is an interactive tool installed in VehicleSim products and accessed from the Tools menu. It has a drag-and-drop interface to assemble scenery from 3D tiles, and to create paths within the scenery and produce a single VS Terrain file. VS

Scene Builder also supports options to import external OpenDRIVE data and generate FBX animator assets and VS Terrain.

All of these tools provide path, road, and scenery data in text files called VS Scene files, with extension `vsscene`. The VS Scene file is a text file that uses JSON (JavaScript Object Notation), an open standard data-interchange format (see json.org). In addition, Atlas can also generate CSV (comma separated variable) text files with GPS data.

Controls of the Scene: External Import Screen

The **Scene External Import** screen (Figure 1) has controls to import path and road information from a `vsscene` file generated by any of the above tools. In the case of a `vsscene` file from the VS Scene Builder, the screen also gives access to animation assets that provide scenery.

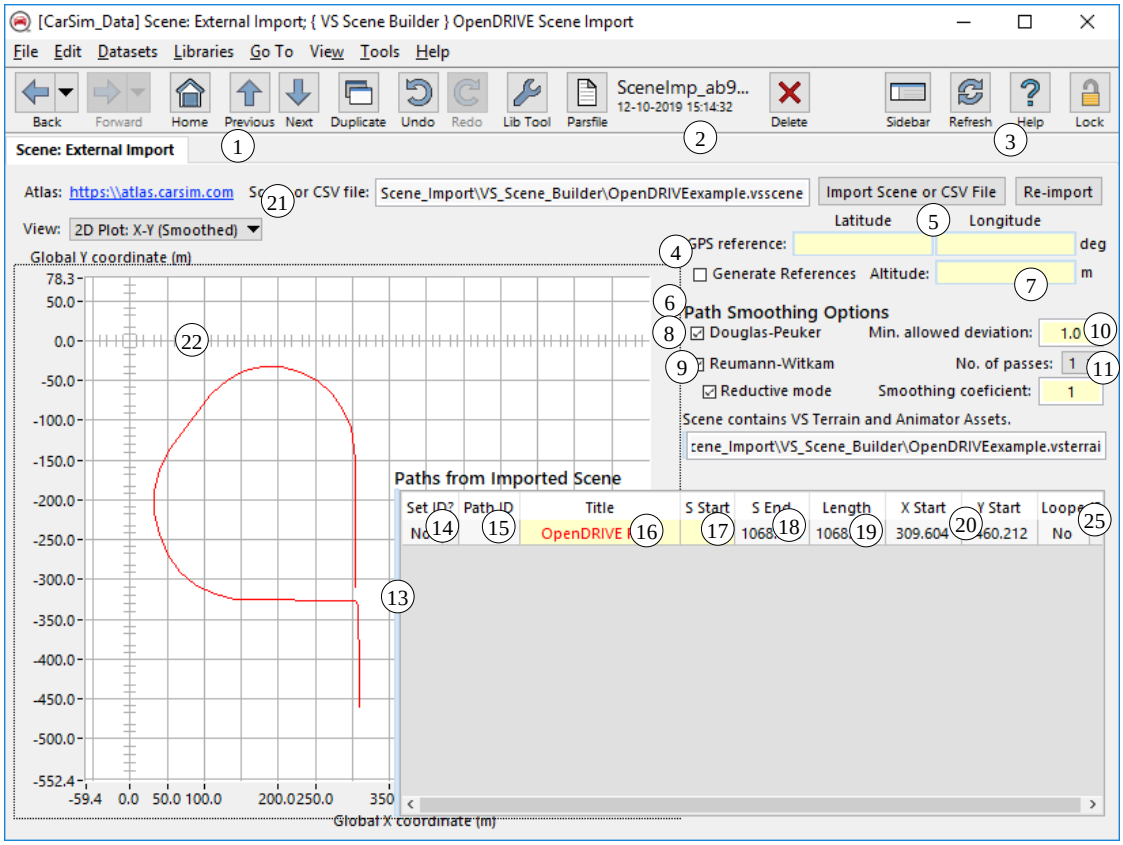

Figure 1. Scene External Import screen when plotting horizontally with X-Y.

The Parsfile datasets from this library always include path information. Links to datasets from this library are made from the first blue link on the **Road: 3D Surface (All Properties)** screen.

Following are the descriptions of the controls shown in the figure.

Importing Scene Data

(1) Link to the Atlas web application. Click on the link to view Atlas with your default web browser.

(2) Pathname for the file that has data that was imported. This field exists to document the source of the information. This field is not editable; use the button **Import Scene or CSV File** (2) to switch to a different file.

(3) There are two buttons to import a CSV or VS Scene file.

When you click the button **Import Scene or CSV File**, you will be asked to locate a file to import with extension `csv` or `vsscene`.

1. A `csv` file has a series of points defined with GPS latitude and longitude. The GPS angles are converted to global X and Y coordinates. There is no elevation data.

2. A `vsscene` file has more information. It may have GPS latitude and longitude and altitude for each point, in which case the GPS data are converted to global X, Y, and Z coordinates. Another possibility is that the `vsscene` file might contain the pathname for a `vsterrain` file that has a complete VS Terrain dataset, which can be used directly by VS Solver math models. In this case, a text label above the table will be shown indicating the presence of VS Terrain data and/or animator assets in the imported scene, and the pathname for the `vsterrain` file is shown (12) (Figure 2).

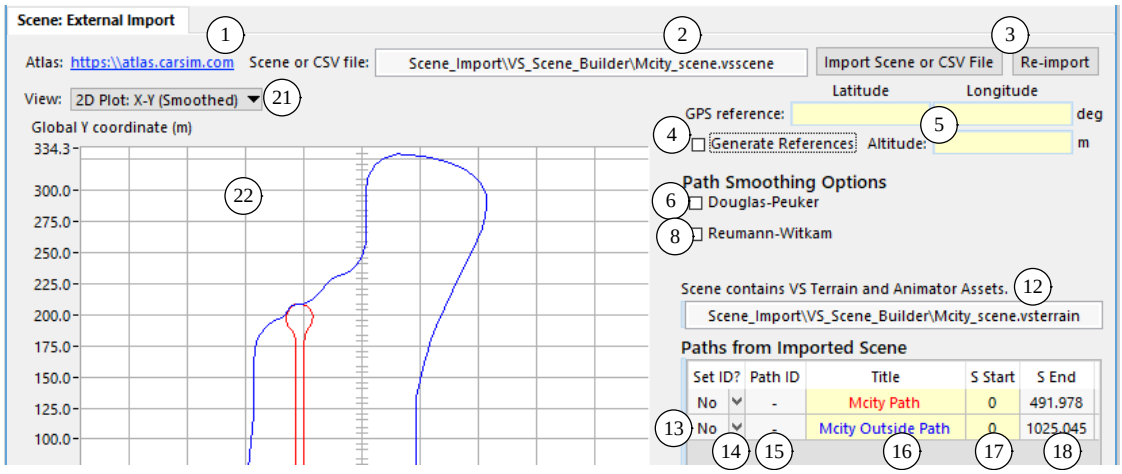

Figure 2. The pathname for a vsterrain file is shown if there is one.

The pathname for the selected `vsscene` file will be displayed in the field (2). Information about paths in the file will be shown in the table in the lower-right part of the screen. Any specified smoothing options will be applied when calculating X, Y, and Z coordinates.

When you click the button **Re-Import**, the previously imported file whose name is displayed (2) will be imported again. For example, if a new CSV or Scene file is generated, use this button to repeat the import process.

If you have entered custom values for the Path ID (15), Title (16), or S Start (17), those values will remain intact if you use the **Re-Import Scene** button. However, if you use the **Import Scene or CSV File** button, all cells in the table will be modified to match data from the imported file. Title (16) will always update when re-importing from the Scene Builder.

(4) Checkbox control for generating references on import. When the box is checked, three GPS fields (5) will automatically be populated based on the data (if available). If unchecked, the contents of these fields will not change when a scene file is imported.

(5) GPS coordinates of the global X-Y-Z coordinate system origin (keywords = `GPS_REF_LAT`, `GPS_REF_LONG`, and `GPS_REF_ALT`). These are the GPS values at the origin of the X-Y-Z coordinate system used by VS Solvers during simulation. Be aware that the location of the origin of the X-Y-Z coordinate system of imported paths depends on the source of the data:

1. If the imported data is a path from Atlas, the first point of the imported path becomes the origin of the X-Y-Z coordinate system (X = Y = Z = 0).
2. If the imported data is a `vsscene` file exported from VS Scene Builder, the origin is at a point set in Scene Builder. It is usually not related directly to where the path(s) start. In this case, automatic setting of the GPS coordinates is not supported; however, they may be set manually.

If multiple datasets (from Atlas) from this library are used to generate paths and possibly VS Roads for the VS math models, then the same GPS reference values can be used for each dataset to ensure that all X-Y-Z coordinates are compatible. Typically, one of the datasets will be set to generate the reference by checking the box (4), and the three values that were set automatically will be copied to the other datasets for a 3D reference point, which will have the box (4) unchecked.

The reference values specified here are also used by the VS Solver to calculate GPS latitude, longitude, and altitude for the vehicle and possibly moving objects. If the simulation covers significant travel distance in latitude (more than 5km), the conversion between X-Y coordinates and latitude and longitude is recalibrated when Y coordinates change by a specified amount (the parameter is `GPS_RANGE_Y`).

Path Smoothing Options

The GPS data obtained from Atlas often define a path that is jagged. Some options are provided to smooth the path.

Douglas-Peuker smoothing algorithm

(6) **Douglas-Peuker** checkbox. Check this box to activate a smoothing method that compares points to a minimum acceptable distance from a sampling of the original path.

The entire path is traversed in search of the largest outlier. This option is not available if the imported path is looped.

(7) Min. Accepted Deviation field. This is a one-for-one assignment of the minimum accepted perturbation. This field is visible only when the Douglas-Peuker box (6) is checked.

Reumann-Witkam smoothing algorithm

(8) **Reumann-Witkam** checkbox. Check this box to activate a smoothing method that simplifies the polyline that defines the path by comparing both adjacent points of each point in the path. The results of those comparisons interpolate a new path, which is built based on the results. There are three options ((9), (10), (11)) to modify how the algorithm calculates a path, thus changing the path output.

(9) **Reductive Mode** checkbox. When checked, the smoothing algorithm removes points that are within the tolerance range, reducing data density. This mode is recommended whenever the Reumann-Witkam method is used. This checkbox is visible only when the Reumann-Witkam box (8) is checked.

(10) Drop-down control to set the number of passes. This control specifies the number of times that the smoothing algorithm will be recursively applied to the data. The choices range from 1 to 10. This control is visible only when the Reumann-Witkam box (8) is checked.

(11) Smoothing coefficient field. This coefficient is a floating value ranging from 0 to 10, where 0 is no smoothing, and 10 is a straight line. The smoothing tolerance is defined as a tenth of the length of the line connecting two neighbor points, multiplied by this coefficient. This field is visible only when the Reumann-Witkam box (8) is checked.

(12) If the imported file (2) was a `vsscene` file and it linked to VS Terrain or animator asset files, a text message is shown above the table. If a `vsterrain` file is linked, the pathname is also shown. The pathname field has a "splitter" bar on the left side to allow the field to be resized if needed to see the whole pathname (Figure 3).

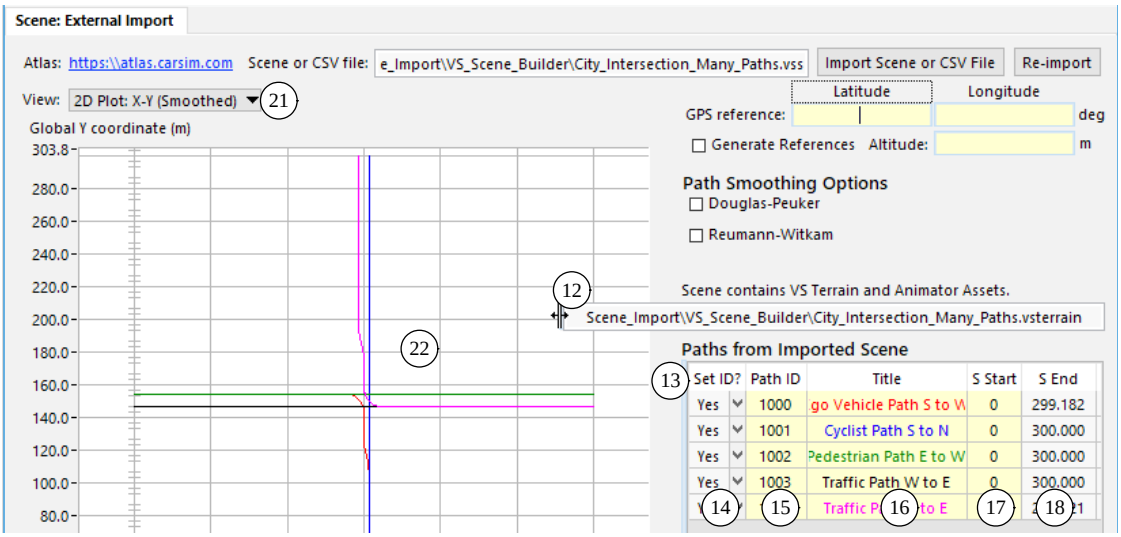

Figure 3. Dataset with multiple paths from imported vsscene file.

Table of Paths from the Imported Scene

A table shows information about each imported path, including information that can be edited for use by the VS Solvers. Each path that was imported is represented by a row in this table.

(13) The left edge of the table is a "splitter" control that can be dragged to make the table wider, to easily see all columns.

(14) The first column has drop-down controls to enable the option to specify a custom User ID number for the path. If set to **No**, then the VS Solver will number the path automatically. If set to **Yes**, then the next cell (15) is activated for editing.

(15) If the adjacent control (14) is set to "No," then this field is dimmed and the contents are not used. If the adjacent control is set to "Yes," then this field is active for editing, and can be used to set a user ID for the path. The value must be 999 or greater.

(16) Path title. This field shows the title for the path. This text will be assigned to the description of the parameter `PATH_ID` and will be written into any Echo files for simulations that make use of this dataset. This field may be edited. The text is colored to match the plot made for the path (22). As such, this field serves as a legend for the plots if there are multiple paths shown (Figure 3).

(17) This is the station at the first point in the path (keyword = `SPATH_START`). Whenever a VS Scene file is imported, the start station is automatically set to 0. However, it can be edited here as is the case for all other library screens that define paths.

(18) This is the station at the last point in the path. This is provided for information; the value cannot be edited directly.

(19) This is the length of the path (station at the end minus station at the start). This is provided for information; the value cannot be edited directly.

(20) These are the global X and Y coordinates of the start position. They cannot be edited.

Viewing Path Data

(21) Drop-down control to determine the view for the path. The control has three options: a plot of X-Y coordinates (Figure 1, Figure 3), a plot of S-Z coordinates (Figure 4), and a table with four columns for viewing and editing X-Y-Z-S values (Figure 5).

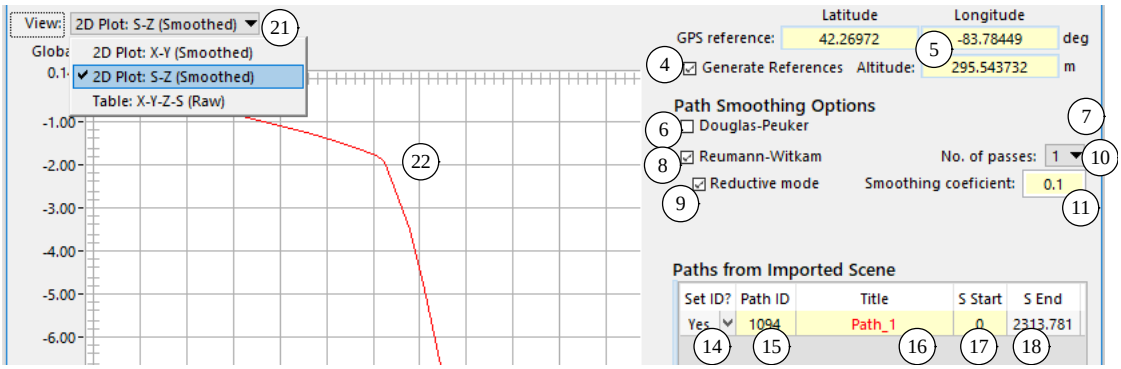

Figure 4. Display when plotting a vertical profile with S-Z.

Both plot options show the effects of any smoothing that is applied to the X and Y coordinates, which carries over to the S and Z coordinates.

(22) View of what is selected in the drop-down control (21). If this is a plot, it shows the effects of the smoothing options that were applied. If this is a table (Figure 5), the data shown are not smoothed, and include all points.

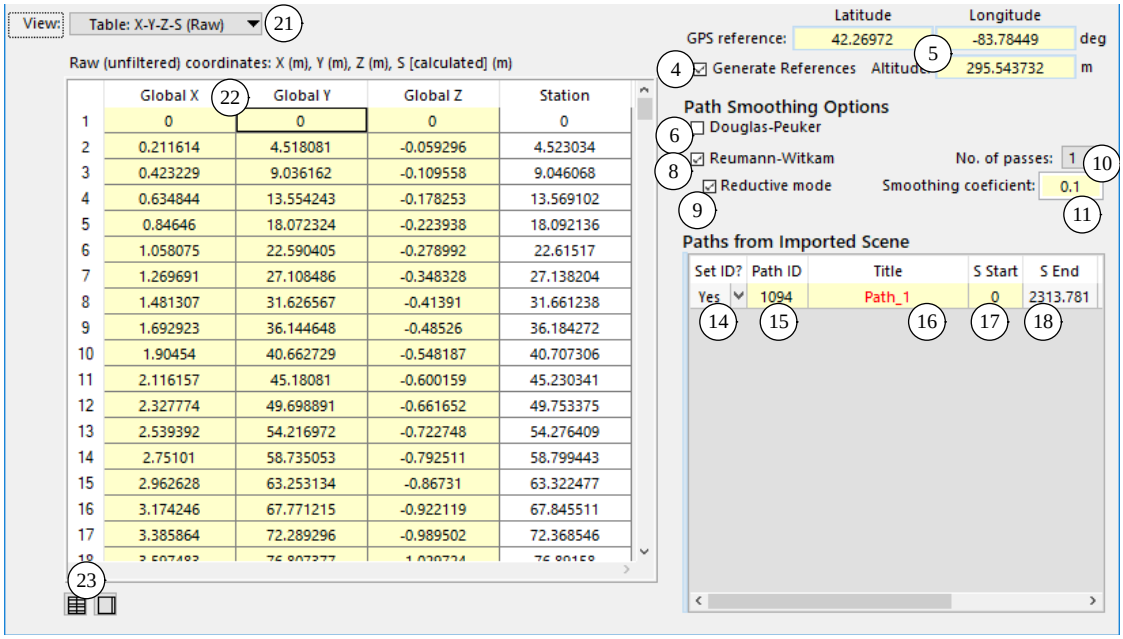

Figure 5. Display for viewing a table of X-Y-Z-S values.

(23) These buttons are shown when a table is viewed (Figure 5). They are used to choose between showing the data in a spreadsheet or in a plain text field. The spreadsheet is

usually best for viewing values, but the plain text may be easier to work with when deleting rows of data.

(24) The VS Scene Builder tool can export multiple paths in a `vsscene` file.

When the imported VS Scene has multiple paths, they are overlaid in the X-Y view (Figure 3). However, for the other two views (Z vs S and spreadsheet), only one path is viewed. In these cases, the drop-control is visible and is used to choose which path to view (Figure 6).

(25) Loop or unloop a path if the start and end points match. This will set the `OPT_PATH_LOOP` parameter in the parsfile.

Using Datasets Made from Imported VS Scene Files

Table 1 shows a summary of what the two tools that make VS Scene Files can do. Documentation PDF files for these tools are available in the **Help** menu in the submenu **Paths, Road Surfaces, and Scenes**.

Table 1. Summary of tools that make VS Scene files.

Tool	Access	Path Data	Ground Data	Visual?
Atlas	atlas.carsim.com	One path	VS Road	No
VS Scene Builder	Tools menu	Multiple paths	VS Terrain	Yes

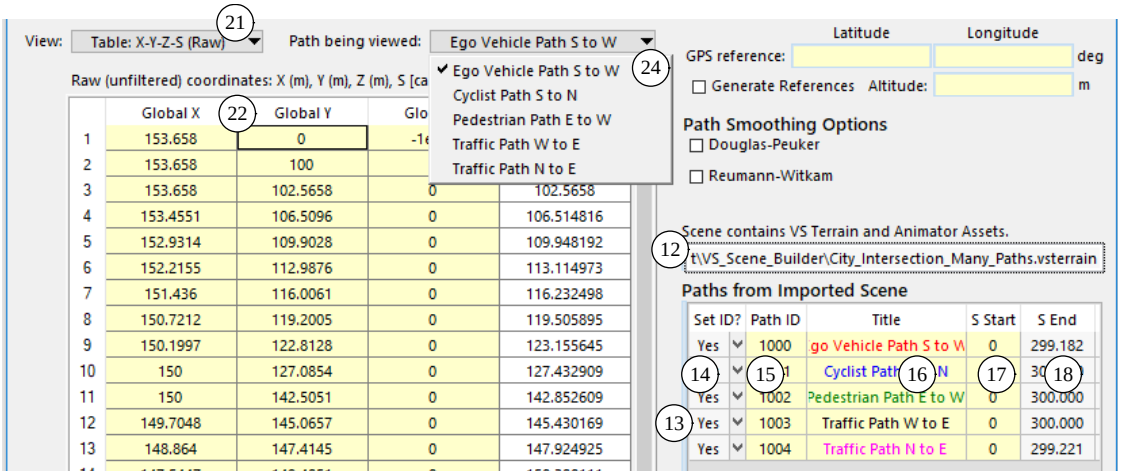

Figure 6. Scenes imported for the VS Scene Builder may have multiple paths.

Each dataset (Parsfile) made within the **Scene External Import** library is typically used to make a road from the **Road: 3D Surface (All Properties)** library. The first link is made to the dataset from the **Scene External Import** library (1) (Figure 7).

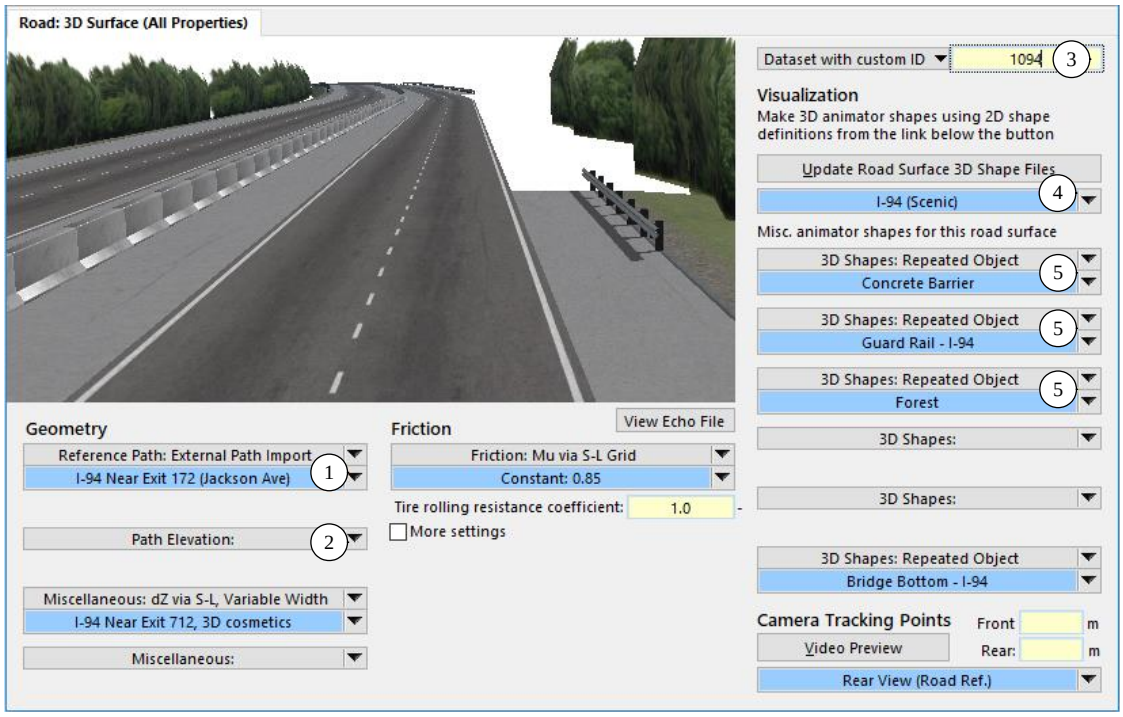

Figure 7. Road 3D dataset that uses path and elevation data imported from Atlas.

Atlas Web Tool

Map information from HERE or Google can be accessed with the Atlas web tool.

The example dataset shown in Figure 1 was based on a VS Scene file generated by Atlas. A road dataset was made in which the first link (path data) goes to this dataset (1) (Figure 7).

Ideally, the dataset from this library (**Scene: External Import**) includes both path and elevation data, so the next link (2) is not used. However, if there are problems with the elevation data imported from the scene file, then the elevation link can be used to specify elevation data that will override whatever is in the first linked dataset (1).

Each VS Road has an ID, which is set from this screen (3). A link is made to road shape information, to give the screen enough information to create animation shapes for a road surface that follows the path (4). Additional links add a sky and scenery such a trees, buildings, guard rails, etc. (5).

VS Scene Builder

VS Scene Builder is installed in CarSim, TruckSim, and BikeSim versions 2018.0 and newer. It uses a simple drag and drop interface for rapidly assembling scenes from predefined tiles. It also supports the creation of paths by clicking on arrow-shaped start/end/continue indicators in the tiles. Multiple paths can be created. A set of tile scenes and paths can be saved, reloaded, and most importantly, exported in the form of a VS Scene file that can be imported into the Scene Import screen to provide paths and scenes ready for use in a simulation.

For example, Figure 8 shows the screen after the tool was used to assemble tiles for an urban scene and define five paths. This scene was exported and imported for the example shown earlier in Figure 6). Notice that the five paths are named in the Scene Builder (3). They are shown in the map (1), and properties of a path near the mouse cursor are shown (2).

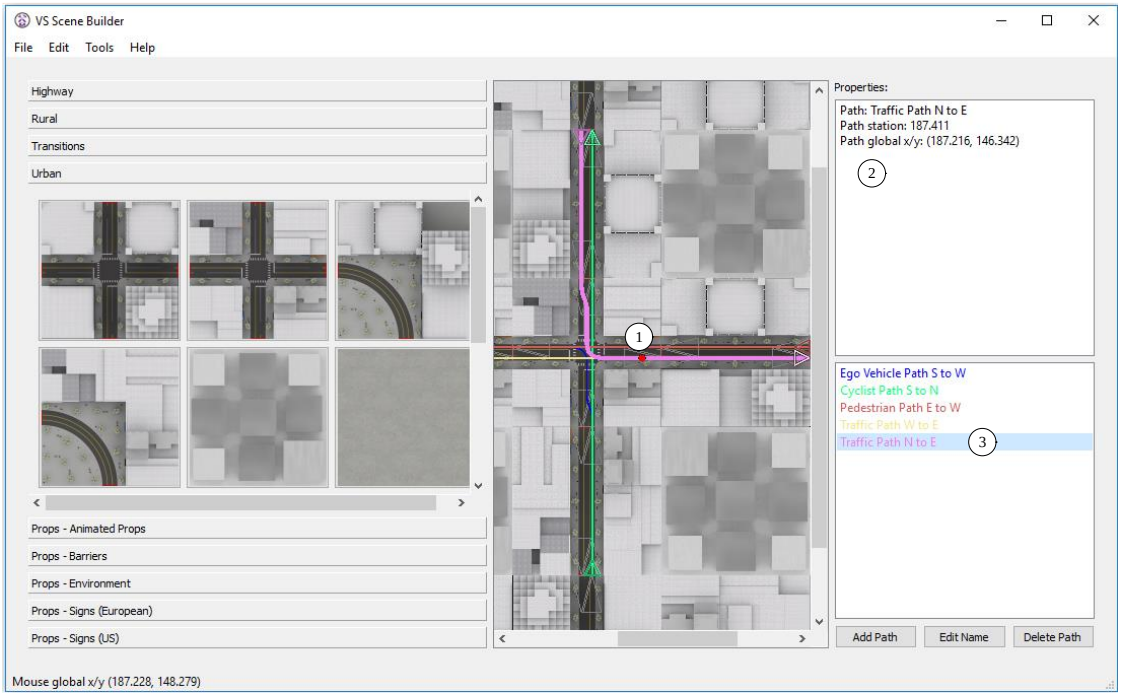

Figure 8. Scene Builder dataset for an urban scene with five paths.

When imported, the path names are also brought in ((16), Figure 6).

Starting with version 2019.1, the tiles usually include full 3D properties of the ground, along with friction and a tire rolling resistance coefficient. When exported to a `vsscene` file, the full VS Terrain file (`vsterrain`) is included. (Note the pathname for a `vsterrain` file and note about animator assets in the **Scene: External Import** dataset (12), Figure 6.)

Paths brought in from VS Scene Builder usually do not require any smoothing, so the checkboxes with smoothing options are typically unchecked.

When the scene includes a link to a `vsterrain` file, the **Road 3D Surface** screen has fewer controls than when linked to a dataset with only path data (Figure 9). When VS Terrain is used, there are no VS Roads, nor the associated parameters such as ID number and rolling resistance, nor the associated Configurable Function datasets for elevation and friction.

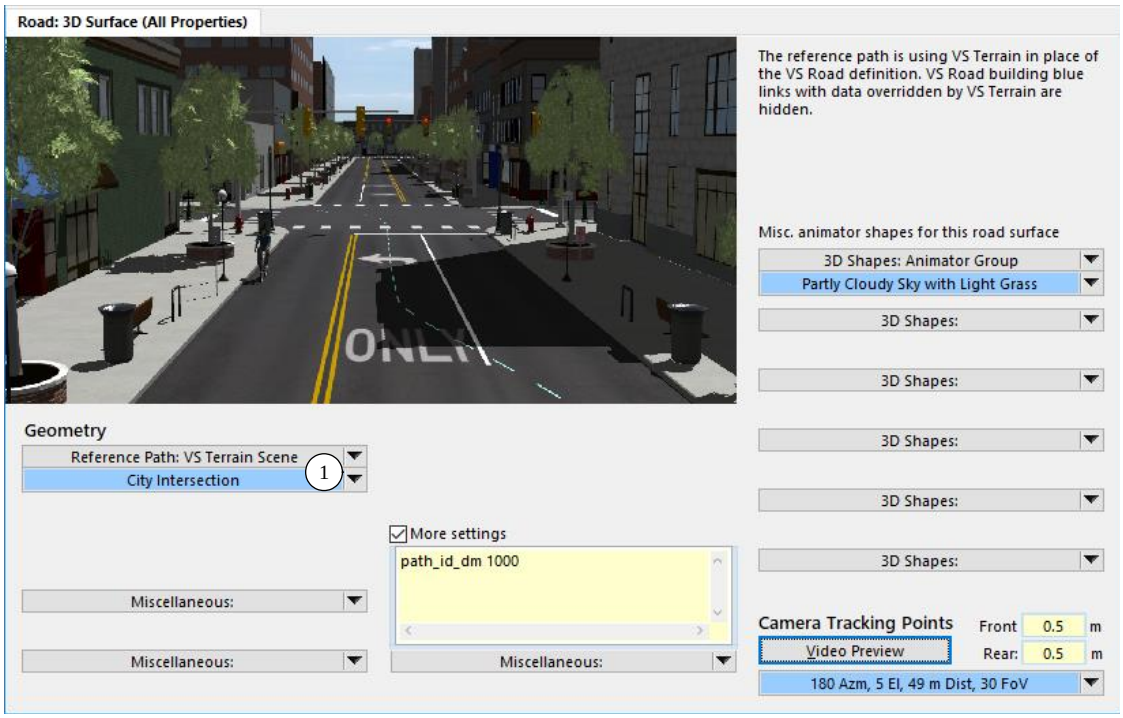

Figure 9. The Road 3D Surface screen has fewer controls for a dataset using VS Terrain.

Datasets from VS Scene Builder may have extensive animation scenery. For example, Figure 10 shows a simulation that uses the scene and paths defined in Figure 8.

Editors for CSV and VS Scene Files

The GPS coordinates in the files imported to datasets in the **Scene: External Import** library are immediately converted to X, Y, and Z coordinates using the reference point. The original GPS values are not needed by VS Solvers (multibody programs that work in global X-Y-Z coordinates and path S-L coordinates). However, both kinds of export files are written in standard formats and can be easily viewed with external tools.

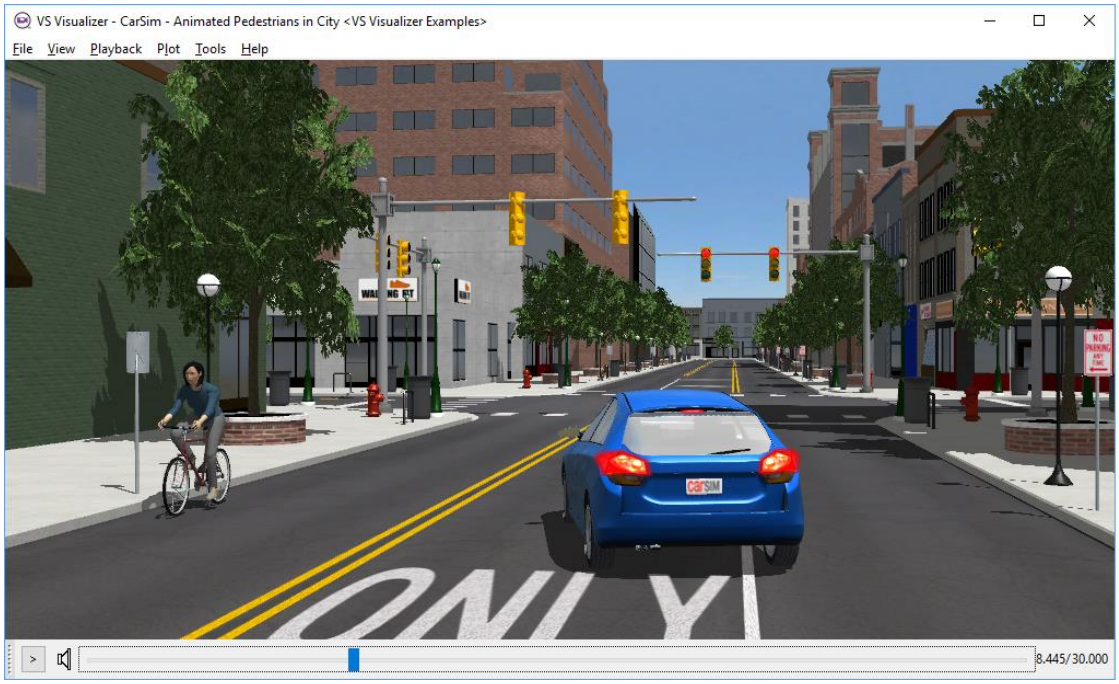

Figure 10. Scene used in simulation, viewed in VS Visualizer.

Viewing CSV Files

CSV is simply a text file with a table, where the elements of each row are separated by commas (hence the name, Comma-Separated Variables). The file can be viewed with a text editor, spreadsheet programs such as Excel, and other software tools. For example, Figure 11 shows a CSV file as viewed in two tools: Microsoft Excel (on the left) and the ConTEXT text editor (on the right).

Viewing VS Scene Files

VS Scene files are text file that use JSON (JavaScript Object Notation), an open standard data-interchange format (see json.org). There are many JSON editors. For example, https://jsoneditoronline.org is a free online tool. View the JSON file by dragging it into the window (Figure 12). Many text editors also have plugins to convert a single JSON line into a human readable format. It is possible to manually edit the VS Scene files, but if the VS Scene JSON file schema is broken it will fail to import.

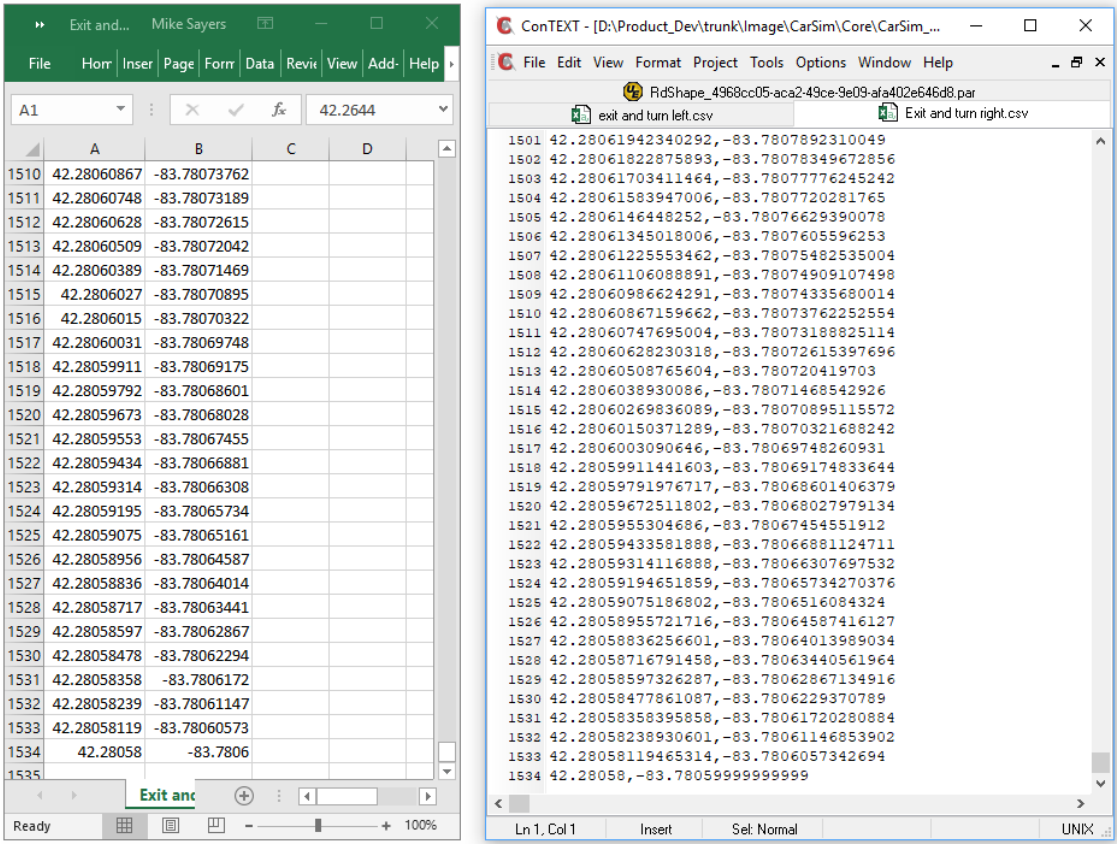

Figure 11. CSV file as viewed in Excel and in the ConTEXT text editor.

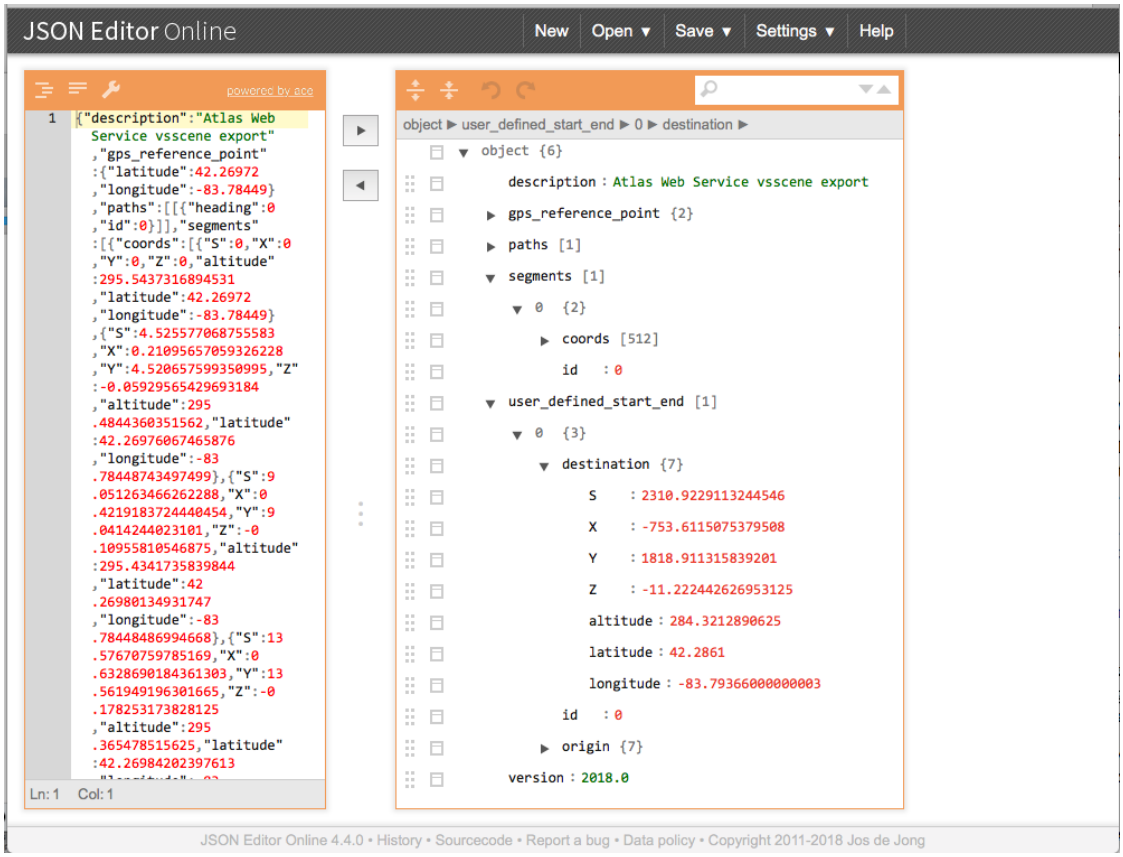

Figure 12. Online editor for JSON files such as VS Scene downloads.