Heavy Vehicle Infrastructure Rating

Online Tool User Guide

Supplying data for the Heavy Vehicle Road Reform

Version 2 – August 2018

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The Heavy Vehicle Road Reform

The ultimate goal of Heavy Vehicle Road Reform (HVRR) is to turn the provision of heavy vehicle road infrastructure into an economic service where feasible. This would see a market established that links heavy vehicle user needs with the level of service they receive, the charges they pay and the investment of those charges back into heavy vehicle road services.

While more direct user charging is needed to fully close the link between the needs of users and the charges they pay, there is much that can be done to improve these linkages within the current heavy vehicle charging framework (PAYGO). These 'supply side' reforms to the way governments plan, govern and invest in roads are the focus of the first three phases of the reform road map agreed by the Transport and Infrastructure Council in May 2015.

Economic analysis indicates that supply side improvements provide the majority of the benefits of implementing more direct heavy vehicle user charges (estimated to be between $22bn and $8bn in net present value, depending on the system).

More details about the reform are available at the Transport and Infrastructure Council.

The Heavy Vehicle Infrastructure Rating

The Heavy Vehicle Infrastructure Rating (HVIR) is an indication of the level of service provided by road infrastructure to heavy vehicles. This rating is intended as one of the inputs to a new charging framework that is built upon data.

The rating has been developed through Austroads-funded projects undertaken by the Australian Road Research Board (ARRB).

This user guide provides instructions on how to use the HVIR Tool which is currently hosted in the Road Manager's Toolbox. User accounts have been provided to state and local jurisdictions who are permitted to use the Tool.

The user guide is divided into three main sections: Preparation of data, Data Management using the Road Manager's Toolbox (RMT), and the use of the HVIR Tool itself to generate ratings.

Glossary and Nomenclature

Access	The size and mass of vehicles that can be legally and/or physically accommodated by a road.
Calculation Method	The method by which a Service Attribute can be calculated. There are multiple methods available for each Service Attribute which use different input data.
Chainage	The position along a length of road, usually measured in kilometres.
.CSV	Comma Separated Variables - a text-based file format where data is stored in rows, with columns demarcated by in-line commas.
Dashboard	A virtual space occupied by widgets and other graphics providing information and data.
Fall back	In the context of the HVIR Tool, fall back refers to calculation methods that are used if the selected calculation method cannot be used because of missing input data.
Feature(s)	Features refers to infrastructure and operational information associated with a road segment or point. It includes inventory data such a lane and shoulder widths, condition data such as roughness or rutting, and operation data such as speed limits and traffic levels.
General Access	Roads that do not provide (and vehicles that do not require) any special allowances to be driven on. Vehicles up to 19 m long and with a gross mass of up to 50 tonnes are considered General Access vehicles.
GPS	Global Positioning System, referring to coordinates that indicate the latitude and longitude of a position.
Heavy Vehicle Infrastructure Rating (HVIR)	A measure of the level of service provided by road infrastructure for heavy vehicles.
Job	In the context of the HVIR Tool, a Job is the term used for the generation of ratings for some purpose at a point in time. Each job has a road network and set of feature data associated with it.
National (Coverage) Map	A map of Australia showing the roads for which HVIR have been generated. This is a placeholder for the map where rating will be published.
Navigation Bar	In the Road Manager's Tool Box, the navigation bar is the vertical menu to the left of the screen used to move between the functions of the Toolbox and the main functions of Tools.
Network	In this document, a network is a road network - i.e. an interconnected collection of roads.

PAYGO	PAYGO refers to the current road-user revenue arrangement of registration fees and taxes on fuels.
Points of Interest	Points of interest are single point locations on the map where there is a feature relevant to freight vehicles. This includes things like bridges, rest stops, weigh bridges and service stations.
Radio button(s)	A graphical interface that is either marked or not. If in a group, then only one can be selected.
Ratings	In the context of the HVIR Tool, this refers to Heavy vehicle Infrastructure Ratings.
Ride Quality	A measure of the comfort experienced by the occupants of a vehicle. It is different from roughness, which is a characteristic of the road surface, because it includes the vehicle's response to the road roughness.
Road Manager's Toolbox	The RMT is the online software platform that allows users to manage their data and access the HVIR Tool.
Segment	A road segment. In this document it is referring to one of the 100 metres segments that road lengths are divided into.
Service Attribute	One of the components of the Heavy vehicle Infrastructure Rating framework. The current Service Attributes are: Access (*A*), Ride Quality (*R*), and Safety (*S*). Each is scored between 0 and 1.
Shapefiles	A geospatial vector data format for geographic information system (GIS) use.
The Heavy Vehicle Road Reform	A reform process currently being undertaken by governments in Australia to reform road funding.
Tool	In this document, a Tool is a piece of online software that takes in data and produces outputs, along with features for visualisation and examination of data/results.
URL	A Uniform Resource Locator, more commonly known as a web address.
Validation	In the context of the HVIR Tool, Validation refers to an automated process of checking data to ensure it is readable, recognisable, and can be used by the Tool.
Widget	A graphical display and interface application that is a component of a larger system and provides a simple representation of information, controls or access to features and functions.

Contents

1. Data Preparation

1.1 Building a National Asset Register

Objectives

The Road Manger's Toolbox and the Heavy Vehicle Infrastructure Rating Tool are components of a data supply process designed to allow state and local government asset owners to supply data about their roads for the purposes of the HVRR. As this process has developed, a need has emerged to provide asset owners with the means to have visibility of their data and to generate HVIR results for their own roads. This gives asset owners control over and responsibility for providing data that meets the needs of national applications, identifying inconsistencies and allowing these to be resolved within a practical application.

The data that is provided on an annual basis is to be combined into a National Asset Register that can serve as a resource for numerous current and future applications.

Harmonisation of Data

Inconsistency of reported data between jurisdictions has long been a problem in Australia. Austroads has been developing a national harmonised data standard which will require jurisdictions to report data in a consistent manner. Once the data standard is adopted by jurisdictions, it will be implemented within the HVIR Tool.

1.2 Data Required for HVIR

Accommodating all levels of Asset Owners

Road asset owners across Australia vary between well-resourced state road agencies that update data on an annual basis; and remote local governments with scare resources. To ensure that asset owners from all across this spectrum can generate HVIR for their freight routes, the data requirements need to be flexible so as not to exclude, but also need to allow the best available data to be used.

In developing the data requirements for HVIR, three key principles were established:

- For each service attribute (e.g. access, ride quality or safety) component of HVIR, a number of Calculation Methods would need to be provided, based on what data was typically available.
- The results of multiple Calculation Methods for a single Service Attribute would need to be equivalent.
- Calculation Methods that use less reliable data should produce a limited HVIR result to reflect the reliability of the data used and to incentivise obtaining higher-quality data.

This approach should allow all asset owners to be able to produce HVIR for their freight routes. The following sections describe what data should be prepared.

Preparing Network Location Files

General Advice

The HVIR tool does not contain any technical requirement for how the network should be segmented; however, the current expectation is as follows:

State road agencies who have their roads surveyed by survey vehicles travelling at traffic speed should report their networks in 100 m intervals, averaging parameters over the 100 m length.

Local governments should provide data for their networks in terms of links between intersections, and other division points (e.g. structures, or simply segmentation of long roads), and report either the average or the minimum (i.e. most restrictive) values.

Network location data can be provided in one of three ways:

1. From Shape files that define the path of each road in the network.
2. From CSV files with one row of data for each road segment.
3. From the network building tool provided in the Road Manager's Toolbox if neither shape or CSV files are available (see Section 2.3).

Whichever of these is used, <u>it is required that there is a unique identifier</u> for each segment. This identifier is also used in the data file to link road features with the locations.

Using Shapefiles for Networks

For using shapefiles for road segments, the HVIR segment attributes are mapped to the shapefile segment attribute names that contain the patterns as shown in Table 1. If multiple segment attribute names share the pattern, the first attribute name encountered will be mapped to the attribute. For example, the field used for the Unique ID will be the first attribute with "id" in its name (even if this is part of another word).

Table 1: Data requirements for road segments in network shapefiles

Attribute	Pattern	Required	Notes
Unique Id	*id*	YES	Recommended GEOMETRY Type: LINESTRING(2) Most projections are supported, but we recommend that the .PRJ file contains the EPSG authority code. The data will be reprojected to EPSG:4326.
Road Name	*name*		
Direction	*direction*		
Chainage Start	*chainagest*		
Chainage End	*chainageend*		
Length	*length*		
Geometry	geom	YES	

The segment attributes marked as required in Table 1 are needed to successfully build a network. The other listed attributes will not affect the definition of the network but serve as information about the network for users.

To include points of interest in the shapefile, the HVIR point attributes are mapped to the shapefile point attribute names as shown in Table 2.

Table 2: Data requirements for road segments in network shapefiles

Attribute	Pattern	Required	Notes
Unique Id	*id*	YES	Recommended GEOMETRY Type: POINT(2) Most projections are supported, but we recommend that the .PRJ file contains the EPSG authority code. The data will be reprojected to EPSG:4326.
Latitude	*lat*		
Longitude	*lng*		
Title	*name*		
Type	*type*		
Road name	*road*		
Direction	*direction*		
Chainage	*chain*		
Geometry	geom	YES	

Using CSV Files for Networks

To provide segments for a network using CSV files, the CSV headers required are shown in Table 3.

Table 3: Data requirements for network road segment CSV files

Attribute	Header	Required	Notes
Unique Id	unique_id	YES	Each interval must have a unique identifier. This can usually be generated by concatenating the road number, section name or ID, the direction and the chainage.
Road number	road_num		Number used as a unique identifier for roads.
Road name	road_name		Highest level name of road.
Section Number	sect_num		Alphanumeric identifier for roads that are broken into sections
Section Name	sect_name		Named section of a longer road. This could be a lower level road name or indicate the locations the road links.
Direction	dirctn		Please use ‘Forward’ rather than ‘Proscribed’ or ‘Gazetted’ and ‘Reverse’ instead of ‘Counter’
Start Longitude	start_long	YES	GPS coordinates of the interval are vital for mapping to be possible.
Start Latitude	start_lat	YES	
End Longitude	end_long	YES	
End Latitude	end_lat	YES	
Chainage start	chain_start		(km) Start chainage is used to identify the sequence of intervals.
Chainage end	chain_end		(km)
Interval length	int_len		(km) Interval lengths may not be consistent.

For points of interest the CSV headers required are shown in Table 4.

Table 4: Data requirements for network points of interest CSV files

Attribute	Header	Required	Notes
Unique Id	unique_id	YES	Each point of interest must have a unique identifier. This can usually be generated by concatenating the name, type, direction and the chainage.
Name	name		Name of point of interest
Type	Type		Type of feature, e.g. Bridge, culvert, rest area, service station, weighbridge
Road name	road_name		Highest level name of road.
Direction	dirctn		Please use ‘Forward’ rather than ‘Proscribed’ or ‘Gazetted’ and ‘Reverse’ instead of ‘Counter’
Longitude	start_long	YES	GPS coordinates of the interval are vital for mapping to be possible.
Latitude	start_lat	YES	
Chainage	chainage		(km)

Preparing Inventory and Condition Dataset Files

General Advice

It is recommended that feature data is prepared and uploaded separately to feature data based on the assumption that some feature data, especially condition data, may be changing from year to year, whereas network locations will only need to be updated when the network itself changes (i.e. when new roads are added).

Feature data can be provided in one of two ways:

1. from Shape files that have the feature data embedded (this can be the same shapefile that was used to define the network)
2. from CSV files with one row of data for each road segment.

Whichever of these is used, it is required that there is a unique identifier for each segment. This identifier is also used in the network file to link road features with the locations.

Using shapefiles for Feature Data

For shapefiles where feature data is embedded into the same file as network locations, the shapefile attribute names must match those shown in Table 5. Data that is not available can be left blank, although some data as indicated is required to produce HVIR results as shown in the table.

Table 5: Feature data attribute naming within a shapefile

Attribute	Shapefile name	Pattern	Requirements
Unique Id	id	*id*	YES
Road Name	roadname	Exact	
Road Category	roadcat	Exact	YES
Carriageway	carriagew	Exact	
Line Marking	linemark	Exact	
Number of Lanes	numlanes	Exact	
Lane width	lanewidth	Exact	YES for By Road Geometry method for Safety
Sealed Shoulder Width	sshlderwid	Exact	YES for By Road Geometry method for Safety
Unsealed Shoulder Width	ushlderwid	Exact	
Pavement Type	pavetype	Exact	
Pavement Date	pavedate	Exact	
Seal Flag	sealflag	Exact	
Seal Date	sealdate	Exact	
Austroads Vehicle Class	avc	Exact	YES for By AVC method for Access
Mass Limit	masslimit	Exact	YES for By Limits method for Access
Length Limit	lengthlimit	Exact	YES for By Limits method for Access
Speed Limit	speedlimit	Exact	YES for By SCS method for Ride Quality YES for By Assumed Safety method of Safety
Traffic	traffic	Exact	
HV %	thvp	Exact	
Climate	climate	Exact	
Subgrade	subgrade	Exact	
IRI	iri	Exact	YES for By IRI method for Ride Quality
HATI	hati	Exact	YES for By HATI Speed method for Ride Quality
Subjective Comfort Speed	scs	Exact	YES for By SCS method for Ride Quality
Visual Condition Grade	vcg	Exact	YES for By VCG method for Ride Quality
Rutting	rutting	Exact	
Texture (OWP)	textureowp	Exact	
Texture (BWP)	texturebwp	Exact	
Cracking	cracking	Exact	
Strength	strength	Exact	
ANRAM VSRS Rating	vsrs	Exact	YES for By ANRAM method for Safety
Annual maintenance costs	cost_maint	Exact	
Asset replacement cost	cost_asset	Exact	

Using CSV files for Feature Data

To provide feature data using CSV files, the CSV headers required are shown in Table 6.

Table 6: Feature data headers and data description

Header	Units	Data description	Requirements
unique_id	-	Each interval must have a unique identifier. This can usually be generated by concatenating the road number, section name or ID, the direction and the chainage.	YES
road_cat	R1 to R5	R1 – Freeways R2 – Urban Highways R3 – Urban arterials or Rural Highways R4 – Collector and distributor roads R5 – Property access roads	YES
lane_width	m	Lane width is an input into the Safety service attribute.	YES for By Road Geometry method for Safety
seal_shld	m	Sealed shoulder width is an input into the Safety service attribute.	YES for By Road Geometry method for Safety
speed_lim	km/h	Speed limit at the beginning of the interval.	YES for By SCS method for Ride Quality YES for By Assumed Safety method of Safety
com_speed	km/h	A subjective assessment of the maximum legal speed the road can be driven and regarded as very comfortable.	YES for By SCS method for Ride Quality
avc	-	The highest Austroads Vehicle Class of vehicle permitted to use the road.	YES for By AVC method for Access
mass_lim	t	What is the mass limit of this road according to Notices?	YES for By Limits method for Access
len_lim	m	What is the length limit of this road, not including entry or exit manoeuvres.?	YES for By Limits method for Access
iri	m/km	International Roughness Index	YES for By IRI method for Ride Quality
hati	m/km	Heavy Articulated Truck Index	YES for By HATI Speed method for Ride Quality
scs	km/h	Subjective Comfort Speed – the highest legal speed at which the road can be travelled in a passenger car and still considered comfortable.	YES for By SCS method for Ride Quality
vcg	0 to 5	Visual condition rating as described in IPWEA Practice Notes 9.0 and 9.1: 0 = Not rated 1 = Very Good 2 = Good 3 = Fair/Moderate 4 = Poor 5 = Very Poor	YES for By VCG method for Ride Quality
vsrs	SRS	Total Vehicle Star Rating Score under the Australian National Risk Assessment Model.	YES for By ANRAM method for Safety
cway	A, B or C	A - Single Carriageway B - Divided carriageway, Forward C - Divided carriageway, Reverse	
line_mark	Yes or No	Unmarked roads are handled differently and so it is important to identify these.	
num_lanes	-	Number of lanes is a secondary check on the road categorisation.	
unseal_shld	m		
pave_type	SS, or SU, or US, or UU or C	SS = stabilised base and subbase SU = stabilised base, unstabilised subbase US = unstabilised base, stabilised subbase (and/or subgrade) UU = unstabilised base and subbase C = Concrete	

Header	Units	Data description	Requirements
pave_date	dd/mm/yyyy	When was the pavement constructed or rehabilitated?	
seal_flag	Sealed or Unsealed	Sealed and unsealed roads are handled differently so it is important to identify these.	
seal_date	dd/mm/yyyy	When was the surface last sealed or resealed?	
traffic	AADT	One-way AADT.	
perc_heavy	%	Percentage of heavy vehicles.	
climate	CD, or CW, or HD or HW	CD = cold and dry CW = cold and wet HD = hot and dry HW = hot and wet	
subgrade	S, or M, or C, or X or R	S = Sandy M = Medium C = Light clay X = Expansive clay R = Rock	
cost_maint	$	Annual expenditure on maintenance per 100 m interval (averaged)	
cost_asset	$	Replacement cost per 100 m interval (averaged)	
rutt	mm	Maximum rut depth	
textowp	MPD	Texture of outer wheel path	
textbwp	MPD	Texture between wheel paths	
cracking	%	% area of surface with cracking	
strength	(microns)	Central deflection from FWD or TSD	

1.3 Sourcing Data for Service Attributes

General Advice

Which Calculation Method is selected for each Service Attribute depends on the data that is available. Following are descriptions of how data can be sourced or defined.

Road categories

The road categories used for HVIR are intended to be applied nationally and differ to some extent from the road categories used in each jurisdiction. The following information in Table 7 will assist in converting your jurisdiction's road classes into the categories used in the calculation of HVIR.

Table 7: HVIR Road category definitions

Road Category	General description of category	Road features
R1	Freeways	Divided carriageway with 2 or more lanes in each direction and wide, sealed shoulders; high capacity and high speed.
R2	Urban Highways	Divided or separated carriageway with 2 or more lanes in each direction, <u>no</u> requirements for shoulders; high capacity and high speed.
R3	Urban arterials and rural highways	Single carriageway with 1 lane in each direction, may have sealed or unsealed shoulders; medium capacity and high speed.
R4	Collector and distributor roads	Single carriageway with 1 lane in each direction, may have sealed or unsealed shoulders; medium capacity and medium speed.
R5	Access roads	Single carriageway with 1 lane in each direction, no requirements for shoulders; low capacity and low speed.

Notes: "High", "Medium" and "Low" speeds are indicators of the function of the road in the network rather than prescriptive ranges. That said, an example of how speeds may be considered is: High: 80 km/h and higher, Medium: 60 to 80 km/h, Low: 60 km/h and under.

Access

Heavy vehicle access defines which freight vehicles can legally use which roads. The access level used in HVIR should be the highest level of access per road as Gazetted or by Notice. Where no heavy vehicle access information is available, the HVIR tool will assume general access, which includes vehicles of up to 19 m length and 55.5 tonne gross vehicle mass.

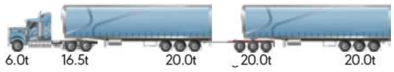
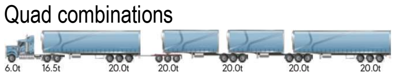
The Austroads vehicle classes describe heavy vehicles in terms of the number of axles and axle groups, and correspond to mass and dimension limits established by the National Heavy Vehicle Regulator. These are shown in Table 8.

. Defining the access level by the Austroads Vehicle Class (AVC) sets the access according to the HVIR Tool as the longest vehicle within that class at General Mass Limits (GML).

It may be necessary to define the access level with greater detail in cases such as roads with tighter turns where the length needs to be restricted, or for roads that permit higher mass such as on Higher Mass Limit (HML) routes. In these circumstances, defining access by the actual length (metres) and mass (tonnes) limits can be used.

It is also possible to mix these types of access information, since the HVIR tool looks to set the access based on available data from the <u>highest selected</u> Calculation Method down to the default value (general access) in the order: By Limits → By Austroads Vehicle Class → by default.

Table 8: Vehicle classification based on Austroads and the NHVR

Austroads				Vehicle examples	National Heavy Vehicle Regulator			
Class	Length	Axles	Axle groups		Length	GML	CML	HML
0 – 9	≤ 19 m	axles = 6 and groups > 2 or axles > 6 and groups = 3		General access 	≤ 19 m	55.5	57	57
10	17.5 to 36.5 m	> 6	4	B doubles 	19 to 26 m	62.5	64.5	68
11	17.5 to 36.5 m	> 6	5 or 6	A doubles  B triples  AB triples  Rigid truck with 2 dog trailers 	26 to 36.5 m	88.5	90.5	91
12	> 36.5 m	> 6	> 6	A triples  A B triples  Quad combinations 	36.5 to 53.5 m	122.5	124.5	135.5

Note: The values shown here are the limits of each class and should not be taken as applying in all circumstances to any individual vehicle combinations represented by name or image.
Disclaimer: all images and values shown here are for general guidance only.

Sources: Austroads Vehicle Classification

NHVR www.nhvr.gov.au/road-access/mass-dimension-and-loading/general-mass-and-dimension-limits

Ride Quality

Ride quality provides a measure of the vibrations and other movements experienced by the driver of a freight vehicle, which can lead to discomfort and even health problems in the long term. Ride quality is caused by road surface characteristics such as longitudinal profile and damage/defects. The following types of data can be used to indicated ride quality for the HVIR tool, but each method produces an increasingly cruder response; i.e. the range of the quantified Ride Quality, *R*, in HVIR is limited as the data it is based on become less direct and more subjective.

Road condition surveys captured by vehicles using laser profilometers can capture all the causes of ride quality and simulate the response of a vehicle in terms of International Roughness Index (IRI) or the Heavy Articulated Truck Index (HATI). This data is usually output at 100 m intervals. IRI is simulated using a quarter-car model and is therefore not suitable for representing the ride quality experienced in the majority of freight vehicles; however, IRI is widely accepted and routinely collected by road agencies. HATI uses a quarter truck model and is more suitable than IRI but does not have the same level of acceptance or use.

If the resources to hire survey companies is not available, two alternative means to indicate ride quality have been included in the HVIR Tool.

The Subjective Comfort Speed (SCS) measure requires a road to be driven in a passenger car and the highest legal speed at which the road remains comfortable noted. This should be reported at whatever interval the network is segmented as. If collected at lesser intervals, data points should be averaged when reported (e.g. SCS can be collected at 100 m intervals, and then averaged to the road segment between intersections). In addition to the SCS, the speed limit data at the same reported interval needs to be available.

While the SCS method is subjective, it is based on the actual ride quality being experienced, albeit in a passenger car (which is selected in order to provide a more standardised experience across time and between jurisdictions). However, collecting SCS does require the investment of resources.

Visual Condition Grade (VCG) takes advantage of surface inspections that are already undertaken routinely or as needed by local governments. The VCG is based on the guidelines established by the Institute of Public Works Engineers Australasia (IPWEA) in their Practice Notes 9.0 and 9.1. This information should be reported at the same intervals as the network segmentation. Similar to above, if collected at lesser intervals, data points should be averaged when reported. Because VCG is intended for local governments, it is limited to R4 and R5 roads.

It is also possible to mix these types of ride quality indication, since the HVIR tool looks to set the ride quality based on available data from the highest selected Calculation Method in the order: By IRI or By HATI → By Subjective Comfort Speed → By VCG (for R4 and R5 roads only). There is no default for ride quality.

Safety

Safety is complex and can involve numerous variables. However, the HVIR Tool limits consideration of safety to variables related to the physical infrastructure of the road.

Surveys of heavy vehicle drivers have identified that a key contributor to perceived safety when driving is the amount of seal width available to the driver, i.e. the combined lane width and sealed shoulder width in metres. Therefore, the fundamental assessment of safety, *S* in the HVIR Tool is based on these parameters. Lane and shoulder width data may be available from construction specifications (although in this case it should be ascertained the edge-break is not an issue), or inventory surveys. If the data does not exist, it can be collected during other road asset inspections. There needs to be one measurement of each parameter for each road segment. If lane and sealed shoulder width data has been collected at lesser intervals than the network segmentation, the lane and sealed shoulder widths can be averaged. If a single measurement is used it should be where the total half seal width (i.e. lane + sealed shoulder width) is at a minimum.

More sophisticated measures of safety do exist such as the Australian National Risk Assessment Model (ANRAM), which is based on a large number of physical variables (including lane and sealed shoulder width). While needing more input data, ANRAM may be considered a more reliable measure of safety than the amount of seal width available alone, therefore provision has been made within the HVIR Tool for this to be used for those jurisdictions that have this data.

If the above information is not available and cannot be collected, in certain circumstances a low level of safety can be assumed by the HVIR Tool. This is limited to R4 and R5 roads based on the assumption that traffic levels are low and therefore that safety is mostly a product of the speed limit. It should be understood that this outcome is based on the operational conditions rather than the condition of the infrastructure and is a provisional indicator intended for the absence of data (usually for local governments) in the short term.

It is also possible to mix these types of safety indication, since the HVIR tool looks to set the safety based on available data from the highest selected Calculation Method down to the default value (if applicable) in the order: By ANRAM → By Geometry → By Assumed Safety (for R4 and R5 roads only).

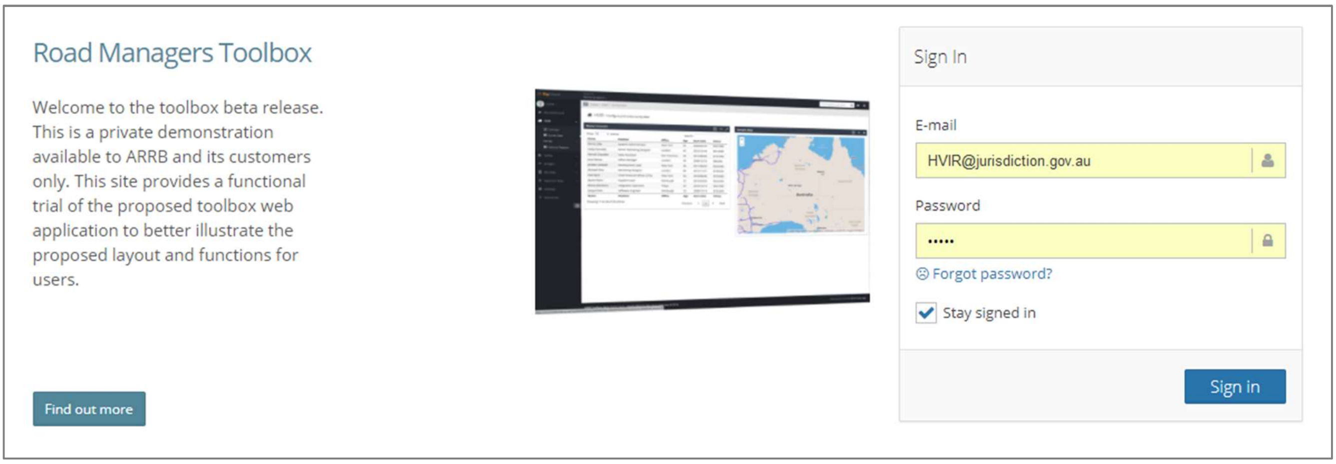
2. Data Management

2.1 Signing in to the Road Manager's Toolbox

The Road Manager's Toolbox (RMT) is an online platform accessible by any web browser for the management of road network data and tools that make use of that data. The RMT is located at: http://toolbox.atlab-arrb.com

A user account should have already been created for your organisation, and the credentials to sign in provided. Each jurisdiction account can have multiple individual users. The first step is to Sign In to the RMT.

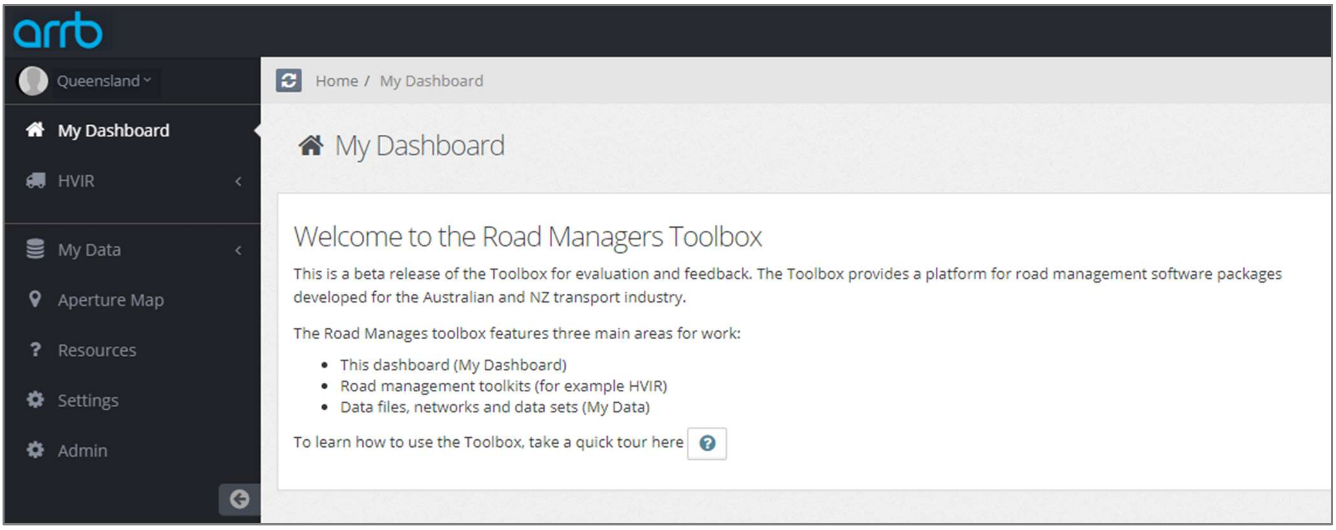
Figure 1: You should already have been provided with the Sign In credentials for your jurisdiction's account



Once you are signed in, you will be taken to the Dashboard welcome page. This Dashboard provides a number of widgets displaying information about activities that have taken place within the account. The widgets shown in the Dashboard, as well as on other screens throughout the RMT and Tools, can be moved around the screen, and minimised and maximised.

The navigation bar on the left of the screen (see Figure 2) will remain in place when using the RMT functions and Tools (although the navigation bar can be minimised with the arrow icon under the last menu item). Data is managed through the sub menu located under 'My Data'.

Figure 2: The Dashboard provides an overview of account activities



Clicking on 'My Data' displays the submenu with the three main activities of data management:

- Uploading data to the Toolbox ('Upload Files')
- Defining networks for use by Tools ('Networks')
- Preparing infrastructure feature data sets for use by Tools ('Data Sets')

The next step depends on what data you have available:

- If you have prepared data files for the network locations and feature data as described in Section 1 , Data Preparation, please follow the instructions in Sections 2.2 to 2.4.

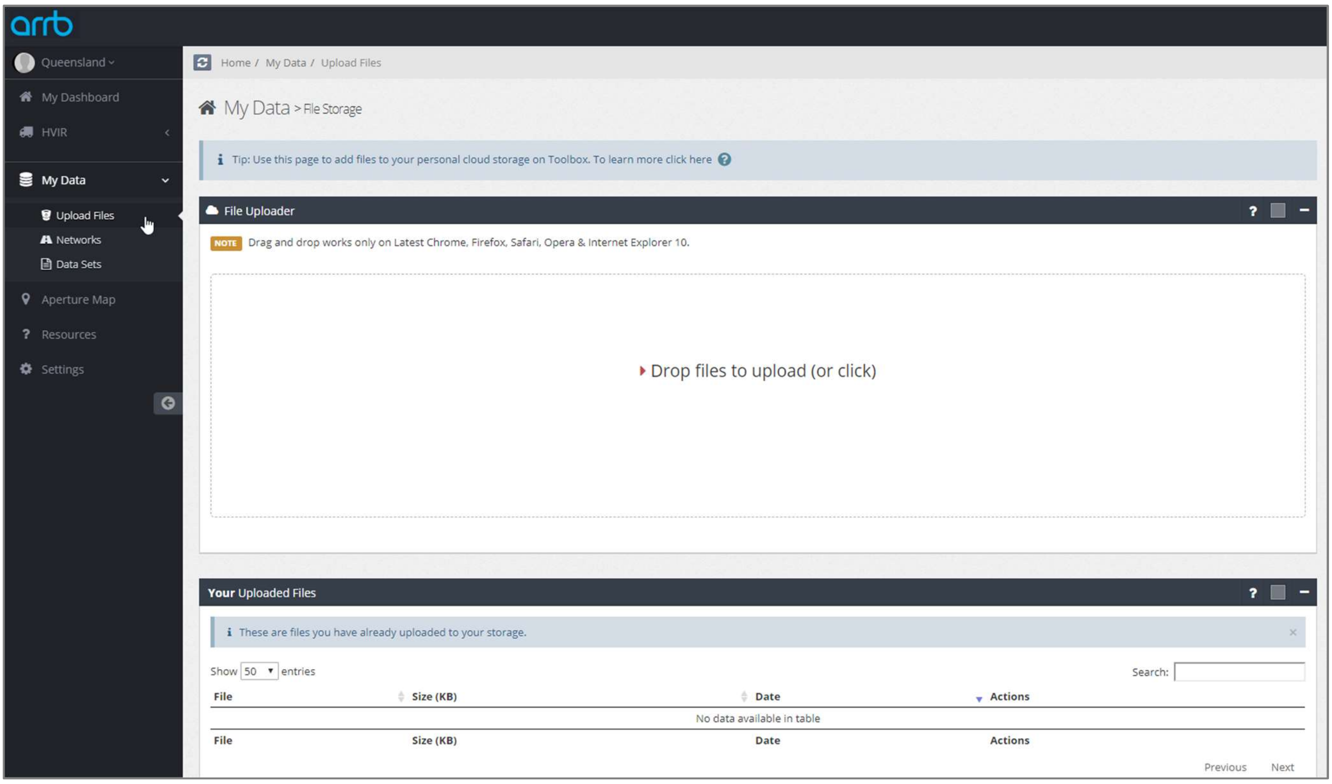
  OR

- If you do not have network location information, please go to Section 0.

2.2 Uploading Data to the Toolbox

- Clicking on the first submenu item 'Upload Files' brings up the file management page (see Figure 3) which contains two widgets: a file upload box, and a list of files that have been previously uploaded. This list is global for the account, so you will see all files that have been uploaded by all users within the account.

Figure 3: Clicking 'Upload Files' brings up the file management page

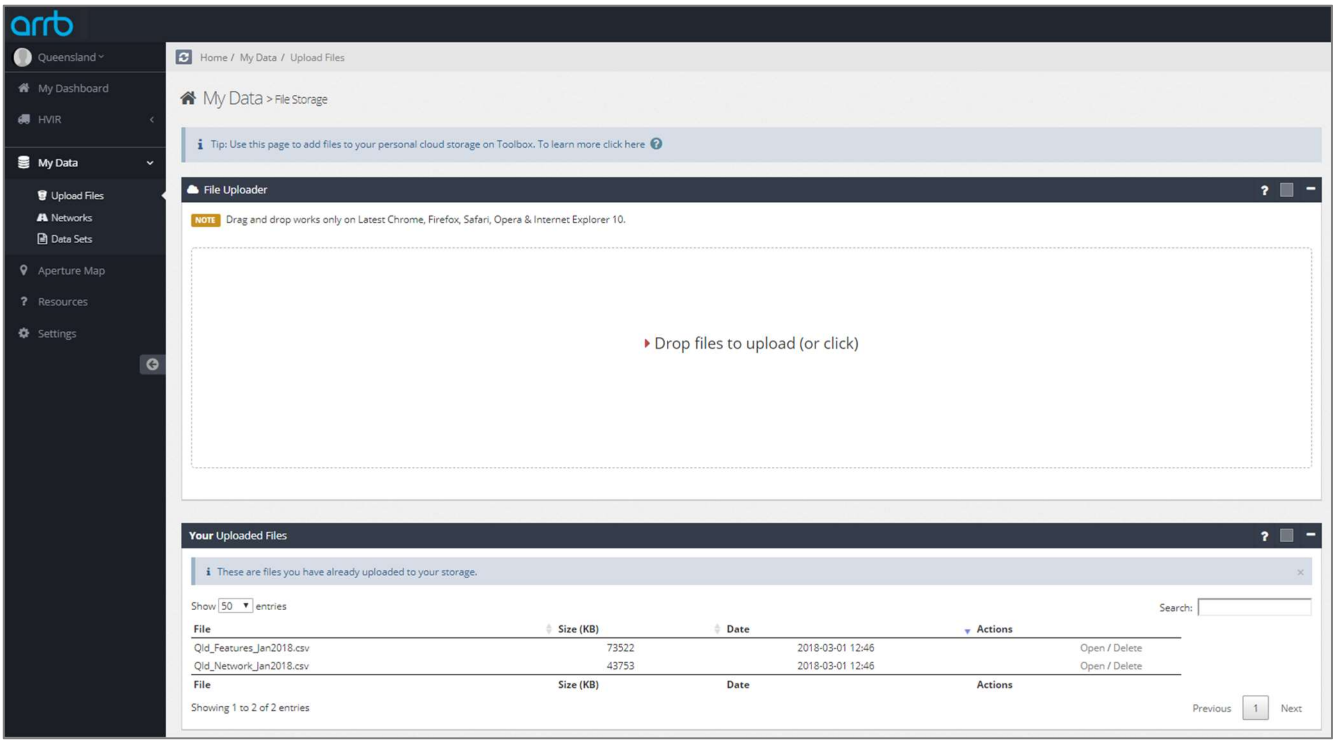


- Files can be uploaded by dragging them across to the File Uploader widget or clicking on the widget to display a standard Windows find file dialogue. The types of files you may wish to upload include both shapefiles and .CSV files containing network locations, road data and features, and Points of Interest (POIs).

For the HVIR tool, network and feature data is required to be in road segments identified by a unique ID. It is recommended that separate files are used for networks and data about features on those networks.

Once all the files have been uploaded (see Figure 4), they need to be prepared for use as a network or infrastructure features file as explained in Sections 2.3 and 2.4 respectively.

Figure 4: File Uploader showing files that are now available

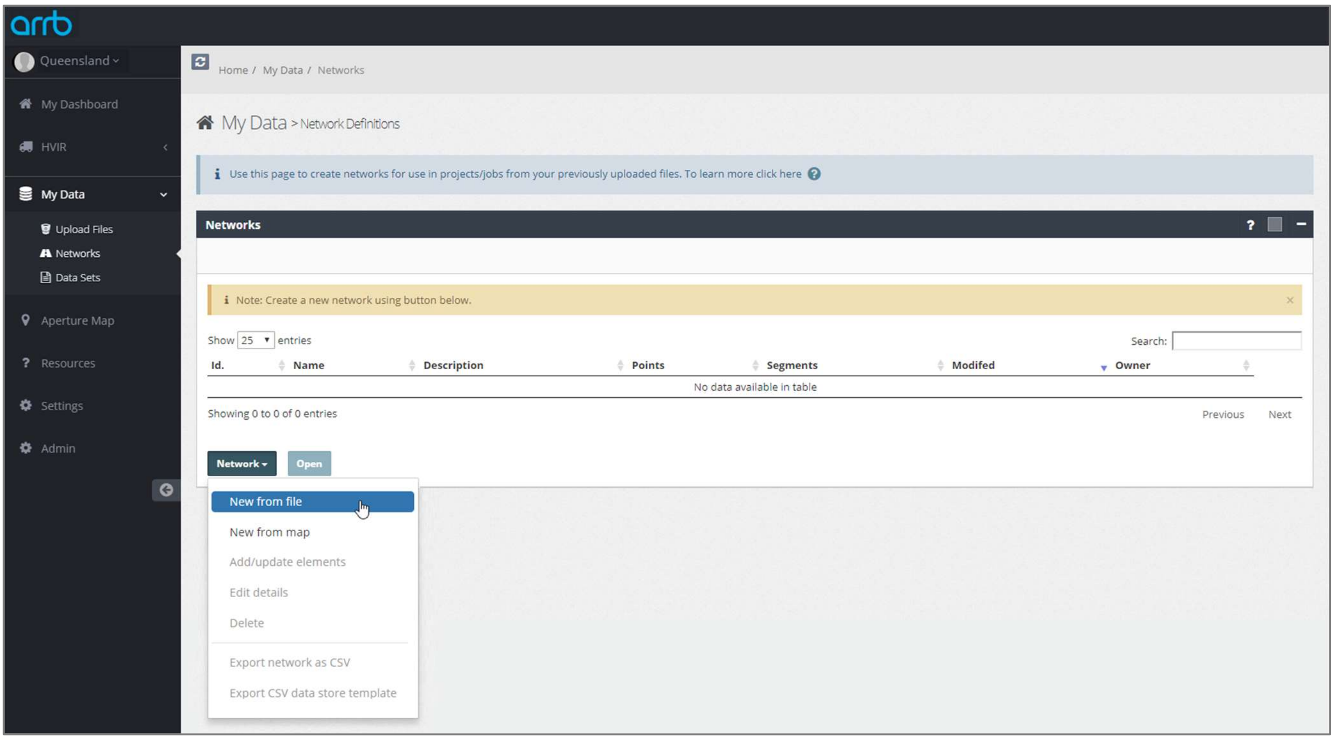


2.3 Defining Networks for use by Tools

The purpose of defining a network from a shapefile or .CSV is to ensure it can be used by the Tools in the Toolbox, and to place it on the server itself.

- Clicking on 'Networks' in the navigation bar brings up a widget that contains a list of all the previously defined networks and some action buttons (see Figure 5).
- To define a new Network, click on the 'Network' dropdown menu in the widget, and then select 'New from File'.

Figure 5: Defining a network allows it to be used by online tools

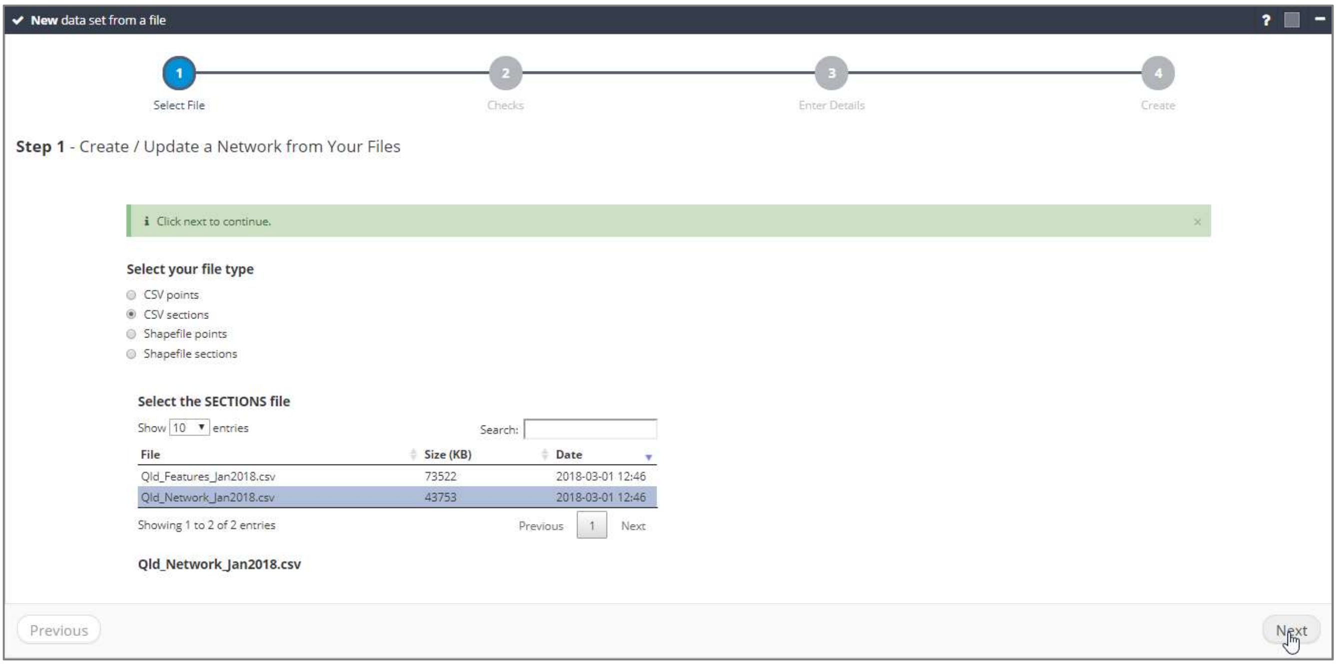


The widget will then change to the four-step process for defining a new network (see Figure 6).

Step 1 – File selection:

- Use the radio buttons to select the type of file you are going to use to define the network, this will make a list of files of the selected type from your file store appear.[1]
- Find the file you want to use to define the network and select it.
- Click the ‘Next’ button on the bottom right of the widget.

Figure 6: Shape files or .CSV files of GPS coordinates can be used to define road networks



Step 2 – File validation:

- The RMT will check the data in the file to ensure it is recognisable and readable (see Figure 7).
- If the Validation does not pass, you may need to go back by clicking the ‘Previous’ button to ensure the file type you selected is correct or choose a different file.
- The Validation process looks for the critical data it needs for location referencing (see Figure 7). If you wish to use different fields of data to those that have been automatically selected for each attribute, you can click the ‘Select fields’ button to assign data manually (see Figure 8). This box allows you to change which field of data is assigned to each of the mandatory attributes needed.
- When the Validation step is complete, click the ‘Next’ button on the bottom right of the widget.

[1] Points of Interest (POIs) can be added to an existing network at a later time. The road sections should be defined first.

Figure 7: A validation of the selected network file takes place to ensure it is readable and complete

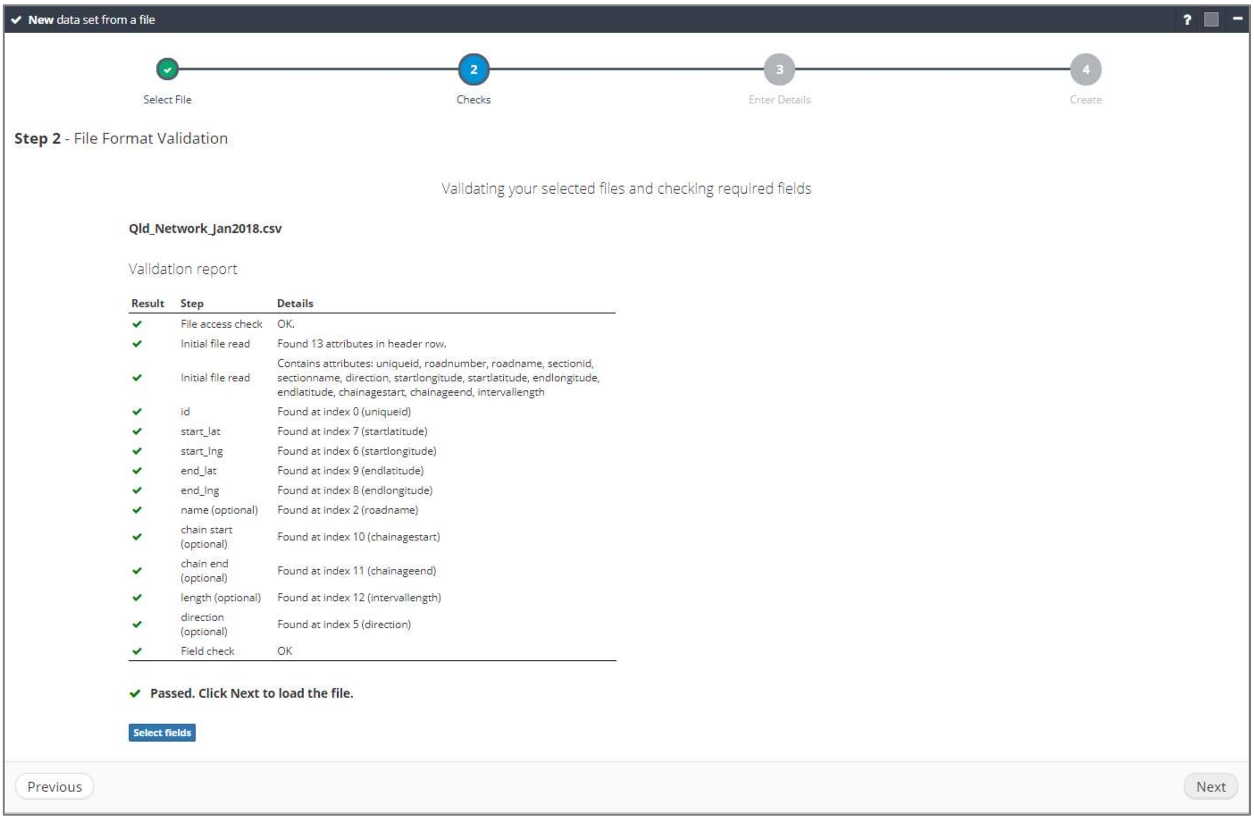
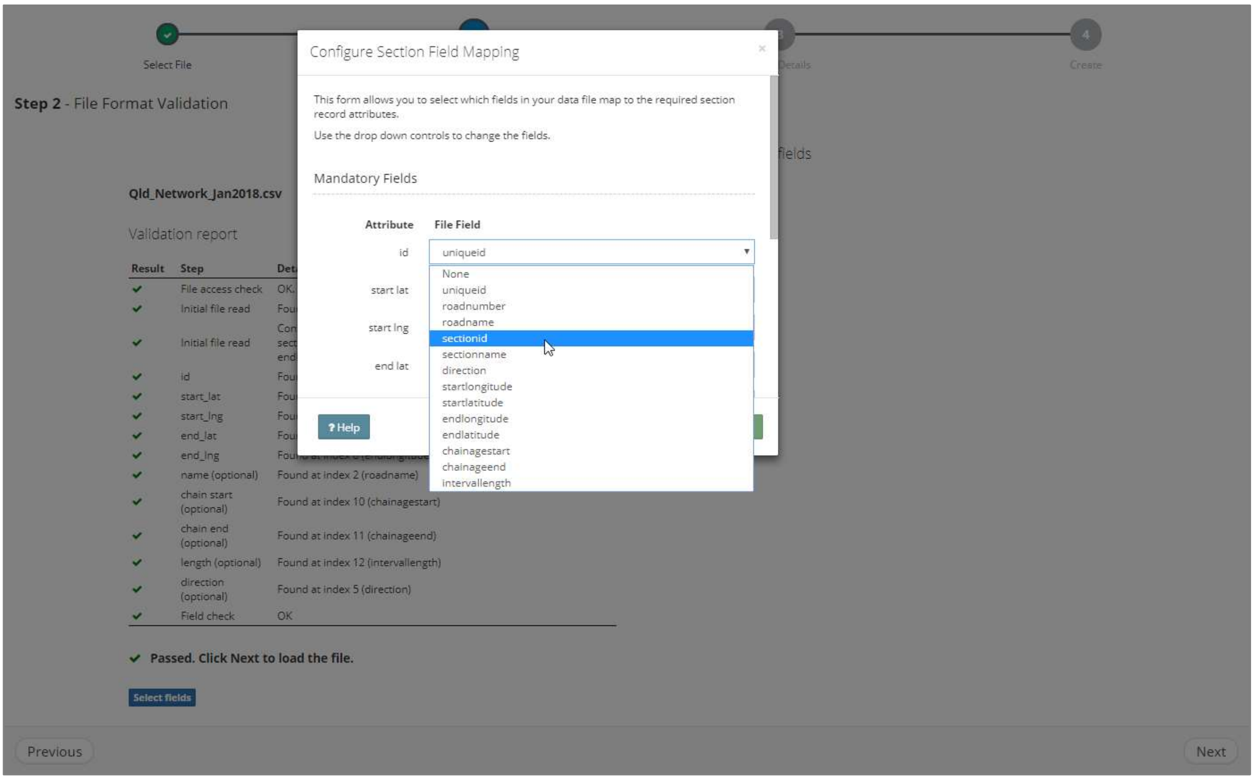


Figure 8: The location of data for each attribute is customisable

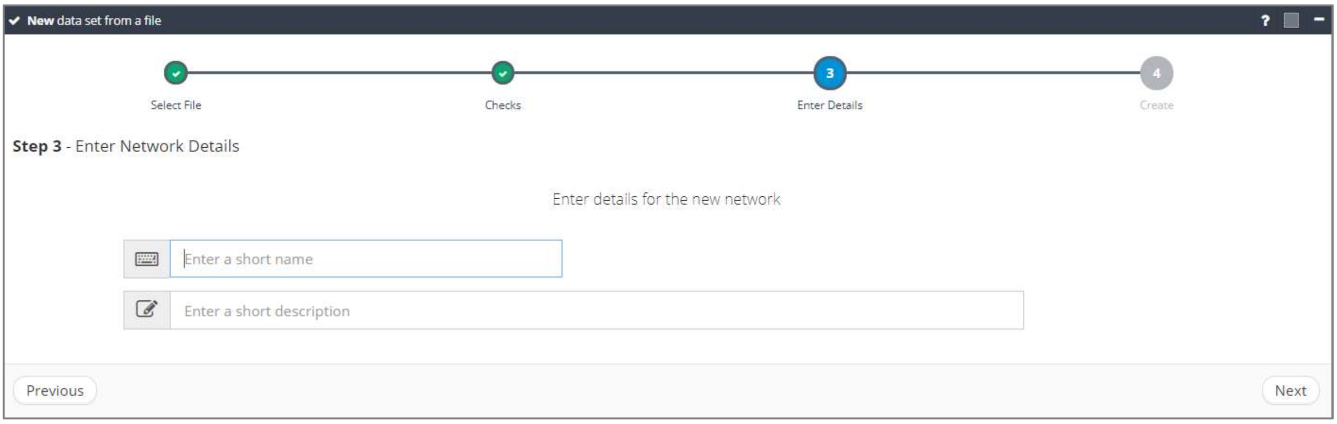


Step 3 – Enter Details

- Give your network a name for quick reference. It is recommended that this includes something to indicate what and where the network is, and the date.
- More detailed information can be entered in the description.
- Click the 'Next' button on the bottom right of the widget.

The name and detail fields can be edited later if needed.

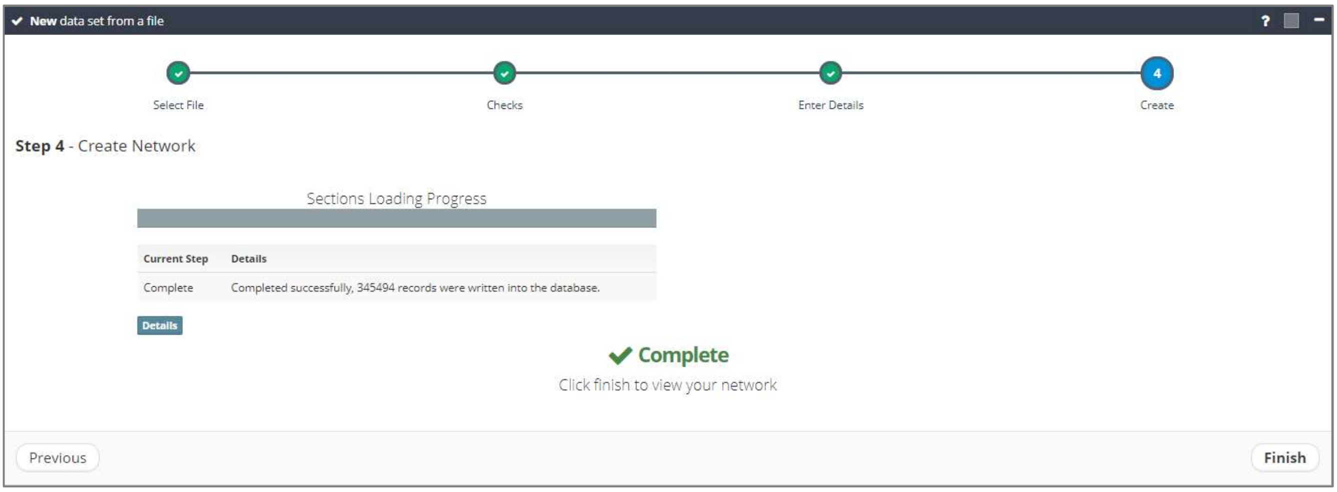
Figure 9: Defined networks can be given a name and a brief description



Step 4 – Create:

- The Toolbox will spend some time processing the network. The amount of time depends on the size of the network and the performance of your computer and internet connection. It is reasonable to expect that it will take less than a minute with an average computer and internet connection.
- Once the processing is completed (see Figure 10), click 'Finish' at the bottom right of the widget.

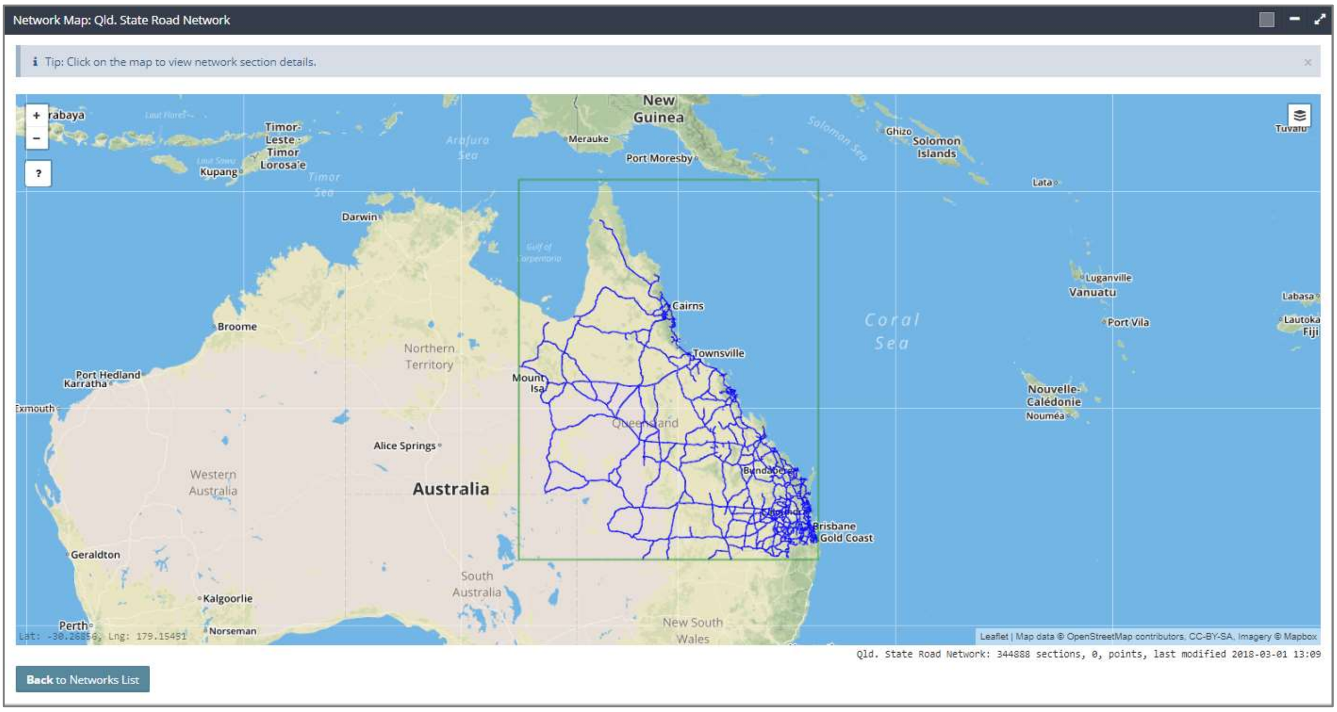
Figure 10: Once the network has been successfully defined, it is ready for use



When the widget closes, a map will open that shows the network locations (See Figure 11). Check that the network shown is correct and complete.

Hint: If you are getting locations at latitude and longitude of 0, 0 (in the Gulf of Guinea off the coast of Africa), then your network data set includes GPS coordinates that are zeros or other symbols interpreted as zero. Missing coordinates should be left blank; this means they will not be mapped.

Figure 11: The mapped network is shown to assist with identifying any errors in the data



If there are any problems, clicking the ‘Back to Networks List’ button will allow you to repeat the above process with changes to correct any errors (although you may need to make corrections to the source file).

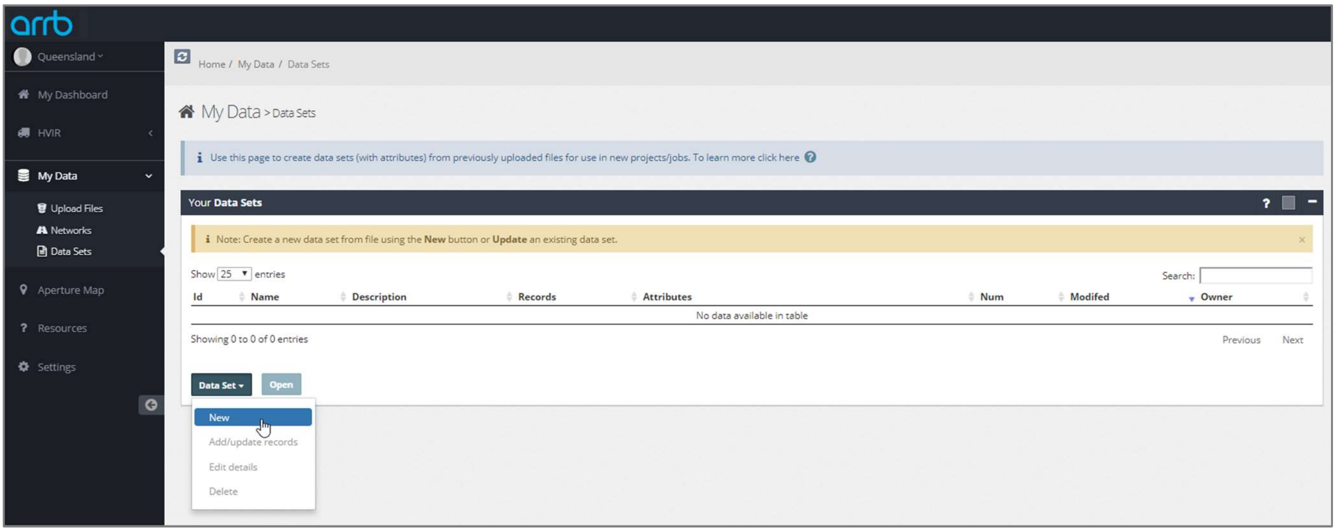
You can go directly to ‘File Upload’ or ‘Feature Sets’ by using the menu in the navigation bar.

2.4 Preparing Feature Data sets for use by Tools

The purpose of defining the infrastructure feature data set (from shapefiles with attributes or a .CSV) is to ensure it can be used by the Tools in the Toolbox, and to place it on the server itself.

- Clicking on ‘My Data’ and then ‘Data Sets’ in the navigation bar brings up a widget that contains a list of all the previously defined data sets and some action buttons (see Figure 12).
- To prepare a new Data set, click on the ‘Data Set’ dropdown menu in the widget, and then select ‘New’.

Figure 12: Preparing an infrastructure feature data set allows it to be used by online tools

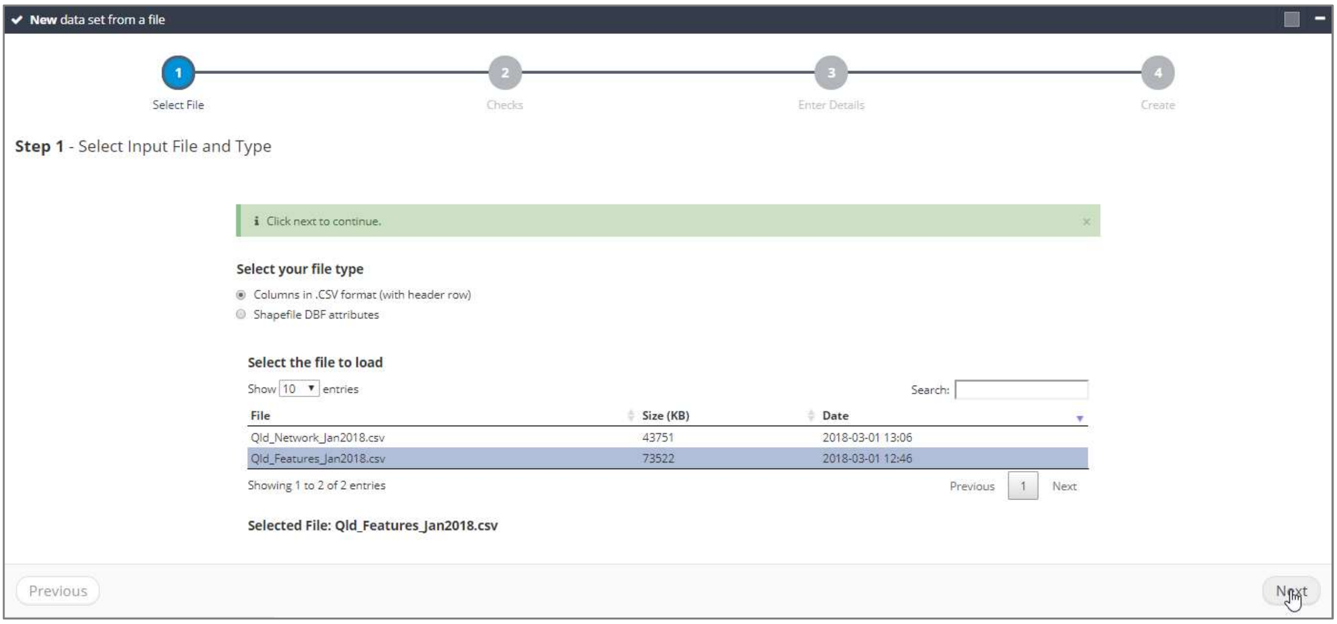


The widget will then change to the four-step process for preparing a new feature data set (see Figure 13).

Step 1 – File selection:

- Use the radio buttons to select the type of file you are going to use (i.e. the file type that contains the feature data), this will make a list of the files of that type in your file store appear.
- Find the file you want to use for the feature data set and select it.
- Click the 'Next' button on the bottom right of the widget.

Figure 13: Shape files with attributes or .CSV files can be used for feature data



Step 2 – File validation:

- The RMT will check the data in the file to ensure it is recognisable and readable (see Figure 14).
- If the Validation does not pass, you may need to go back by clicking the 'Previous' button to ensure the file type you selected is correct or choose a different file.
- The Validation process looks for the ID column, which is used to link the feature data with network locations (see Figure 14). If you wish to use a different ID field to what was automatically selected, you can click the 'Select fields' button to manually assign a different field (see Figure 15).
- When the Validation step is complete, click the 'Next' button on the bottom right of the widget.

Figure 14: A validation of the selected feature data file takes place to ensure it is readable and complete

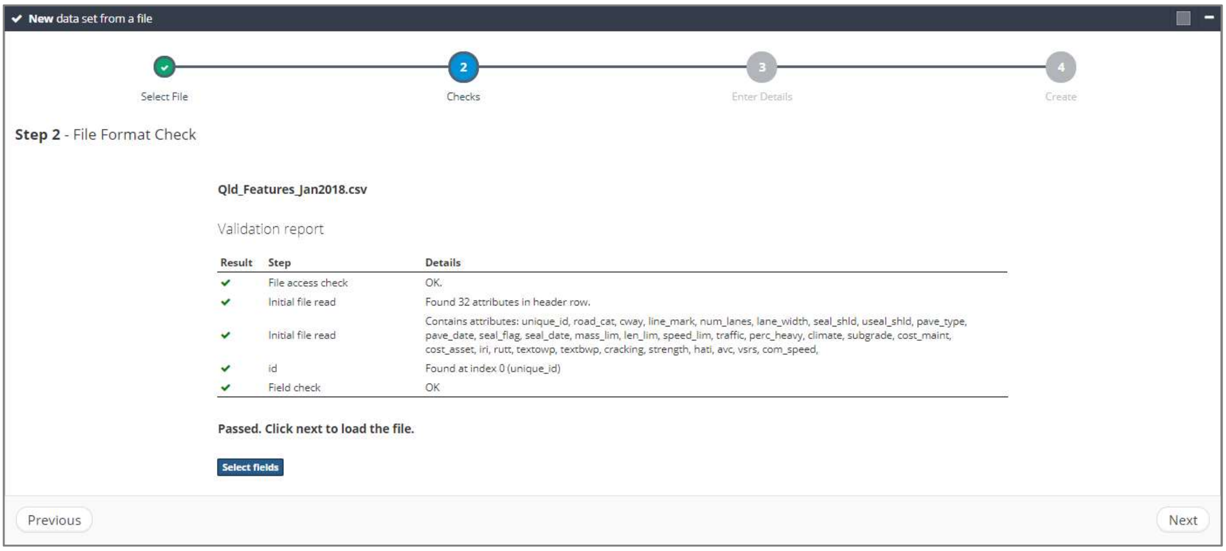
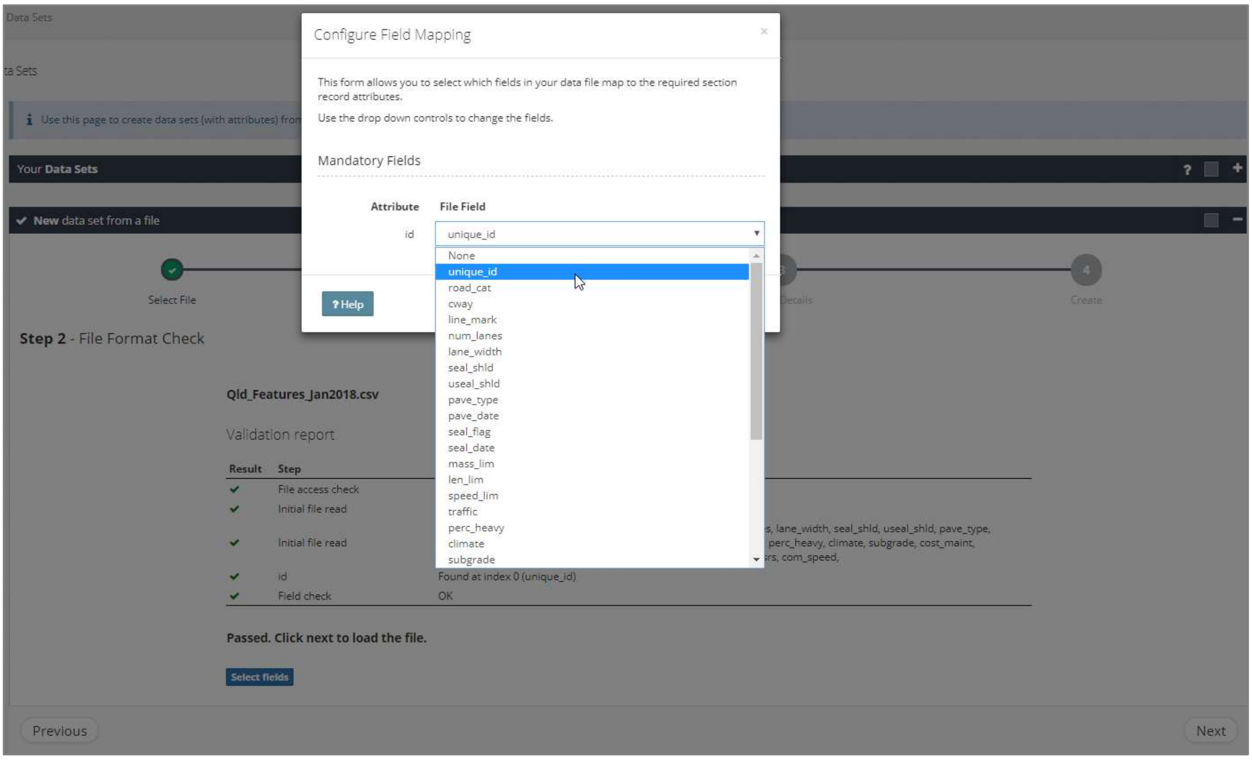


Figure 15: The location of the unique ID is customisable. The unique ID is used to link features with network locations.

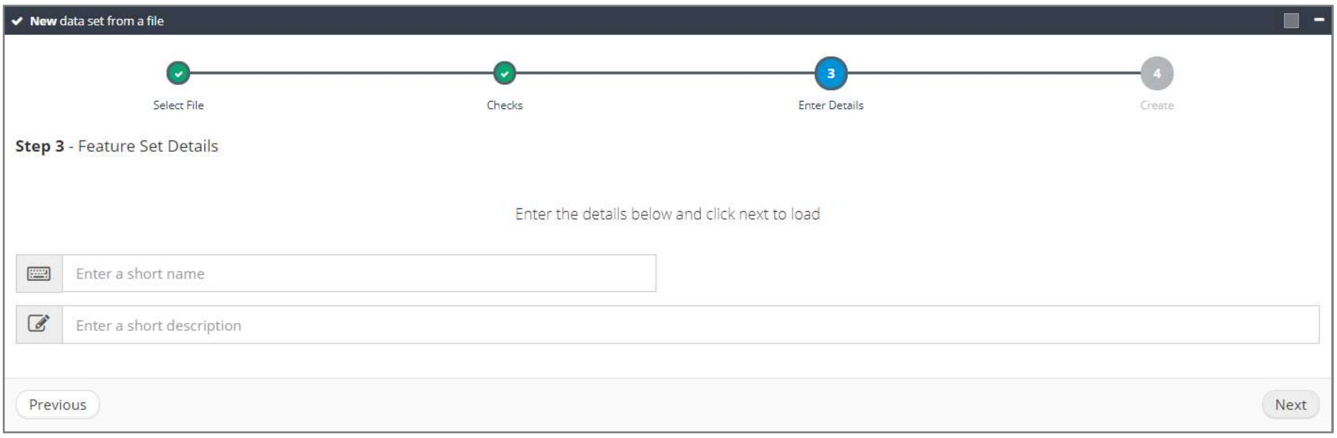


Step 3 – Enter Details

- Give your feature data set a name for quick reference (see Figure 16). It is recommended that this includes something to indicate what the data is, and the date it was collected.
- More detailed information can be entered in the description.
- Click the 'Next' button on the bottom right of the widget.

The name and detail fields can be edited later if needed.

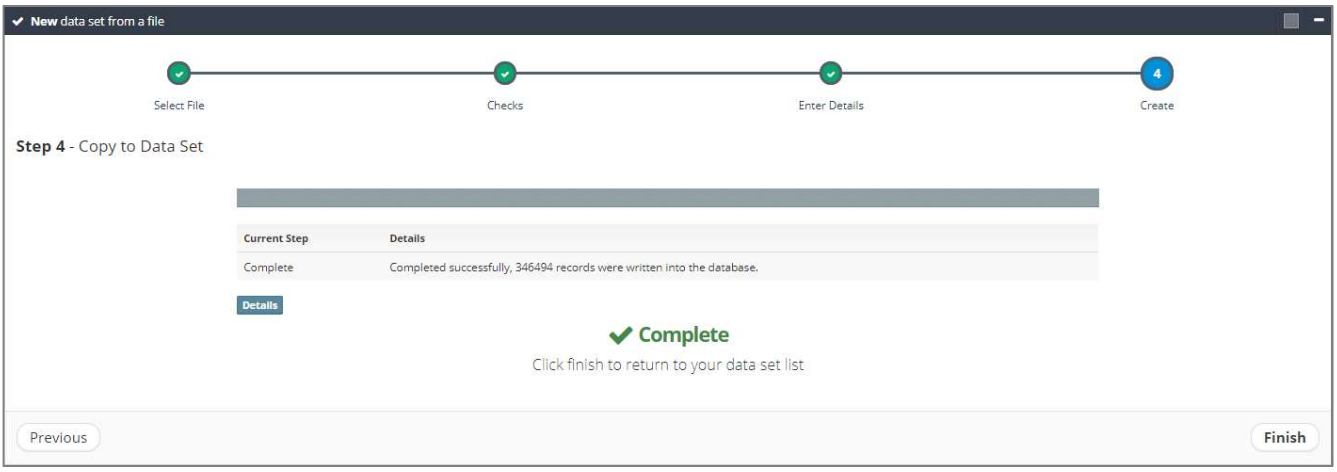
Figure 16: Feature data sets can be given a name and a brief description



Step 4 – Create:

- The Toolbox will spend some time processing the data set. The amount of time depends on the size of the data set and the performance of your computer and internet connection. It is reasonable to expect that it will take less than a minute with an average computer and internet connection.
- Once the processing is completed (see Figure 17), click 'Finish' at the bottom right of the widget.

Figure 17: Once the feature data set has been successfully defined, it is ready for use



You have successfully prepared your data to be used by the HVIR Tool.

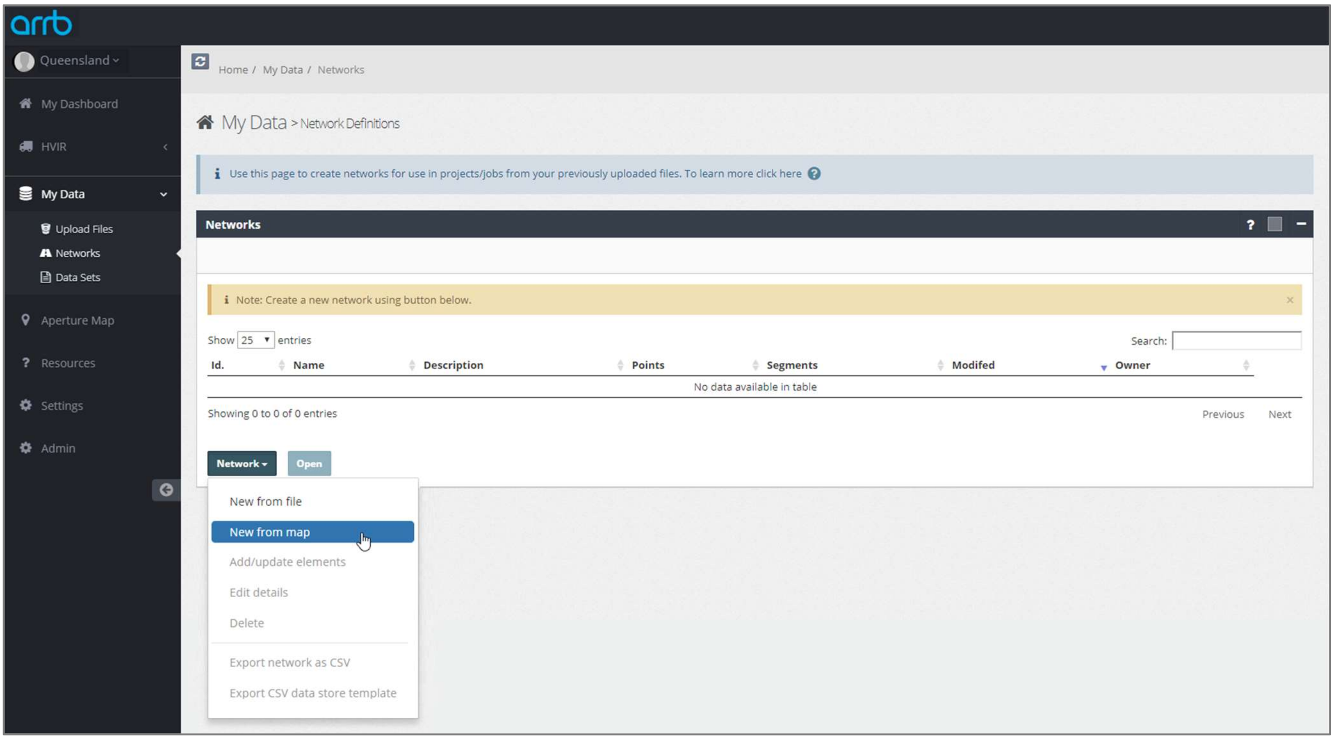
- Please go to section 3.

2.5 Generating Network Locations from a Map

This section describes how to use the Road Manager's Toolbox to generate network locations and a .csv file that can be populated with feature data. This is intended for road manager's that do not have any location information in a form that can be used by the tool.

- Clicking on 'Networks' in the navigation bar brings up a widget that contains a list of all the previously defined networks and some action buttons (see Figure 5).
- To define a new Network, click on the 'Network' dropdown menu in the widget, and then select 'New from map'.

Figure 18: A network can be defined from a map if there is no existing network location data available

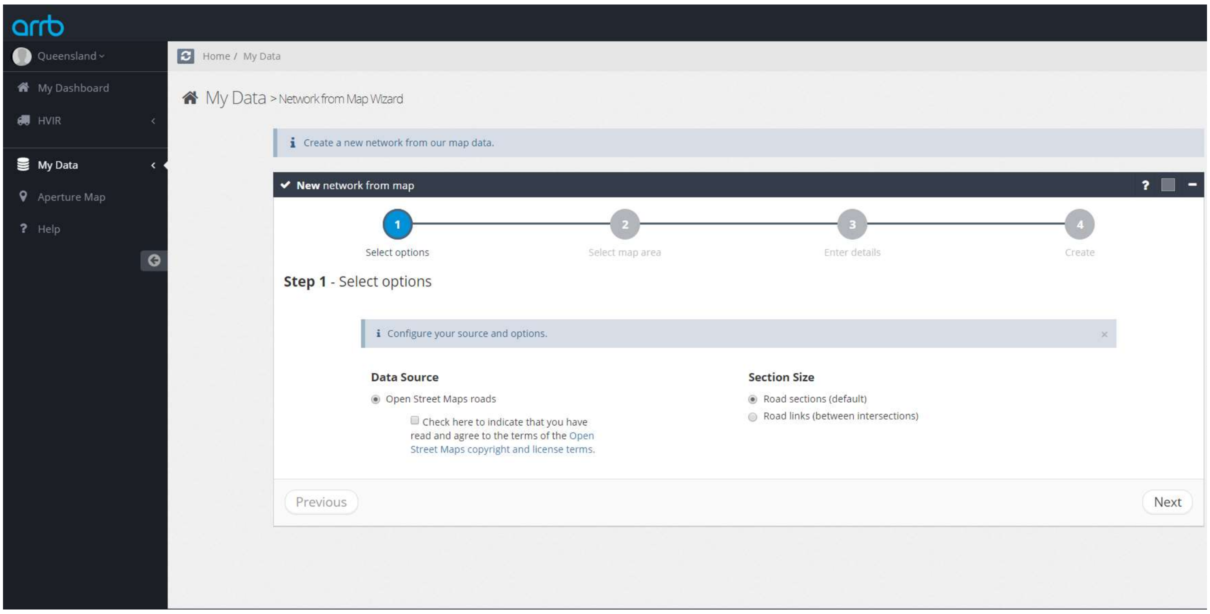


The widget will then change to the four-step process for defining a new network (see Figure 19).

Step 1 – Select options:

- There is currently only one source of map data. Click the check box to indicate you have read the Open Street Maps copyright and license terms.
- Choose the Section Size by clicking one of the radio buttons.
  'Road Sections (default)' divides the network into named roads.
- 'Road links (between intersections)' divides the network into links between intersections and is currently the recommended approach.
- Click the 'Next' button on the bottom right of the widget.

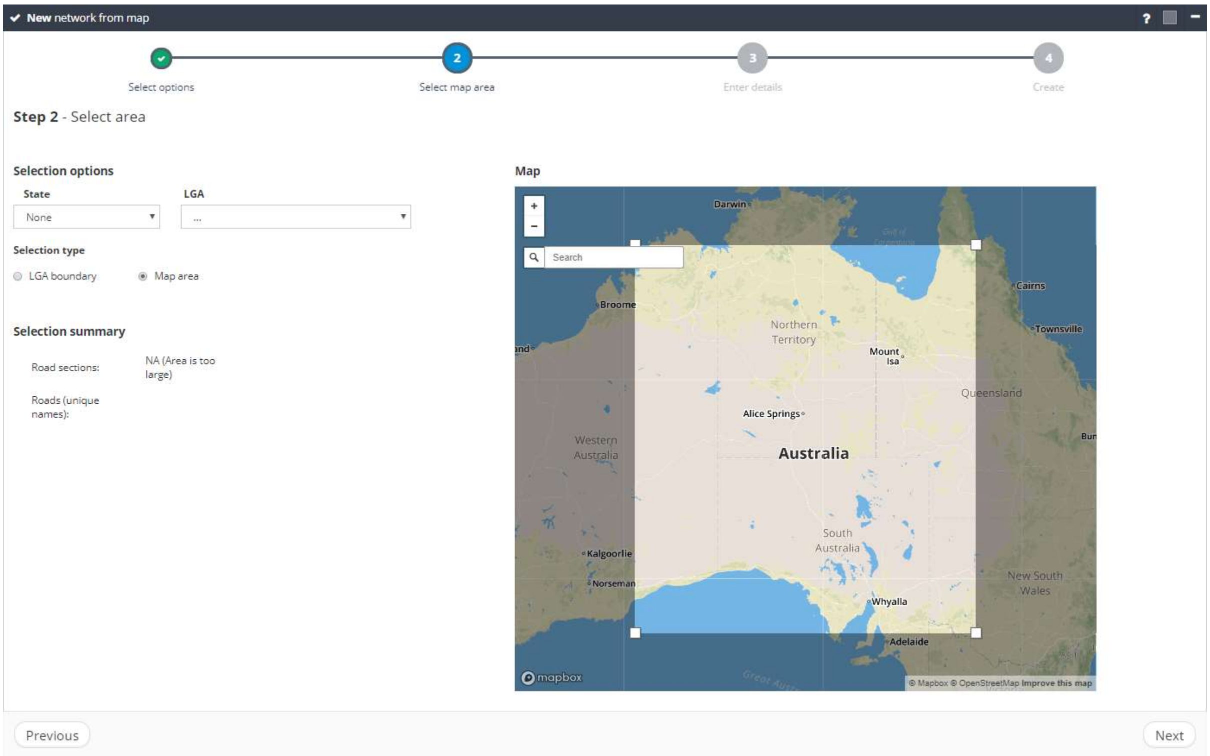
Figure 19: The new network from map wizard will generate network locations for you



Step 2 – Select area:

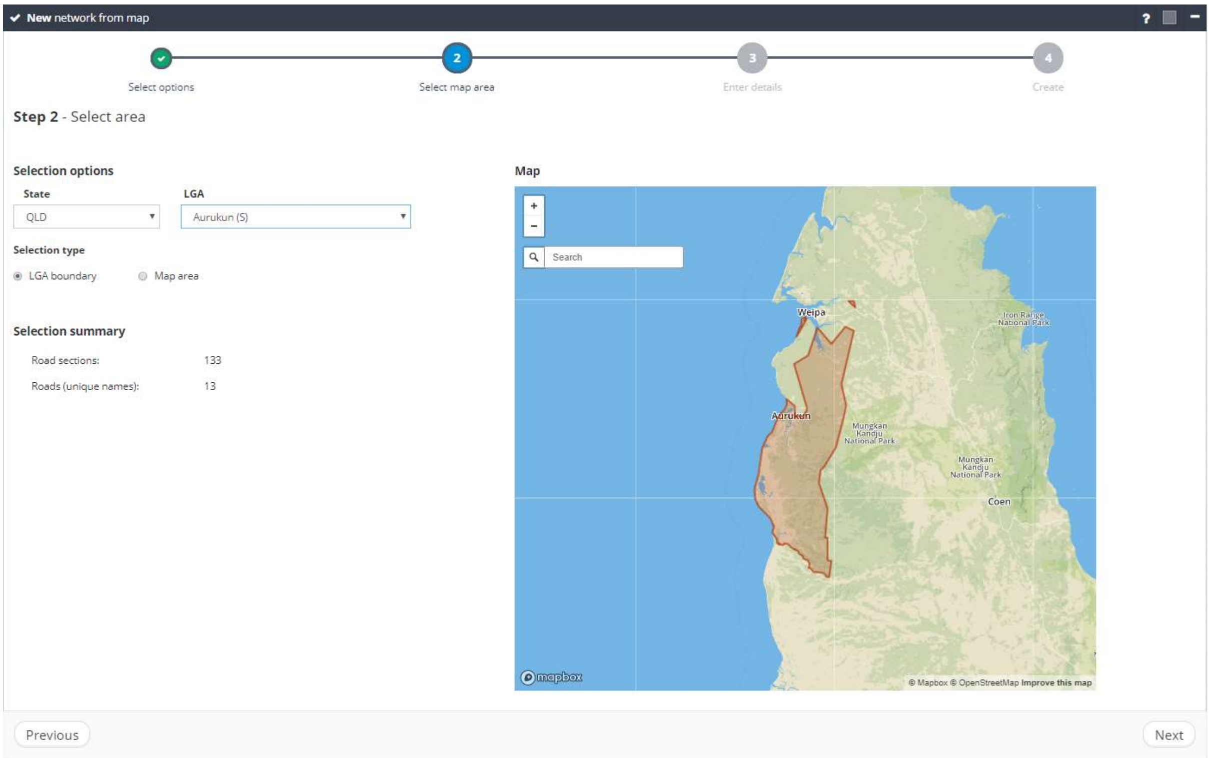
➢ The widget offers two ways to locate and define the road network (see Figure 20). For either method, selecting your state or territory in the 'State' dropdown box will zoom the Map to that area.

Figure 20: Locate your network from the map by Local Government name or by the area on the map



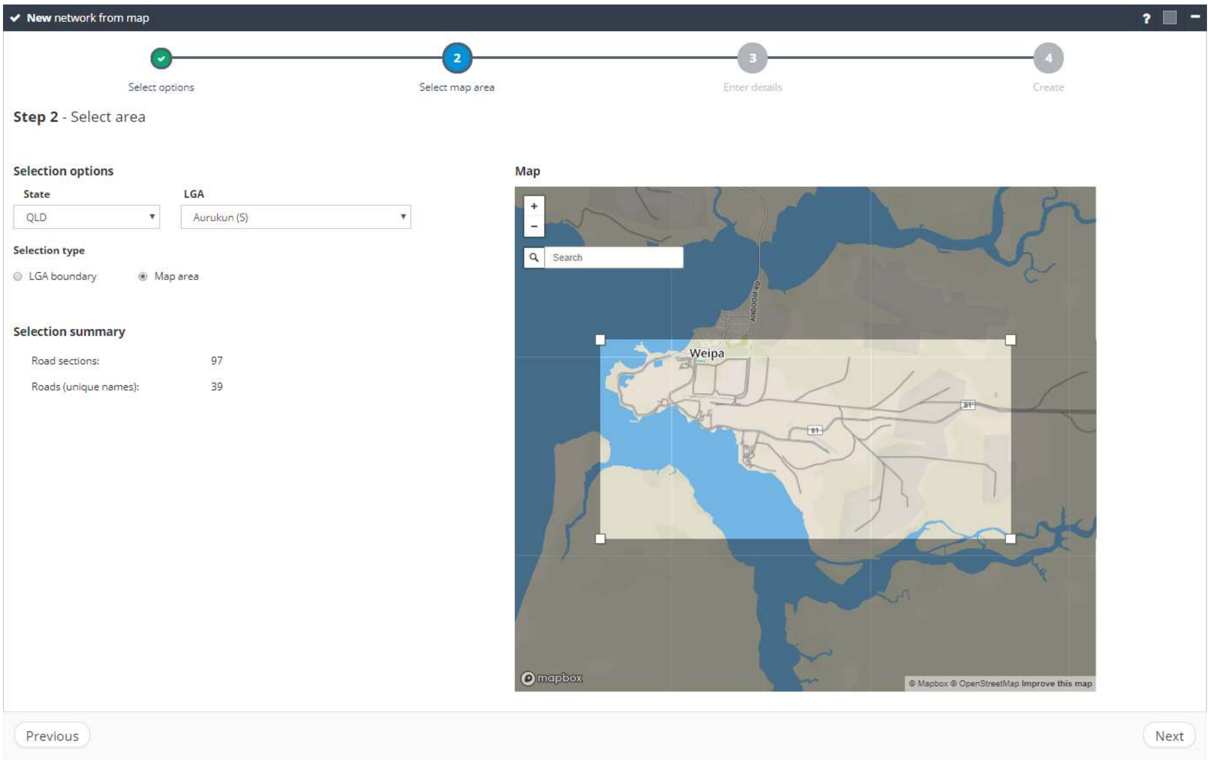
- ➢ If you are a local government, you can click the dropdown 'LGA' menu and locate your Local Government area by name (see Figure 21).
- ➢ If you want to select only some roads within this LGA, or if you would like to change to selecting the area directly from the map, click the 'Map area' radio button under 'Selection type'.
- ➢ If you want to keep the LGA boundary, click the 'Next' button on the bottom right of the widget and go to Step 3 on the next page.

Figure 21: Local governments can define a network by the official council boundaries



- ➢ To select the area directly from the map, you can move the map by clicking a dragging it; and resize the selection box by clicking and holding the squares in the corners until you have bound the roads you want to have in your network (see Figure 22).
- ➢ NOTE: In both cases, the entire length of named roads are included in the network, even if they cross the LGS boundary or the edge of the box positioned on the map.
- ➢ Click the 'Next' button on the bottom right of the widget.

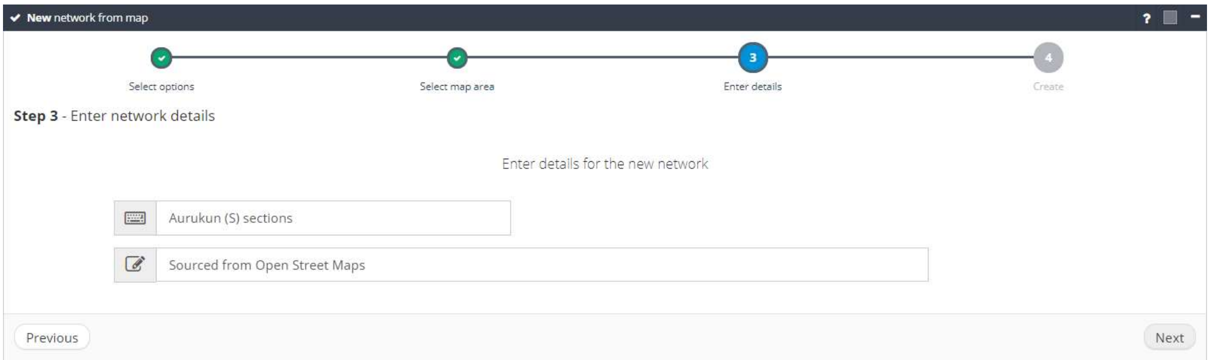
Figure 22: The area of the network can be selected by manipulating the map directly



Step 3 – Enter Details

- Give your network a name for quick reference (see Figure 23). It is recommended that this includes something to indicate what and where the network is, and the date.
- More detailed information can be entered in the description.
- Click the 'Next' button on the bottom right of the widget.

Figure 23: A selected network can be given a name and a brief description

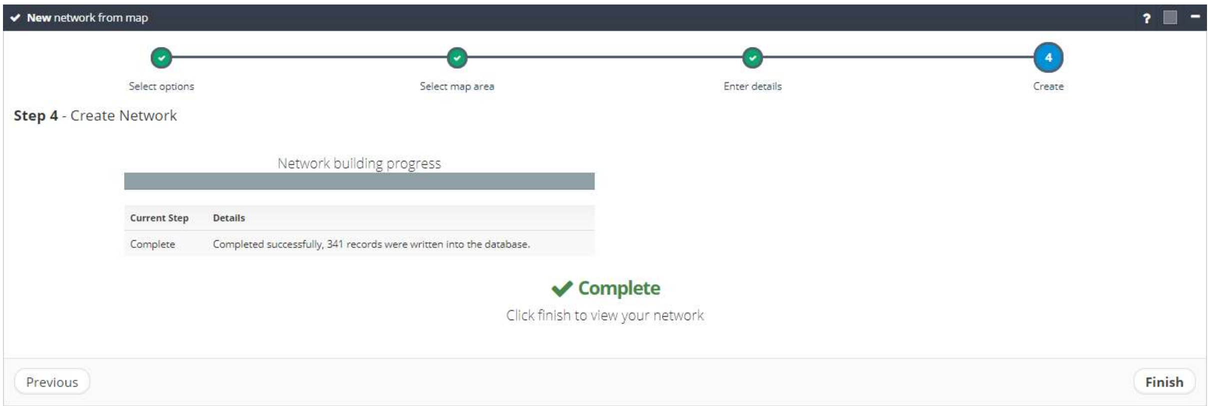


Step 4 – Create:

- The Toolbox will spend some time processing the network. The amount of time depends on the size of the network and the performance of your computer and internet connection. It is reasonable to expect that it will take less than a minute with an average computer and internet connection.

- Once the processing is completed (see Figure 24), click 'Finish' at the bottom right of the widget.

Figure 24: Once the network has been successfully selected, it is ready for review



When the widget closes, a map will open that shows the network locations (See Figure 25). Check that the network shown is correct and complete.

Step 5 – Review:

- If the network is complete and correct, click the 'Back to Networks List' button.
- If you would like to remove roads from the network, such as state roads or roads that are not freight routes, you can click on these roads directly and select the option to delete them (see Figure 26). When finished editing the network, click the 'Back to Networks List' button.

Figure 25: The network selected from the map is shown for review

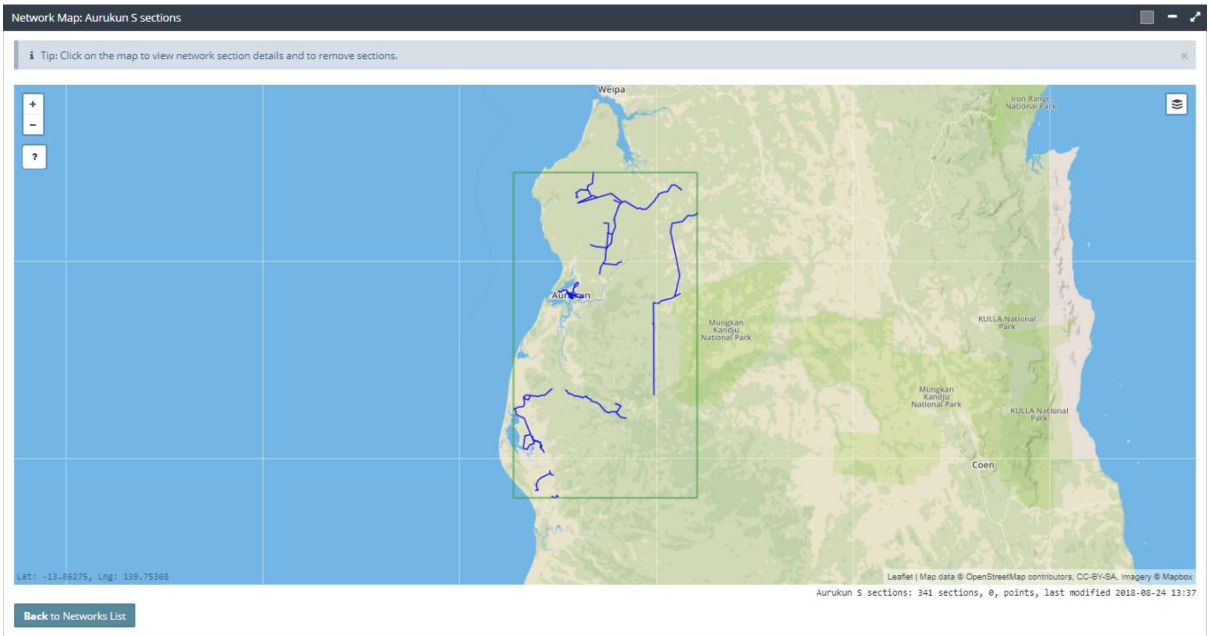
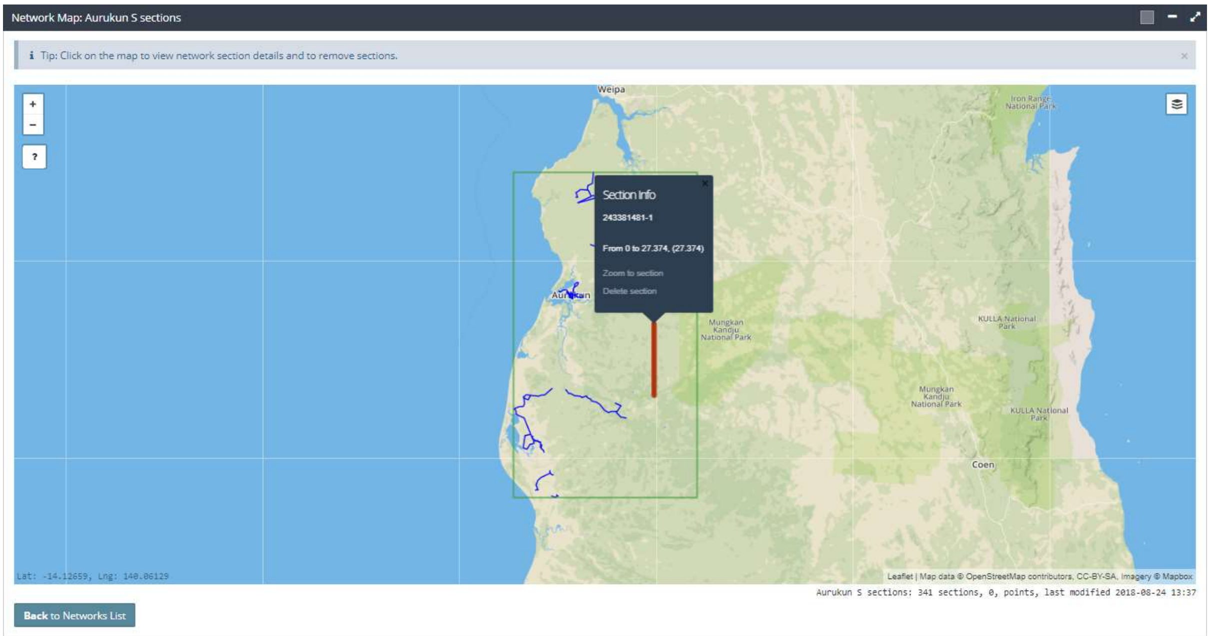


Figure 26: Roads can be deleted from a selected network

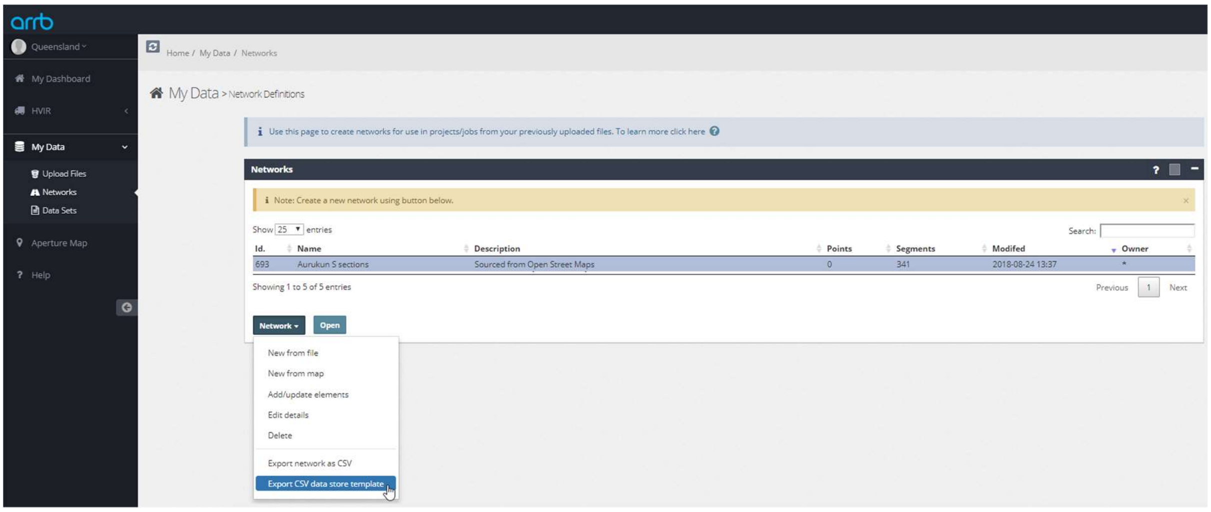


After clicking 'Back to Network Lists', you will see the network you have selected in the list. The next part of the process is to create a feature data set that can be associated with the network locations you have just created.

Step 6 – Generate Dataset Template:

- Select the new network in the list (see Figure 27).
- Click the 'Network' button to reveal the dropdown menu, then select 'Export CSV data store template'.

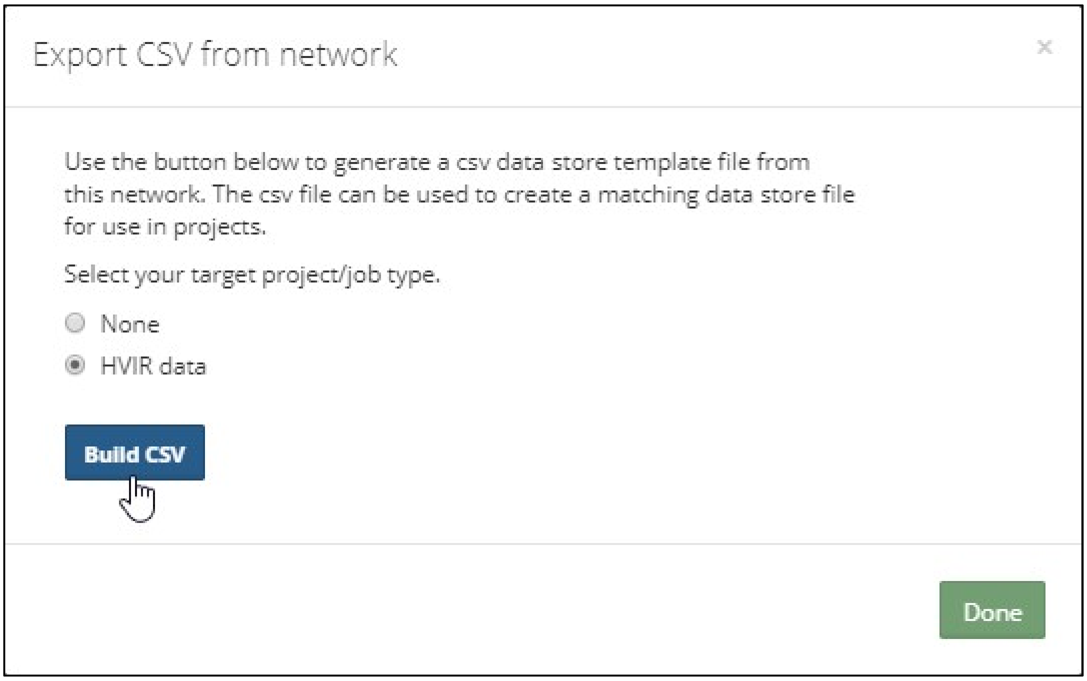
Figure 27: A dataset template can be exported from the network you have just defined



The widget will display a configuration panel to 'Export CSV from network' (see Figure 28).

- Select the type of dataset needed, in this case HVIR data. This will make the 'Build CSV' button appear.
- Click the 'Build CSV button.

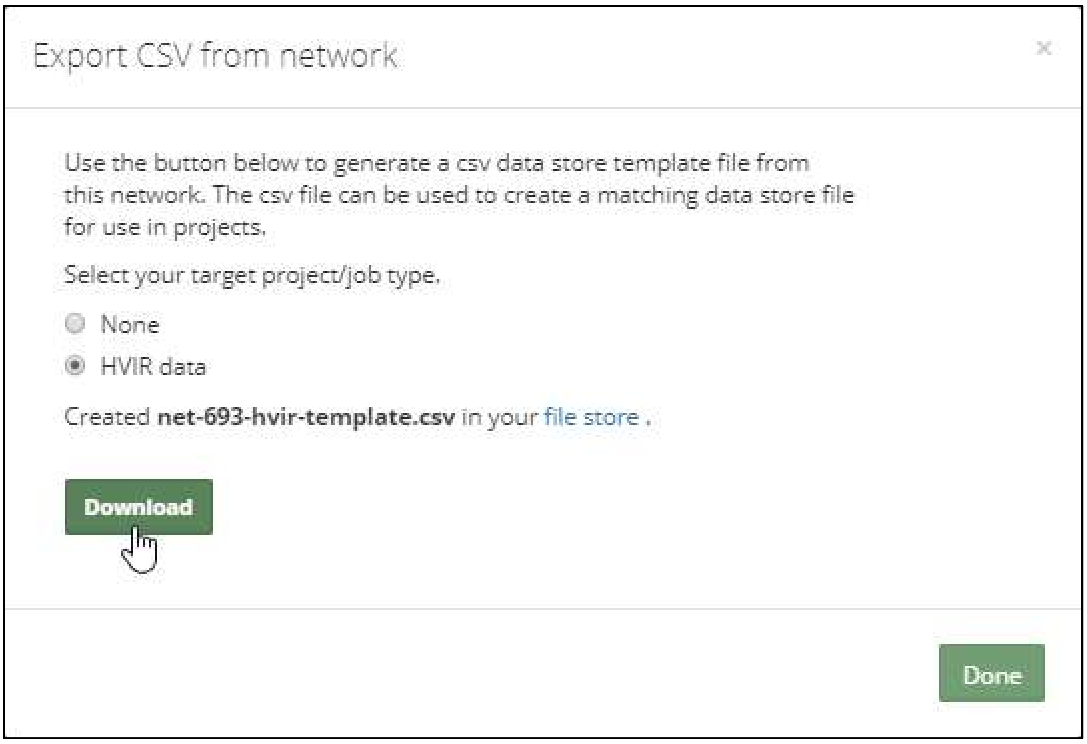
Figure 28: The export CSV panel allows you to select the type of data template needed



The 'Export CSV from network' panel will change with a message that a template file has been placed in your file store, and also creates a 'Download' button (see Figure 29).

- Click the 'Download' button. The template will be downloaded to your computer's default downloads folder.
- Click 'Done'

Figure 29: The data store template can be downloaded and populated



Step 7 – Populate Data

- Find and open the .csv template file. You will notice it has the same headers as listed in Table 6: Feature data headers and data description.
- Populate the rows you would like to include in the dataset with the appropriate information. Section 1.3 provides guidance on how to do this. It is not necessary to populate every row.
- Follow the instructions in Section 2.2 to upload your file, and section 2.4 to prepare it as a feature data set for HVIR.

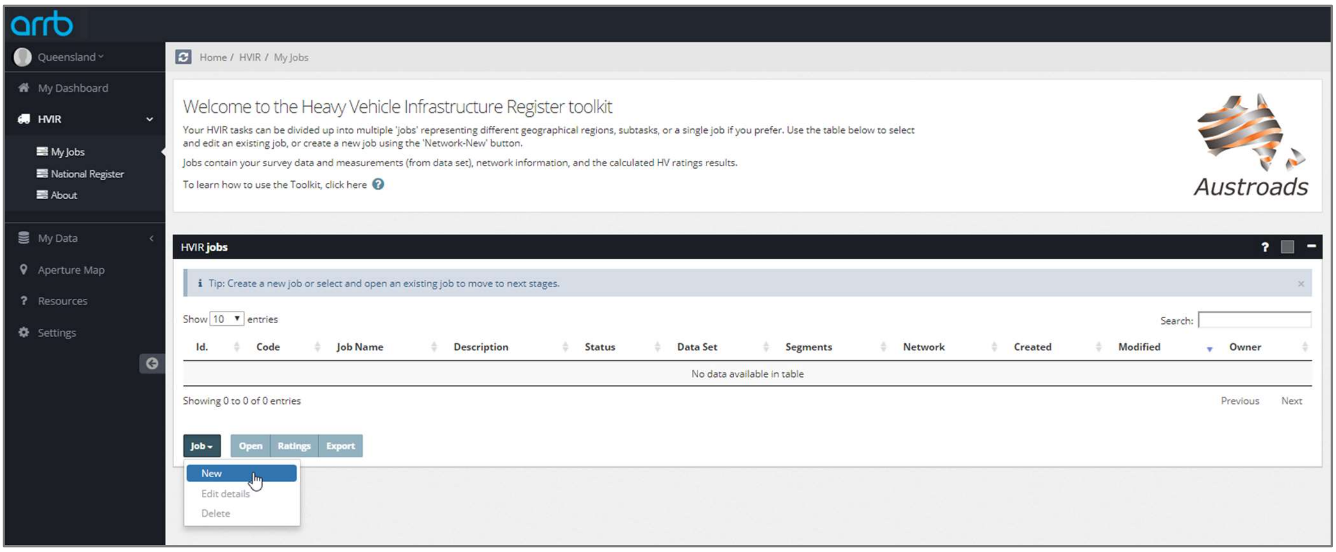
3. Heavy Vehicle Infrastructure Ratings

3.1 Creating a HVIR 'Job'

A HVIR 'Job' refers to a set of ratings that are produced for a particular purpose at one point in time. The key part of setting up the job is the association of a feature data set with a network.

- Select the HVIR Tool from the Navigation bar, the click 'My Jobs'. This will bring up the HVIR Jobs widget containing a list of previous Jobs and some action buttons (see Figure 30).
- To create a new Data Set, click on the 'Data Set' dropdown menu in the widget, and then select 'New'.

Figure 30: A HVIR 'Job' is a set of ratings produced for a purpose



The widget will then change to the three-step process for creating a HVIR Job.

Step 1 – Job Information

- Give your Job a short name for quick reference (see Figure 31). It is recommended that this includes something to indicate what the Job is for, and the date.
- More detailed information can be entered in the description.
- If the HVIR Job is associated with a project or other body of work, codes and reference numbers can be included in the remaining field.
- Click the 'Next' button on the bottom right of the widget.

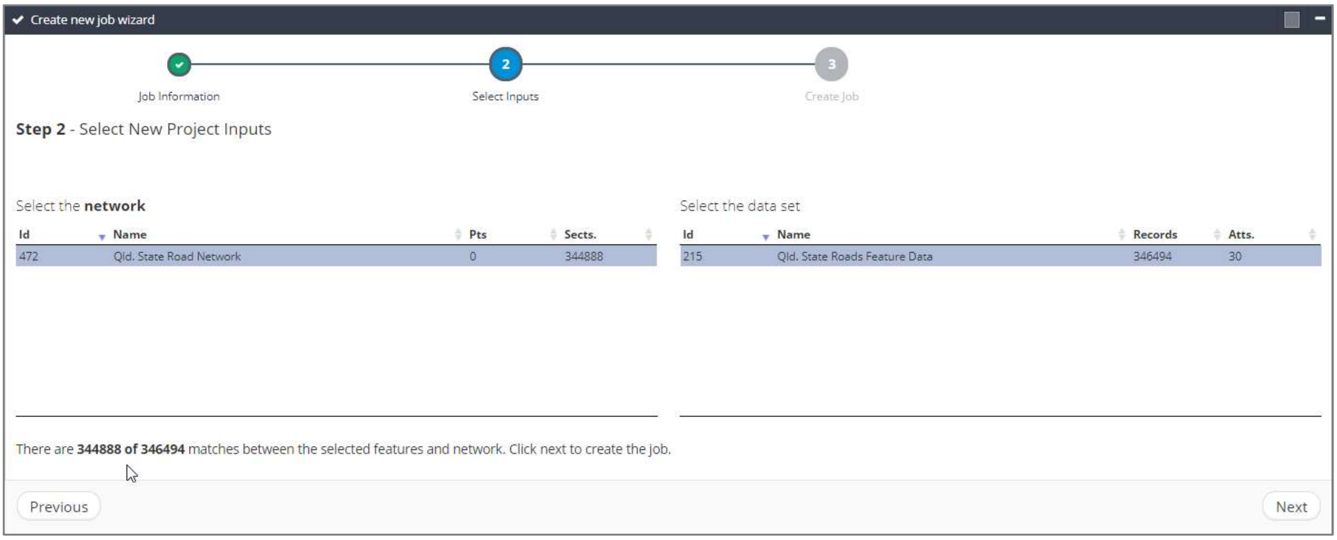
All fields can be edited later if needed.

Figure 31: The Job can be given a name and a brief description

Step 2 – Select Inputs:

- You will be shown two lists of all the defined networks and all the prepared data sets available. Select the network and feature dataset for this Job from the lists.
- If you wait a few moments, you can see a check at the bottom of the widget running (see Figure 32). This check is counting how many matches (by Unique ID) there are between the Data set and the Network you have selected. If there are zero matches you will not be able to generate any ratings. Both numbers do not need to be the same, since there may not be feature data for every network location.
- Click the 'Next' button on the bottom right of the widget.

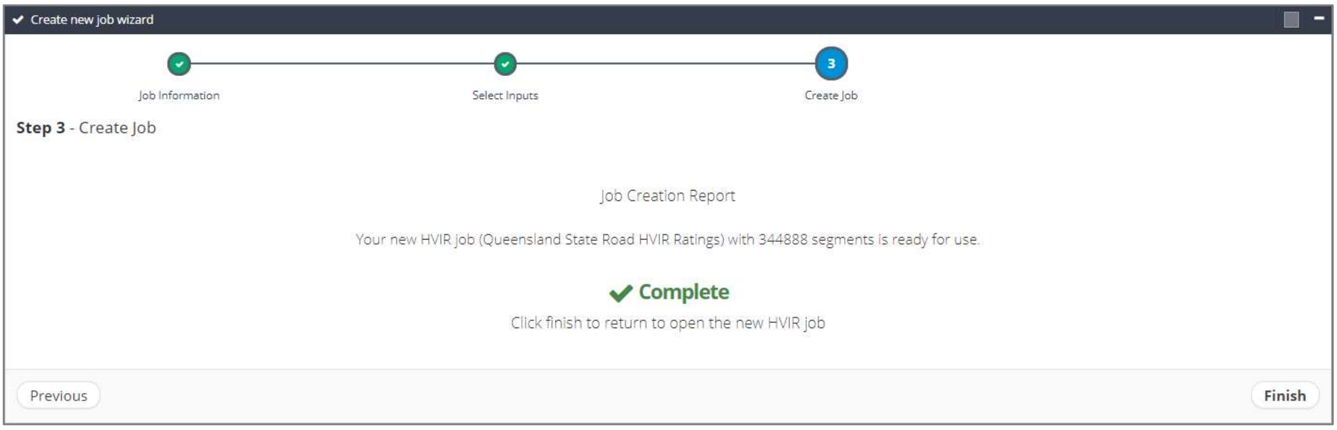
Figure 32: The feature data set must be associated with the network locations for which ratings are to be generated



Step 3 – Create Job:

- The Toolbox will spend some time processing the Job.
- Once the processing is completed (see Figure 33), click 'Finish' at the bottom right of the widget.

Figure 33: Once the job has been created, the ratings are ready to be generated



After clicking finish, the Tool will automatically start the three-step process to produce ratings:

- Reviewing the inputs and calculating the Heavy Vehicle Infrastructure Ratings.
- Viewing and investigating the results.
- Sharing and publishing of ratings.

3.2 Reviewing the Network and Infrastructure Feature Data

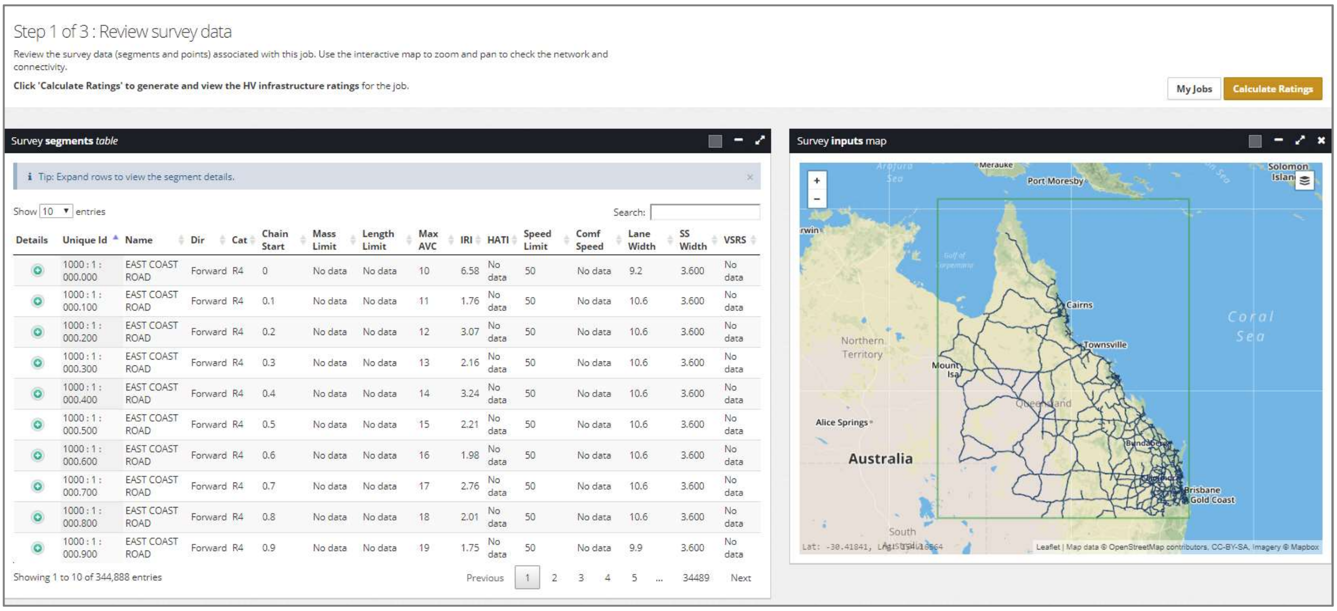
The first step in generating HVIR results is to review the input data. The Tool will display two widgets (see Figure 34): a table of all of the data that could be used in the calculations (different methods use different data), and a map of the network locations.

The lines in the (100 m) survey segments table can be expanded by clicking on the green plus symbol in the ‘Details’ column in the first column of the table. This will show all the information recorded for that segment. The search box can be used to locate specific segments or groups of segments, and the table can be sorted by the data in individual columns.

The map is fully interactive.

➢ If the network and feature data is in order, click ‘Calculate Ratings’.

Figure 34: The review screen shows the network in which the HVIR results will be generated



Details	Unique Id	Name	Dir	Cat	Chain Start	Mass Limit	Length Limit	Max AVC	IRI	HATI	Speed Limit	Comf Speed	Lane Width	SS Width	VSRS
	1000 : 1 : 000.000	EAST COAST ROAD	Forward	R4	0	No data	No data	10	6.58	No data	50	No data	9.2	3.600	No data
	1000 : 1 : 000.100	EAST COAST ROAD	Forward	R4	0.1	No data	No data	11	1.76	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.200	EAST COAST ROAD	Forward	R4	0.2	No data	No data	12	3.07	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.300	EAST COAST ROAD	Forward	R4	0.3	No data	No data	13	2.16	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.400	EAST COAST ROAD	Forward	R4	0.4	No data	No data	14	3.24	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.500	EAST COAST ROAD	Forward	R4	0.5	No data	No data	15	2.21	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.600	EAST COAST ROAD	Forward	R4	0.6	No data	No data	16	1.98	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.700	EAST COAST ROAD	Forward	R4	0.7	No data	No data	17	2.76	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.800	EAST COAST ROAD	Forward	R4	0.8	No data	No data	18	2.01	No data	50	No data	10.6	3.600	No data
	1000 : 1 : 000.900	EAST COAST ROAD	Forward	R4	0.9	No data	No data	19	1.75	No data	50	No data	9.9	3.600	No data

3.3 Calculating HVIR Ratings

When the ‘Calculate Ratings’ button is clicked, a ‘Configure Calculation’ panel will appear (see Figure 35).

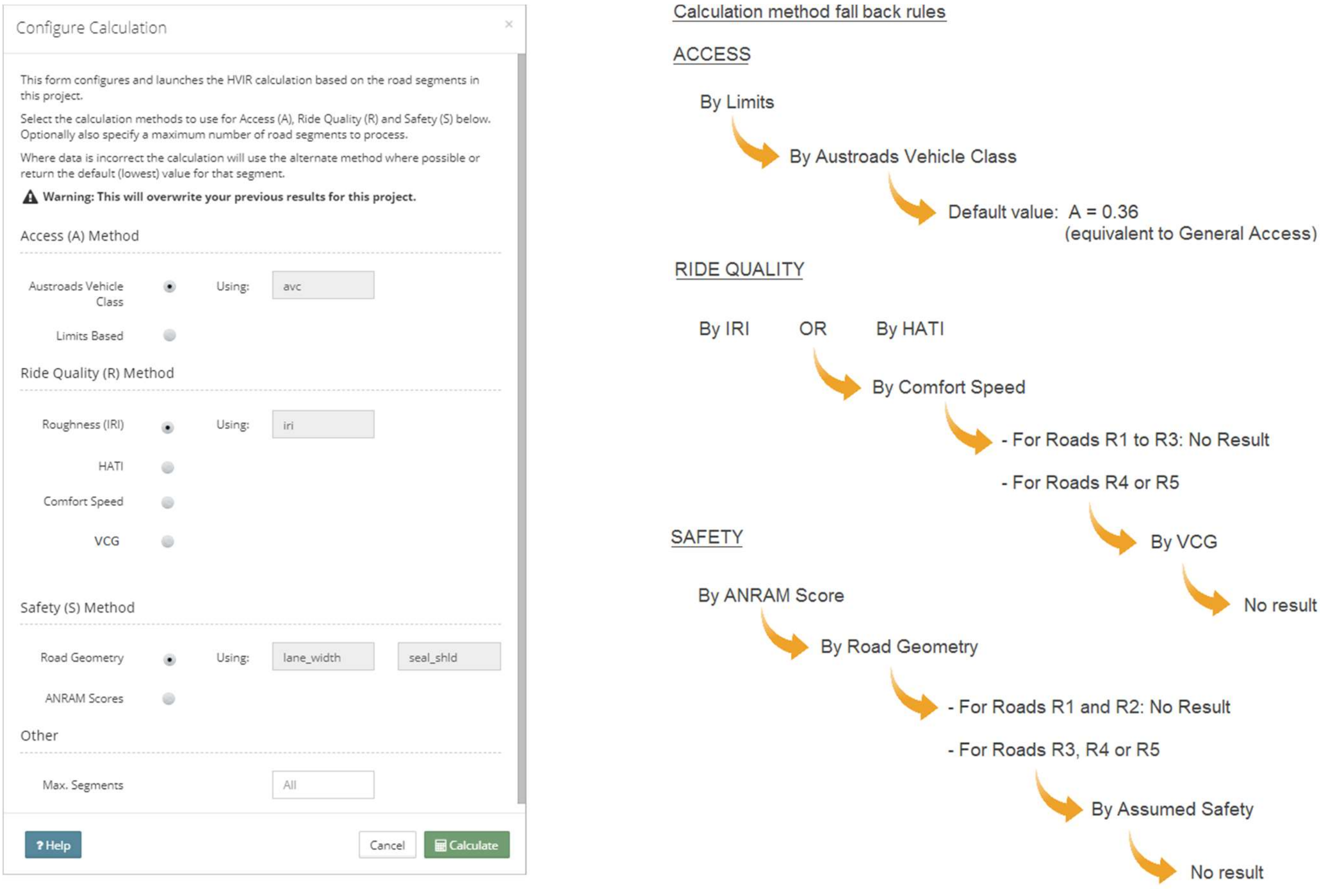
The HVIR Tool allows rating to be calculated by a number of alternative methods (see Appendix) depending on what data is available.

- Select the calculation method you want to use for each Service Attribute by using the radio buttons.

The calculation method selection is for the entire data set. However, in the case of lines where data is missing, there are ‘fall back’ rules from the advanced to the more basic methods of calculation and, in the case of the Access Service Attribute, to a default representing General Access. The fall backs only move in one direction, so if a basic method is selected, the fall back will be to the default value or null result, even if the data for the advanced method is present.

- Once the calculation methods have been selected (or to accept the defaults), click the ‘Calculate’ button at the bottom right of the panel.
- The Tool with then calculate the ratings. The amount of time this takes depends on the size of the data set and the performance of your computer and internet connection. It is reasonable to expect that it will take less than a minute with an average computer and internet connection.
- Click ‘View Ratings’ when the button appears.

Figure 35: HVIR calculations are customisable



3.4 Reviewing Results

Once the Ratings have been calculated, the screen will show a number of widgets (see Figure 36), each of which is interactive:

- The ‘Segments Rating’ Table showing the results for each segment, with sorting and search functions.
- A main map of the network showing colour-coded ratings.
- A list of roads in the network with averaged results.
- A table of financial data.
- Graphics providing indications of the distribution of results.

The results can be investigated by zooming in on the interactive map and clicking on road segments to bring up a pop-up box containing more detailed information about the results for that segment. Clicking ‘Filter’ in the pop-up box with automatically filter the ‘Segments Rating’ table for that unique ID (see Figure 37).

Figure 36: Once HVIR ratings have been generated, they are shown on the map and in tables

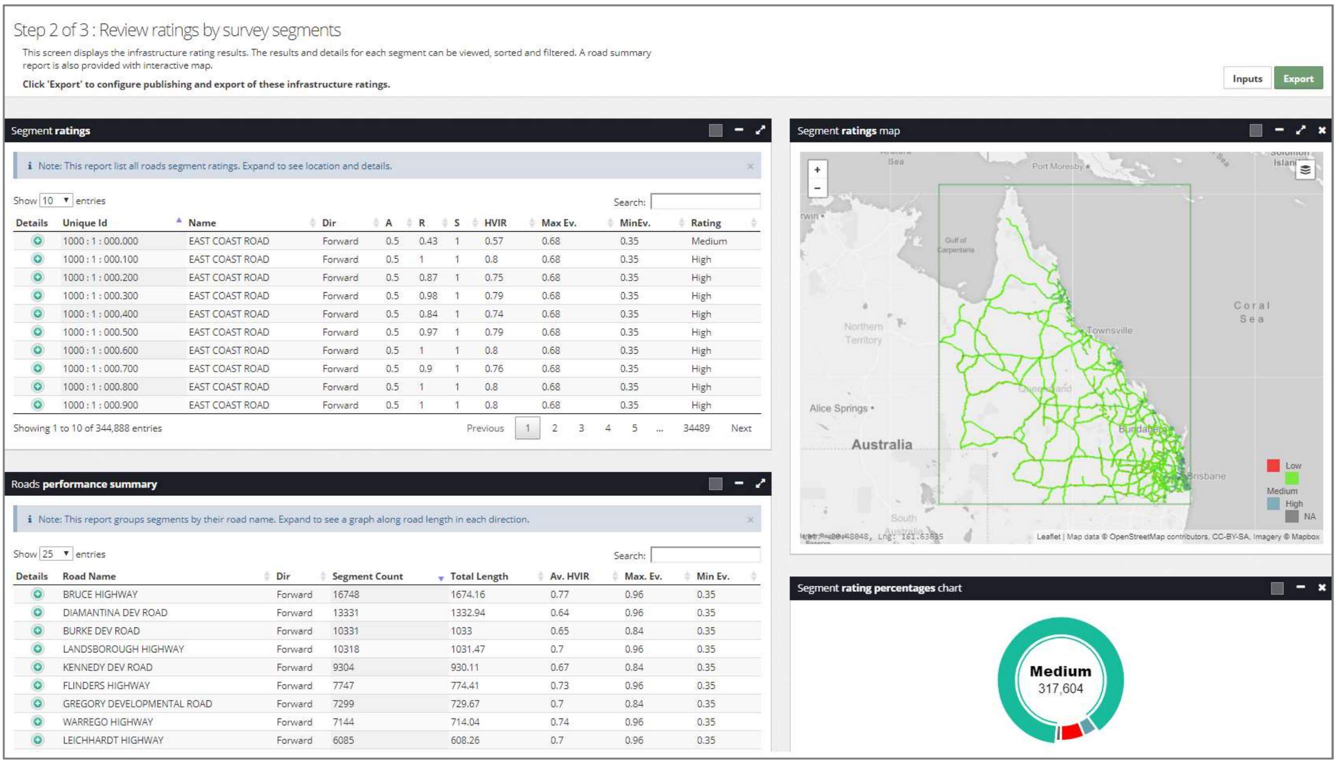
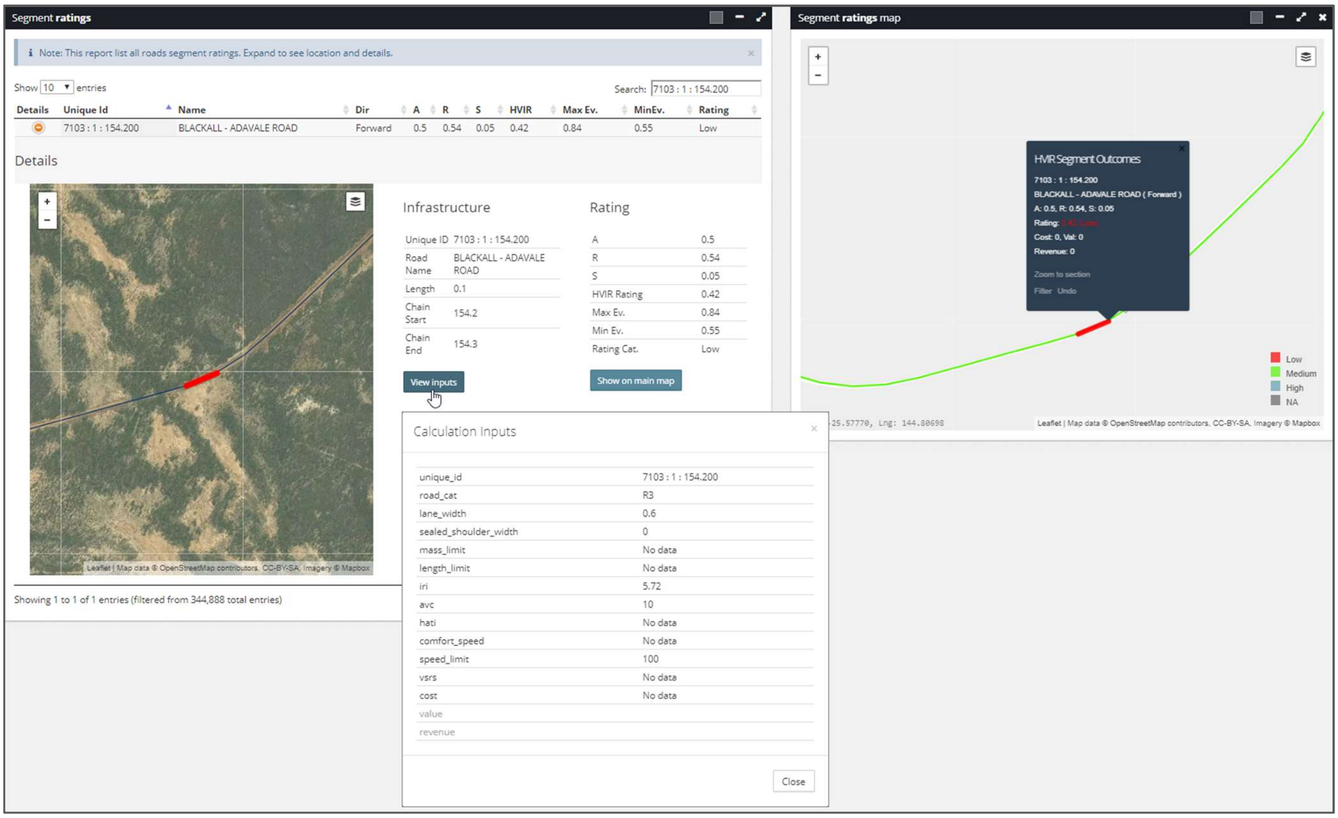


Figure 37: Using the interactive map and the tables, results can be investigated



In the ‘Segments Rating’ table individual segments can be expanded by clicking the green plus symbol (see Figure 38). Doing so brings up information about the results for that segment and a map of the segment. The ‘Show Inputs’ button can be clicked to bring up a pop-up box with the input data for that segment, allowing users to locate an explanation for why the results are as they are (e.g. if trying to ascertain why a road segment has a ‘Low’ result). Clicking the ‘Show on Main Map’ button will zoom the network map to the location of the road segment.

Figure 38: Lines in the Segment Ratings table can be expanded

Segment ratings

ℹ Note: This report list all roads segment ratings. Expand to see location and details.

Show 10 entries

Search:

Details	Unique Id	Name	Dir	A	R	S	HVIR	Max Ev.	MinEv.	Rating
+	1000 : 1 : 000.000	EAST COAST ROAD	Forward	0.5	0.43	1	0.57	0.68	0.35	Medium
+	1000 : 1 : 000.100	EAST COAST ROAD	Forward	0.5	1	1	0.8	0.68	0.35	High
+	1000 : 1 : 000.200	EAST COAST ROAD	Forward	0.5	0.87	1	0.75	0.68	0.35	High
+	1000 : 1 : 000.300	EAST COAST ROAD	Forward	0.5	0.98	1	0.79	0.68	0.35	High
+	1000 : 1 : 000.400	EAST COAST ROAD	Forward	0.5	0.84	1	0.74	0.68	0.35	High
−	1000 : 1 : 000.500	EAST COAST ROAD	Forward	0.5	0.97	1	0.79	0.68	0.35	High

Details

Infrastructure

Unique ID	1000 : 1 : 000.500
Road Name	EAST COAST ROAD
Length	0.1
Chain Start	0.5
Chain End	0.6

Rating

A	0.5
R	0.97
S	1
HVIR Rating	0.79
Max Ev.	0.68
Min Ev.	0.35
Rating Cat.	High

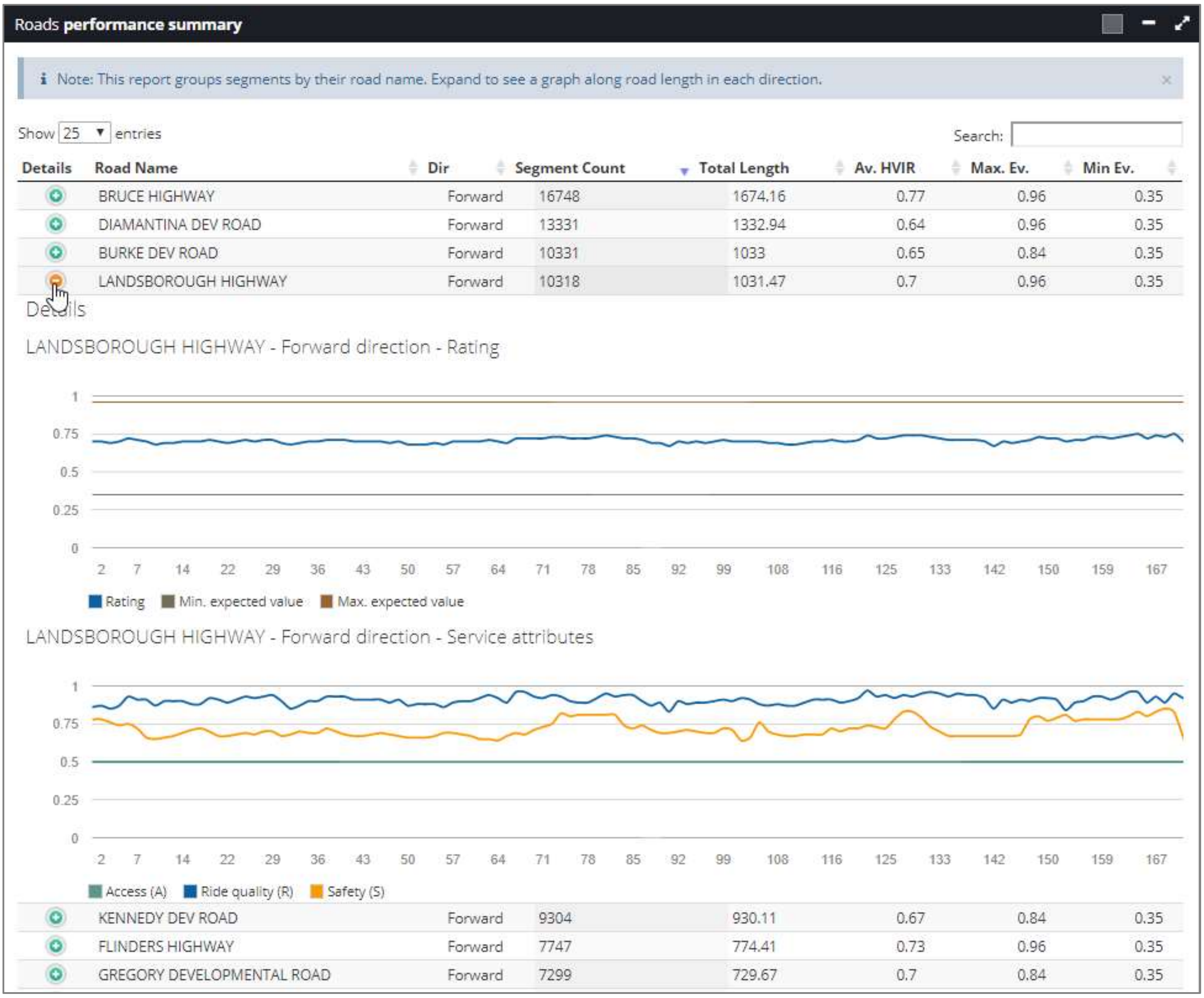
Show on main map

Details	Unique Id	Name	Dir	A	R	S	HVIR	Max Ev.	MinEv.	Rating
+	1000 : 1 : 000.600	EAST COAST ROAD	Forward	0.5	1	1	0.8	0.68	0.35	High
+	1000 : 1 : 000.700	EAST COAST ROAD	Forward	0.5	0.9	1	0.76	0.68	0.35	High

The rows in the road performance table can also be expanded to see the HVIR results against chainage for the length of the road, and the individual Service Attributes against the chainage (see Figure 39).

- To share or publish the results, click the ‘Export’ button in the message box.

Figure 39: Lines in the Roads Performance Summary table can be expanded



Details	Road Name	Dir	Segment Count	Total Length	Av. HVIR	Max. Ev.	Min Ev.
	BRUCE HIGHWAY	Forward	16748	1674.16	0.77	0.96	0.35
	DIAMANTINA DEV ROAD	Forward	13331	1332.94	0.64	0.96	0.35
	BURKE DEV ROAD	Forward	10331	1033	0.65	0.84	0.35
	LANDSBOROUGH HIGHWAY	Forward	10318	1031.47	0.7	0.96	0.35
	KENNEDY DEV ROAD	Forward	9304	930.11	0.67	0.84	0.35
	FLINDERS HIGHWAY	Forward	7747	774.41	0.73	0.96	0.35
	GREGORY DEVELOPMENTAL ROAD	Forward	7299	729.67	0.7	0.84	0.35

3.5 Sharing and Publishing Results

The final step is the sharing of HVIR results (see Figure 40), and the tool offers three methods for this:

- Downloading a .CSV of the ratings.
- Providing a Public URL for a version of the 'Review ratings' page without navigation controls.
- Publishing the results to the National Map.

➢ A .CSV of the results can be generated by clicking the 'Build CSV' button in the download widget.

For the remaining methods, permissions must be provided by the Tool. If visibility is set to ‘Off’, this will turn off permissions for data that has already been shared; i.e. the Public URL will not work and the results will not be shown on the National Map.

To generate a valid Public Share URL:

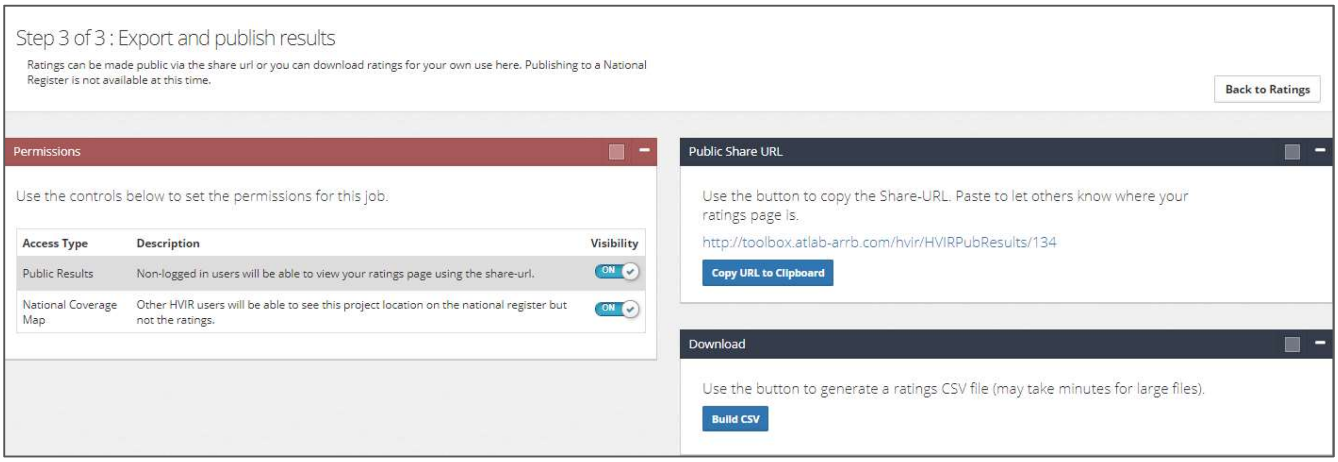
- In the ‘Permissions’ widget, click the ‘Visibility’ control to on for the Public Share results.
- In the ‘Public Share URL’ widget, either select and copy (Ctrl-C or right click → Copy) the link manually or click the ‘Copy to Clipboard’ button.
- The URL can now be pasted into an email body or messaging window and sent for anyone to access the interactive results screen (but they cannot navigate into other areas of the HVIR Tool).

Publishing coverage to the national map is the placeholder for the formal submission of results for the purposes of the reform. Only the locations are published to the map at this time, not the ratings.

To publish coverage:

- In the ‘Permissions’ widget, click the ‘Visibility’ control to ‘on’ for the ‘National Coverage Map’.

Figure 40: There are a number of controlled means of sharing HVIR results



4. Support

Any queries regarding the use of the HVIR Tool and the Road Manager's Toolbox should be directed to:

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Appendix – HVIR Calculation Methods

A1 HVIR Calculation Framework

The equation for the calculation of HVIR is:

$$\text{HVIR (\%)} = 100 \times (0.4A + 0.4R + 0.2S) \qquad 1$$

Where the three Service Attributes (with relative weighting) are:

- A = Access (0.4),
- R = Ride quality (0.4), and
- S = Safety (0.2)

The framework permits other Service Attributes to be added with appropriate adjustments to weightings to ensure the result always varies between 0 and 100%.

Each Service Attribute must have the following qualities:

- The outputs are reported on a scale from 0 (bad) to 1 (good).
- The input parameters are based on infrastructure.
- All parameters are to be reported at 100 metre intervals.

For each Service Attribute, a number of Calculation Methods are permitted based on what data is available. However:

- All of the Calculation Methods must produce equivalent results
- Calculation Methods that rely on cruder or less reliable data must be limited compared to other Calculation Methods.

The current set of calculation methods are shown in Table 9.

Table 9: Calculation Methods for HVIR Service Attributes

Service attribute	Calculation method	Parameters	Unit of measurement
Access	By Limits (Advanced)	Mass limit	t
		Length limit	m
	By Austroads Vehicle Class (Basic)	Max. permitted vehicle class	Class #
	Assumed Access (Default)	-	-
Ride quality	By IRI (Advanced 1)	Roughness	IRI m/km
	By HATI (Advanced 2)	Roughness	HATI (m/km)
	By Subjective Comfort Speed (Basic1)	Speed limit	km/h
		Subjective speed of comfort	km/h
	By VCG (Basic 2)	Visual Condition Grade	Grade #
		Road Category	R4 or R5
Safety	By ANRAM Risk Score (Advanced)	ANRAM Rating	Total Vehicle SRS
	By Road Geometry (Basic 1)	Lane width	m
		Sealed shoulder width	m
	Assumed Safety (Default)	Speed limit Road Category	km/h R4 or R5

Equation 1 allows any road to be given a HVIR score based on its physical characteristics. However, for roads of different categories there are different expectations based on factors such as speed limits, traffic levels and role or importance in the network. These expectations, encapsulated in the HVIR functional road category, provide a context for the interpretation of HVIR values.

A range of expected values is defined for each HVIR road category, stated in Table 10. The range as indicated by the maximum and minimum expected values varies according to the road category and are higher (more demanding of quality and capacity) for higher category roads.

Table 10: Maximum and minimum expected values for HVIR by road category

Road Category	General description of category	HVIR	
		Max.	Min.
R1	Freeways	96%	73%
R2	Urban Highways	92%	60%
R3	Urban arterials and rural highways	84%	55%
R4	Collector and distributor roads	68%	40%
R5	Access roads	56%	31%

These expected values divide the range of possible ratings into:

- Low – the HVIR is below the minimum expected value for that road category
- Medium – the HVIR is between the minimum and maximum expected values for that road category
- High – the Infrastructure Rating is above the maximum expected value for that road category.

Figure 41: Maximum and minimum expected ranges defining ranges for High, Medium and Low ratings

The means of determining the Expected Values is explained in the following Sections B2, B3 and B4 as part of the explanation of the Calculation Methods.

A2 Calculation Methods for Access

By Limits

The calculation of Access by Limits is based on a consideration of the mass and length limits of a road. The 'amount of access' of a road is measured by comparing these limits against the upper end of mass and length limits present in the vehicle fleet across Australia, as defined by the NHVR's mass and dimension limits.

For the mass limit the upper end of access is taken as a mass of 119 tonnes; based on the General Mass Limit (GML) of a BAB Quad-configuration road train. The method of calculating the capacity by mass (*M*) is shown in equation 2:

$$M = \frac{Mass\ limit\ of\ road\ (t)}{119\ t} \qquad 0 \le M \le 1 \qquad (2)$$

For the length limit the maximum vehicle length of 53.5 metres for the longer road trains. The method of calculating the capacity by length (*L*) is shown in equation 3:

$$L = \frac{Length\ limit\ of\ road\ (m)}{53.5\ m} \qquad 0 \le L \le 1 \qquad (3)$$

The Access service attribute (*A*) is then calculated by Equation 4:

$$A = \frac{2M}{1 + \frac{M}{L}} \quad (4)$$

Maximum and minimum expected values of *M* and *L* considered appropriate for each road category are determined by expectations of the range of vehicles each road category is reasonably expected to be able to accommodate under normal circumstances

- R5, access or local roads, are required to be able to accommodate general access vehicles, so the minimum expected value is set by inputs of 50 tonnes and 19 metres. The maximum is defined by the minimum for the next level:
- R4, collector and distributor roads, are required to be accommodate the longest B doubles, so minimum expected value is set by inputs of 62.5 tonnes and 25 metres. The maximum expected value is set by the minimum for the next level:
- The minimum requirements for the remaining road categories (R3, R2 and R1) are the same since these roads need to offer the same level of access in order for the network to be used (i.e. a higher level of access on a freeway is pointless since a vehicle requiring the higher level of access would not be able to use lesser roads to enter it, and or lesser roads to leave). Therefore, the minimum inputs are 99 tonnes and 36.5 metres. The maximum inputs are 119 tonnes and 53.5 metres.

Table 11 shows the Expected values for the Access service attribute when these inputs are used.

Table 11: Expected values for Access

Road category	General description of category	Mass limits (tonnes)		Length limits (m)		Access	
		Maximum expected value	Minimum expected value	Maximum expected value	Minimum expected value	Maximum expected value	Minimum expected value
R1	Freeways	119	99	53.5	36.5	1.00	0.75
R2	Urban Highways	119	99	53.5	36.5	1.00	0.75
R3	Urban arterials and rural highways	119	99	53.5	36.5	1.00	0.75
R4	Collector and distributor roads	99	62.5	36.5	25	0.75	0.50
R5	Access roads	62.5	50	25	19	0.50	0.39

By Austroads Vehicle Class

The determination of Access by Austroads vehicle class is an equivalent calculation to the By Limits method. It uses as an input the highest class of vehicle allowed to use the road, and outputs the corresponding access level that would be determined by the longest and heaviest vehicle in that class using the By Limits method.

Table 12 shows the access levels associated with each Austroads class:

Table 12: Access by Austroads vehicle class

Austroads Class	A
3	0.17
4	0.21
5	0.22
6	0.26
7	0.30
8	0.34
9	0.36
10	0.50
11	0.75
12	1.00

The expected values as determined in the By Limits methods are used for this method.

Assumed Access

If no Access data is available, the access level is assumed to be General access only. This corresponds to AVC = 9, which is $A = 0.36$.

A3 Calculation Methods for Ride Quality

By IRI

Ride Quality for a sealed road is determined by the IRI of a road on a linear scale between a value nominated as reasonable for a new, high quality road and a value as the lowest acceptable value for an old, low-speed, low traffic road.

An IRI of 2 m/km has been selected for the upper end of the scale. While newly constructed, rehabilitated or resealed roads are often required to have a higher lower (better) IRI, this upper value is not only for new surfaces but is meant to reflect the range of IRI values for which a newer road is still considered to be offering the highest level of ride quality .

The lower end of the ride quality scale is set to an IRI of 10 m/km.

With these values of 2 and 10 m/km determining the upper and lower bounds of the liner scale, ride quality (R) by IRI is calculated by equation 5.

$$R = -0.125 \times IRI + 1.25 \qquad 0 \le R \le 1 \qquad (5)$$

The expected values of IRI chosen by the project team for each road category are based on considerations of the speed limit, traffic level and function within the network. The current values are shown in Table 13. These are largely arbitrary.

Table 13: Maximum and minimum expected values of roughness and the Ride Quality service attribute

Road Category	General description of category	IRI (m/km)		R	
		Max.	Min.	Max.	Min.
R1	Freeways	2	4	1	0.75
R2	Urban Highways	2.5	5	0.94	0.63
R3	Urban arterials and rural highways	3	6	0.88	0.50
R4	Collector and distributor roads	3.5	7	0.81	0.38
R5	Access roads	4	8	0.75	0.25

By HATI

Ride Quality using the Heavy Articulated Truck Index is similar to using IRI except that HATI uses profile data collected from the wheel path of heavy vehicles, and utilises a half-truck model that is intended to represent the greater sensitivity of heavy vehicles.

The linear scale for HATI has been determined as varying between 1.0 and 5.5. This is based on a comparison of IRI and HATI data collected from A, B and C class roads to determine a relationship between these measures.

With the values of 1.0 and 5.5 m/km determining the upper and lower bounds of the liner scale, ride quality (*R*) by HATI is calculated by equation 6.

$$R = -0.2222 \times HATI + 1.2222 \quad 0 \le R \le 1 \qquad (6)$$

The expected values of *R* for each road category as determined in the By IRI methods are used for this method.

By Subjective Comfort Speed

Because local governments often do not have the resources for collecting road roughness by vehicle surveys, the following method has been included to allow an indication of ride quality to be obtained. Because the input to this measure is far less reliable that the methods by IRI or HATI, the output, *R*, is limited to one of two values: the middle of the Expected range (Medium), or the middle of the Below Expectations range (Low).

The subjective data is collected, still at 100 m intervals, by sitting in a passenger car and noting the maximum legal speed at which the road can be travelled and considered comfortable. The rougher the road is, the slower the vehicle will have to travel to achieve a comfortable ride.

This ‘Comfort Speed’ is compared to the speed limit and a value of 80% is defined as the limit of acceptable speed reduction. The calculation method and outputs are shown in Table 14.

Table 14: Determination of R by the Comfort Speed method for each road category

For Road Category	$If \quad \frac{Comfort\ Speed\ (\frac{km}{h})}{Speed\ Limit\ (\frac{km}{h})} \geq 0.80,$	Eq. 7
	Then *R* =	**Else: *R* =**
R1	0.88	0.38
R2	0.78	0.31
R3	0.69	0.25
R4	0.53	0.13
R5	0.38	0.00

By Visual Condition Grade

Local governments often collect visual condition information about roads on their network, noting the extent of surface defects such as deformation and damage. The Institute of Public Works Engineers Australasia (IPWEA) have attempted to create a national standardised rating system for this, explained in IPWEA Practice Notes 9 and 9.1. While the ARRB project team was aware of this, initially the Subjective Comfort Speed (SCS) method, was devised in order to attempt to directly assess ride quality, albeit subjectively. The visual inspection rating is both subjective and indirect. However, based on the feedback, LGs are unlikely to commit additional resources to collect the SCS. Therefore, it seems prudent at this time to include a method that uses data that is already collected to obtain an indication of the ride quality.

The IPWEA visual inspection assessment has 6 possible grades as shown in Table 15

Table 15: IPWEA visual condition grades

Grade	Condition
0	Not Rated
1	Very Good
2	Good
3	Fair/Moderate
4	Poor
5	Very Poor

The Visual Condition Grade (VCG) Calculation Method for ride quality (*R*) is as defined in Table 16, and relates each grade to a value of *R*. This method is intended for use by local governments and is therefore limited to R4 and R5 roads only.

Table 16: Visual Condition Grade (VCG) Calculation Method for Ride Quality

Grade	*R*		Justification
	R4 roads	R5 roads	
0	-	-	No result
1	0.81	0.75	Top of expected (Medium) range for an ‘as new’ road
2	0.59	0.50	Middle of expected range
3	0.38	0.25	Lower end of expected range
4	0.19	0.13	Middle of below expectations (Low) range
5	0	0	Surface has failed

A4 Calculation Methods for Safety

By Road Geometry

Safety by Road Geometry uses the widths of the (outer) lane and left-hand sealed shoulder.

The calculation of the safety benefit of lane width is based on horizontal tracking requirements of vehicles under PBS, which range from 2.9 m for general access vehicles up to 3.3 metres for the longest vehicles. Rather than topping out at 3.3 metres, which would not register the increased safety benefit of wider lanes, the maximum safety is considered to be conferred by lanes widths of 5.8 m, which is double the minimum lane requirement under PBS. The reasoning for this is that once lanes are effectively double width, traffic tends to drive side by side as if there are two, unmarked lanes, thereby eliminating any safety benefit from additional width. The calculation of this is by Equation 8.

$$S_{LW} = \frac{Width\ of\ lane\ (m)}{5.8} \quad , \qquad 0 \leq S_{LW} \leq 1 \qquad 8$$

The safety benefit of sealed shoulder width is calculated on a liner scale that maximises at 3 m, which provides enough room to park a vehicle out of the lane with additional clearance from roadside barriers and ongoing traffic. The calculation of this is by Equation 9.

$$S_{SSW} = \frac{Width\ of\ sealed\ shoulder\ (m)}{3} \quad , \qquad 0 \leq S_{SSW} \leq 1 \qquad 9$$

These are averaged for the calculation of the Safety service attribute. This is shown in Equation 10.

$$S = \frac{(S_{LW} + S_{SSW})}{2} \qquad 10$$

The values of 3.3 m and 2.9 m are also used for the maximum and minimum expected values for lane widths across all five road categories since vehicles travelling at traffic speeds (50+ km/h) must have suitable width. This is affected to some degree by speed, but since the PBS Guidelines do not include speed, it is also not included here.

The maximum and minimum expected values for sealed shoulder widths were determined by attributes of road types under the M, A, B and C road system, with the following additional justifications.

- R1 roads (e.g. freeways) are required to have a wide sealed shoulder that is often an emergency stopping lane. For this reason, the maximum of 3 metres is used. The minimum must be able to accommodate the standard heavy vehicle; therefore, it cannot be any narrower than maximum vehicle width according to the Australian Design Rules, which is 2.5 m.
- R2 roads (e.g. highways and major arterials) often do not have shoulders in built up areas. Therefore, the minimum expected value is zero. Where they are present, the maximum width expected is sufficient to accommodate vehicle width of 2.5 m.
- R3 roads can be urban arterials or rural highways. These are in the same category since they are both important connecting roads that are usually one lane in each direction. Urban arterials may not have shoulders, or the shoulder area can also be used for parking. Although rural arterials are usually required to have shoulders, these may not be sealed. Therefore, the minimum expected value for R3 roads is zero. The sealed shoulder area of an urban arterial or a rural highway is treated here as not being for the purpose of allowing a vehicle to pull over, but simply to provide extra clearance. This is important in built-up areas to increase space between a heavy vehicle and the road side, and on rural highways for allowing heavy vehicle passing each other in opposite directions to move away from the centreline. The maximum expected value for sealed shoulder width on R3 roads is therefore 1 metre.
- R4 and R5 roads general do not have requirements for shoulders and any shoulders that exist are very likely to be used for parking and effectively be unavailable. Therefore, both the maximum and minimum expected values are zero.

The maximum and minimum expected values for all the road categories mentioned above are shown in Table 17 along with the resultant maximum and minimum values for the Safety service attribute.

Table 17: Maximum and minimum expected values for Safety

Road category	Lane width (m)		Sealed shoulder width (m)		S	
	Max.	Min.	Max.	Min.	Max.	Min.
R1	3.3	2.9	3	2.5	0.78	0.67
R2	3.3	2.9	2.5	0	0.70	0.25
R3	3.3	2.9	1	0	0.45	0.25
R4	3.3	2.9	0	0	0.28	0.25
R5	3.3	2.9	0	0	0.28	0.25

By ANRAM Risk Score

The Australian National Risk Assessment Model (AMRAM) includes a risk score assessment for vehicles based on 14 elements of road infrastructure. This score reflects the likelihood of crashes occurring and ranges from a theoretical zero (no likelihood of a crash) up to maximums in the hundreds.

The road category that had the highest risk factors was R3, which includes rural highways. The average ANRAM vehicle Star Rating Score (SRS) for R3 roads was 18.97, with a standard deviation of 17.52. This average plus three standard deviations is 71.54, representing about 99.7% of deviations from the average. This SRS is rounded to 70 and used to define the upper limit of risk score.

The Safety service attribute is calculated by Equation 11:

$$S = \frac{(Vehicle\ SRS\ Total\ - 70)^2}{4900},\ \ 0 \leq S \leq 1 \qquad (11)$$

This is a power relationship that better approximates the distribution of risk factors than a linear relationship.

The Expected Values for Safety using this method are the same as those calculated in the By Geometry method.

By Assumed Safety

Local governments may not have access to detailed inventory information about their roads, and even collecting data about minimum lane and sealed shoulder widths could be challenging. In order to allow ratings to calculated, a certain level of safety has been allowed for local roads only based on assumption that local roads have low traffic. It would be possible to use traffic levels (e.g. AADT) as an input – however, not all councils collect traffic counts on all of their roads.

Every road will have a speed limit, and coupled with the assumption of low traffic, the speed limit is used to indicate the value of S as shown in Table 18.

Table 18: Values of safety using the By Assumed Safety method

Rules	R3 Roads	R4 roads	R5 roads
If speed limit ≤ 50 km/h, S =	0.25	0.25	0.25
If 80 km/h ≥ speed limit > 50 km/h, S =	0.13	0.13	0.13
If speed limit > 80 km/h, S =	0	0	0

The justification for these outputs is:

- This method is intended for Local Governments only therefore it is limited to R5 (Access), R4 (collector/distributor), and R3 (urban arterial) roads only.
- R3, R4 and R5 roads are treated the same since for a local government these categories are intended to indicate a distinction of the role in the network rather than a dramatically different design of road.
- *S* = 0.25 is the lowest value in the ‘Medium’ range of expected values, i.e. it is the minimum safety expected for the road. Roads up to 50 km/h are deemed to be slow enough to be assumed to be (barely) safe at low traffic levels.
- *S* = 0.13 is the middle of the ‘Low’ range of expected values. Roads in the speed range 50 to 80 km/h are assumed to be unsafe, but not associated with the highest risk on the network due to the low traffic levels.
- If the speed is greater than 80 km/h, the risk is perceived to be high regardless of the traffic level, therefore *S* = 0.