2006 Australasian Road Safety Research Policing & Education Conference, Gold Coast, QLD

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CHRISTCHURCH NEW ZEALAND

Application of IHSDM Highway Safety Modelling to New Zealand

Glen Koorey
University of Canterbury
Christchurch, New Zealand

Presentation Outline

- Rural Roads in NZ
- Background to IHSDM Package
- Adaptation of IHSDM to NZ
  - Calibration of Crash Prediction Model
  - Development of Local Design Policy File
  - Importing Road Alignment Data
- Local Site Testing

NZ Road Network...

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NZ Road Network

- 90,000 km of Roads
  - ~65% sealed
- 10,800 km of State Highways (Transit NZ)
  - 170 km of motorway
  - Remaining SHs largely two-lane rural roads
- Relatively difficult terrain

Major concerns with sub-standard curves and lack of passing opportunities

Evaluating Road Network Improvements

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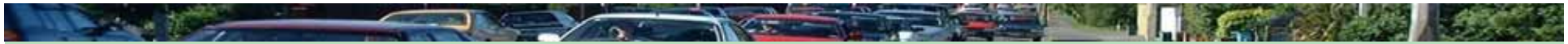
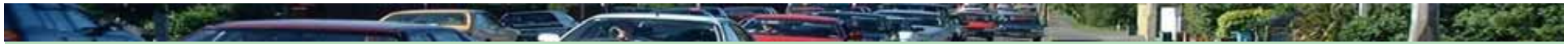


- Key consideration is expected crash risk
  - Existing & Proposed alignments
- This information helps to
  - Prioritise existing sections for investigation
  - Determine relative cost-effectiveness of different improvement options
- Relatively simplistic tools available in NZ
  - More suited to isolated features

    e.g. single curve

IHSDM has potential to help here

Background to IHSDM



Interactive **H**ighway **S**afety **D**esign **M**odel

- Developed by US Federal Highways Administration (FHWA) since ~1994
- Set of software tools for assessing safety impacts of geometric design decisions
- Combines available knowledge about safety into an easily accessible form

"Help planners and designers maximise safety benefits of highway projects within the constraints of cost, environmental, etc"

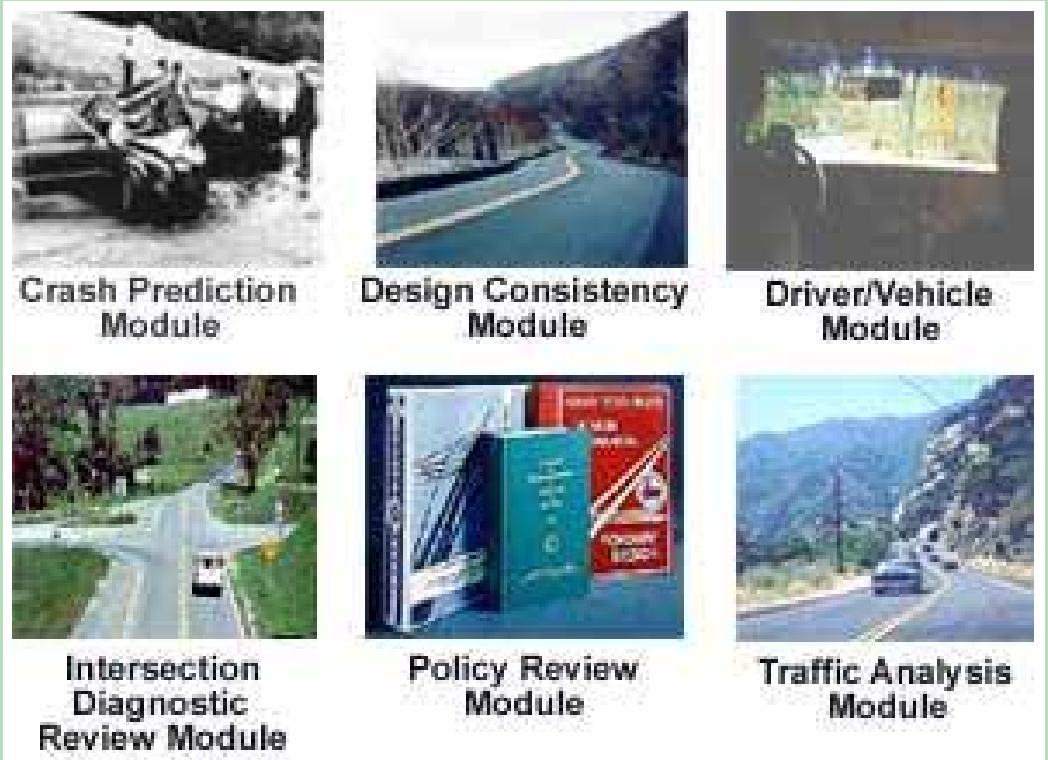
IHSDM Development

- Initial development focused on two-lane rural highways
  - First public version, start of 2003
  - Version 3.0, Sept 2006
- Work on multi-lane rural highways & urban arterials to come
  - First modules by 2007

IHSDM very applicable to the bulk of NZ's rural state highway network

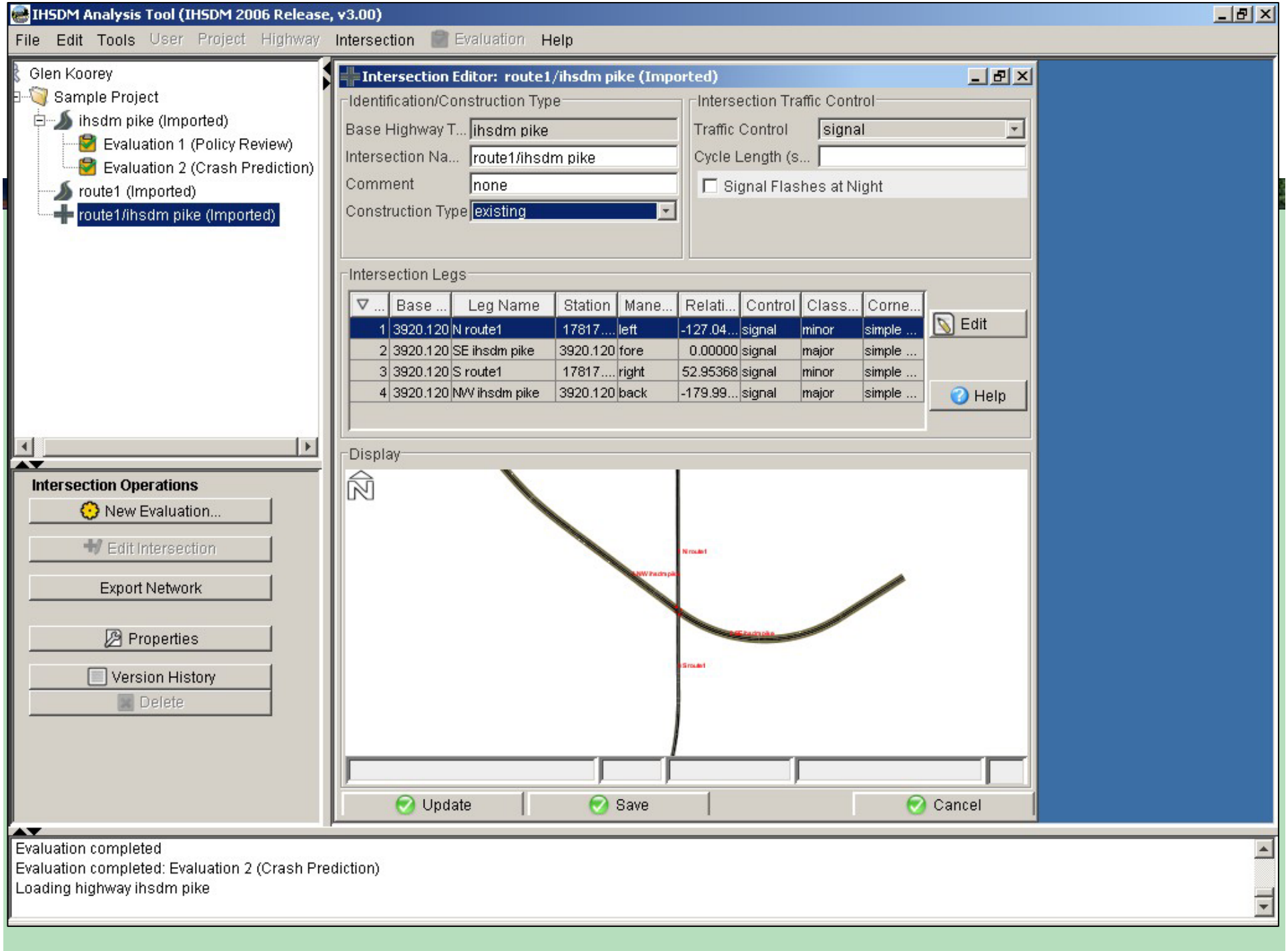
IHSDM Modules

- Six modules (in single application)



(Driver/Vehicle Module still under development)

- All combined with associated support tools


IHSDM Analysis Tool (IHSDM 2006 Release, v3.00)
File Edit Tools User Project Highway Intersection Evaluation Help
Glen Koorey
Sample Project
ihsdm pike (Imported)
Evaluation 1 (Policy Review)
Evaluation 2 (Crash Prediction)
route1 (Imported)
route1/ihsdm pike (Imported)
Intersection Operations
New Evaluation...
Edit Intersection
Export Network
Properties
Version History
Delete
Intersection Editor: route1/ihsdm pike (Imported)
Identification/Construction Type
Base Highway T... ihsdm pike
Intersection Na... route1/ihsdm pike
Comment none
Construction Type existing
Intersection Traffic Control
Traffic Control signal
Cycle Length (s...
Signal Flashes at Night
Intersection Legs
... Base ... Leg Name Station Mane... Relati... Control Class... Corne...
1 3920.120 N route1 17817.... left -127.04... signal minor simple ...
2 3920.120 SE ihsdm pike 3920.120 fore 0.00000 signal major simple ...
3 3920.120 S route1 17817.... right 52.95368 signal minor simple ...
4 3920.120 NW ihsdm pike 3920.120 back -179.99... signal major simple ...
Edit
Help
Display
Update
Save
Cancel
Evaluation completed
Evaluation completed: Evaluation 2 (Crash Prediction)
Loading highway ihsdm pike

Adaptation of IHSDM to NZ

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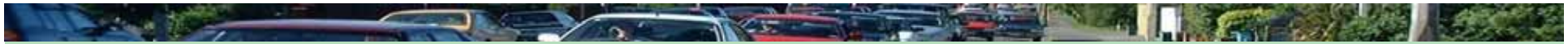

- IHSDM designed for local customisation
- Tasks to make IHSDM suitable for NZ use:
  1. Calibrate crash prediction model with NZ data
  2. Develop NZ Design Policy file based on local agency standards and guidelines
  3. Develop importing routine for NZ highway geometry data
  4. Modify model's vehicle fleet in traffic simulation module
  5. Validate speed prediction routines for NZ conditions

Crash Prediction Module (CPM)

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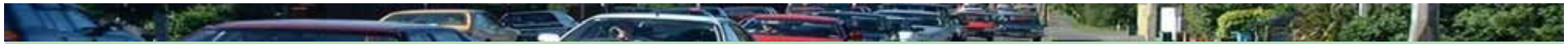


- Estimates number & severity of crashes on roadway segments and intersections
- CPM algorithm consists of

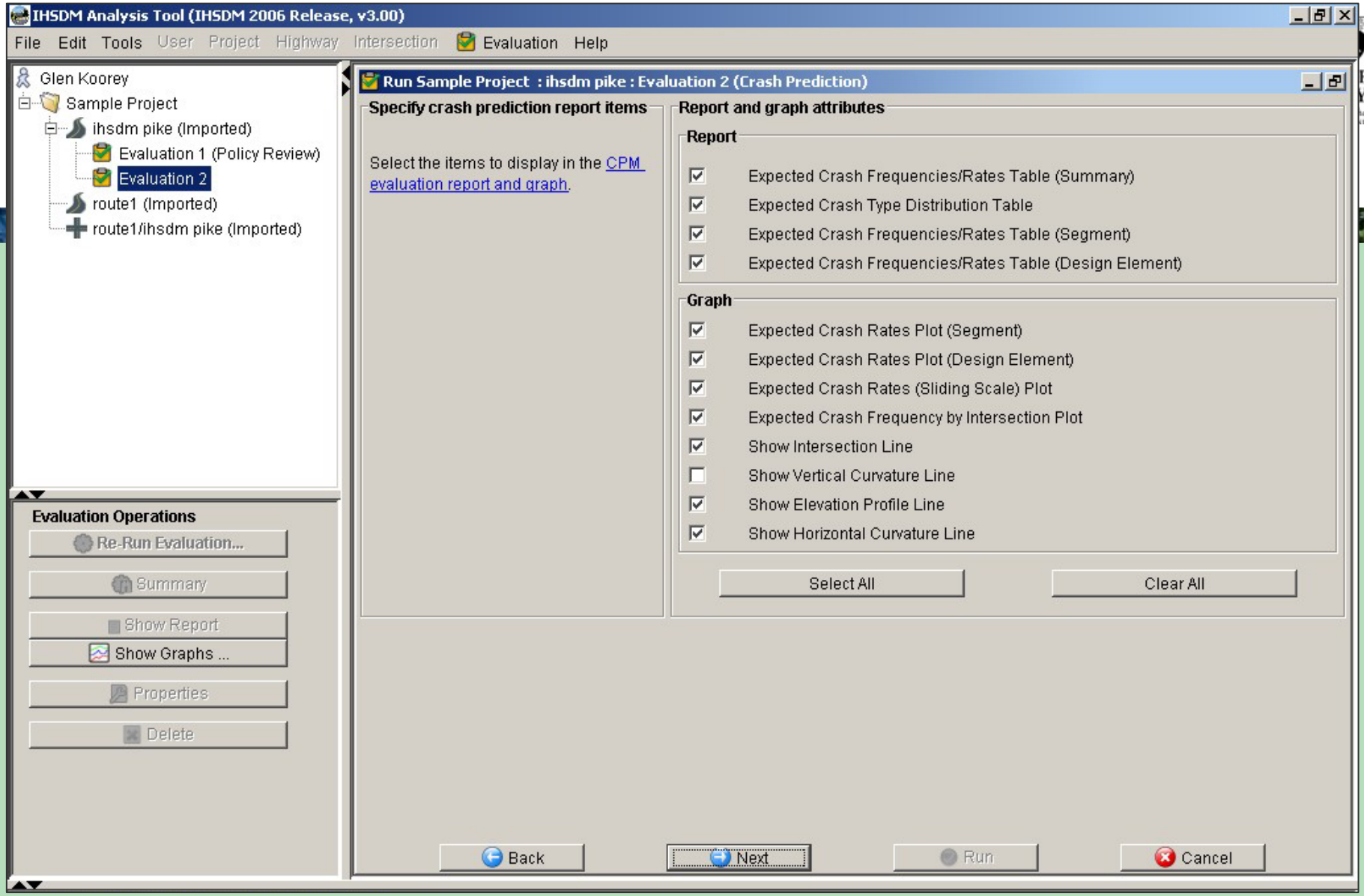
  Base model

  - Provide estimate of safety performance for a set of assumed nominal conditions

  Crash modification factors

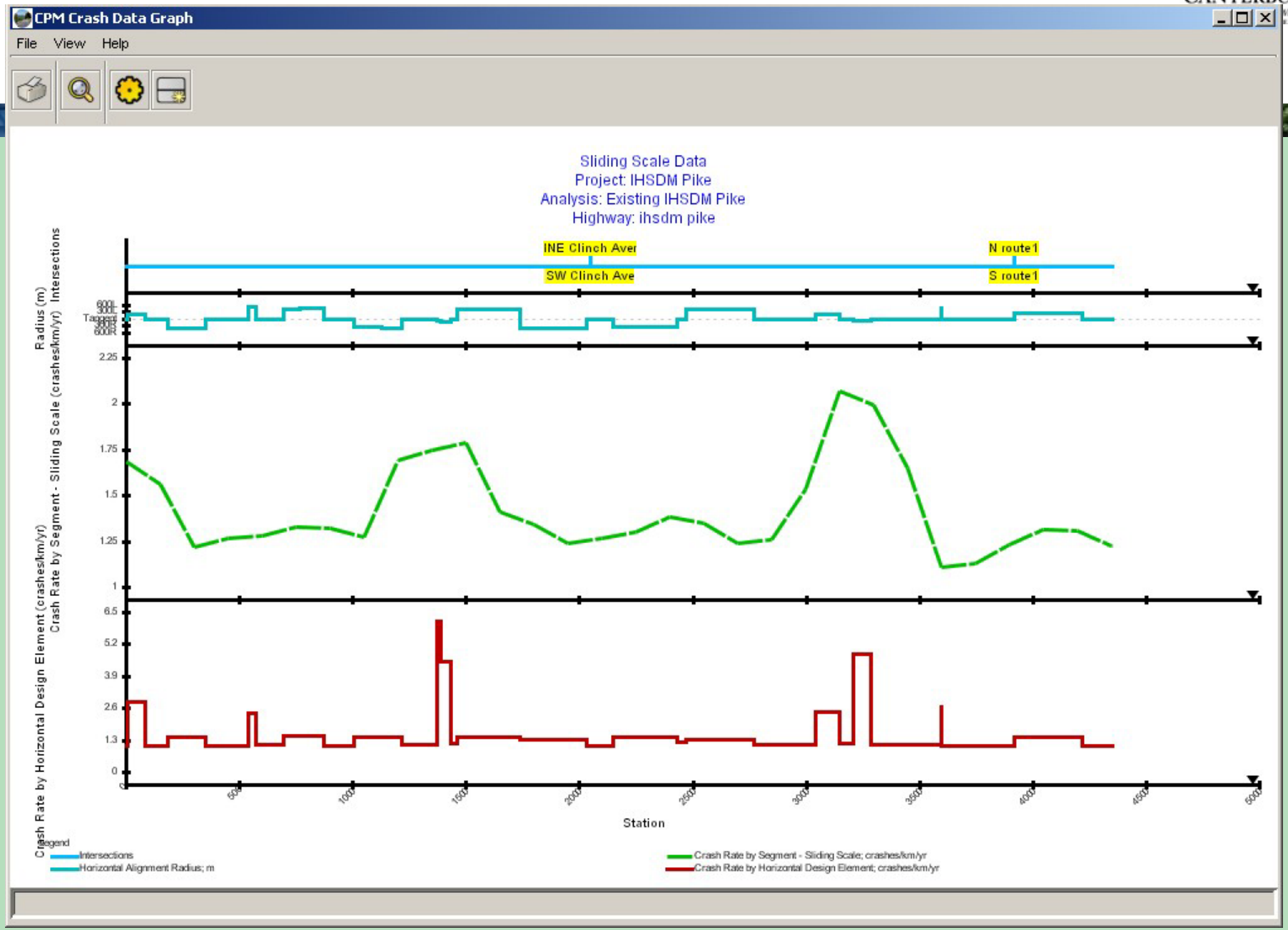
  - Adjust base model to account for effects of:

    Lane width, Shoulder width/type, Driveways, Horizontal curves, Grades, Sight distance, Passing lanes, Intersection control, Turn lanes

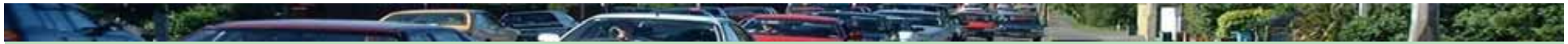


- Can use Empirical Bayes procedure
  - Combine safety predictions with crash history

CPM Outputs


CPM Crash Data Graph
File View Help
Sliding Scale Data
Project: IHSDM Pike
Analysis: Existing IHSDM Pike
Highway: ihsdm pike
INE Clinch Aver
SW Clinch Ave
N route1
S route1
Radius (m)
Intersections
Tangent
600R
Crash Rate by Segment - Sliding Scale (crashes/km/yr)
2.25
2
1.75
1.5
1.25
1
Crash Rate by Horizontal Design Element (crashes/km/yr)
6.5
5.2
3.9
2.6
1.3
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Station
Legend
Intersections
Horizontal Alignment Radius; m
Crash Rate by Segment - Sliding Scale; crashes/km/yr
Crash Rate by Horizontal Design Element; crashes/km/yr

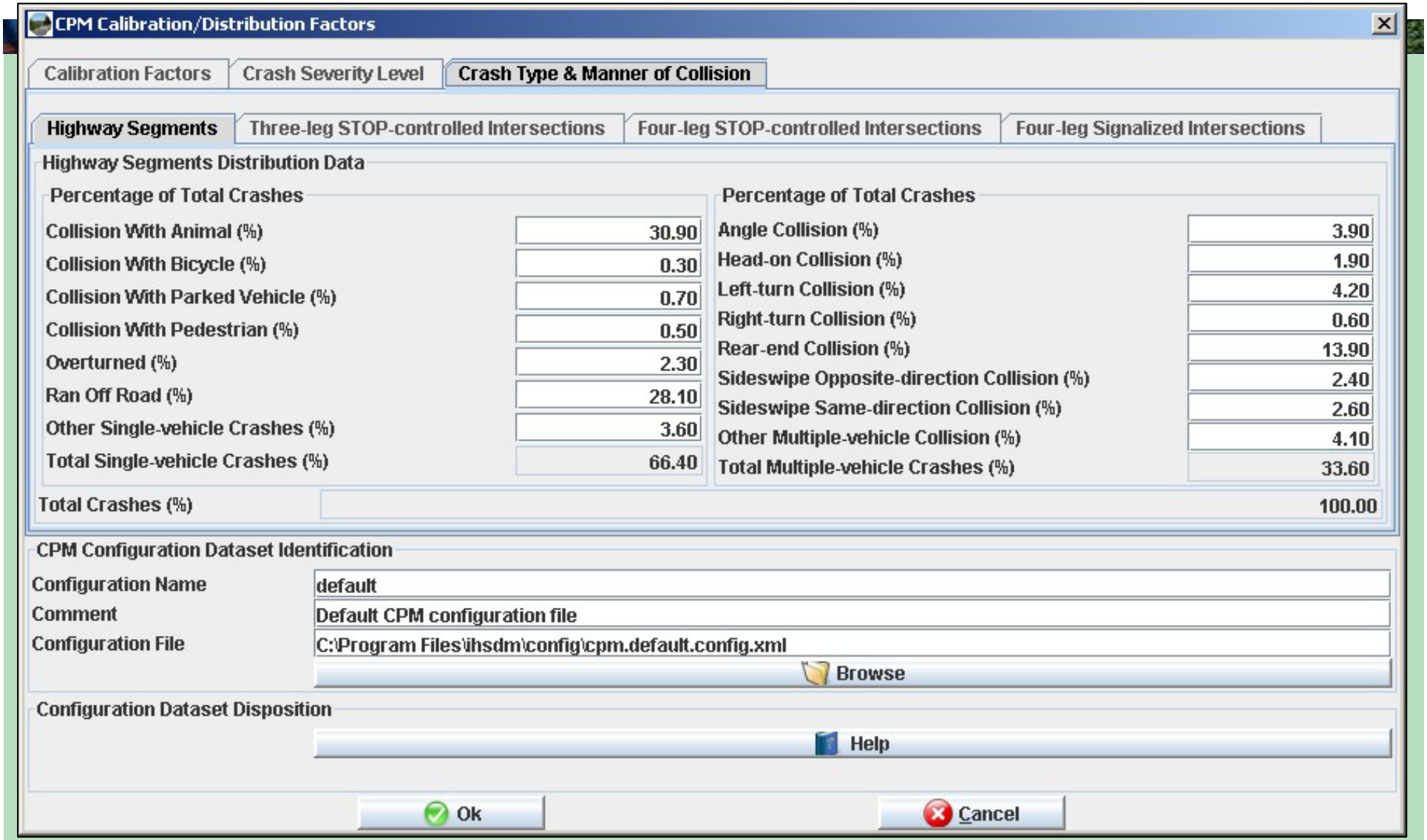
CPM Calibration



- Calibration process available for adapting CPM to any particular highway agency
- Process allows for adjustment of 3 factors
  - Scaling factor for overall crash numbers
  - Modify relative crash severity proportions
  - Modify relative crash type proportions
- Spreadsheet templates for derivation of suitable calibration parameters

Ability to directly include historical crash data also helps to calibrate the model

CPM Calibration



Policy Review Module (PRM)

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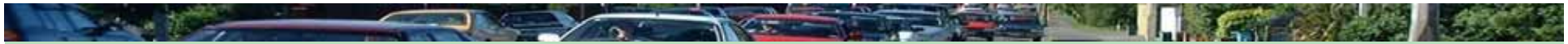
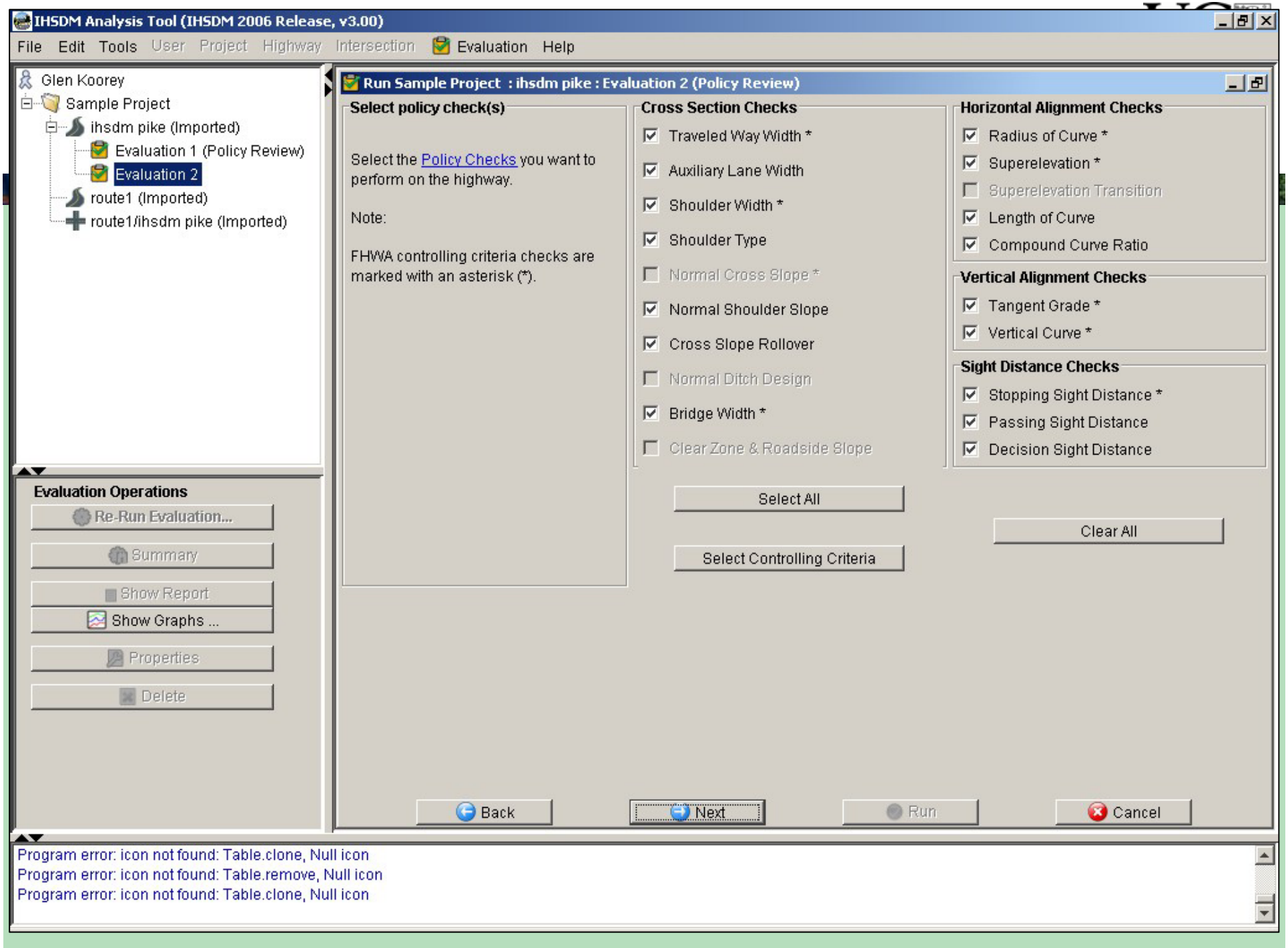
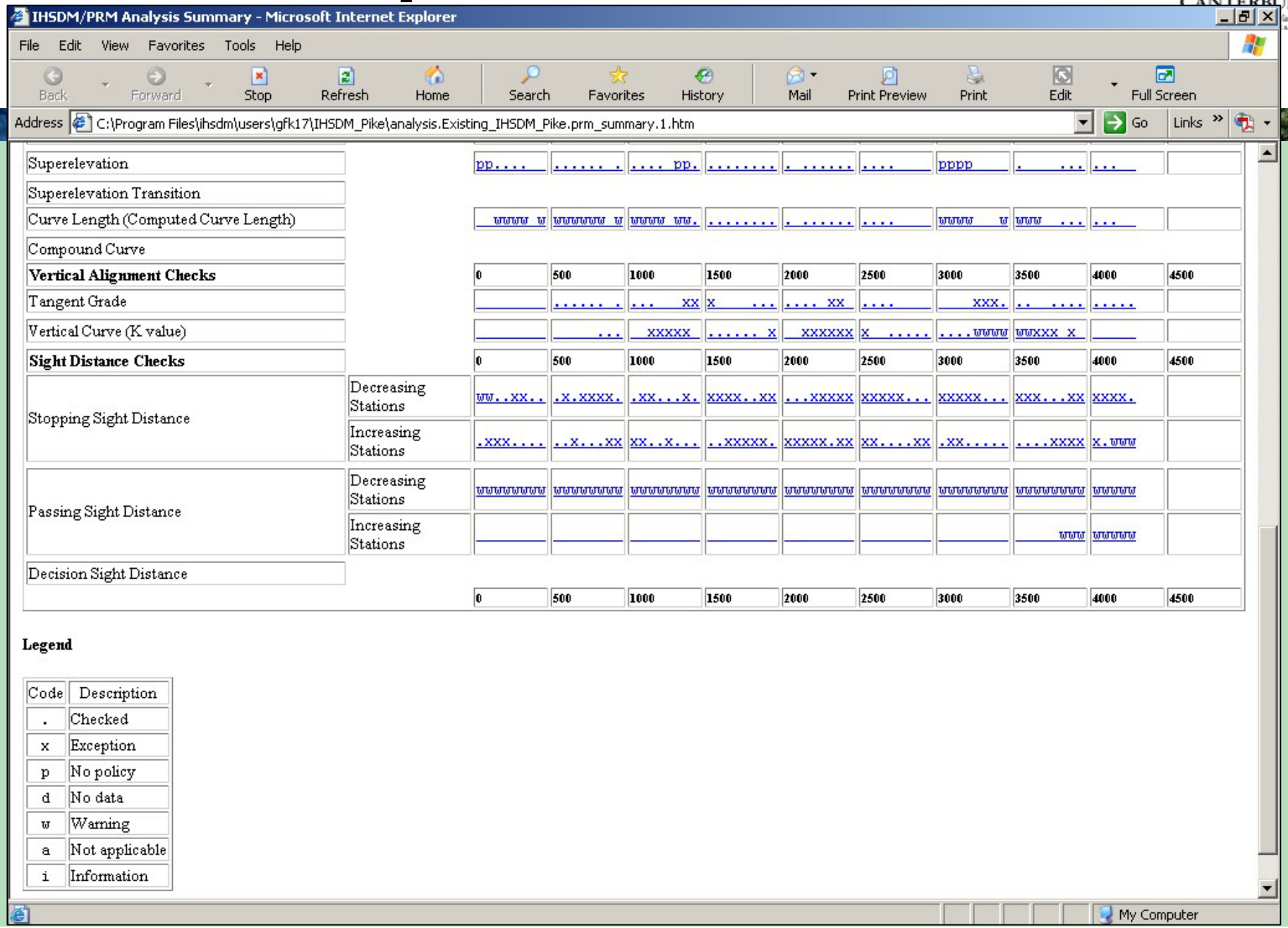


- Automates checks of compliance with state/national highway design policies
- Currently provided with US Federal (AASHTO) standards & guidelines
  - Specified in external files
  - Able to accept alternative criteria

    e.g. state dept or local design policies
- Local policy file developed for this work
  - Based on Austroads *Rural Road Design*


IHSDM Analysis Tool (IHSDM 2006 Release, v3.00)
File Edit Tools User Project Highway Intersection Evaluation Help
Glen Koorey
Sample Project
ihsdm pike (Imported)
Evaluation 1 (Policy Review)
Evaluation 2
route1 (Imported)
route1/ihsdm pike (Imported)
Evaluation Operations
Re-Run Evaluation...
Summary
Show Report
Show Graphs ...
Properties
Delete
Run Sample Project : ihsdm pike : Evaluation 2 (Policy Review)
Select policy check(s)
Select the Policy Checks you want to perform on the highway.
Note:
FHWA controlling criteria checks are marked with an asterisk (*).
Cross Section Checks
Traveled Way Width *
Auxiliary Lane Width
Shoulder Width *
Shoulder Type
Normal Cross Slope *
Normal Shoulder Slope
Cross Slope Rollover
Normal Ditch Design
Bridge Width *
Clear Zone & Roadside Slope
Select All
Select Controlling Criteria
Horizontal Alignment Checks
Radius of Curve *
Superelevation *
Superelevation Transition
Length of Curve
Compound Curve Ratio
Vertical Alignment Checks
Tangent Grade *
Vertical Curve *
Sight Distance Checks
Stopping Sight Distance *
Passing Sight Distance
Decision Sight Distance
Clear All
Back
Next
Run
Cancel
Program error: icon not found: Table.clone, Null icon
Program error: icon not found: Table.remove, Null icon
Program error: icon not found: Table.clone, Null icon

PRM Outputs

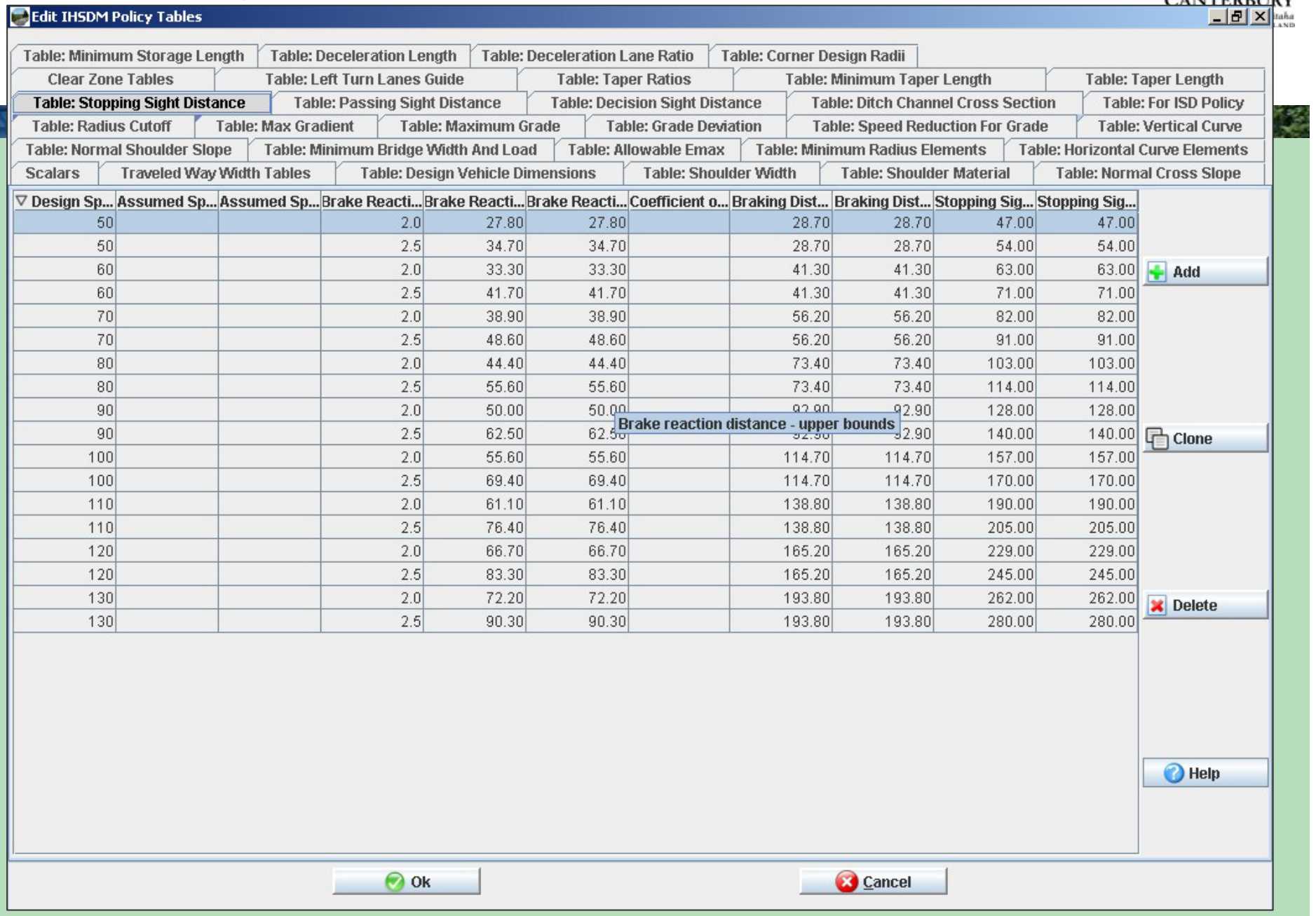


Superelevation		pp....	..... .	.... pp.	.....	. .....	....	pppp	. ...	...
Superelevation Transition										
Curve Length (Computed Curve Length)		www w	wwwww w	www ww.	.....	. .....	....	www w	www ...	...
Compound Curve										
Vertical Alignment Checks		0	500	1000	1500	2000	2500	3000	3500	4000	4500
Tangent Grade		_____	..... .	... xx	x ...	 xx	....	xxx.	.. ....	.....	
Vertical Curve (K value)		_____	...	xxxxx	 x	xxxxxx	x	....www	wxxx x	_____	
Sight Distance Checks		0	500	1000	1500	2000	2500	3000	3500	4000	4500
Stopping Sight Distance	Decreasing Stations	ww..xx..	.x.xxxx.	.xx...x.	xxxx..xx	...xxxxx	xxxxx...	xxxxx...	xxx...xx	xxxx.	
	Increasing Stations	.xxx....	..x...xx	xx..x...	..xxxxx.	xxxxx.xx	xx....xx	.xx.....	xxxx	x.www	
Passing Sight Distance	Decreasing Stations	wwwwwww	wwwwwww	wwwwwww	wwwwwww	wwwwwww	wwwwwww	wwwwwww	wwwwwww	wwwww	
	Increasing Stations	_____	_____	_____	_____	_____	_____	_____	www	wwwww	
Decision Sight Distance											
		0	500	1000	1500	2000	2500	3000	3500	4000	4500

Legend

Code	Description
.	Checked
x	Exception
p	No policy
d	No data
w	Warning
a	Not applicable
i	Information

Policy File Calibration



Design Sp...	Assumed Sp...	Assumed Sp...	Brake Reacti...	Brake Reacti...	Brake Reacti...	Coefficient o...	Braking Dist...	Braking Dist...	Stopping Sig...	Stopping Sig...
50			2.0	27.80	27.80		28.70	28.70	47.00	47.00
50			2.5	34.70	34.70		28.70	28.70	54.00	54.00
60			2.0	33.30	33.30		41.30	41.30	63.00	63.00
60			2.5	41.70	41.70		41.30	41.30	71.00	71.00
70			2.0	38.90	38.90		56.20	56.20	82.00	82.00
70			2.5	48.60	48.60		56.20	56.20	91.00	91.00
80			2.0	44.40	44.40		73.40	73.40	103.00	103.00
80			2.5	55.60	55.60		73.40	73.40	114.00	114.00
90			2.0	50.00	50.00		92.90	92.90	128.00	128.00
90			2.5	62.50	62.50		92.90	92.90	140.00	140.00
100			2.0	55.60	55.60		114.70	114.70	157.00	157.00
100			2.5	69.40	69.40		114.70	114.70	170.00	170.00
110			2.0	61.10	61.10		138.80	138.80	190.00	190.00
110			2.5	76.40	76.40		138.80	138.80	205.00	205.00
120			2.0	66.70	66.70		165.20	165.20	229.00	229.00
120			2.5	83.30	83.30		165.20	165.20	245.00	245.00
130			2.0	72.20	72.20		193.80	193.80	262.00	262.00
130			2.5	90.30	90.30		193.80	193.80	280.00	280.00

Importing Road Alignment Data

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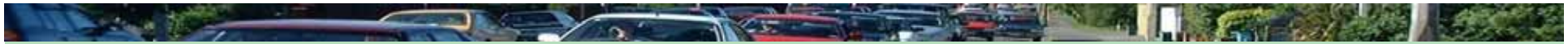
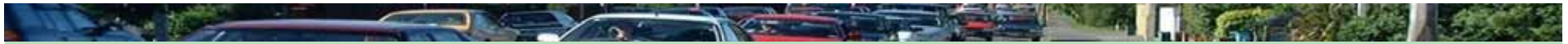


- A number of different ways for road data to be created or directly imported:
  - Manually entered using Highway Editor tool
  - IHSDM "comma-separated values" (CSV) files
  - Industry-standard LandXML files
- Most roading design software packages can produce LandXML files from alignment data

  e.g. Geopak, MX-Road, 12D

What about existing road geometry data?

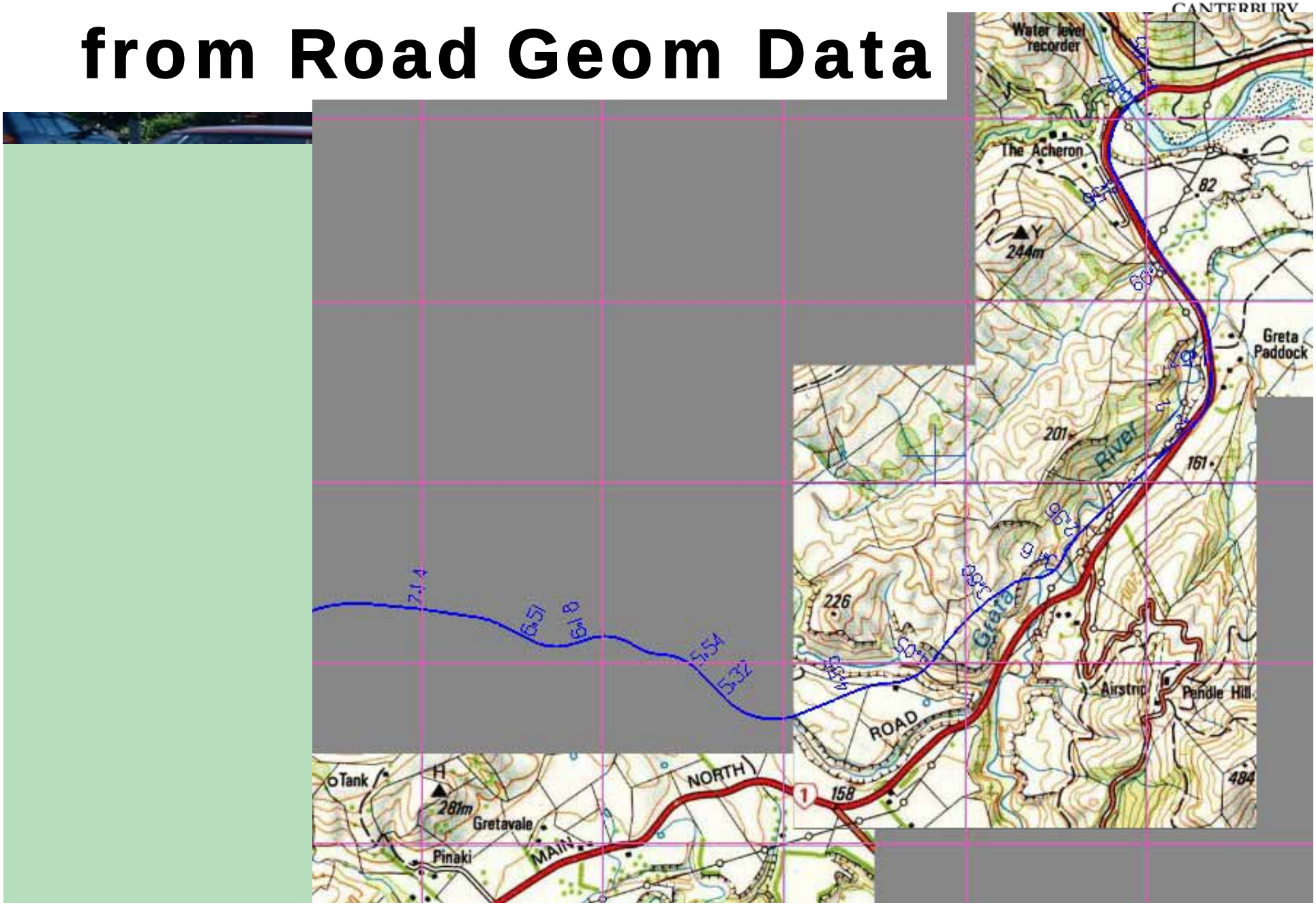
SH Geometry Data
(10m Intervals)



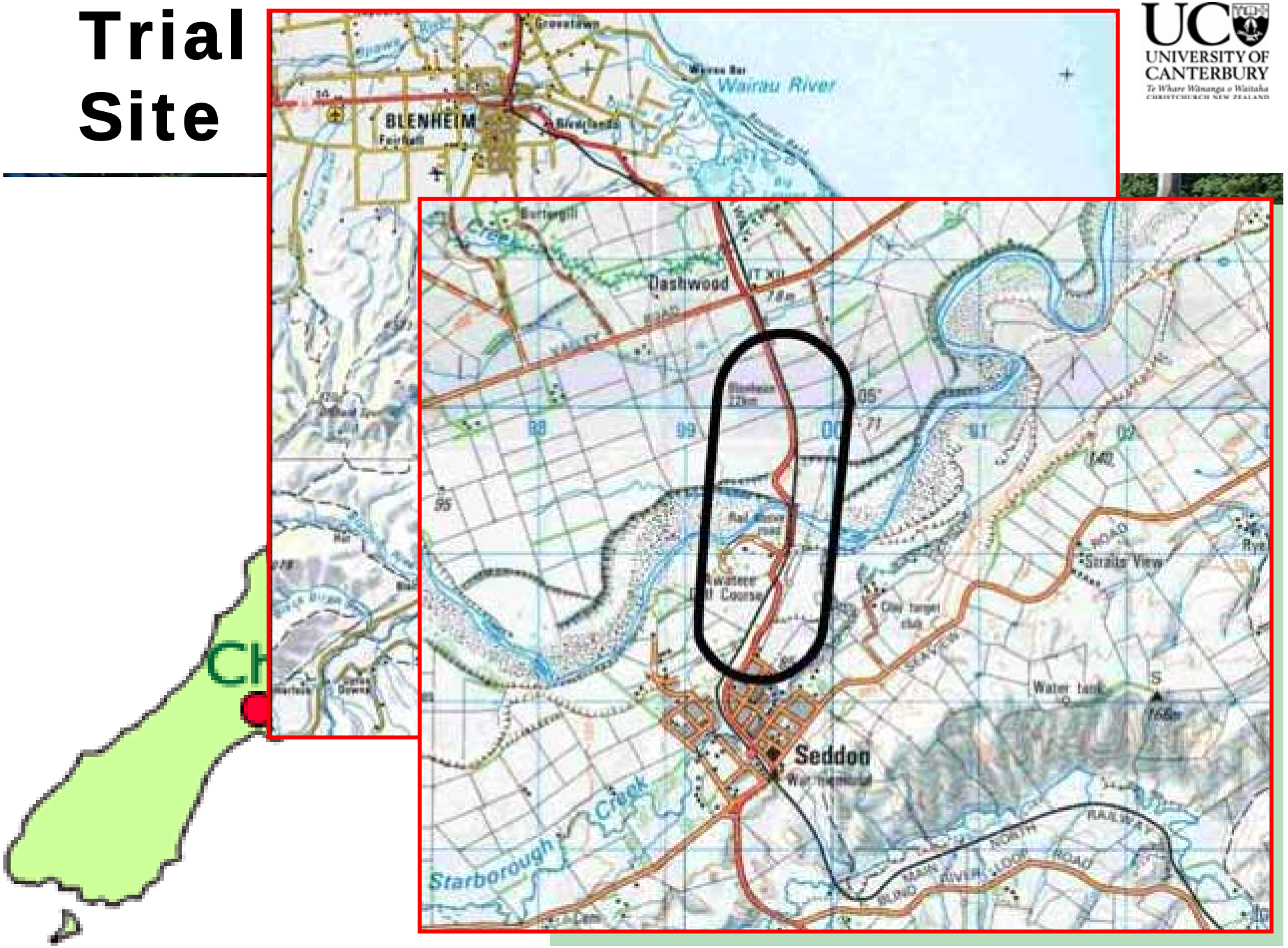
geometry : Table

	Dirn	SH	RS	RP	Gradient	HzRad	HzCurv	XFALL	Curve	AdvSpd
	Incr	003	158	0.98	8.2	3735	0.3	-1.9	Right	83.9
	Incr	003	158	0.99	8.2	14713	0.1	-1.4	Straight	84.1
	Incr	003	158	1.00	8.2	-8627	-0.1	-1.2	Left	84.2
	Incr	003	158	1.01	8.1	-6555	-0.2	-1.1	Left	84.5
	Incr	003	158	1.02	8.0	11865	0.1	-1.3	Straight	84.9
	Incr	003	158	1.03	7.9	-32019	0.0	-2.0	Straight	85.4
	Incr	003	158	1.04	7.9	-7250	-0.1	-2.8	Left	85.6
	Incr	003	158	1.05	7.9	4642	0.2	-2.8	Right	85.6
	Incr	003	158	1.06	7.8	2891	0.3	-2.9	Right	85.8
	Incr	003	158	1.07	7.7	1549	0.6	-2.7	Right	86.4
	Incr	003	158	1.08	7.6	1075	0.9	-1.3	Right	87.0
	Incr	003	158	1.09	7.5	810	1.2	-0.1	Right	87.4
	Incr	003	158	1.10	7.4	493	2.0	1.1	Right	81.0
	Incr	003	158	1.11	7.2	455	2.2	1.7	Right	77.8

Elements Generated from Road Geom Data



Trial Site


BLENHEIM
Wairau River
Dashwood
Seddon
Starborough Creek
Water tank
Straits View
RAILWAY
MAIN NORTH ROAD
RIVER LOOP ROAD

SH1 Awatere Bridge

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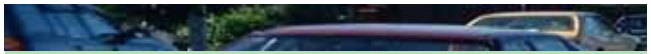
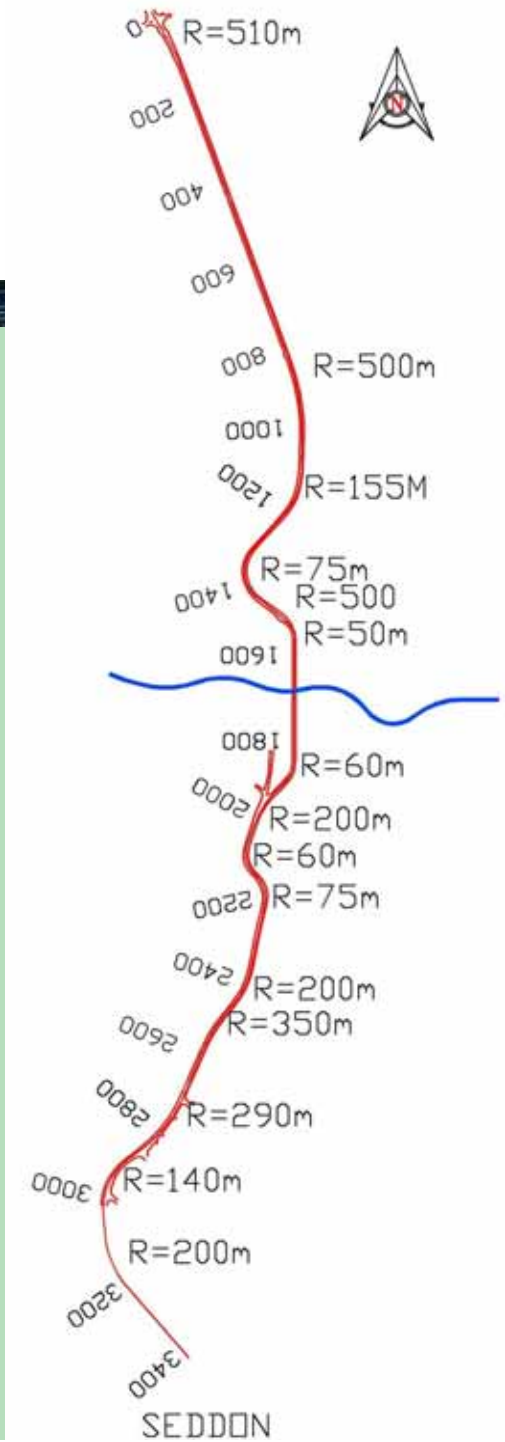
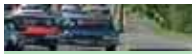
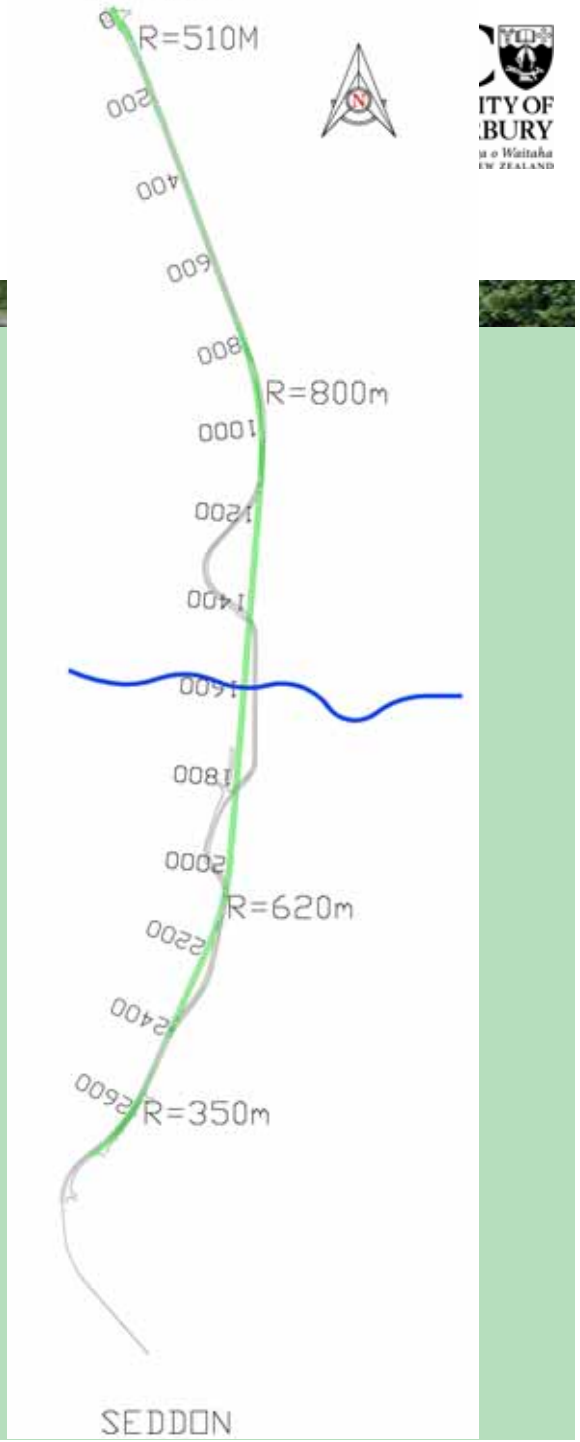
Site Design



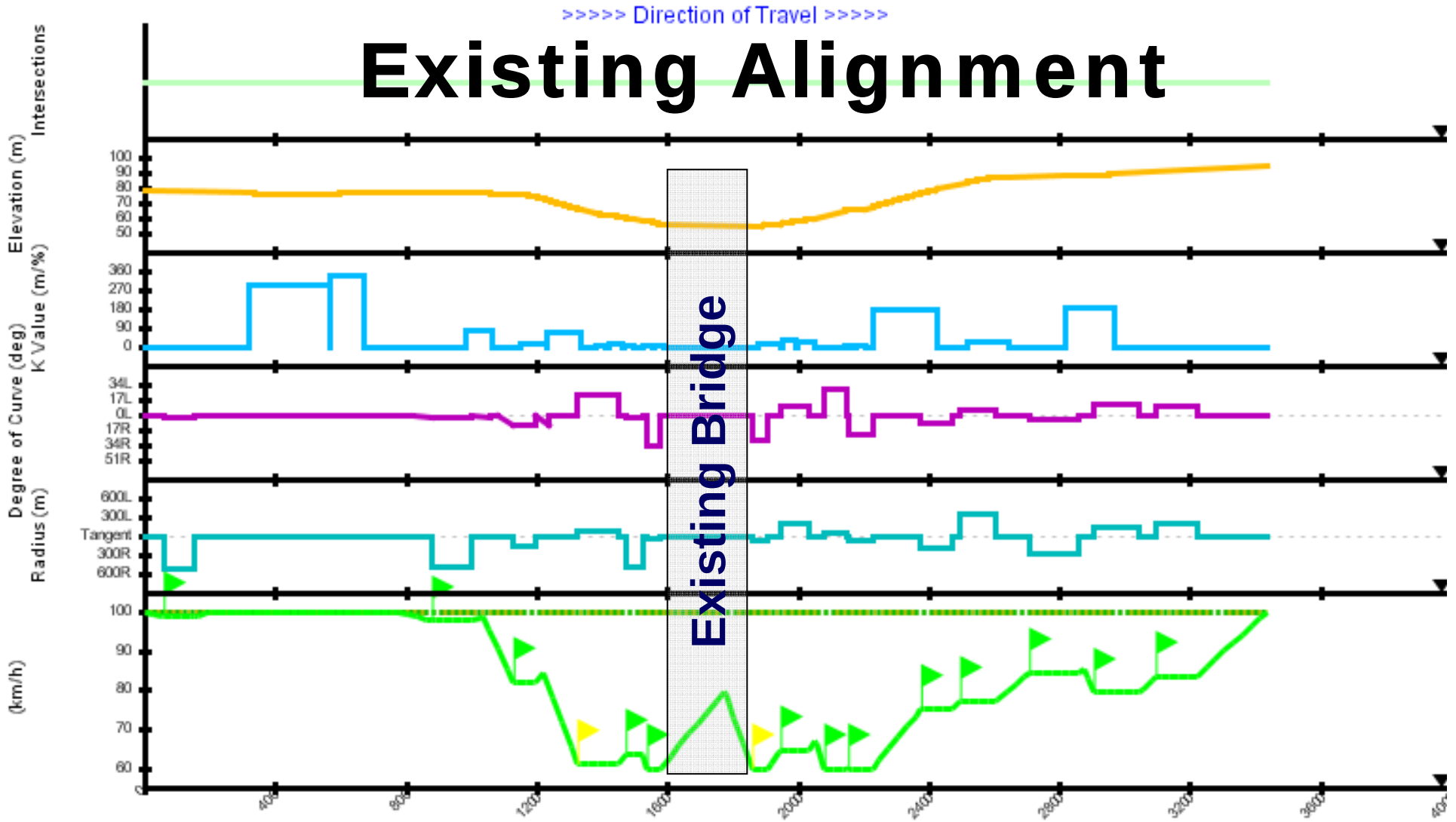
- Existing/ Proposed Alignments
  - New route also removes railway crossing







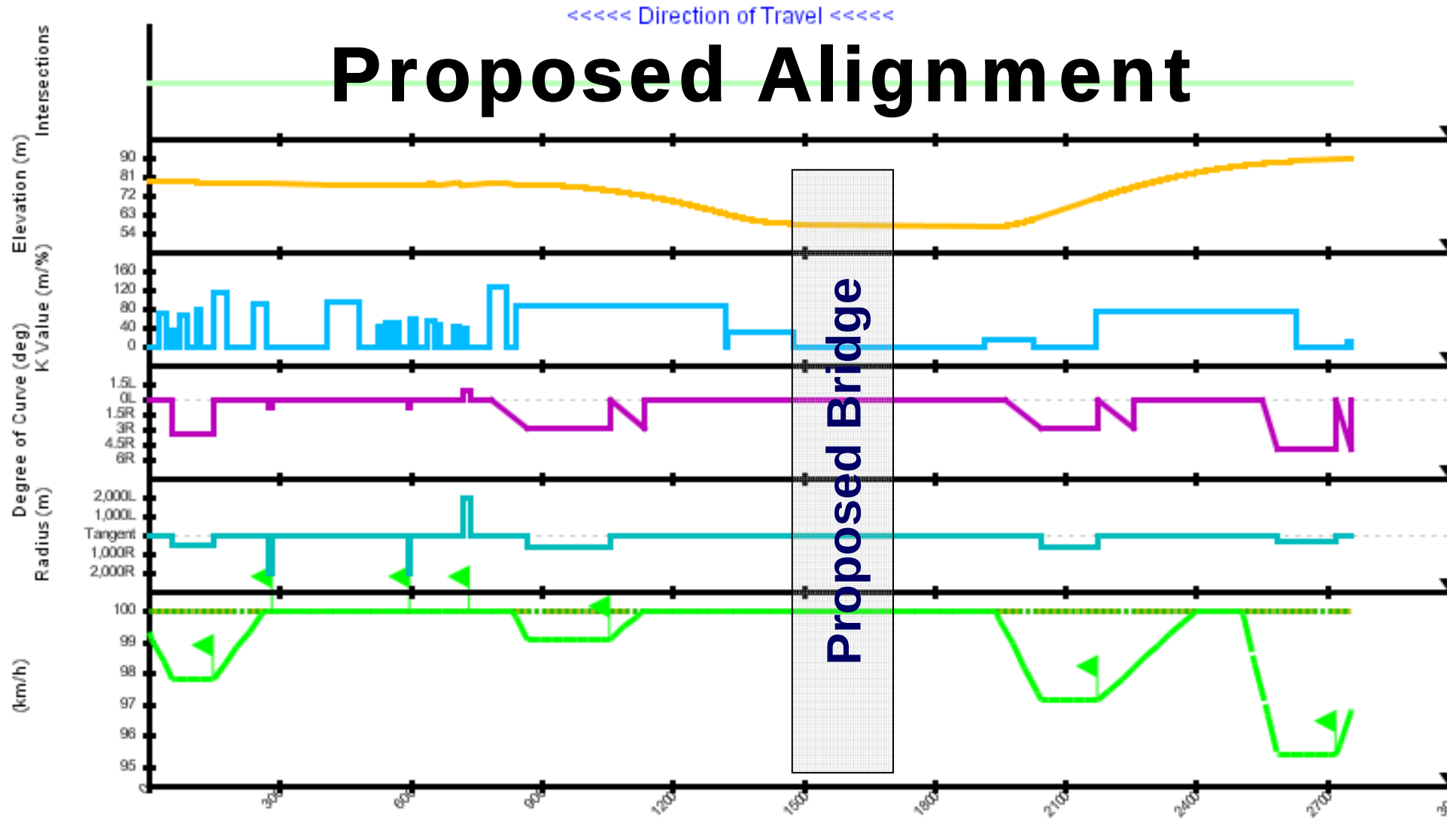
Existing Alignment



NOTE: Speed profile does NOT account for intersections.

Legend

- Intersections
- Vertical Alignment (Elevation); m
- Vertical Alignment Curvature K Value; m/%
- Horizontal Alignment Degree of Curve; deg
- Horizontal Alignment Radius; m
- Desired Speed; km/h
- Design Speed; km/h
- V85 Speed; km/h; differential between design and V85 speed <= 10 km/h
- V85 Speed; km/h; differential between design and V85 speed > 10 km/h, <= 20 km/h
- V85 Speed; km/h; differential between design and V85 speed > 20 km/h
- Critera 2; V85 speed differential of adjacent horizontal elements <= 10 km/h
- Critera 2; V85 speed differential of adjacent horizontal elements > 10 km/h, <= 20 km/h
- Critera 2; V85 speed differential of adjacent horizontal elements > 20 km/h



NOTE: Speed profile does NOT account for intersections.

Legend

- Intersections
- Vertical Alignment (Elevation); m
- Vertical Alignment Curvature K Value; m/%
- Horizontal Alignment Degree of Curve; deg
- Horizontal Alignment Radius; m
- Desired Speed; km/h
- Design Speed; km/h
- V85 Speed; km/h; differential between design and V85 speed <= 10 km/h
- V85 Speed; km/h; differential between design and V85 speed > 10 km/h, <= 20 km/h
- V85 Speed; km/h; differential between design and V85 speed > 20 km/h
- Critera 2; V85 speed differential of adjacent horizontal elements <= 10 km/h
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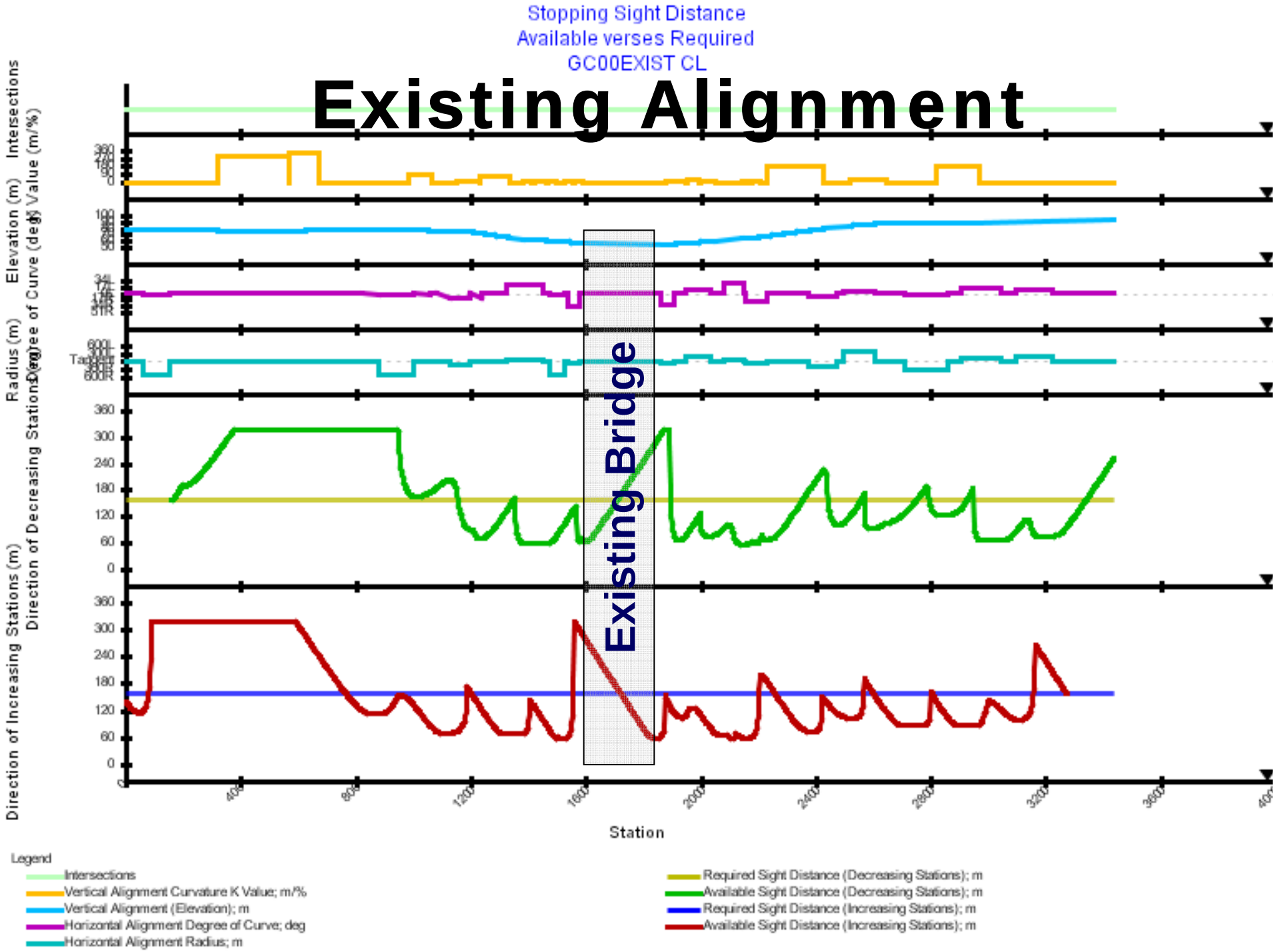
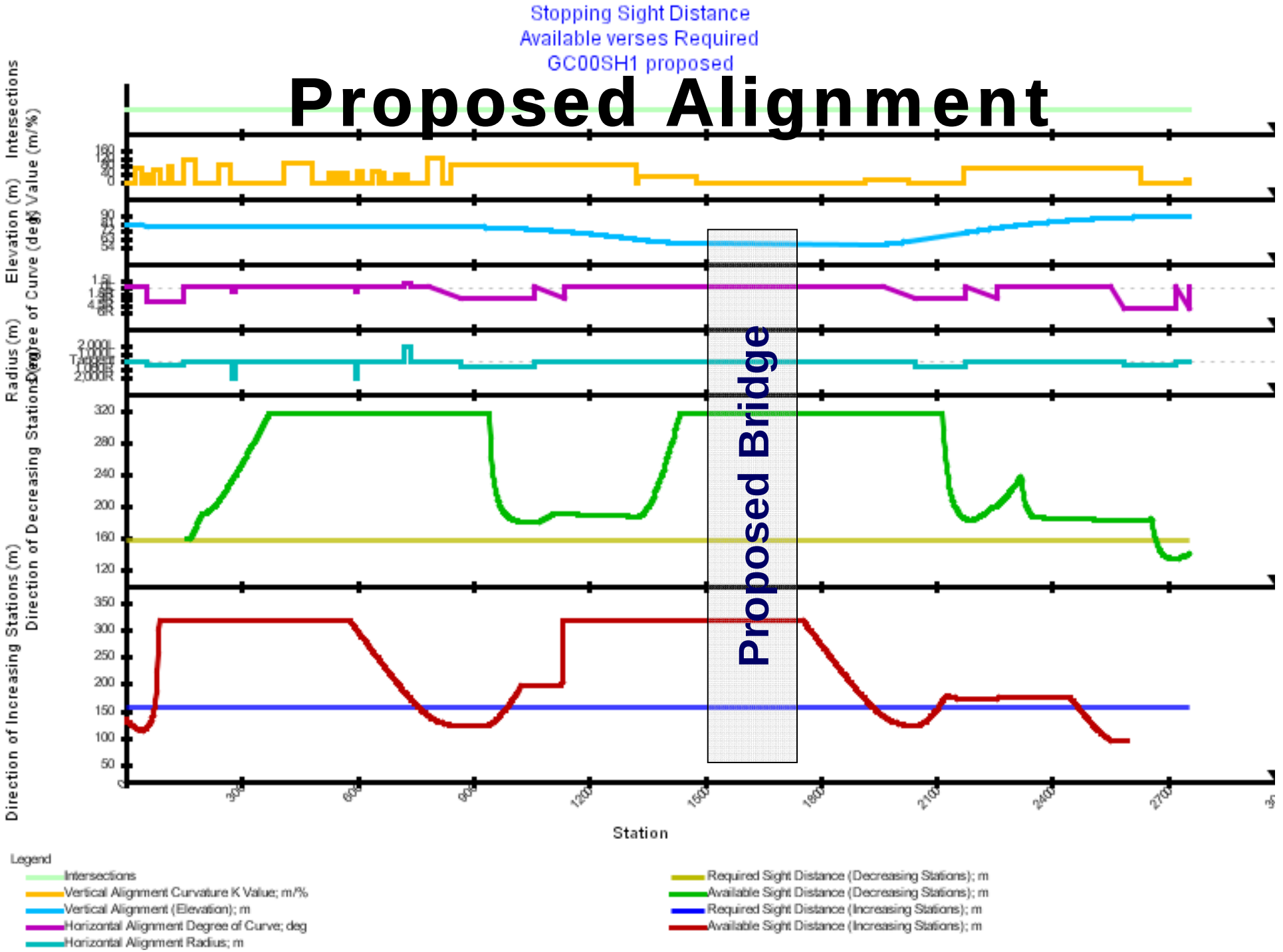
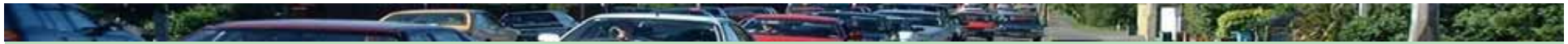
- Critera 2; V85 speed differential of adjacent horizontal elements > 20 km/h


Stopping Sight Distance
Available verses Required
GC00EXIST CL
Existing Alignment
Existing Bridge
Intersections
Elevation (m)
Vertical Alignment Curvature K Value (m/%)
Radius (m)
Horizontal Alignment Degree of Curve (deg)
Direction of Decreasing Stations (m)
Direction of Increasing Stations (m)
Station
Legend
Intersections
Vertical Alignment Curvature K Value; m/%
Vertical Alignment (Elevation); m
Horizontal Alignment Degree of Curve; deg
Horizontal Alignment Radius; m
Required Sight Distance (Decreasing Stations); m
Available Sight Distance (Decreasing Stations); m
Required Sight Distance (Increasing Stations); m
Available Sight Distance (Increasing Stations); m

Proposed Alignment



Future Work



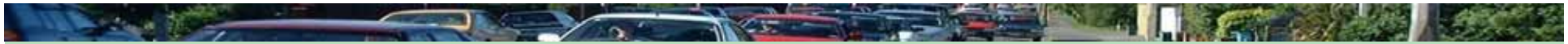
- Local calibration tasks to complete
- Awatere Bridge now under reconstruction
  - Validation of the crash prediction models for the new alignment can't yet be undertaken
- Further local testing of IHSDM planned
  - Highway sections realigned some years ago
  - Geometry data for both alignments
  - Sufficient before/after crash data available

Conclusions

- IHSDM is a promising tool for safety and operational assessment of highway alignments in New Zealand
  - Further work ongoing to carry out necessary calibrations for general use here
- Merit in a similar process being used to adapt IHSDM for other jurisdictions?

  e.g. Australian states

Further Information



- Glen Koorey
  - University of Canterbury, Christchurch, NZ
  - *Glen.Koorey@canterbury.ac.nz*

  http://www.civil.canterbury.ac.nz
- Download software from IHSDM website

  http://www.ihsdm.org/
- FHWA Background references/research

  http://www.tfhrc.gov/safety/ihsdm/ihsdm.htm

Thank You!

Any Questions?

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