Stormwater Victoria Conference

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Celine Marchenay
Senior Engineer (Water Technology)
celine.marchenay@watertech.com.au

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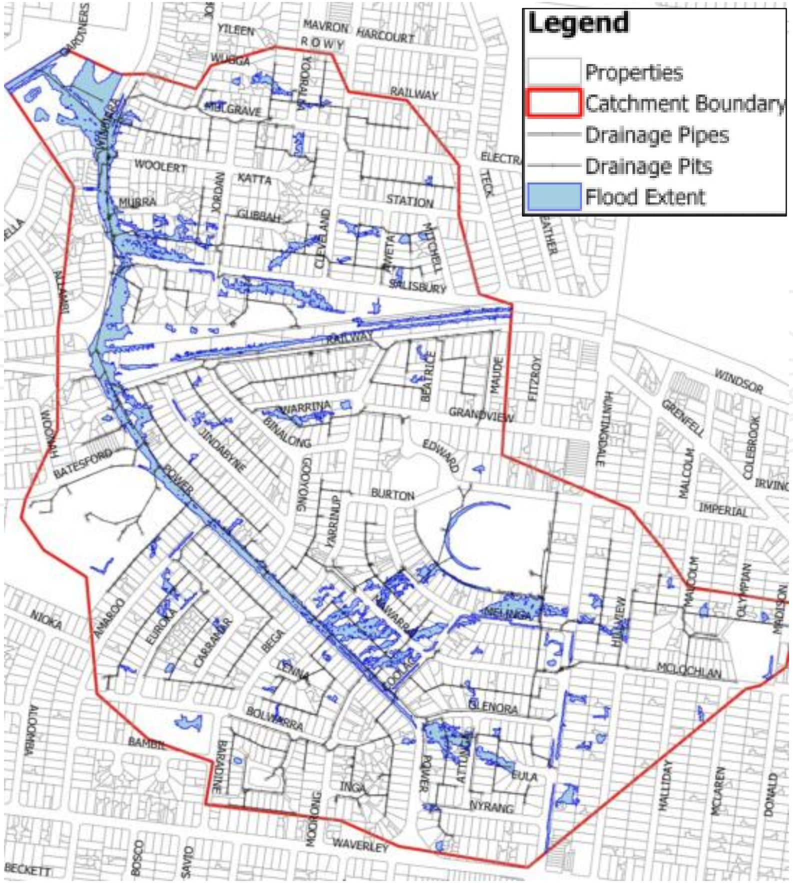
Development of a city-wide Drainage Model to assess System Performance

Melbourne Water

Background



- Different view to traditional approach of drainage management
- Melbourne Water identified a need for a system-wide drainage network for integrated water planning of Melbourne
- Create a “living breathing” hydraulic model to be updated and improved over time

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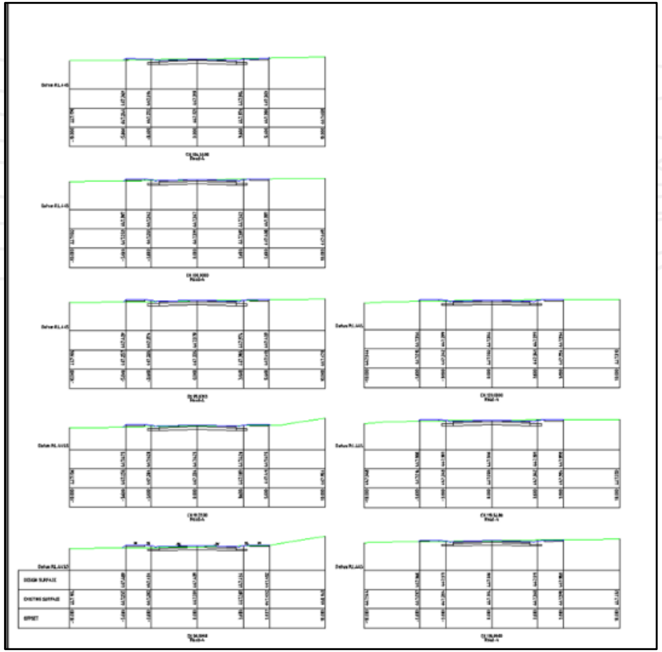
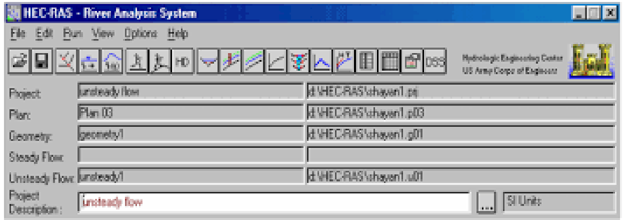
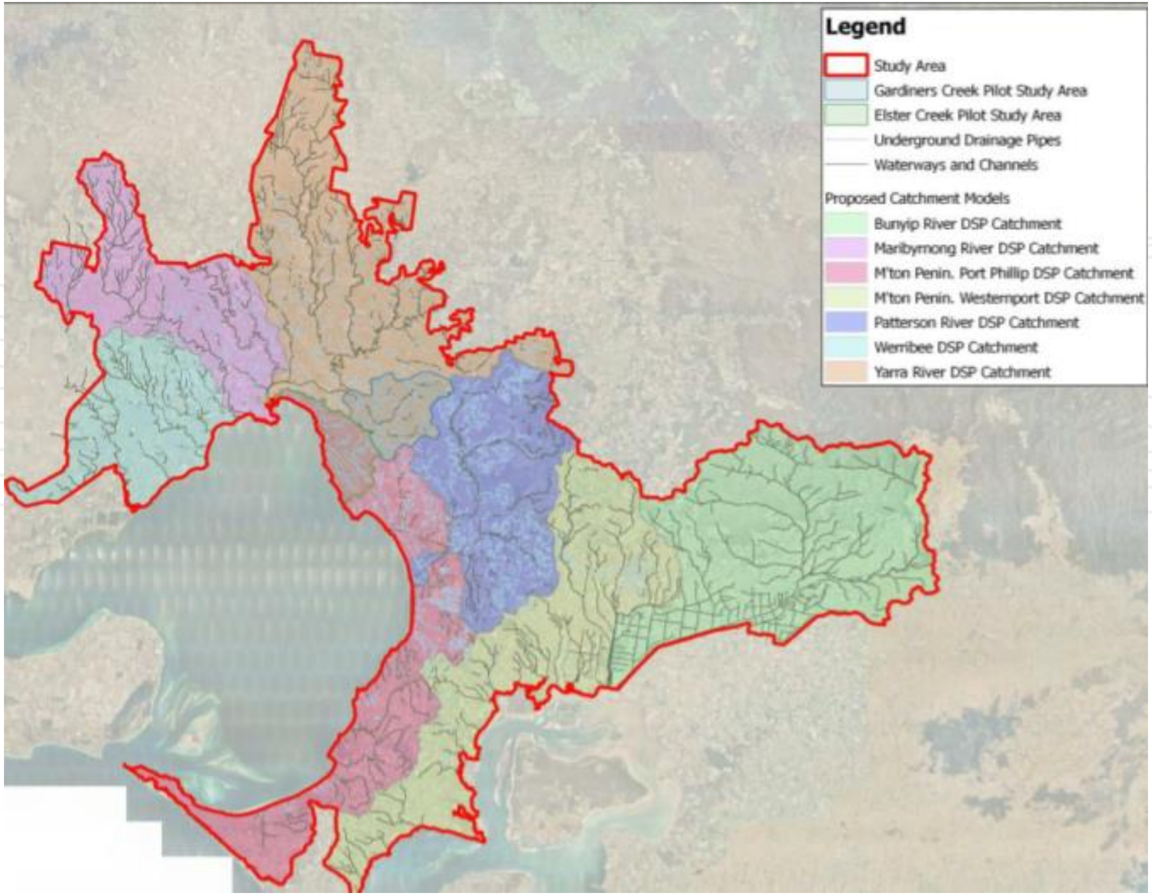
Objectives



- Make use of what we already have
- Build a functional drainage network model to assess capacity of the system
- Assess the drainage capacity (20% AEP and higher) over a range of scenarios including increase population and climate change



Study Area and Approach



- Melbourne Metropolitan and Urban Growth Boundary
- **1,200 km^2** area; **22,000** pipes, **700 km** of open drain and **210** flood storages
- Accepting it won't be perfect
- Assumptions and flagging

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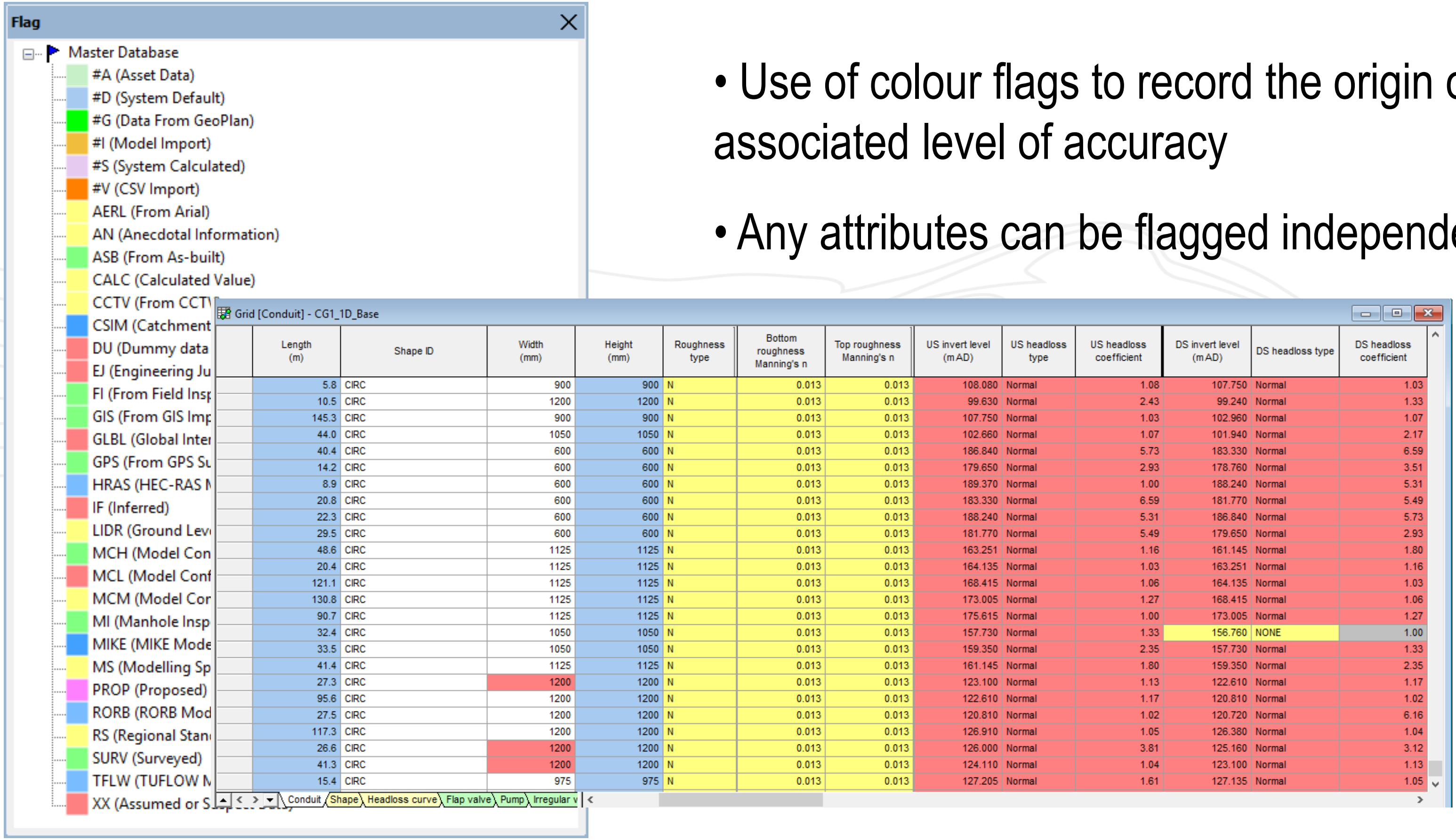
Flagging - to record sources of information

- Use of colour flags to record the origin of the data and associated level of accuracy
- Any attributes can be flagged independently



Length (m)	Shape ID	Width (mm)	Height (mm)	Roughness type	Bottom roughness Manning's n	Top roughness Manning's n	US invert level (m AD)	US headloss type	US headloss coefficient	DS invert level (m AD)	DS headloss type	DS headloss coefficient
5.8	CIRC	900	900	N	0.013	0.013	108.080	Normal	1.08	107.750	Normal	1.03
10.5	CIRC	1200	1200	N	0.013	0.013	99.630	Normal	2.43	99.240	Normal	1.33
145.3	CIRC	900	900	N	0.013	0.013	107.750	Normal	1.03	102.960	Normal	1.07
44.0	CIRC	1050	1050	N	0.013	0.013	102.660	Normal	1.07	101.940	Normal	2.17
40.4	CIRC	600	600	N	0.013	0.013	186.840	Normal	5.73	183.330	Normal	6.59
14.2	CIRC	600	600	N	0.013	0.013	179.650	Normal	2.93	178.760	Normal	3.51
8.9	CIRC	600	600	N	0.013	0.013	189.370	Normal	1.00	188.240	Normal	5.31
20.8	CIRC	600	600	N	0.013	0.013	183.330	Normal	6.59	181.770	Normal	5.49
22.3	CIRC	600	600	N	0.013	0.013	188.240	Normal	5.31	186.840	Normal	5.73
29.5	CIRC	600	600	N	0.013	0.013	181.770	Normal	5.49	179.650	Normal	2.93
48.6	CIRC	1125	1125	N	0.013	0.013	163.251	Normal	1.16	161.145	Normal	1.80
20.4	CIRC	1125	1125	N	0.013	0.013	164.135	Normal	1.03	163.251	Normal	1.16
121.1	CIRC	1125	1125	N	0.013	0.013	168.415	Normal	1.06	164.135	Normal	1.03
130.8	CIRC	1125	1125	N	0.013	0.013	173.005	Normal	1.27	168.415	Normal	1.06
90.7	CIRC	1125	1125	N	0.013	0.013	175.615	Normal	1.00	173.005	Normal	1.27
32.4	CIRC	1050	1050	N	0.013	0.013	157.730	Normal	1.33	156.760	NONE	1.00
33.5	CIRC	1050	1050	N	0.013	0.013	159.350	Normal	2.35	157.730	Normal	1.33
41.4	CIRC	1125	1125	N	0.013	0.013	161.145	Normal	1.80	159.350	Normal	2.35
27.3	CIRC	1200	1200	N	0.013	0.013	123.100	Normal	1.13	122.610	Normal	1.17
95.6	CIRC	1200	1200	N	0.013	0.013	122.610	Normal	1.17	120.810	Normal	1.02
27.5	CIRC	1200	1200	N	0.013	0.013	120.810	Normal	1.02	120.720	Normal	6.16
117.3	CIRC	1200	1200	N	0.013	0.013	126.910	Normal	1.05	126.380	Normal	1.04
26.6	CIRC	1200	1200	N	0.013	0.013	126.000	Normal	3.81	125.160	Normal	3.12
41.3	CIRC	1200	1200	N	0.013	0.013	124.110	Normal	1.04	123.100	Normal	1.13
15.4	CIRC	975	975	N	0.013	0.013	127.205	Normal	1.61	127.135	Normal	1.05

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Model Build – Open Drains/Channels

- ‘Channel’ requires a Shape, US and DS IL to derive associated conveyance and capacity

- GIS Database only contains, ‘**SHAPE**’, ‘**BASE_WIDTH**’ and ‘**CHANNEL_WIDTH**’ – insufficient to derive a profile

- Minor Low Flow Channel derived from drawings

- How far to extent the cross-section profile ?

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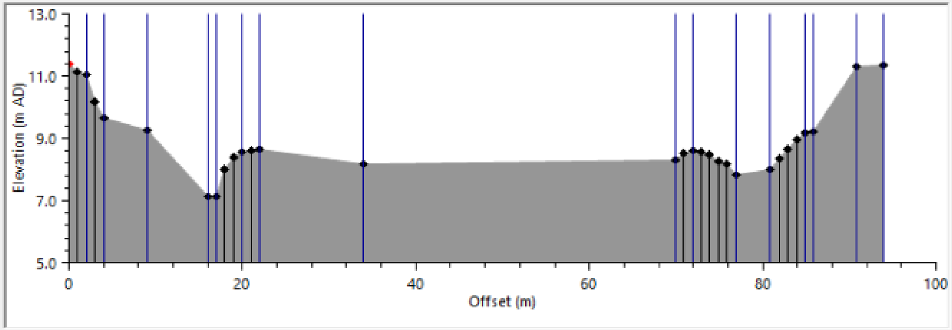
Model Build – Natural Waterways

Cross section line : 10081397_xs14!!!!!! : Section data

	Offset (m)	X coordinate (m)	Y coordinate (m)	Bed level (m AD)	Roughness Manning's n	New panel
1	0.000	343662.919	5788917.378	11.380	0.0600	☒
2	0.999	343662.515	5788918.291	11.120	0.0600	☐
3	1.997	343662.112	5788919.205	11.040	0.0600	☒
4	2.996	343661.708	5788920.118	10.190	0.0600	☐
5	3.995	343661.304	5788921.032	9.650	0.0600	☒
6	8.988	343659.286	5788925.599	9.240	0.0600	☒
7	15.978	343656.460	5788931.993	7.110	0.0600	☒
8	16.977	343656.057	5788932.906	7.120	0.0600	☒
9	17.976	343655.653	5788933.819	8.010	0.0600	☐
10	18.974	343655.249	5788934.733	8.400	0.0600	☐
11	19.973	343654.846	5788935.646	8.570	0.0600	☒



OK Cancel

- How far to extend the cross-section profile again ?
- How much modelling effort should be spent ?
- Example where one ‘river reach’ alignment

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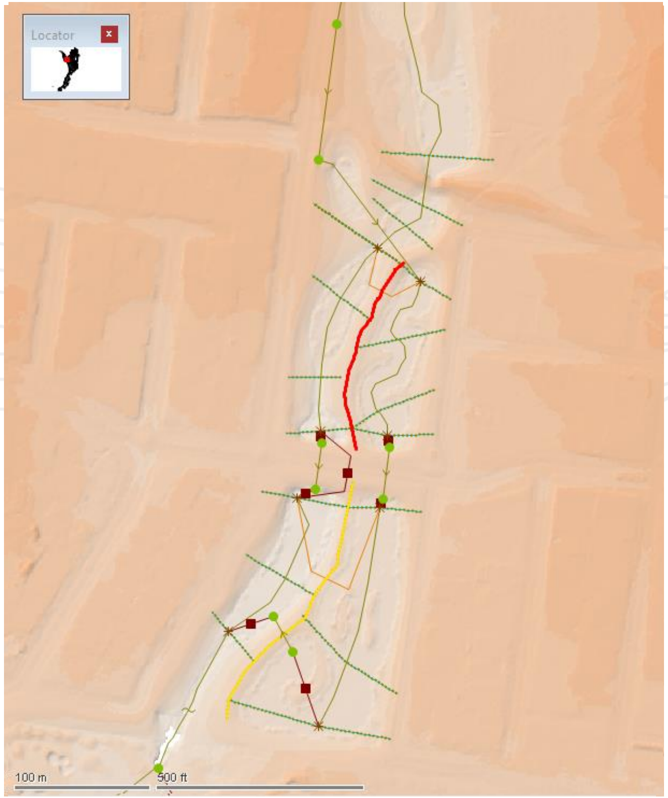
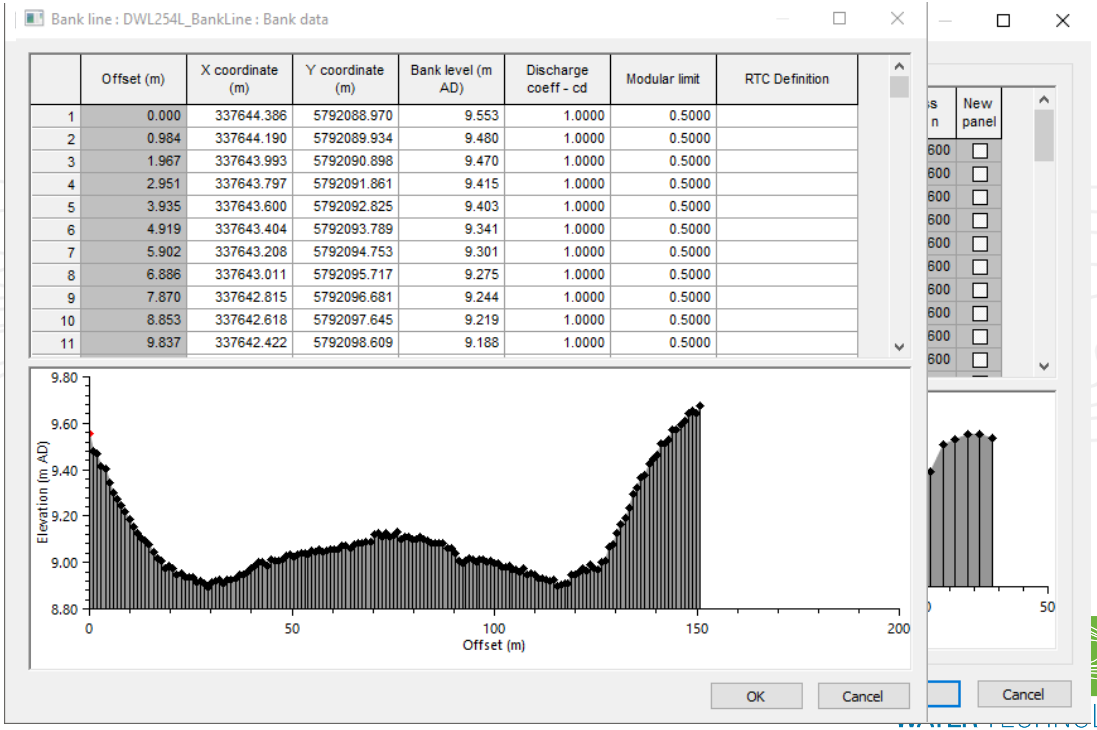
Model Build – Natural Waterways

- Example where two 'river reach' alignments with 'bank line' allowing overland connections





	Offset (m)	X coordinate (m)	Y coordinate (m)	Bank level (m AD)	Discharge coeff - cd	Modular limit	RTC Definition
1	0.000	337644.386	5792088.970	9.553	1.0000	0.5000	
2	0.984	337644.190	5792089.934	9.480	1.0000	0.5000	
3	1.967	337643.993	5792090.898	9.470	1.0000	0.5000	
4	2.951	337643.797	5792091.861	9.415	1.0000	0.5000	
5	3.935	337643.600	5792092.825	9.403	1.0000	0.5000	
6	4.919	337643.404	5792093.789	9.341	1.0000	0.5000	
7	5.902	337643.208	5792094.753	9.301	1.0000	0.5000	
8	6.886	337643.011	5792095.717	9.275	1.0000	0.5000	
9	7.870	337642.815	5792096.681	9.244	1.0000	0.5000	
10	8.853	337642.618	5792097.645	9.219	1.0000	0.5000	
11	9.837	337642.422	5792098.609	9.188	1.0000	0.5000	

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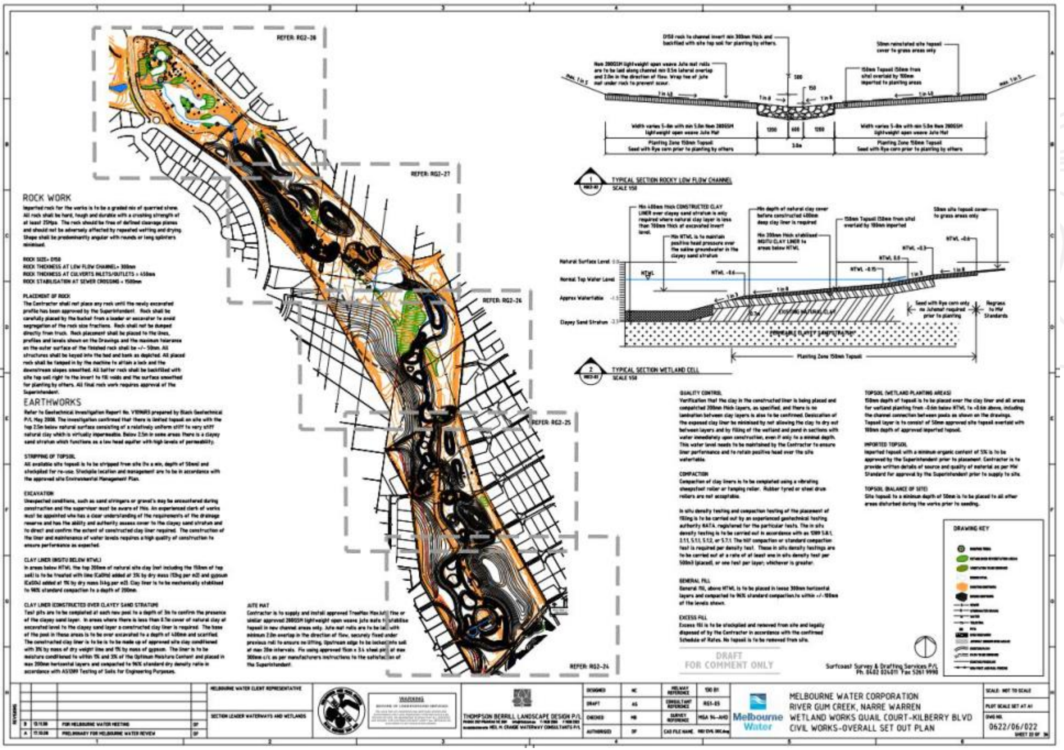
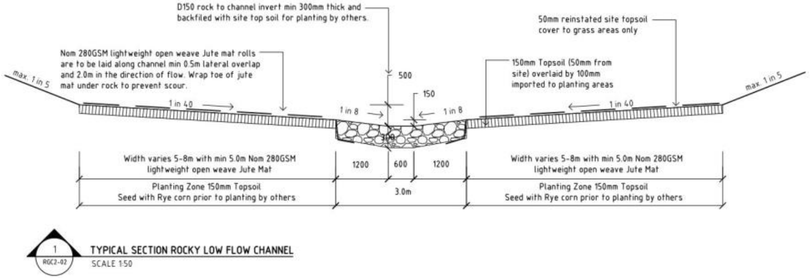
Model Build – Natural Waterways

- Simply representation in more complex waterways





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Model Build – Underground pipes/pumps

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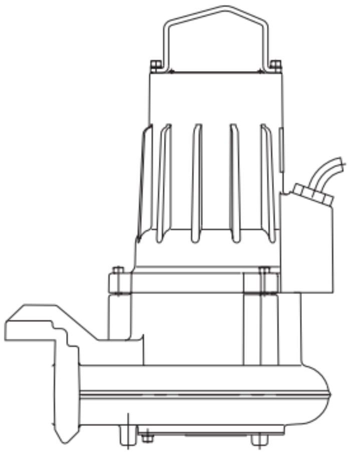
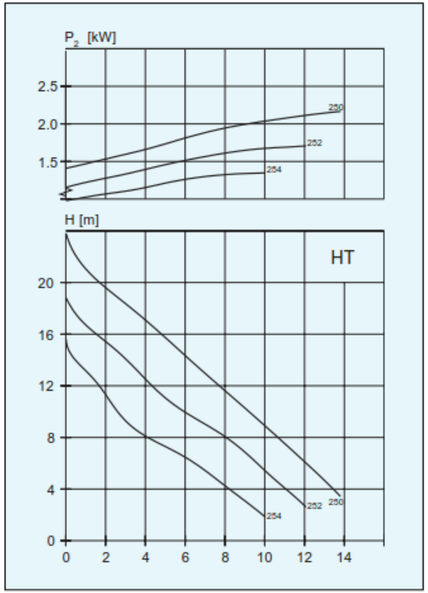


Weight kg	CP	CF	CS
HT	34	34	34

CP/CF/CS



Impeller code	No. of vanes	Outlet dia mm CP vers.	Through-let, mm	Motor rating kW P_1	Motor rating kW P_2	rpm	Available versions
W250	1	50	48	3.1	2.4	2695	CP/CF/CS
250	1	50	48	2.3	1.7	2695	CP/CF/CS
W252	1	50	48	3.1	2.4	2695	CP/CF/CS
252	1	50	48	2.3	1.7	2695	CP/CF/CS
252*	1	50	48	2.1	1.5	2695	CP/CF/CS
W254	1	50	48	3.1	2.4	2695	CP/CF/CS
254	1	50	48	2.3	1.7	2695	CP/CF/CS
254*	1	50	48	2.1	1.5	2695	CP/CF/CS

- MW pits/pipes GIS and some Council assets included
- 13 MW operated pump stations in City of Kingston and Frankston municipality
  - Pump curves derived from pump manufacturer
  - Extracted pump operating levels to set controls of each pumps

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Model Build – Flood Storages

- Includes retarding basins and any other storages holding flood retardation properties.

No Council retarding basin GIS dataset

- Represented using stage-storage relationship derived from RORB, drawings or LiDAR.

Highlighted issues in data and asset management

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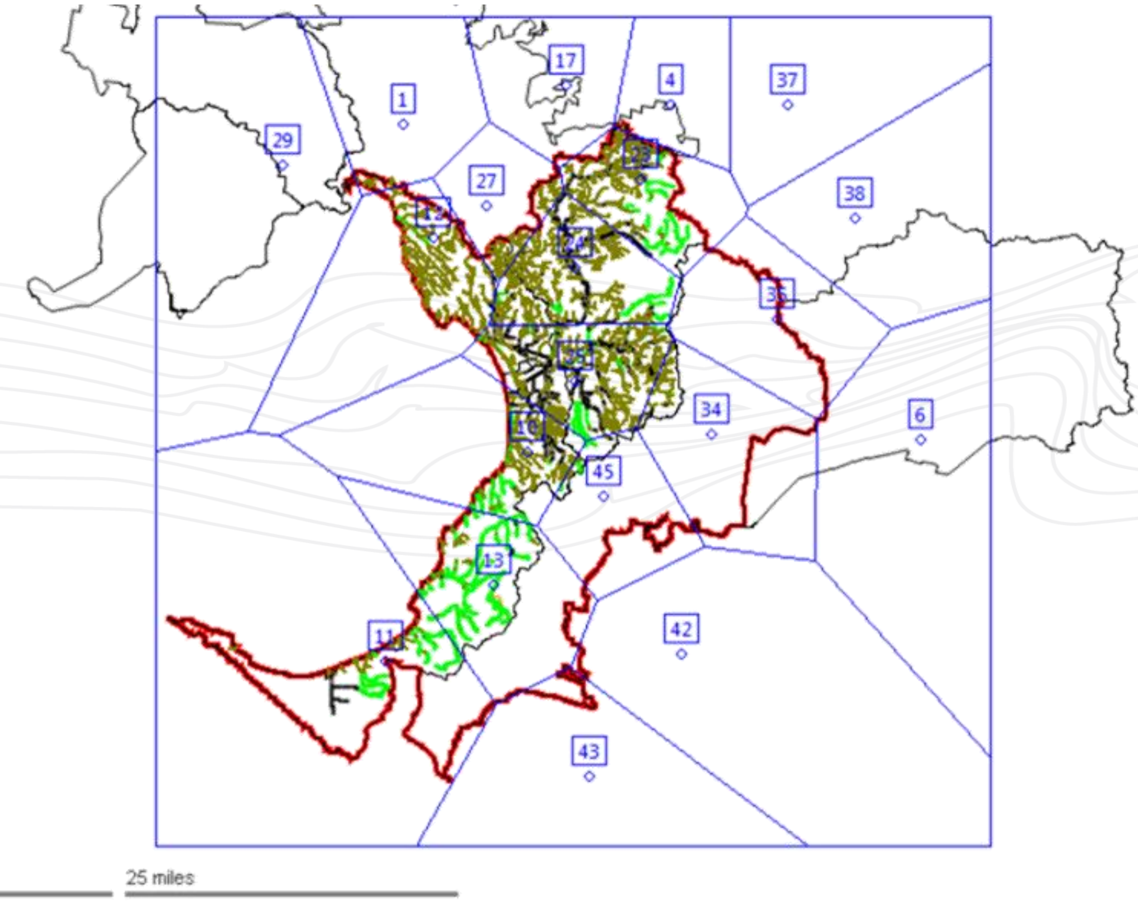
Model Simulation & Verification



- Spatial variability using 17 existing MW rainfall stations
- Rainfall timeseries for the 5 year ARI (20% AEP) design storms (1; 2; 6; 9; 12; 24; 48 and 72 hour)
- Flow checks against MW flood study
- Checks completed for all open drains under capacity to ascertain the cause

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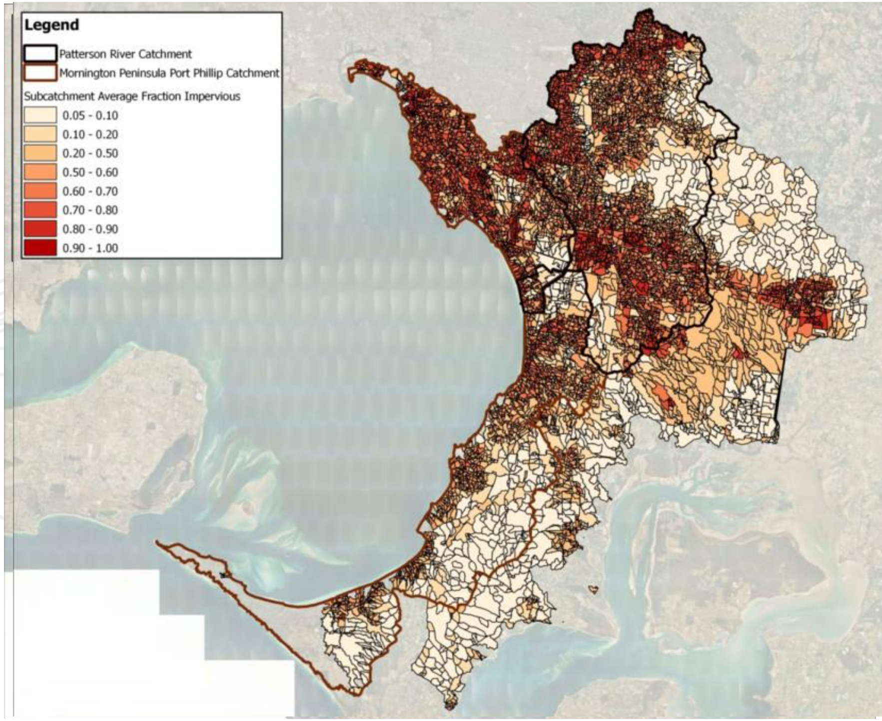
Scenario Modelling

- Existing Conditions Scenario
- Future Conditions Scenarios
  - Scenario 1: Increase in population
    - 6 million (2031)
    - 7 million (2041)
    - 8 million (2051)
    - 10 million (extrapolation from 2051)
  - Scenario 2: Climate Change (0.8m SLR increase + 10% increase rainfall intensity)
  - Scenario 3: Densification of development 8 million (2051)



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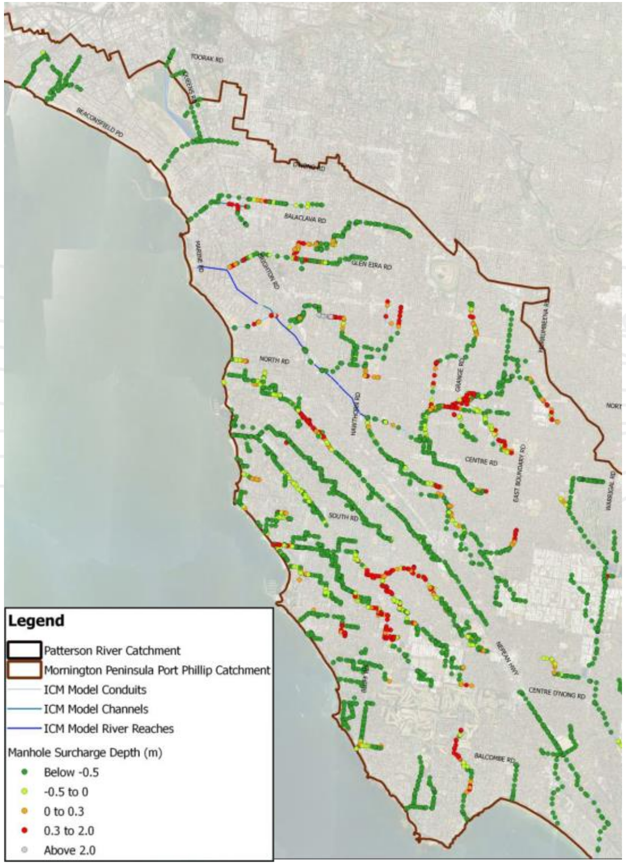
System Performance Assessment



- pipe surcharge state and node (manhole) flood depth
- maximum calculated flow against the pipe at full capacity

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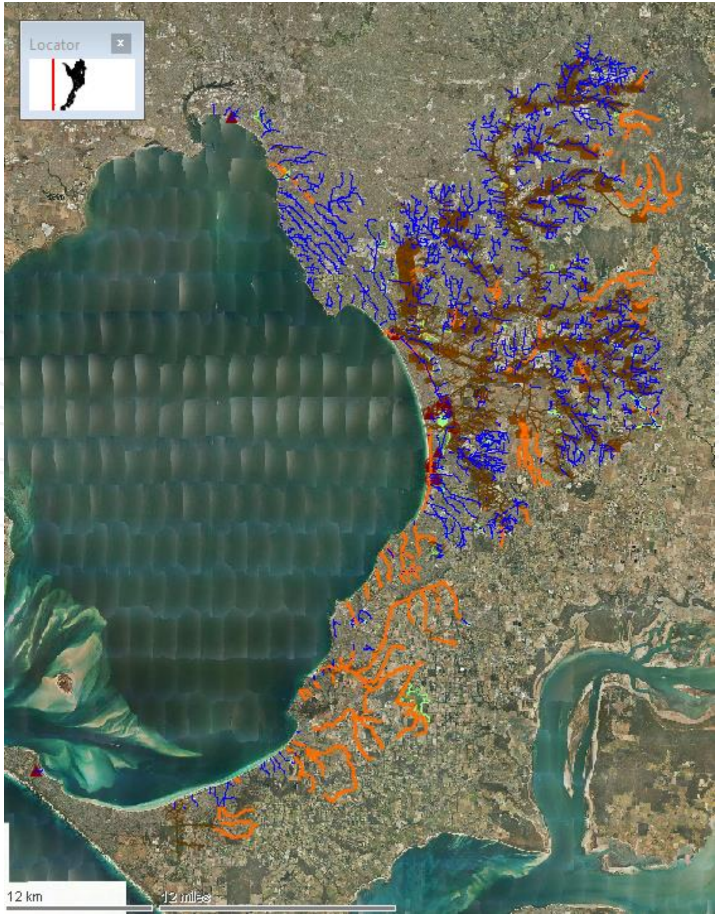
Practical Aspects and Learnings



- Challenging representation of waterways in 1D
- Interpretation of the Ground Model problematic
- Future conditions scenario modelling cannot be relied on for Greenfield areas
- Quick run time
- Coupling with sewer network model for sewer dilution assessment

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Acknowledgements:

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(Project Engineers, Water Technology)

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Thank you
Any questions?

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