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Ridgley Stormwater Investigations Project Report
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Ridgley Stormwater Investigations Project Report

transport | community | mining | industrial | food & beverage | energy



Prepared for:	**Burnie City Council**
Client representative:	**Chris Trelaor**
Date:	**23 March 2018** **Rev 02**

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Revision History

Rev No.	Description	Prepared by	Reviewed by	Authorised by	Date
00	Ridgley Stormwater Investigations Project Report - Final	Hamish Peacock	Martin Jacobs	Dr Haydn Betts	19/03/2018
01	Ridgley Stormwater Investigations Project Report – Revision to Final	Hamish Peacock	Martin Jacobs	Dr Haydn Betts	22/03/2018
02	Ridgley Stormwater Investigations Project Report – Revision to Final	Hamish Peacock	Martin Jacobs	Dr Haydn Betts	23/03/2018

Executive Summary

Burnie City Council (Council) has commissioned **pitt&sherry** to carry out investigations of the stormwater drainage system at Ridgley, and to identify mitigation options. Flooding problems have been identified in two areas: the area around 881 to 883 Ridgley Highway, and the area around the intersections between Ridgley Highway, Parker Court and Circular Road. Mitigation options have been identified and developed to a preliminary design and cost estimate. The strategies for the mitigation options rely upon the replacement of existing pipes with larger pipes.

1. Background

Burnie City Council (Council) has commissioned **pitt&sherry** to carry out investigations of the stormwater drainage system at Ridgley, as described in its Brief of 27 October 2017 and subsequent communications. Ridgley is located about 10km south of Burnie. Areas of the town have been subjected to flooding in recent years, including damage to property and infrastructure.

Council will use the outcomes of the investigations to prioritise investment in works to mitigate the impacts of current flooding problems.

The objectives of the investigations are to:

- Assess the extent and quantum of overland flooding and network capacity issues
- Identity options to address flooding problems
- Identify and model flood mitigation and capacity improvement options
- Recommend beneficial and cost-effective options to mitigate flooding problems
- Document design principles, parameters, and concepts for the recommended options in sufficient detail to support detailed design
- Prepare a proposed stormwater network plan for the Ridgley Township, identifying existing infrastructure, upgrades to existing infrastructure and new infrastructure. Provide plans detailing overland flood flow paths and depth.

2. Existing drainage system and flooding problems

Figure 1 shows the extents of the stormwater network investigation. The pipes are shown in red. The southern section of the network (south of West Mooreville Road) discharges into Pet Reservoir and the northern section discharges into Cooee Creek.

Within the extents of the stormwater network, most road and roof drainage is intercepted by kerb and channel and/or pits and pipes. The overland flows in minor rain events are mostly contained between the kerbs on either side of the road. Some kerbs are overtopped in major rainfall events, leading to overland flow through private property.

Current drainage and flooding problems within Ridgley have been identified by Council through its liaison with local residents. The following locations, as shown in Figure 3, are of particular interest.

- Area 1: Flooding has occurred at the southern boundary of private property at 881 to 883 Ridgley. There is a natural flow path through these properties but there are no effective stormwater drainage pipes to convey flows northwards to the Ridgley Highway. Modelling suggests that flooding will occur in events less than 20% Annual Exceedance Probable (AEP).
- Area 3: Flooding has occurred through private property at 959 to 989 Ridgley Highway. Stormwater runoff originates in the paddocks to the east, and flows generally south west towards the Ridgley Highway.
- Area 3: Flooding in this area has caused closure of the Ridley Highway. Modelling suggests that the 600mm pipe network has a low capacity (less than 20% AEP) and there are problems in capturing surface flows (such as the flooding through private property at 959 to 989 Ridgley Highway) and conveying them into the stormwater pipe system.

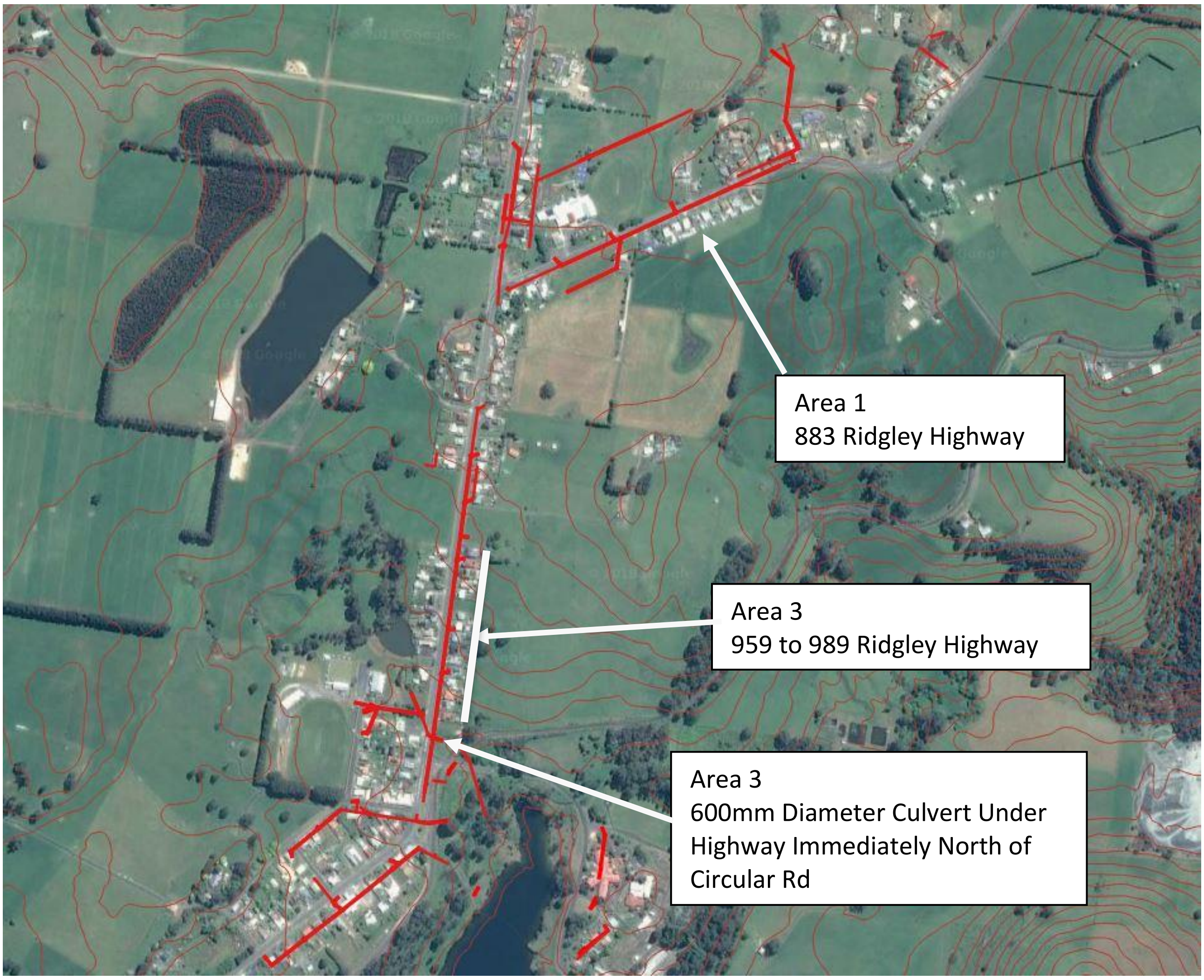

Figure 1 Ridgley Stormwater Network (pipes only)

3. Design AEP capacity

Council has requested that the stormwater model should assess capacity for the following events:

- 20% AEP
- 5% AEP
- 2% AEP
- 1% AEP
- The 600mm culvert under the highway immediately north of Circular road is to be designed to convey flows up to the 2% AEP event.

4. Hydraulic model development

4.1 Strategy

The hydrologic and hydraulic modelling has been undertaken in accordance with Australian Rainfall and Runoff (Ball et al 2016) guidelines including the analysis of temporal patterns for the relevant storm durations and AEPs.

4.2 Software

The hydraulic modelling software used for the storm water analysis was DRAINS Version 2018.01. Geographic Information System (GIS) software Quantum GIS (QGIS)[1] version 2.18 was used to:

- Interrogate and manipulate the council and survey data for input into DRAINS
- Size and delineate sub-catchments
- Determine overland flow paths.

4.3 Input data

4.3.1 Available data

Terrain and stormwater network data were acquired from the following sources:

- Council's existing Global Information Systems (GIS) data for the pipes and pits in Ridgley
- Council's GIS data for topography
- Topographical data sourced from TheList[2]
- A survey of the current network by Peacock, Darcey & Anderson (PDA) surveyors.

The features within the model are summarised in Table 1.

Table 1 Storm water distribution network

Infrastructure	Council GIS	Survey GIS	DRAINS model (Including Dummy Elements)
Pipes	134	101	158
Manholes	76	Not Specified	66
Pits	67	Not Specified	86
Headwalls	3	10	8
Node (Outlets)	4	Not Specified	8

Appendix A outlines the issues provided by PDA in conducting its survey. The survey data was used as the primary input into the hydraulic model, and the Council data were used to fill in gaps.

The topographic information used was a combination of 0.5m elevation contour data within the Catchment extents of the network (provided by Council), and 5m elevation contours obtained from TheList for areas not covered by the 0.5m contour data.

Rainfall depths files were obtained from Australian Bureau of Meteorology[3] (see Appendix B) with Temporal Patterns and Climate Change factors obtained from the Australian Rainfall and Runoff (ARR) data hub[4].

The state aerial image and Google Street View (2010 image) were used to assist catchment delineation.

[1] http://www.qgis.org/en/site/
[2] https://maps.thelist.tas.gov.au/listmap/app/list/map
[3] Australian Government Bureau of Meteorology (BOM), 2017 http://www.bom.gov.au/water/designRainfalls/revised-ifd/?
[4] The Australian Rainfall & Runoff Datahub, Mark Babister, Aaron Trim, Isabelle Testoni , Monique Retallick, WMAwater, Sydney, Australia http://data.arr-software.org/

4.3.2 Comparison of survey and Council GIS data

Most surveyed surface levels of pits and pipes were close to those shown in the supplied 0.5m contours, but some assumptions were required complete the working hydraulic model.

Some assumptions were made in estimating the sub-catchments reporting to each pit because the stormwater network data from the survey and Council's GIS do not include the internal plumbing on private property. Where the survey included the size of pipes at some easement locations, it was assumed that they accepted flows from part of the sub-catchment and overflowed when the they reached their capacities. These pipes were generally 150-225mm diameter. Google Street View was also used to identify where kerb adapters were visible along un-piped sides of the road.

4.3.3 Pits

There were two types of pits in the survey and Council Data, which are scheduled in Table 2 with the method of estimating the pit inlet capacity.

Pits were assumed to be 30% blocked. Pit loss coefficients were determined in accordance with Melbourne Water[5] suggested values. Pits at the start of the line were assigned a loss coefficient of 5. Manholes with inline flows were generally assigned a loss coefficient of 0.5. Loss coefficients for other pits were estimated by standard methods according to the individual pit configuration. Ponding volumes and overflow levels were determined from the 0.5m contours.

Surcharging levels at pits were estimated from the survey data. Flows exceeding these levels overtopped the road or rail, or were conveyed overland.

Table 2 Pit types

Pit type	Number of pits	Method of estimating the pit inlet capacity
Single Grated Pit	63	HEC22 Inlet Capacity Wizard function in DRAINS
Side Entry Pit	4	DIER Pits on Barrier Kerb B1, Side Entry Pit

4.3.4 Pipes

Two types of pipes were observed; Reinforced Concrete Pipes (RCP) and Polyvinyl Chloride Pipes (PVC). Default Manning's 'n' values of 0.013 and 0.012 were used for the RCP and PVC pipes respectively.

Pipe invert levels were generally acquired from the PDA survey. Where no invert data was present for pipes, the pipe was assumed to be at the grade of the terrain or at 1% as appropriate.

4.3.5 Overflow routes

Modelling overflow routes from headwalls and pits required a significant level of interpretation and judgement for entry into the DRAINS model. The following general rules were adopted:

- Half of 7.5m wide roadway with 3% cross-fall
- Overflow across road low point, based on the assumption of the vertical profile of the road crest following a parabolic curve
- Swale with 1:4 and 1:6 batters.

[5] https://www.melbournewater.com.au/planning-and-building/developer-guides-and-resources/standards-and-specifications/loss-coefficient

4.3.6 Headwalls

Headwalls were modelled with inlets loss coefficients of 0.5.

Overflow levels at headwalls were estimated from the 0.5m contours. Flows exceeding these levels overtopped the road or rail, or were conveyed overland.

4.3.7 Catchments

Each gully pit and headwall was assigned its own catchment. Catchments were determined from 0.5m contours, 5m contours, aerial imagery and Google street view. The times of concentration were estimated either from the Bransby-Williams method, with a lower limit of 5 and 10 minutes for pervious and impervious areas respectively (as recommended in the Queensland Urban Drainage Manual[6]). The areas of pervious and impervious surfaces were interpreted from the current aerial imagery, with consideration of the Burnie Interim Planning Scheme Zoning[7].

The hydrologic model used for the stormwater main design and analysis was an ILSAX model. This model incorporates an initial-continuing loss model combined with depression storage for each sub-catchment. This was compared with an extended Rational Method.

The following inputs were used:

- An Antecedent Moisture Condition (AMC) value of 3 which represents a relatively wet catchment with 12.5-25mm of rain falling in the preceding 5 days
- DRAINS Soil Type 3 representing a relatively low infiltration soil which impedes the downwards movement of water through the soil
- Depression Storage of 1mm and 5mm for impervious and pervious areas respectively.

Parameters for individual catchments are scheduled in Appendix C.

4.3.8 Basins

Farm dams were assumed to be 100% full. The hydraulics of spillways including flow attenuation at minor spillway levels were not included in the analysis.

4.3.9 Minor and major storms

Council has requested that four storms be run, 20%AEP, 5%AEP, 2% and 1% AEP. These were run as follows:

- Minor storms were 5% and 20% AEP.
- Major storms were 1% and 2% AEP.

4.3.10 Model verification

The DRAINS model was verified by two methods, comparing outputs with anecdotal evidence of flooding and comparing peak flows with Rational Method estimates at selected locations.

The DRAINS model compared favourably with anecdotal evidence by predicting flooding problems in areas where complaints have been submitted to Council.

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[6] https://www.dews.qld.gov.au/__data/assets/pdf_file/0008/78128/qudm2013-provisional.pdf
[7] http://www.iplan.tas.gov.au/pages/plan/book.aspx?exhibit=bccips

The Rational Method comparison was made for selected sub-catchments, as shown in Table 3. The comparison shows that The Rational Method estimates higher flows for the 20%AEP events, and lower flows for the 1%AEP events. Given the difference in the methodology, and the uncertainty in estimating design flows, it is considered that this comparison indicates that the DRAINS model is adequate for the purposes of designing upgrade works.

Table 3 Rational Method peak flow comparison

Catchment		20% AEP Peak Flow (m^3/s)		1% AEP Peak Flow (m^3/s)	
ID	Area (ha)	Rational Method	DRAINS	Rational Method	DRAINS
A	39.8	1.21	1.03	2.98	4.20
B	10.8	0.43	0.32	1.15	1.70
C	11.1	0.45	0.34	1.19	1.80

5. DRAINS Results

5.1 20% AEP event

Areas that are subject to significant overland flow during 20%AEP events are highlighted in Figure 2. Overland flow is expected in the road corridor and in private property in locations 1, 2 and 3.

The capacity of existing pit inlets will affect the overland flow significantly. Most pits are a single grated pit with no kerb inlet, which is susceptible to blockage. The modelling assumes that these pits are 30% blocked.

The pipes generally are not surcharging except for pipes in areas 1 and 3, which suggests that the stormwater system generally has 20% AEP capacity in these locations.

Location 1 is expected to experience flooding of properties in the immediate vicinity of 883 Ridgley Highway. However, all properties from 865 to 889 Ridgley highway are susceptible to varying degrees of flooding from paddocks to the south. The location of flow paths will depend on the type and extent of the fences at the southern end of these properties. As flows enter the roadway, they will travel north-east along the road and discharge into the roadside table drain east of 865 Ridgley Highway. In high flow situations, it is anticipated that some flow will overtop the barrier kerb and pass directly into Cooee Creek.

Location 2 will experience concentrated flow along the road way from approximately the entrance of 955-957 Ridgley Highway down to the 600mm diameter culvert immediately north of Circular Road. The road grade is around 5% in this section of highway. The water here originates mostly from the pasture and paddocks east of the highway. Contours suggest that Property 971 and 973 Ridgley Highway may be susceptible to overland flows if the flow does not pass through the 969 Ridgley Highway access.

Location 3 has a history of inundation and Ridgley Highway closure. In the 20% AEP rainfall event, overland flows of 0.3-0.4 m^3/s approach the highway crossing. Inundation may last for up to 1-2 hours.

Locations 4 and 5 are expected to experience minor roadway flooding for periods of about 10 to 15 minutes.

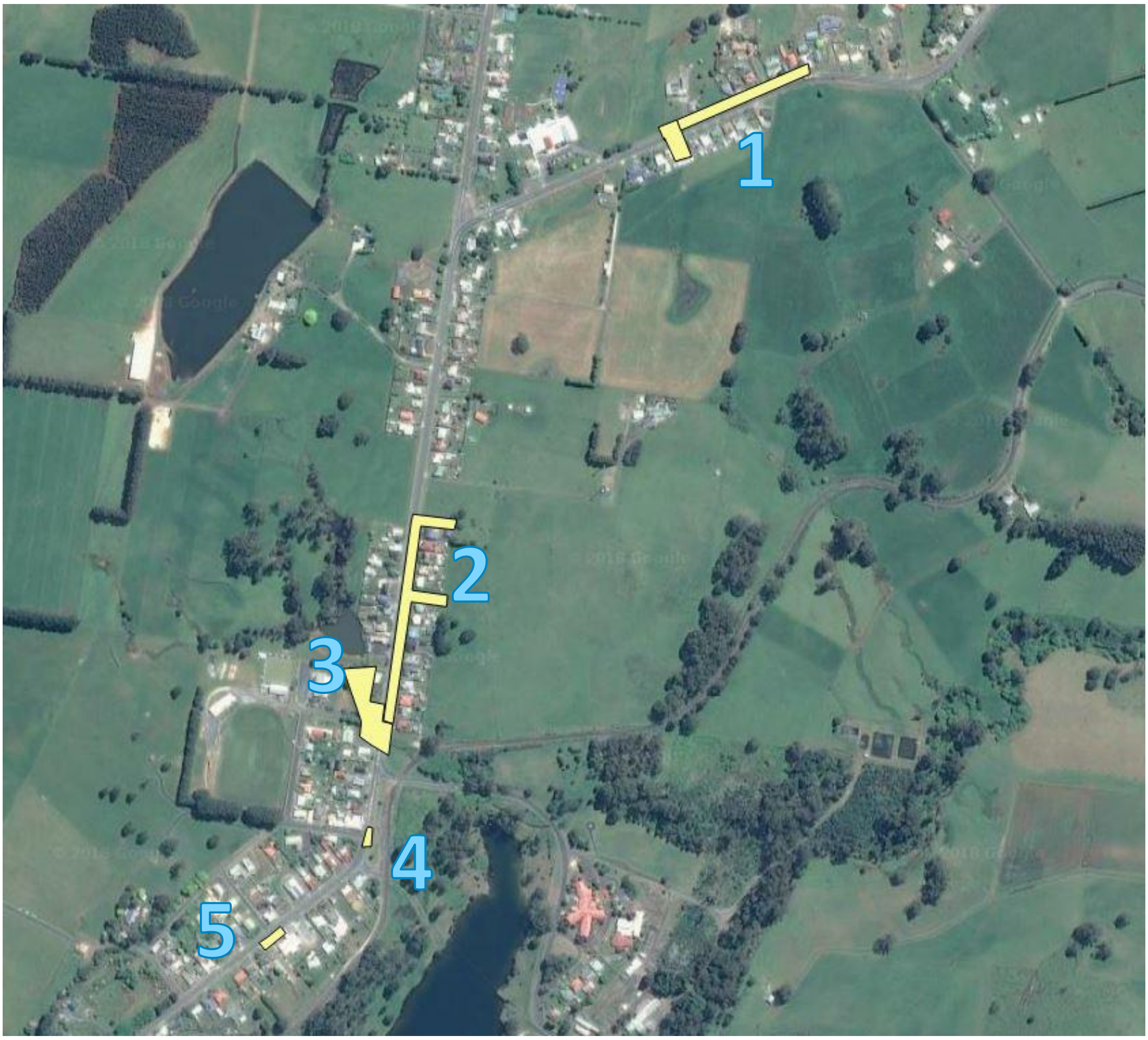

Figure 2 Areas of flooding in 20% AEP event.

5.2 1% AEP event

Areas that are subject to significant overland flow during 1%AEP events are highlighted in Figure 3. Overland flow is expected in the road corridor and in private property in locations 1, 2 and 3.

The capacity of existing pit inlets will affect the overland flow significantly. Most pits are a single grated pit with no kerb inlet, which is susceptible to blockage. The modelling assumes that these pits are 30% blocked.

Location 1 is expected to experience flooding of properties in the immediate vicinity of 883 Ridgley Highway, as described for the 5%AEP, but with higher flows and more extensive flooding. About 1.14m^3/s of water move through properties in the immediate vicinity of 883 Ridgley Highway. From here, about 1.7m^3/s will split and flow either directly north over the highway into Cooee Creek, or north west along the roadway and into the roadside table drain past 865 Ridgley highway. The road at this location is expected to be flooded for 1-2 hours in longer duration 1% AEP events.

Location 2 will experience flooding through the same properties as the 5% AEP event. Up to 1.2m^3/s is expected to flow down the roadway prior to 600mm culvert north of Circular Road. Water may flood most of the properties along the east of the Highway from 959 to 989 Ridgley Highway. Up to about 1.2m^3/s could concentrate and flow through properties in the immediate vicinity of 959 Ridgley Highway and

971 Ridgley Highway. The road at this location is expected to be flooded for 30 to 60 minutes in longer duration 1% AEP events.

Location 3 will experience significant flooding with up to 5.8m^3/s flowing overland into the channel beyond the 600mm culvert crossing. The path between the headwall of the 600mm culvert and the open channel is anticipated to experience overland flow and inundation of the highway crossing for up to 3 to 5 hours. Both the Rail culvert and the Circular road culvert will be overtopped in the 1% AEP event.

Location 4 will experience flooding in the 1% event with most flows approaching from the 40-hectare catchment to the west. This catchment flows through a paddock headwall into the existing 600mm pipe, down Queen Street and across the highway. The 1.07m^3/s peak overflow is generally expected to follow this path with possible flooding into properties around 13 George street and 1 Queen Street. Overland flow at the highway crossing is estimated to be about 1.55m^3/s, which will split into flows heading north along the highway and east over the barrier kerb. The flooding of the roadway is expected to last up to 20 to 40 minutes.

Location 5 will experience flooding along the roadway with overland flows up to 0.45m^3/s. This flow should be contained within the road reserve and flow north east and then east across the railway. Flooding will last 10 to 30 minutes.

Location 6 will experience flooding up to 0.41m^3/s. This will flow overland through the undeveloped properties from 891 to 903 Ridgley Highway. The flow then approaches the highway and will flow north east where it will meet will floodwater from Location 1. The existing network has a 300mm diameter PVC pipe to convey flow through these properties, which has a capacity of about 20% AEP.

Location 7 will experience peak flooding up to 0.39m^3/s from the West Mooreville Road through properties in the immediately vicinity to 1263 West Mooreville Road. An existing drainage easement exists through the southern edge of 1267 West Mooreville road. This easement has a 225mm, which has a capacity of about 20% AEP.

The flooding problems and mitigation options are described in detail in the memos in Appendix D and are summarised in Table 4.

Figure 3 Areas of flooding in 1% AEP rainfall event.

Table 4 Summary of mitigation options

Option	Description	Cost estimate		Notes
		Low	High	
1A	Location 1: New 750 dia pipe under private property and highway, existing to Cooee Creek, about 75 m long	$112K	$186K	Most direct route to outlet. Requires works within private property.
1B	Location 1: Diversion to north and west with about 320 m new pipework	$416K	$615K	Redirects flows to different sub-catchment. Requires works within private property.
1C	Location 1: Diversion to north and west with about 300 m new pipework and table drain along Ridgely Highway	$255K	$384K	Redirects flows to different sub-catchment.
3A	Location 3: Replace culverts under Ridgley High, railway and Circular Road, excavate new inlet at Community centre, catch drains at rear of properties on Ridgley Highway	$280K	$382K	Improves existing system.

Note: More details for each mitigation option are described in Appendix D.

6. References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia.

Appendix A

Issues encountered during survey

Unique ID (measured)	MHNO	Type	Issue
4043.2	1	GP	Outlet unknown
6396	1	MH	Outlet unknown
4046	1	GP	Outlet and inlet unknown
4050.1	1	GP	Outlet unknown
7745.2	46470	Outlet	Open drain – nothing else found
7764	52000	EOL	MH appears to be sewer
4532	46300	MH	Lid sealed – not opened
7744	46290	COD	Not located
7761	46315	COD	Not located
26	46241	MH	Outlet unknown
7735	46453	EOL	Not located
7746	46442	COD	Not located
1200	46404	GP	Connection to line unknown
4538	51620	MH	Not found
7749	46480	MH	Painted sewer
4550	51605	MH	Not found
14	46550	MH	Not found
13 to 6395	46549 to 46541		150 PVC pipe to 300 RCP
7753	46610	MH	Under playground – unable to open
6392	46600	MH	Under trampoline in backyard – will take time to open
7758	46602	MH	Not found
4547	46590	MH	No South pipe (connection to 15 not found)
1191	46242	GP	Connection to line unknown

Appendix B

IFD data

Duration		ARI (years)						
Minutes	**Hours**	**1**	**2**	**5**	**10**	**20**	**50**	**100**
1	0.017	90.0	102.0	142.2	172.2	204.0	249.6	288.0
2	0.033	80.1	90.3	123.0	146.1	169.5	198.6	221.4
3	0.050	70.6	79.6	109.0	130.0	151.4	179.2	202.0
4	0.067	63.2	71.4	98.4	117.9	138.2	165.0	187.5
5	0.083	57.4	64.9	89.9	108.2	127.2	153.6	176.4
10	0.167	40.8	46.3	64.8	79.2	94.2	116.4	135.0
15	0.25	32.9	37.3	52.4	64.0	76.0	94.4	110.0
20	0.33	*28.1*	*31.9*	*44.6*	*54.4*	*64.5*	*79.7*	*92.5*
25	0.42	*24.9*	*28.3*	*39.4*	*47.9*	*56.8*	*69.9*	*80.8*
30	0.50	22.6	25.6	35.6	43.2	51.2	62.8	72.4
45	0.75	*18.3*	*20.6*	*28.4*	*34.1*	*40.2*	*48.5*	*55.4*
60	1.0	15.7	17.7	24.2	28.9	33.8	40.4	45.8
90	1.5	*12.8*	*14.4*	*19.4*	*23.0*	*26.6*	*31.4*	*35.1*
120	2.0	11.1	12.4	16.6	19.6	22.4	26.2	29.1
180	3.0	9.0	10.1	13.4	15.6	17.7	20.5	22.6
270	4.5	*7.3*	*8.1*	*10.7*	*12.4*	*14.1*	*16.3*	*17.9*
360	6	6.3	7.0	9.2	10.6	12.0	13.8	15.2
540	9	*5.0*	*5.5*	*7.2*	*8.3*	*9.4*	*11.0*	*12.1*
720	12	4.2	4.7	6.1	7.0	8.0	9.3	10.3
1080	18	*3.2*	*3.6*	*4.6*	*5.4*	*6.2*	*7.3*	*8.1*
1440	24	2.7	2.9	3.8	4.5	5.1	6.1	6.9
1800	30	*2.3*	*2.5*	*3.2*	*3.8*	*4.4*	*5.2*	*5.9*
2160	36	*2.0*	*2.2*	*2.8*	*3.3*	*3.8*	*4.6*	*5.2*
2880	48	1.6	1.8	2.3	2.7	3.1	3.8	4.3
4320	72	1.2	1.3	1.7	2.0	2.3	2.7	3.1
5760	96	1.0	1.0	1.3	1.6	1.8	2.2	2.4
7200	120	0.8	0.9	1.1	1.3	1.5	1.8	2.0
8640	144	0.7	0.8	1.0	1.2	1.3	1.5	1.7
10080	168	0.7	0.7	0.9	1.1	1.2	1.4	1.5

NOTE: Values in italics have been interpolated

Appendix C

Table of catchment parameters

Catchment parameters

CATCHMENT ID	NODE	Catchment Area (Hectares)	Area Impervious (%)	Area Pervious (%)	Impervious Tc (min)	Pervious Tc (min)
Cat147	32887	0.028	35	65	5	10
Cat32	46208	0.075	100	0	7	0
Cat30	46207	0.670	10	90	7	15
Cat19	46200	0.690	25	75	7	12
Cat13	46209	0.050	100	0	6	0
Cat38	46220	0.200	20	80	6	10
Cat87	HW3	0.500	15	85	7	10
Cat7	1001	0.121	65	35	7	12
Cat10	26693	0.080	45	55	6	11
Cat179	51623	0.472	40	60	6	10
C	HW5	11.050	2	98	5	16.5
D	HW6	1.105	5	95	6	12.1
Cat45	1002	0.100	20	80	5	10
Cat106	46420	0.185	20	80	6	11
Cat55	46242	0.070	20	80	6	11
Cat80	46330	0.045	100	0	6	0
Cat82	46320	1.037	20	80	6	20
Cat84	46325	0.327	50	50	6	15
Cat181	51631	0.091	100	0	6	0
Cat78	46295	0.010	100	0	5	0
Cat130	46404	0.032	60	40	6	8
Cat43	46243	0.200	20	80	6	11
Cat108	46380	0.040	85	15	5	5
Cat117	1206	0.029	100	0	6	0
Cat113	46370	0.015	100	0	5	0
Cat187	51621	0.104	100	0	6	0
Cat185	51622	3.260	6	94	6	13.4
Cat189	51611	0.082	100	0	6	0
F	51602	3.928	3	97	5	17.7
Cat241	46581	0.255	50	50	6	10
Cat244	SEP	0.215	60	40	6	10
Cat193	46521	0.086	100	0	6	0
Cat194	46490	1.028	20	80	6	15.5
Cat223	44422	0.169	100	0	6	0
Cat225	44420	0.984	15	85	5	10
Cat227	44430	0.097	35	65	6	10
Cat210	46552	0.035	100	0	6	0
Cat209	46553	0.100	90	10	7	10
Cat231	46543	0.210	90	10	6	10
J4	46533	1.170	10	90	6	20.2
Cat239	46534	0.095	100	0	5	0
Cat219	46611	0.119	35	65	6	10
Cat208	46559	0.052	100	0	6	0
Cat197	46511	0.136	70	30	6	10
Cat207	46551	0.063	100	0	6	0
Cat198	46500	0.048	100	0	6	0

CATCHMENT ID	NODE	Catchment Area (Hectares)	Area Impervious (%)	Area Pervious (%)	Impervious Tc (min)	Pervious Tc (min)
Cat203	51604	0.362	30	70	6	10
Cat201	51603	0.073	100	0	6	0
Cat23	46253	0.316	0	100	5	10
Cat21	46251	0.177	50	50	7	12
Cat96	46352	0.059	100	0	6	0
Cat138	1004	0.275	60	40	6	11
Cat235	46542	0.055	100	0	6	0
Cat152	4043.2	0.252	20	80	6	10
Cat161	4044	0.034	40	60	5	10
Cat164	4045	0.051	20	80	5	10
Cat166	4046	0.052	40	60	5	10
Cat168	4047	0.020	100	0	5	0
Cat170	4048	0.014	100	0	5	0
Cat172	4049	0.006	100	0	5	0
Cat174	4050.2	0.194	50	50	6	10
Cat237	46547	0.071	100	0	6	0
Cat263	4054	0.097	100	0	5	0
Cat64	46311	0.086	100	0	7	0
Cat136	7739	1.500	23	77	7	5
Cat102	7742.1	0.160	0	30	5	10
J1	71214.3	0.550	10	90	10	10
J2	71214.4	1.570	5	95	16	16
Cat60469	71214.5	0.830	0	100	5	10
Cat104	11880	0.206	10	90	6	11
Cat34	46230	0.462	55	45	6	11
A	HW1	39.830	5	95	15	33.2
DUMMY ROOFS	N1042	0.200	100	0	5	5
B	HW2	10.800	0	100	0	16.7
DUMMY SPORTS	DUMMY PIT SPORTS	1.425	10	90	8	5
DUMMY SPORTS 2	DUMMY PIT SPORTS 2	0.261	100	0	6	0
DUMMY ROOFS 3	DUMMY PIT ROOF 3	0.300	100	0	6	0
DUMMY ROOF 2	DUMMY PIT 2	0.077	100	0	5	0
Cat158	HW7	0.117	15	85	6	10
DUMMY EASEMENT 2cat	DUMMY EASEMENT PIT	0.630	70	30	7	12
DUMMY ROOFS 4	DUMMY PIT 4	0.060	100	0	5	0
Cat220	46613	0.083	100	0	6	0

CATCHMENT ID	NODE	Catchment Area (Hectares)	Area Impervious (%)	Area Pervious (%)	Impervious Tc (min)	Pervious Tc (min)
DUMMY ROOFS 6	DUMMY PIT ROOFS	0.200	100	0	5	0
Cat246	46561	0.300	20	80	7	12
Cat256	46562	0.170	20	80	7	12
H	46570	3.703	0	100	5	10
DUMMY SPORTS GROUND	DUMMY pit sport	0.930	5	95	10	20
Cat67	46270	0.156	5	95	6	10
Cat76	46280	0.059	100	0	6	0
DUMMY EASEMENT	DUMMY PIT EASSE	0.200	100	0	7	0
I	HW	8.070	0	100	5	22.5

Appendix D

Mitigation option memos

Memo

To: Chris Treloar, Burnie City Council

From: Martin Jacobs, Hamish Peacock

Date: 23-03-2018

RE: DV17114 Ridgley Stormwater Hydraulic Modelling
Mitigation Option 1A

1. Introduction and context

Burnie City Council has commissioned **pitt&sherry** to carry out hydraulic modelling of the stormwater Network at Ridgley. The hydraulic model was developed to represent the existing situation, and has been modified to include various options for works to mitigate stormwater flooding problems within the system. The purpose of this memo is to describe one of the mitigation options for the stormwater flooding problems. Other options and other flooding problems are addressed in separate memos.

2. Location and description of stormwater flooding problems

Flooding has been reported and shown by hydraulic modelling at the locations highlighted in yellow in Figure 1. These areas are the areas where overland flow will impact property and infrastructure in 20% Annual Exceedance Probability (AEP) (5 year ARI) event. Figure 1 also shows sub-catchment areas flowing to each pit and pipe. The area of interest to this memo is Location 1 in Figure 1..

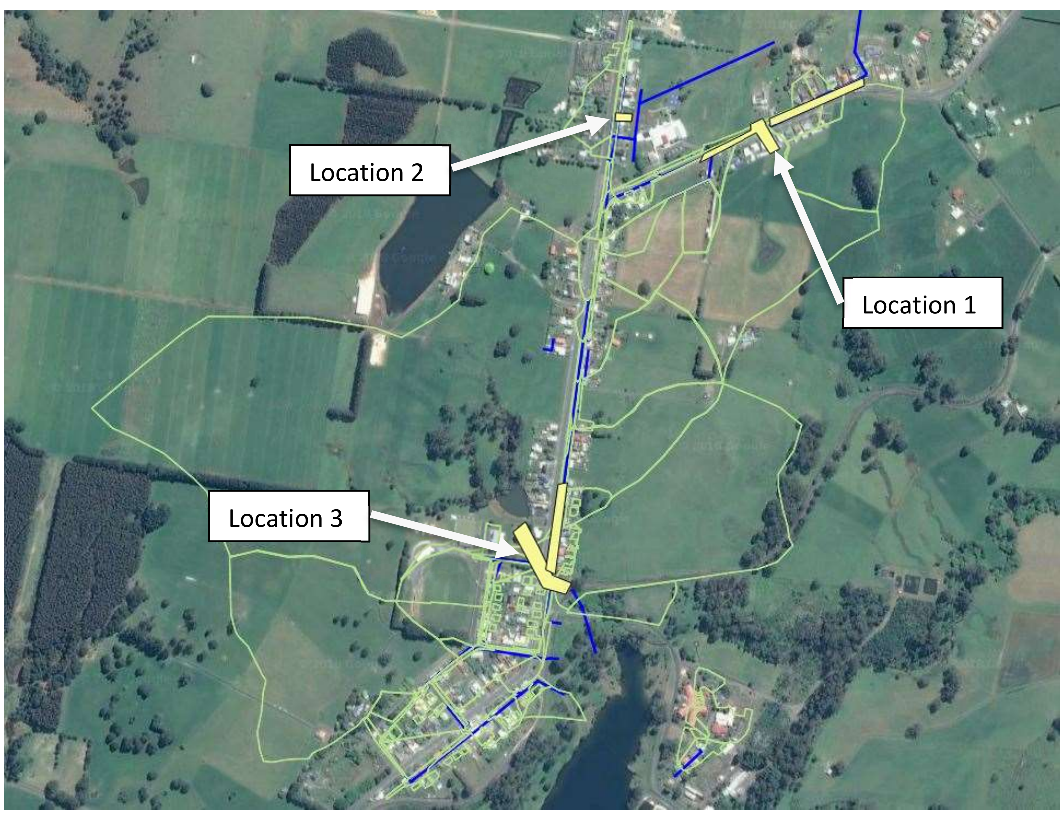

Figure 1 Location of Stormwater Flooding shown in Yellow (Hydraulic Modelling Suggests Flooding in Events Less Than 20% AEP)

3. Technical analysis

The rainfall events analysed comprised the 1%, 2%, 5% and 20% AEP events for the existing system, and 1%, 2%, 5% and 20% AEP plus a 10% allowance for climate change for the mitigation options.

Stormwater runoff flows towards the Ridgely Highway from the south, and collects in Cooee Creek that passes to the east of the school. The houses on the south of the Ridgley Highway, and the Ridgley highway itself form a barrier to stormwater runoff as it flows northwards. An existing 300mm diameter pipe has been provided to convey flows northwards, but it has insufficient capacity, leading to frequent flooding of the properties, especially 883 Ridgely Highway. The existing 30mm diameter pipe is not owned by Council.

4. Mitigation Option 1A

Option 1A is shown in Figure 2, and comprises a new pipe constructed under private property in the vicinity of 883 Ridgley Highway and a catch drain and/or bunded barrier along the southern edge of properties from 865 to 887 Ridgley Highway, which directs flows to the inlet of the new pipe.

The new pipe extends from the southern boundary of the private property to the outlet to Cooee Creek to the north of Ridgely Highway. This requires a pipe length of about 60 to 75 m, connections to existing pipes and inlet and outlet headwalls. For 1%AEP capacity, the new pipe should be 750mm diameter. For 20%AEP capacity, the new pipe should be 375mm diameter.

The catch drain at the rear of the properties at 865 to 887 Ridgley Highway has a minimum slope of about 0.5% and a 1%AEP flow of about $0.5m^3/s$.

Figure 2 Mitigation Option 1A Pipe Under private property discharging northern side of Highway into Cooee Creek

5. Preliminary Estimate of costs

Table 1 Option 1A cost estimate

Description	Quantity	Unit	Rate (lower)	Rate (Higher)	Cost (lower)	Cost (higher)
Form channel and bund	300	m	$71	$116	$21,300	$34,860
Pipe 750mm	75	m	$549	$793	$41,190	$59,490
750mm Headwalls	2	No	$1,245	$1,618	$2,490	$3,236
Manholes	3	No	$2,470	$2,890	$7,410	$8,670
Property Reinstatement	1	No	$35,000	$70,000	$35,000	$70,000
Driveway Pavement	1	No	$5,000	$10,000	$5,000	$10,000
TOTAL					$112,390	$186,256

6. Outcomes and Constraints of Mitigation Option 1A

Outcomes:

- Property 883 Ridgley Highway and those immediately adjacent would be provided protection from overland flow up to the 1% AEP rainfall event.
- Option 1A provides a robust solution for conveying flows across private property without redirecting flow to different sub-catchments.
- This option effectively conveys the flow into the natural receiving waterway.
- The option will reduce the volume of water flooding the roadway in minor and major rainfall events.

Constraints:

- The construction of a new stormwater pipe is required through private property and close to residential buildings.
- The construction of a catch drain is required through private property.
- Excavation will be required near the inlet headwall on property 899 Ridgley Highway. This will include local reshaping of terrain to direct water into the inlet.
- Existing public water and gravity sewer infrastructure are to be crossed.

Memo

To: Chris Treloar, Burnie City Council

From: Martin Jacobs, Hamish Peacock

Date: 23-03-2018

RE: DV17114 Ridgley Stormwater Hydraulic Modelling Mitigation Option 1B

1. Introduction and context

Burnie City Council has commissioned **pitt&sherry** to carry out hydraulic modelling of the stormwater Network at Ridgley. The hydraulic model was developed to represent the existing situation, and has been modified to include various options for works to mitigate stormwater flooding problems within the system. The purpose of this memo is to describe one of the mitigation options for the stormwater flooding problems. Other options and other flooding problems are addressed in separate memos.

2. Location and description of stormwater flooding problems

Flooding has been reported and shown by hydraulic modelling at the locations highlighted in yellow in Figure 1. These areas are the areas where overland flow will impact property and infrastructure in 20% Annual Exceedance Probability (AEP) (5 year ARI) event. Figure 1 also shows sub-catchment areas flowing to each pit and pipe. The area of interest to this memo is Location 1 in Figure 1.

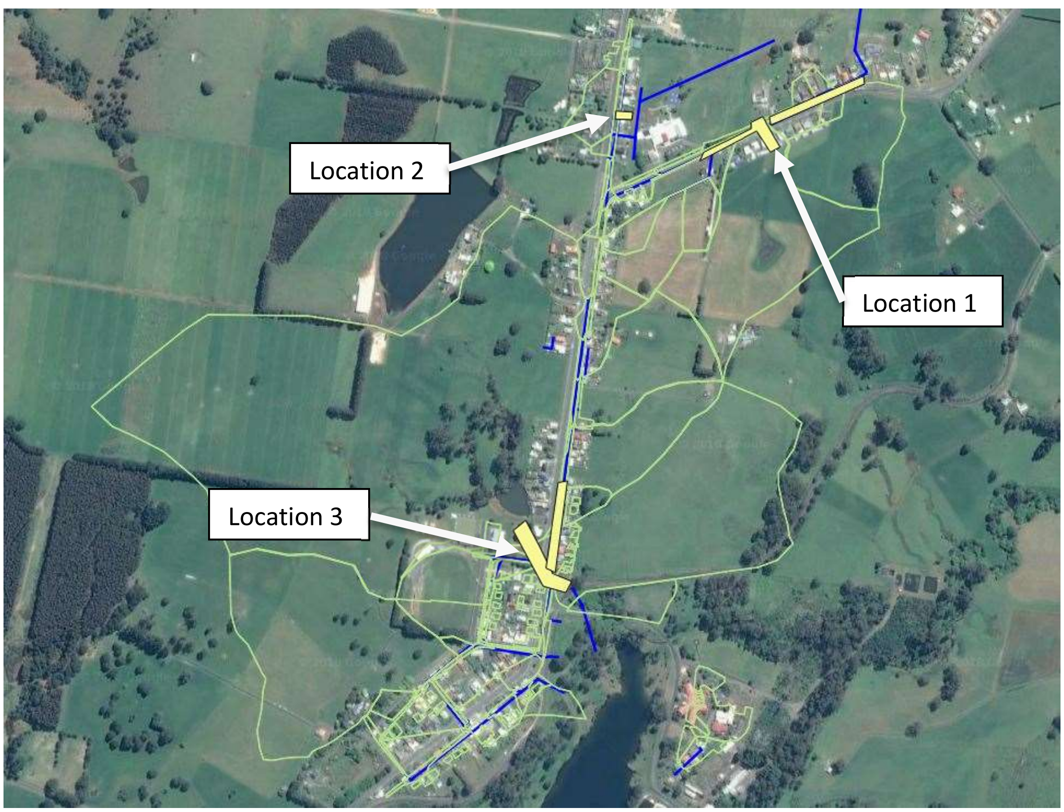

Figure 1 Location of Stormwater Flooding shown in Yellow (Hydraulic Modelling Suggests Flooding in Events Less Than 20% AEP)

3. Technical analysis

The rainfall events analysed comprised the 1%, 2%, 5% and 20% AEP events for the existing system, and 1%, 2%, 5% and 20% AEP plus a 10% allowance for climate change for the mitigation options.

Stormwater runoff flows towards the Ridgely Highway from the south, and collects in Cooee Creek that passes to the east of the school. The houses on the south of the Ridgley Highway, and the Ridgley highway itself form a barrier to stormwater runoff as it flows northwards. An existing 300mm diameter pipe has been provided to convey flows northwards, but it has insufficient capacity, leading to frequent flooding of the properties, especially 883 Ridgely Highway. The existing 30mm diameter pipe is not owned by Council.

4. Mitigation Option 1B

Option 1B is shown in Figure 2, and comprises the diversion of stormwater runoff from 883 Ridgely Highway to the north and west through upgrades to the pipe network to the south west corner of 860 Ridgley Highway. Beyond here it is proposed to surcharge additional flow overland.

For a 1%AEP capacity, the pipe upgrades comprise 150m of 750mm Diameter pipe, 50 metres of 900mm pipe and 120 meters of 1050mm diameter pipe.

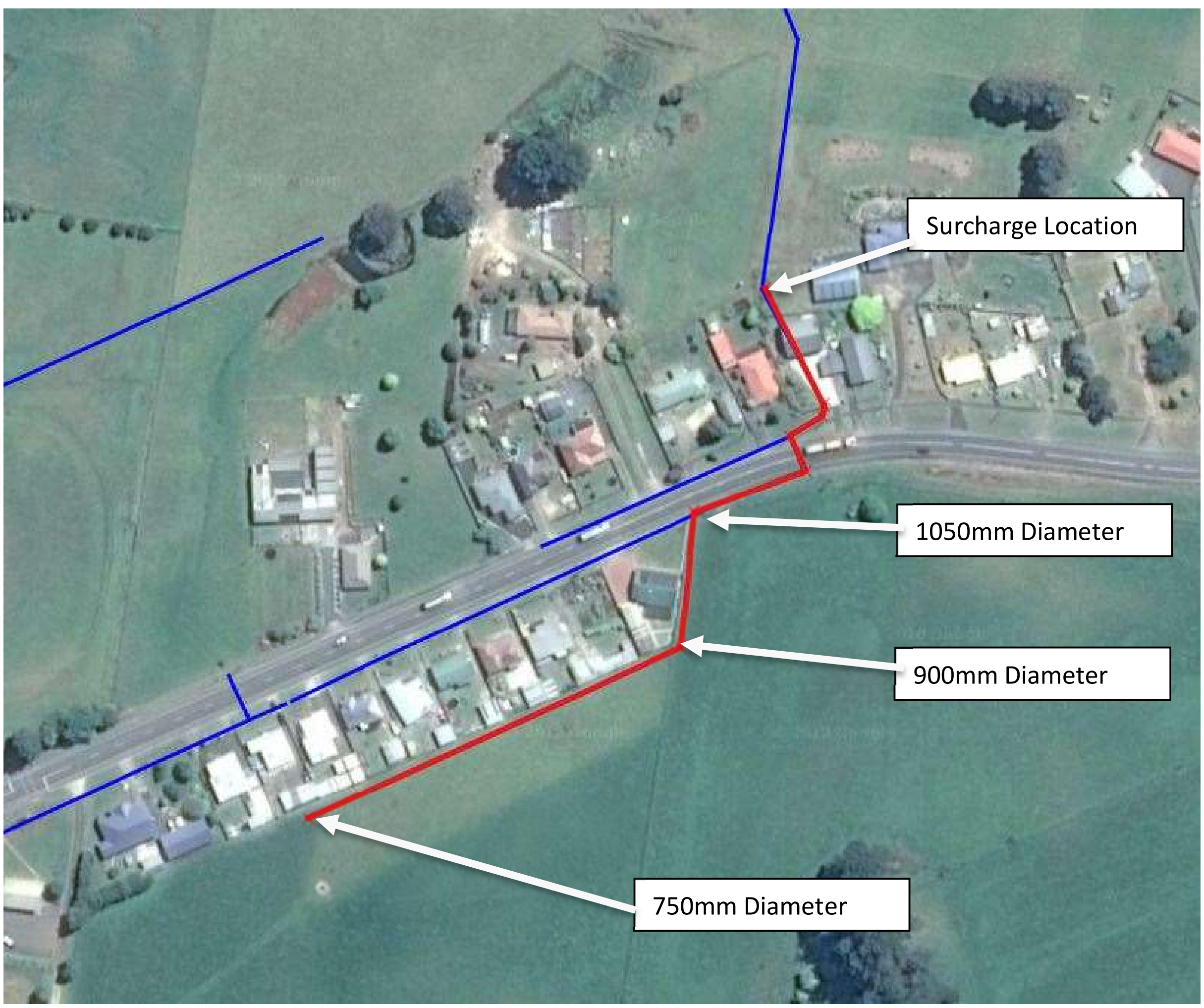

Figure 2 Mitigation Option 1B Pipe east along property boundary the north across highway.

5. Preliminary Estimate of costs

Table 1 Option 1B cost estimate

Description	Quantity	Unit	Rate (lower)	Rate (Higher)	Cost (lower)	Cost (higher)
Pipe 750mm	150	m	$866	$1,306	$129,892	$195,974
Pipe 900mm	50	m	$1,137	$1,621	$56,828	$81,058
Pipe 1050mm	120	m	$1,407	$1,940	$168,859	$232,827
Headwalls	1	No	$1,245	$1,618	$1,245	$1,618
750/900 Manholes/Pits	3	No	$2,470	$2,890	$7,410	$8,670
1050 Manholes/Pits	5	No	$4,320	$4,890	$21,600	$24,450
Property Reinstatement	1	Allow	$20,000	$50,000	$20,000	$50,000
Driveway Reinstatement	1	Allow	$5,000	$10,000	$5,000	$10,000
Ancillary road furniture (e.g. vehicle barriers, bollards, gates, signs)	1	Allow	$5,000	$10,000	$5,000	$10,000
TOTAL					$415,834	$614,598

6. Outcomes and Constraints of Mitigation Option 1B

Outcomes:

- Property 883 Ridgley Highway and those immediately adjacent would be protected from flooding up to the 1% AEP rainfall event.
- Flow reaching the location of the Highway Crossing would be conveyed through the system up to the 1% AEP rainfall as opposed to the current overflow in minor events down the Ridgley Highway table drain to the east.

Constraints:

- This option will redirect flows to a different sub-catchment. This necessitates upgrading of downstream infrastructure to accommodate higher flows.
- This option requires construction of 200m of new stormwater pipe through private property at 899 Ridgley highway, and 50m of pipe through private property at 863 Ridgley Highway where residential buildings and a shed are nearby.
- Existing public water and gravity sewer infrastructure in the Ridgely Highway will need to be crossed.
- Additional water will flow overland through 860 Ridgley Highway after surcharging on the south-western corner of the property.

Memo

To: Chris Treloar, Burnie City Council

From: Martin Jacobs, Hamish Peacock

Date: 21-03-2018

RE: DV17114 Ridgley Stormwater Hydraulic Modelling
Mitigation Option 1C

1. Introduction and context

Burnie City Council has commissioned **pitt&sherry** to carry out hydraulic modelling of the stormwater Network at Ridgley. The hydraulic model was developed to represent the existing situation, and has been modified to include various options for works to mitigate stormwater flooding problems within the system. The purpose of this memo is to describe one of the mitigation options for the stormwater flooding problems. Other options and other flooding problems are addressed in separate memos.

2. Location and description of stormwater flooding problems

Flooding has been reported and shown by hydraulic modelling at the locations highlighted in yellow in Figure 1. These areas are the areas where overland flow will impact property and infrastructure in 20% Annual Exceedance Probability (AEP) (5 year ARI) event. Figure 1 also shows sub-catchment areas flowing to each pit and pipe. The area of interest to this memo is Location 1 in Figure 1.

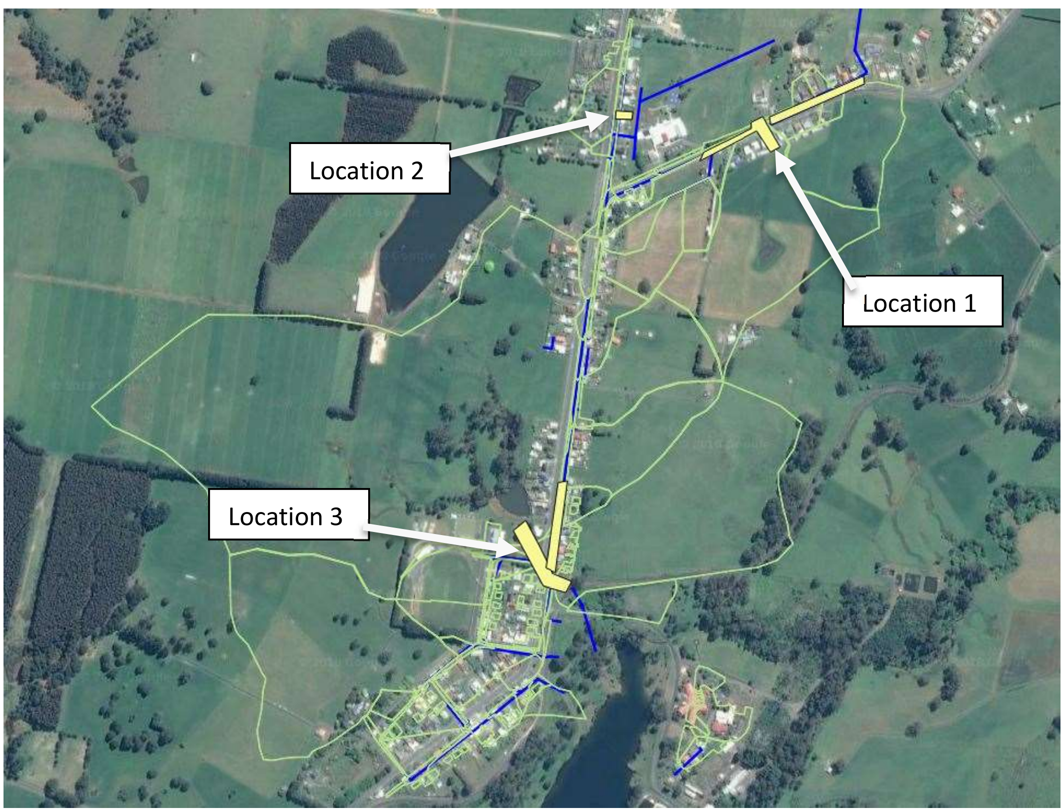

Figure 1 Location of Stormwater Flooding shown in Yellow (Hydraulic Modelling Suggests Flooding in Events Less Than 20% AEP)

3. Technical analysis

The rainfall events analysed comprised the 1%, 2%, 5% and 20% AEP events for the existing system, and 1%, 2%, 5% and 20% AEP plus a 10% allowance for climate change for the mitigation options.

Stormwater runoff flows towards the Ridgely Highway from the south, and collects in Cooee Creek that passes to the east of the school. The houses on the south of the Ridgley Highway, and the Ridgley highway itself form a barrier to stormwater runoff as it flows northwards. An existing 300mm diameter pipe has been provided to convey flows northwards, but it has insufficient capacity, leading to frequent flooding of the properties, especially 883 Ridgely Highway. The existing 30mm diameter pipe is not owned by Council.

4. Mitigation Option 1C

Option 1C is shown in Figure 2, and comprises the diversion of stormwater runoff from 883 Ridgely Highway to the north and west through upgrades to the pipe network to the roadside table drain on the southern side of the highway. The table drain would to be enlarged for accommodate the increased flows, and considerable earthworks may be required to cut back existing cuttings. From here the water would enter a 900mm diameter pipe and flow down to a receiving watercourse on the northern side of the highway.

At this stage the existing downstream stormwater system has not been analysed.

Figure 2 Mitigation Option 1C

5. Preliminary Estimate of costs

Table 1 Option 1C cost estimate

Description	Quantity	Unit	Rate (lower)	Rate (Higher)	Cost (lower)	Cost (higher)
Pipe 750mm	200	m	$549	$793	$109,840	$158,640
Pipe 900mm	100	m	$866	$1,306	$86,595	$130,650
750 Headwalls	2	No	$1,245	$1,618	$2,490	$3,236
900 Headwalls	4	No	$1,624	$2,111	$6,495	$8,443
Manholes/Pits	8	No	$2,470	$2,890	$19,760	$23,120
Enlardge table drain and cut back existing embankment	1	Allow	$30,000	$60,000	$30,000	$60,000
TOTAL					$255,179	$384,089

6. Outcomes of Mitigation Option

Outcomes:

- Property 883 Ridgley Highway and those immediately adjacent would be protected from flooding up to the 1% AEP rainfall event.

Constraints:

- This option will redirect flows to a different sub-catchment. This necessitates upgrading of downstream infrastructure to accommodate higher flows.
- This option requires construction of 200m of new stormwater pipe through private property at 899 Ridgley Highway.
- Further construction between 70 and 100m of pipe through private property at 863 Ridgley Highway where residential buildings and a shed are nearby.
- Existing public water and gravity sewer infrastructure will need to be crossed.
- Additional water will flow overland through 860 Ridgley Highway after surcharging on the south-western corner of the property.

Memo

To: **Chris Treloar, Burnie City Council**

From: **Martin Jacobs, Hamish Peacock**

Date: **23-03-2018**

RE: **DV17114 Ridgley Stormwater Hydraulic Modelling Mitigation Option 3A**

1. Introduction and context

Burnie City Council has commissioned **pitt&sherry** to carry out hydraulic modelling of the stormwater Network at Ridgley. The hydraulic model was developed to represent the existing situation, and has been modified to include various options for works to mitigate stormwater flooding problems within the system. The purpose of this memo is to describe one of the mitigation options for the stormwater flooding problems. Other options and other flooding problems are addressed in separate memos.

2. Location and description of stormwater flooding problems

Flooding has been reported and shown by hydraulic modelling at the locations highlighted in yellow in Figure 1. These areas are the areas where overland flow will impact property and infrastructure in 20% Annual Exceedance Probability (AEP) (5 year ARI) event. Figure 1 also shows sub-catchment areas flowing to each pit and pipe. The area of interest to this memo is Location 3 in Figure 1.

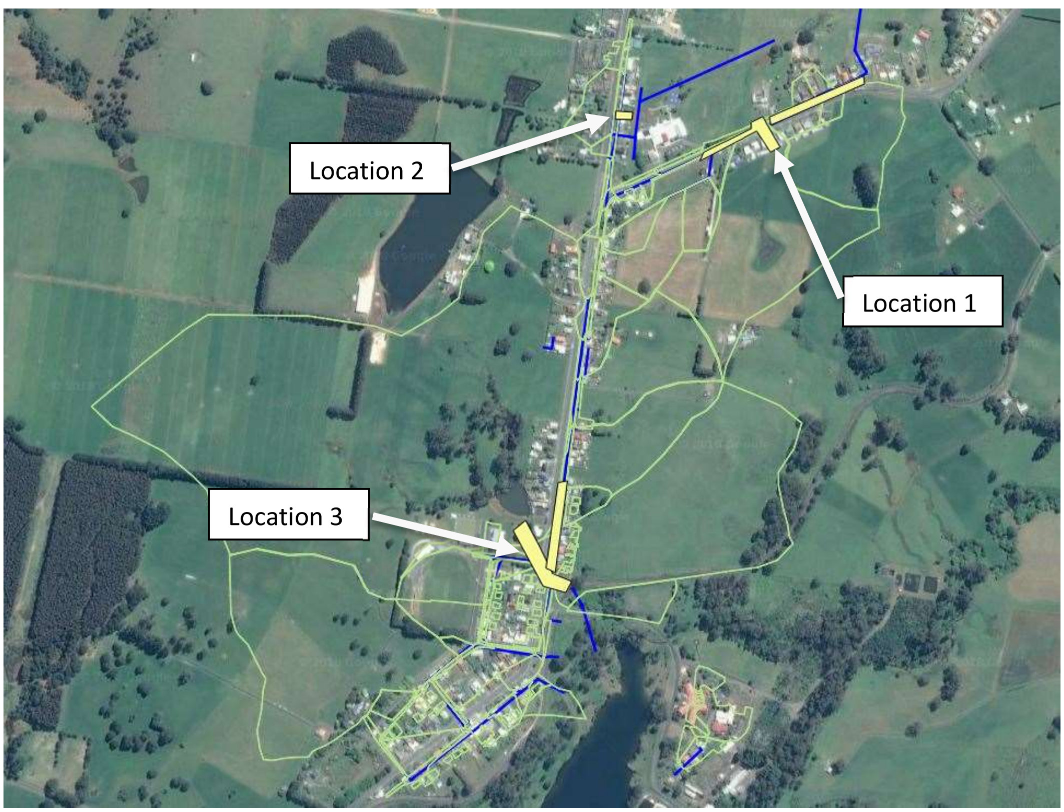

Figure 1 Location of Stormwater Flooding shown in Yellow (Hydraulic Modelling Suggests Flooding in Events Less Than 20% AEP)

3. Technical analysis

The rainfall events analysed comprised the 1%, 2%, 5% and 20% AEP events for the existing system, and 1%, 2%, 5% and 20% AEP plus a 10% allowance for climate change for the mitigation options.

Stormwater runoff flows southwards from the farm dam towards the Ridgley Community Centre. It enters a 600mm diameter culvert in private property at 984 Ridgely Highway, which passes under open space at the Ridgely Community Centre, then the Ridgely Highway, then private property to the East of Ridgely Highway. The pipe then discharges to a channel that passes beneath the railway and Circular Road before discharging to the Pet Reservoir. The catchment is about 40 ha, and the existing 600mm pipe only has capacity for rainfall events less than 20%AEP. In the major rainfall events, significant overland flooding occurs across the Ridgley highway.

Additionally, approximately 10 ha of mostly paddock/pasture flows from the east toward Ridgley Highway between 959 and 989 Ridgley Highway. There appear to be no formal stormwater infrastructure until this water meets the road. Some properties between 959 and 989 have experience overland flow in significant rainfall events.

4. Mitigation Option 3A

Mitigation Option 3A is shown in Figure 2, and comprises the following

- Replacing the existing 600mm diameter pipe under the Ridgely Highway with a 1200mm diameter pipe to convey flows up to the 2% AEP rainfall event.
- Replacing the culvert under the railway embankment with a 1350 mm diameter pipe
- Excavating the channel to maintain adequate cover over the new pipe culverts. The existing channel has a slope of 2.5% and, on this basis, it is considered feasible to reduce the invert level.
- Replace the existing inlet headwall in the private property in 984 Ridgely Highway with a new inlet and headwall in the open space in the community centre at 2 Parker Court. This would provide better access for maintenance, and improves the capture of overland flows into the pipe system
- Several new pits at connections to existing pipe systems and upgrade of existing pits.
- New pit at the access to 969 Ridgley Highway with a 225mm pipe leading to the next side entry pit location.
- A catch drain and bund along the side (northern side) of properties 971 Ridgley Highway. Grass-lined trapezoidal channel with a base width of 1.0m, 1 in 3 side slopes, a depth of 0.3 m and a length of about 50m
- A catch drain and bund along the rear (eastern side) of properties 977-989 Ridgley Highway. Grass-lined trapezoidal channel with a base width of 1.0m, 1 in 3 side slopes, a depth of 0.3 m and a length of about 150m
- The existing culvert under Circular Road replaced and upgraded.

Figure 2 MItigation Option 3A

5. Preliminary Estimate of costs

Table 1 Option 3A cost estimate

Description	Quantity	Unit	Rate (lower)	Rate (Higher)	Cost (lower)	Cost (higher)
Pipe 225mm	30	m	$204	$306	$6,108	$9,168
Pipe 1200mm	90	m	$1,407	$1,940	$126,645	$174,620
Pipe 1350mm	30	m	$1,640	$2,226	$49,197	$66,788
1200 Headwalls	2	No	$3,680	$4,784	$7,360	$9,568
1350 Headwalls	2	No	$4,384	$5,699	$8,767	$11,398
Earthworks at new inlet	1	Allow	$3,000	$5,000	$3,000	$5,000
Manholes/New Pits	12	No	$4,320	$4,890	$51,840	$58,680
Earthworks to deepen channel	1	Allow	$10,000	$20,000	$10,000	$20,000
Form channel and bund 0.3m deep	200	m	$38	$62	$7,600	$12,320
Ancillary fences, gates and other road and park furniture	1	Allow	$10,000	$15,000	$10,000	$15,000
TOTAL					$280,517	$382,542

6. Outcomes of Mitigation Option

Outcomes:

- A new much larger pipe will provide flood protection up to the 2% AEP event at the Ridgley Highway culvert crossing, rail crossing and Circular Road.
- A new catch drain and bund will negate the flooding through the rear of Properties from 971-989 Ridgley Highway.
- New larger pits at the highway crossing will reduce water ponding at the low point in the road.

Constraints:

- Existing public water and gravity sewer infrastructure will need to be crossed.
- Construction of new stormwater pipe through private properties Ridgley Fire Station and Ridgley Community Centre.
- TasRail culvert under railway will require upgrade.
- Construction of new stormwater pipe under Circular Road.

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