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Engineering

Working Beyond Expectations

Water and Wastewater Servicing Strategy

FINAL

Property:
Killingworth

Applicant:
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Executive Summary

ADW Johnson has been engaged by Lake Macquarie City Council (Council) to prepare a water and wastewater servicing strategy to service an additional 24 residential lots at Killingworth.

The proposed development area consists of 24 residential lots situated on the south western edge of the existing Killingworth Township fronting Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street. The slopes range from low to moderate with ground elevations ranging from approximately RL 38 m to RL 58 m AHD.

The proposed number of additional ET is 24.

WATER

The existing water mains servicing the Killingworth Township do not currently extend into the proposed development area. A Pipes ++ model of the existing network was created. The network was extended via a series of DN100 pipes to service the proposed lots. It was found that pressures were inadequate to service the proposed development to HWC minimum requirements.

The water strategy addresses four options to supply water services to the proposed development. The four options considered were:

- Option 1: Individual rainwater tanks;
- Option 2: Duplicate the trunk mains from Wakefield Road;
- Option 3: Provide a booster pump station at the intersection of Stephenson Street and Park Street; and
- Option 4: Provide 100mm mains to the service area with standard connections below an RL of 47m AHD and non-standard connections at higher elevations.

The option of providing a reservoir was also considered, however, this option was discounted early due to the economic cost involved for the benefit of only 24 lots.

Option 1 provides for individual rainwater tanks as the sole source of water for each dwelling. While the WSA03-2011 Hunter Water Version does not exclude the provision for rainwater tanks it is noted that any monitoring and compliance of the onsite rainwater tank requirements and maintenance would be the onus of Local Government Authority and not Hunter Water Authority. The total rainwater tank size required the service each of the lots for both firefighting purposes and residential use was determined to be 40kL for the purposes of this strategy. It is noted that the size of the tank is highly sensitive to roof area and demand assumptions. The capital cost of Option 1 was found to represent the lowest cost to the community however cost externalities such as lot devaluing, community expectations and water security were not considered.

During a draft strategy review meeting held on 1st September 2017 between Council, HWC and ADWJ the possibility of connecting the proposed rainwater tanks to the mains water supply to maintain security of supply to the proposed development area was discussed. The tank sizes determined in this report are to be reassessed on a case by case basis by each individual land owner and may be reduced should mains connections be made available for topping up the tanks during periods of low rainfall.

Of the other two options that provide mains water supply to the proposed area, it was found that neither option in isolation would achieve the minimum HWC service requirements. Only a combination of both options together would ensure sufficient minimum pressures and supply capacity could be delivered to the proposed additional 24 Lots.

Option 4, the preferred solution, has been added to this strategy following HWC's advise based on their review of this report provided on 24 April 2018. Option 4 involves extending HWC mains to service the proposed properties with standard connections made to properties below an elevation of 47m AHD and nonstandard connections above this elevation.

WASTEWATER

The existing DN150 sewer mains in Westcroft Street, Park Street, Stephenson Street and The Boulevarde do not extend into the proposed development. It is proposed that the existing mains are extended from their current locations to service the proposed development.

The Killingworth Township is serviced by Killingworth 1 and Killingworth 2 WWPS. The proposed development drains towards Killingworth 2 which pumps flows to Killingworth 1. Calculations have been undertaken to show that Killingworth 1 and 2 have adequate capacity to service the proposed development.

HWC requires 4 hours of emergency storage at WWPS. The emergency storage at Killingworth 2 was found to be inadequate for both the current and the proposed scenarios. As requested by HWC, the emergency storage upgrades are to be constructed as online storage, as discussed. This will be resolved in the detail design for that portion of the works.

A Net Present Value (NPV) analysis of the infrastructure proposed for the wastewater servicing strategy was undertaken. Over a 30 year period at a discount rate of 7%, indicated the wastewater works have an NPV $251,653.

The proposed wastewater servicing strategy provides an effective solution to service the entire study area whilst meeting the technical requirements as specified in the Sewerage Code of Australia, WSA 02-2002 Version 2.3.

1.0 Background

ADW Johnson has been engaged by Lake Macquarie City Council (Council) to prepare a water and wastewater servicing strategy to service the existing residential paper subdivision at Killingworth.

1.1 DEVELOPMENT DESCRIPTION

The additional area to be serviced consists of 24 residential lots situated on the south western edge of the existing Killingworth Township fronting Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street. The slopes range from low to moderate with ground elevations ranging from approximately RL 38 m to RL 58 m AHD. **Figure 1** below shows the study area.

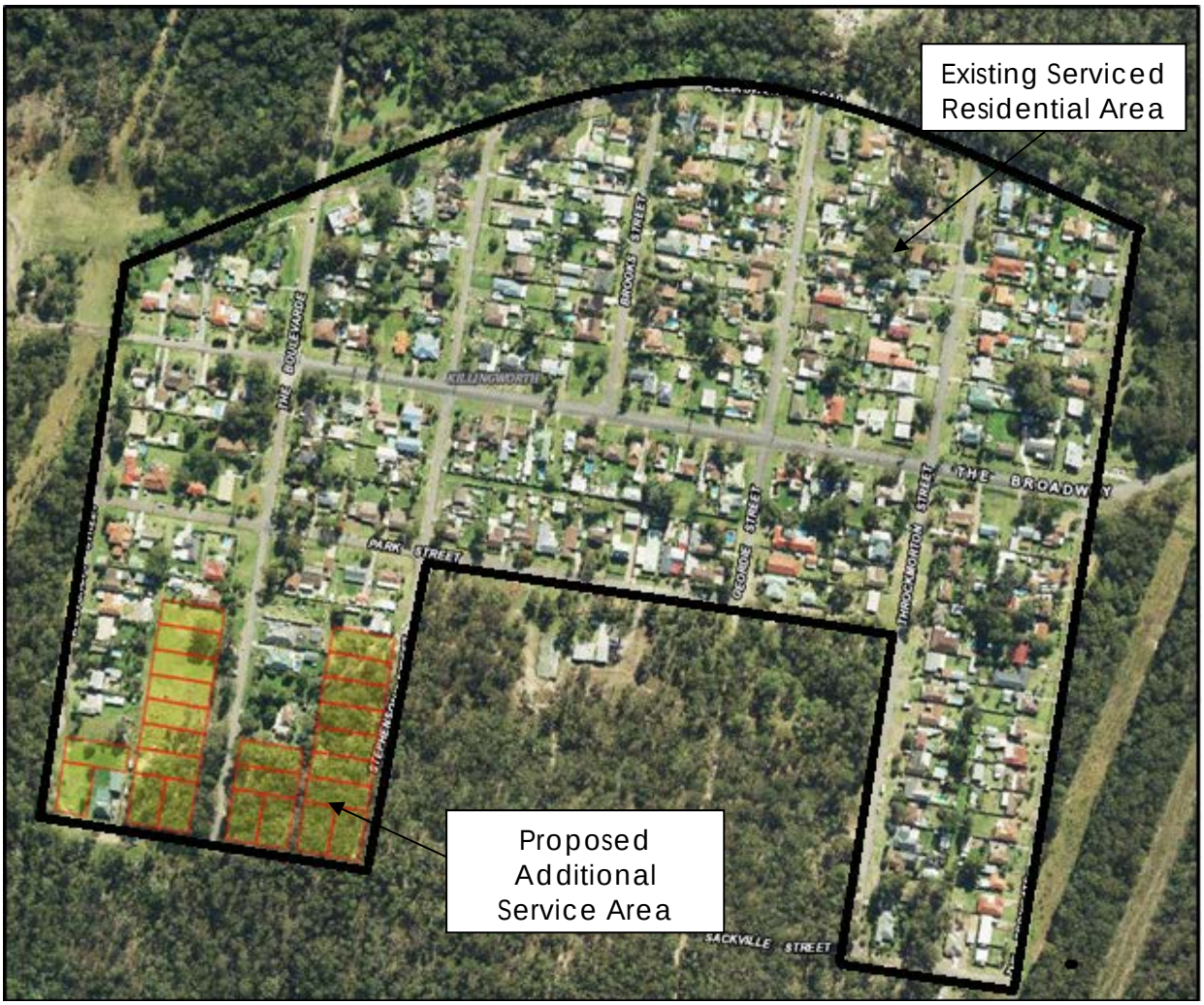


Figure 1: Study Area.

The study area encompasses the proposed development in addition to an existing residential area to the north of the proposed development area.

1.2 DESIGN CODE

In developing a variety of options the design requirements specified in the following manuals have been adhered to unless otherwise stated:

- Sewerage Code of Australia, WSA 02-2014 Version 3.1 HWC Version 2; and
- Water Supply Code of Australia, WSA 03-2011 Version 3.1 HWC Version 2.

HWC service pressure limits for water mains are as specified below in **Table 1**.

Table 1: Water Supply Service Pressures

Demand	Minimum Pressure (m)
Peak hour flow on a peak day of a peak week	20
Peak hour flow on a peak day of a peak week in a boosted system	25
Peak hour flow on an extreme day of an extreme week	12
Peak hour flow on a 95th percentile peak day plus fire fighting flow (at location of fire flow)	15
Peak hour flow on a 95th percentile peak day plus fire fighting flow (at location other than fire flow)	3

The maximum pressure as specified by HWC is 60m.

2.0 Options Development

2.1 DESIGN LOADINGS

The additional service area has an ET of 24 based on one ET per residential lot.

2.1.1 Water Design Loads

Water demands for the study area were calculated in accordance with *Water Supply Code of Australia, Hunter Water Edition Version 2* (WSA 03-2011-3.1).The adopted water consumption for the residential development in the Lake Macquarie LGA is as follows:

- Residential – 255 kL/year.

A summary of design water demands are provided in **Table 2**.

Table 2: Water Supply Design Demands.

	Base Annual Demand (kL/ET/yr)	Diurnal Factor	Average Day Demand (kL/day)	Peak Day Demand (kL/day)	Peak Hour Demand (kL/day)	Extreme Day Demand (kL/day)
Existing	255	2.02	159	533	1076	613
Proposed	255	2.02	17	71	144	82

Appendix C contains detailed calculations of the demands.

2.1.2 Wastewater Design Loads

A summary of the design sewage loadings for the catchment including the proposed development can be seen in **Table 3**. The theoretical loadings presented are based on ultimate development within the study area.

Table 3: Wastewater Design Flows Including existing residential area.

WWPS	ET	ADWF (L/s)	r	PDWF (L/s)	SA (L/s)	PWWF (L/s)
Killingworth 1	165	1.815	2.3	4.2	9.57	13.7
Killingworth 2	135	1.485	2.3	3.4	7.83	11.2

Appendix D contains detailed calculations of the demands.

2.2 POINTS OF CONNECTION & AVAILABLE CAPACITY

2.2.1 Water Points of Connection & Available Capacity

The existing water mains that service the Killingworth township do not currently extend into the proposed development area. Preliminary advice from HWC provided in a concept meeting on the 05/05/2017 suggests that the current water servicing network does not have adequate pressure to service lots above RL 40m.

A Pipes ++ model of the existing network was created and the existing water services were extended along Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street to check the capacity of the existing network to service the proposed development.

HWC has provided the boundary conditions at Wakefield Road and at the intersection of The Broadway and The Throngate as shown below in **Table 4**. These boundary conditions were used to calibrate the Pipes ++ model.

Table 4: Boundary Conditions.

Location	Description	Pressure (kPa)
Node 1	Maximum pressure at property under average day demand conditions.	650
	Residual pressure at the following flow rates under peak day demand conditions (0 L/s minimum).	410
	Residual pressure at the following flow rates under 95th percentile peak day demand conditions (10.0 L/s).	415
Node 25	Maximum pressure at property under average day demand conditions.	770
	Residual pressure at the following flow rates under peak day demand conditions (0 L/s minimum).	635
	Residual pressure at the following flow rates under 95th percentile peak day demand conditions (10.0 L/s).	670

Note that the boundary conditions provided by HWC show that the service pressure maximum limit of 60m is exceeded at both boundary condition locations during average day demand conditions.

Pipes++ modelling was untaken based on the total demand equivalent to the ultimate development within Killingworth of 253 lots. The demand scenarios modelled included:

- Average Day Demand (ADD);
- Peak Day Demand (PDD);
- Extreme Day Demand (EDD); and
- 95th Percentile Demand with Fire Flow (95PDD).

A summary of the modelling results are provided in **Table 5**.

Table 5: Pipes++ Demand Scenario Modelling Results.

Minimum ADD Pressure (m)	Maximum ADD Pressure (m)	Minimum PDD Pressure (m)	Maximum PDD Pressure (m)	Minimum EDD Pressure (m)	Maximum EDD Pressure (m)
29.4 RL (58m)	78.6 RL (9.9m)	**0.4** RL (58m)	58.6 RL (9.9m)	**-2.7** RL (58m)	58.6 RL (9.9m)

A review of **Table 5** indicates the supply pressures are between 29.4m and 78.6m during average day demands. For the ADD modelling scenario pressures are higher than HWC minimum pressures. As discussed above, HWC maximum pressure of 60m is exceeded at Node 25 which represents the intersection of Wakefield Road and The Broadway. There are also several instances of the maximum service pressure being exceeded over the

network during average day demand pressures in both the current and proposed scenarios.

A fire flow analysis was undertaken by nesting a fire flow demand within the 95th percentile peak day demands. The fire flow demand applied was:

- Residential – 10 L/s.

The systems performance under fire flow demands was analysed at the peak domestic diurnal variation of 20:00 hours. The results of the fire flow analysis are provided in **Table 6**.

Table 6: Pipes++ Fire Flow Analysis Results.

Condition	Minimum Supply Pressure (m)	Occurring at Node
20:00 hrs (Peak Domestic Diurnal)	**-3.4** RL (58m)	N30*

* Refer to **Appendix G** for Pipes++ Modelling Layout Diagram showing location of nodes

It can be seen that the minimum supply pressures available in a fire flow scenario do not meet HWC requirements for the proposed development.

The existing network without any modification other than extending the service mains was found to have adequate pressures for the average day demands. During peak day demands, extreme day demands and firefighting scenarios the existing system was found to have inadequate capacity to service the additional paper subdivision lots. Three options for servicing the proposed development have been assessed and are discussed further in **Section 3.1.1**.

2.2.2 Wastewater Points of Connection & Available Capacity

The existing Killingworth Township is currently serviced by a series of gravity mains that drain towards two WWPS, Killingworth 1 and 2. Currently, sewer mains servicing the existing Killingworth Township do not extend into the proposed additional development area. Four points of connection into the existing network in Park Street, Westcroft Street and The Boulevarde are anticipated to service the proposed development. The current and proposed wastewater network can be seen in the figures provided in **Appendix B**.

The proposed development drains towards Killingworth 2 WWPS. Flows from Killingworth 2 WWPS are pumped to Killingworth 1 WWPS via an existing DN150 rising main and gravity main in The Broadway.

Both Killingworth 1 and 2 WWPS currently have adequate capacity to service the existing and proposed development. However, Killingworth 2 does not meet HWC minimum emergency storage requires in both the current and proposed scenarios. Hence, it is proposed that additional emergency storage is constructed at Killingworth 2, as further discussed in **Section 3.2**.

3.0 Servicing Options

This section discusses the details associated with the available servicing options and new infrastructure required within the study area to provide water and wastewater services to the proposed additional development.

3.1 WATER SERVICING OPTIONS

Several options for water augmentation were developed in consultation with HWC and Council. Three options have been assessed to supply water services to the proposed development. The three options considered were:

- **Option 1:** The proposed development is serviced via individual rainwater tanks situated on each lot.
- **Option 2:** The existing DN150 main servicing the entire Killingworth Township is duplicated for approximately 1,730m between the intersection of The Broadway with Wakefield Road and The Throngate. The existing DN100 services in Westcroft Street, The Boulevarde and Stephenson Street would then be extended to service Sackville Street.
- **Option 3:** A pressure booster station is supplied to the existing network at the intersection of Stephenson Street and Park Street. As with Option 2 the existing DN100 services in Westcroft Street, The Boulevarde and Stephenson Street would then be extended to service Sackville Street.
- **Option 4:** Provide 100mm mains to the service area with standard connections below an RL of 47m AHD and non-standard connections at higher elevations.

Refer to **Appendix B** for plans detailing the water servicing options.

The option of providing a reservoir that could also act as a security of supply for the greater Killingworth Township was discounted early due to the limited additional lots to be serviced and the likely economic cost. Given the topography of the area a reservoir would need to be provided with a bottom water level of RL 78m. At this level a water booster pump would be required. To ensure adequate supply capacity during EDD periods a duplicated main from Wakefield Road would also be required. The cost of the required infrastructure for this option was therefore determined to be unacceptable and this option was discounted.

The water servicing options are discussed in further detain in **Sections 3.1.1 - 3.1.4** below.

3.1.1 Option 1

Option 1 is to provide rainwater tanks to each of the lots providing total substitution of mains water for collected rainwater.

WSA03-2011_HW Edition Version 2 provides the following factors for consideration where it is considered appropriate to allow for partial or total substitution of collected rainwater for drinking water and/or non-drinking water:

- Adaptation responses to climate change;
- Reliability (design, operations and maintenance) of the on-property rainwater collection, storage and distribution facilities and individual items;
- Usable volume of the rainwater tank;
- Top-up of rainwater tanks, which may be supplied from either the drinking water or

non-drinking water supply systems; and
- Connection of the rainwater supply system to fixtures and outlets for various end uses.

Ongoing monitoring and regulating of the onsite rainwater tank system would be the onus of Local Government Authority and not Hunter Water Authority.

For the purposes of this strategy proposed rainwater tanks have been sized based on two components; firefighting requirements and residential use requirements.

Council has indicated that firefighting provisions in the rainwater tanks are to be provided as per the requirements laid out in the NSW Rural Fire Fighting Service's (RFS) 'Planning for Bushfire Protection' guidelines.

For development in a non-reticulated area a dedicated water supply for firefighting purposes must be provided in addition to any volume provided for residential use. Table 4.2 of the RFS guidelines states that 5,000L of dedicated firefighting water must be provided to lots less than 1,000m^2 while 10,000L must be provided to lots between 1,000-10,000m^2. The lots in the proposed development are 1,011m^2, hence, 10,000L of firefighting water must be stored per lot without access to reticulated water. Due to the minor nature of the lot size exceedance firefighting provisions may be reduced to 5,000L per lot, however, this would be subject to Council and RFS approval and has not been accounted for in the costings provided in **Appendix E**.

The residential use component of the tank was sized using a daily water balance based on assumed demands and daily rainfall data for a 15 year period. Rainfall data from Maryville Station 61223 was used in the calculations for a period from 1978 to 1993. *Water Supply Code of Australia, Hunter Water Edition Version 1* (WSA 03-2002-03) recommends adopting an average daily demand of 700L/day per ET. This is considered to be an overly conservative assumption, particularly associated with the use of homes serviced by rainwater as these households are generally more water conscious than homes connected to mains supply. An average daily usage of 113L per day per resident was determined based on the assumptions provided in **Appendix G.**

Table 7 outlines the assumptions made in the calculations.

Table 7: Rainwater Tank Water Balance Assumptions Per Lot

Parameter	Value	Comment
Average Roof Area	300m^2	Measured from existing residences in the Killingworth township.
Average Occupancy	3.1	Average occupancy rate as provided in Councils Section 94 Plan based on future residential development as forecast to 2030.
Daily Demand	350L	Based on residential uses as outlined in **Appendix C**
Storage Capacity Excluding Detention	30kL	

Over the 15 year modelling period the rainwater tank storage capacity excluding the detention volume was depleted only twice during periods of extremely low rainfall. Should rainwater tanks be considered this may be mitigated by decreasing daily rainwater uses in periods of low rainfall.

A sensitivity analysis was undertaken to determine the impact of roof area and occupancy on the tank sizing. **Table 8** shows the results of the analysis.

Table 8: Rainwater Tank Size Sensitivity Analysis

Occupancy	2	3.1	6.6*
300 m² Roof Area	15kL	30kL	175kL
600 m² Roof Area	10kL	20kL	60kL

*Number of equivalent occupants to produce 700L/day as per *Water Supply Code of Australia, Hunter Water Edition Version 1* (WSA 03-2002-03).

Table 8 shows the tank sizing is highly sensitive to both roof size and occupancy, hence, individual tank sizes would need to be calculated at the Development Application stage for each lot.

It can also be seen that in order for rainwater tanks to provide the same level of service as required by regular reticulated water mains 60-175kL would need to be provided per lot depending on the roof size and occupancy.

The total rainwater tank size required the service the lots for both firefighting purposes and residential use is 40kL based on the assumptions outlined in **Table 6**.

During a draft strategy review meeting between Council, HWC and ADWJ held on 1st September 2017 the possibility of connecting the proposed rainwater tanks to the mains water supply to maintain security of supply to the proposed development area was discussed. Connection to the mains supply would allow the landowners to purchase water from HWC during periods of low rainfall and significantly reduce the tank sizes needed to supply the proposed development area. The tank sizes determined in this report are to be reassessed on a case by case basis by each individual land owner and may be reduced from the volumes calculated in this report should mains connections be made available for topping up the tanks during periods of low rainfall.

Cost estimates for the implementation of the various options are further explained within **Section 4.1.4**.

3.1.2 Option 2

Option 2 for providing water services to the proposed development is to provide a duplicate main adjacent to the existing DN150 water main from the intersection of Wakefield Road and the Broadway to the intersection of The Broadway and The Throngate.

Existing DN100 water services would then be extended from their current locations in Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street. The preliminary water reticulation layout and pipe sizes are shown in the figures provided in **Appendix B**.

The proposed reticulation network was modelled in Pipes++ to confirm the primary pipe sizes and assess system performance. A summary of the modelling results are provided in **Table 9**.

Table 9: Pipes++ Demand Scenario Modelling Results – Option 2.

Option	Minimum ADD Pressure (m)	Maximum ADD Pressure (m)	Minimum PDD Pressure (m)	Maximum PDD Pressure (m)	Minimum EDD Pressure (m)	Maximum EDD Pressure (m)
Option 2	30.3 RL (58m)	**78.6** RL (9.9m)	**7.2** RL (58m)	58.6 RL (9.9m)	**6.2** RL (58m)	58.6 RL (9.9m)

A review of **Table 9** indicated the supply pressures do not meet HWC minimum requirements for both the peak day demands and extreme day demands for lots at elevations greater than 45m AHD despite the provision of a duplicated mains supply.

A number of scenarios were trialled to increase the pressures such as increased pipe diameters and increased mains duplication length, however, minimum peak and extreme pressures were not significantly improved.

A fire flow analysis was undertaken by nesting a fire flow demand within the 95th percentile peak day demands. The results of the fire flow analysis are provided in **Table 10**.

Table 10: Pipes++ Fire Flow Analysis Results.

Option	Condition	Minimum Supply Pressure (m)	Occurring at Node
Option 2	20:00 hrs (Peak Domestic Diurnal)	**11.9** RL (58m)	N30*

* Refer to **Appendix G** for Pipes++ Modelling Layout Diagram showing location of nodes

A review of the modelling results indicated the minimum supply pressures available in a fire flow scenario are insufficient at Node 30 only.

Should Option 2 be adopted lots located above RL 45m AHD would not be able to be sufficiently serviced for water to HWC's minimum standards. These lots would be unable to be developed without HWC approval of the reduced level of service to these lots.

3.1.3 Option 3

Option 3 for providing water services to the proposed development is to provide a water pressure booster pump at the intersection of Stephenson Street and Park Street. Existing DN100 water services would then be extended from their current locations in Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street.

The proposed reticulation network was modelled in Pipes++ to confirm the primary pipe sizes and assess system performance. A summary of the modelling results are provided in **Table 11**.

A number of HWC approved pump suppliers have supplied pump curve data for input into the Pipes++ model. The results presented below were modelled using a KSB high pressure inline pump provided at Node 7.

Table 11: Pipes++ Demand Scenario Modelling Results – Option 3.

Option	Minimum ADD Pressure (m)	Maximum ADD Pressure (m)	Minimum PDD Pressure (m)	Maximum PDD Pressure (m)	Minimum EDD Pressure (m)	Maximum EDD Pressure (m)
Option 3	27.9 RL (58m)	78.6 RL (9.9m)	17.1 RL (42m)	58.6 RL (9.9m)	14.3 RL (42m)	58.6 RL (9.9m)

The results provided in **Table 11** indicate that the provision of a water booster pump delivers HWC minimum supply pressures to the proposed additional development for the average day, peak day and extreme day demands. However, the modelling shows that pressures in the existing system are reduced to less than HWC's minimum required pressures for the PDD due to the addition of the booster pump.

A fire flow analysis was undertaken by nesting a fire flow demand within the 95th percentile peak day demands. A secondary pump would need to be provided to supply the proposed development given the difference in the flowrates required for the residential use and firefighting use. The results of the fire flow analysis are provided in **Table 12**.

Table 12: Pipes++ Fire Flow Analysis Results – Option 3.

Condition	Minimum Supply Pressure (m)	Occurring at Node
20:00 hrs (Peak Domestic Diurnal)	-4.2 RL (39m)	N13*

* Refer to **Appendix G** for Pipes++ Modelling Layout Diagram showing location of nodes

As can be seen from the results provided in **Table 12** in order to provide sufficient fire flow pressures to the proposed development the pressures in the existing system would fall to below acceptable levels. This issue can be resolved by providing a duplicated mains such as in Option 2. The combination of duplicated mains and a booster pump would provide sufficient pressures to the entire study area for all scenarios.

3.1.4 Option 4

Option 4 is the preferred servicing strategy based on advice provided by HWC which has been attached to this report in **Appendix A**. Option 4 involves extending HWC mains to service the proposed properties with standard connections made to properties below an elevation of 47m AHD and nonstandard connections above this elevation.

The maximum and minimum pressures for Option 4 have been provided in Tables 5 and 6. As can be seen, the minimum service pressures are not met for the PDD, EDD and firefighting requirements. HWC have indicated that the reduced pressures will be acceptable for customers with non standard connections given Council and the RFS approve of alternate options for firefighting. The RFS requires that dwellings with no access to reticulated water require rainwater tanks with a dedicated firefighting volume as discussed in **Section 3.1.1**.

The RFS advises that 10,000L tanks are required for fire fighting purposes for lots over 1,000m^2 in size with no access to reticulated mains and 5,000L for lots under this size. 5,000L tanks have been proposed in this instance as although the lots in the proposed development are 1,011m^2, given the minor nature in lot size exceedance and the fact that the lots in question have access to reticulated mains for topping up the tanks during periods of low rainfall a reduced size would be appropriate.

HWC has advised that while rainwater tanks are not considered mandatory for general water supply purposes, residents may wish to construct individual on lot rainwater tanks with back up connections to the HWC watermains for use during periods of high demand when service pressures will be low.

Fire fighting pressures at an elevation of 41m AHD have been assessed and are provided below in **Table 13**.

Table 13: Pipes++ Fire Flow Analysis Results.

Elevation	Condition	Supply Pressure (m)
RL 41m	20:00 hrs (Peak Domestic Diurnal)	**15.6**

* Refer to **Appendix G** for Pipes++ Modelling Layout Diagram showing location of nodes

Note that velocities through the proposed 100mm watermain are significantly lower than the HWC optimal velocities. The ADD maximum velocities range from 0.01-0.05m/s while maximum velocities during the EDD range from 0.05-0.2m/s.

3.2 WASTEWATER SERVICING OPTION

Only one option has been assessed for providing wastewater services to the proposed development. As discussed in **Section 2.1.2** it is recommended that wastewater services are extended from Park Street, Westcroft Street and The Boulevarde to service the proposed development.

Calculations have been undertaken to show the emergency storage available at Killingworth 2 does not meet the minimum HWC requirement of 4hrs in both the current and proposed scenarios. Currently Killingworth 2 has an emergency storage capacity of approximately 3.6hrs. The emergency storage available at Killingworth 2 was also calculated with the additional 24 proposed lots and was found to be further reduced to 3hrs. **Table 14** shows the available and required emergency storage at Killingworth 2.

Table 14: Killingworth Emergency Storage

Killingworth 2 WWPS	Value
Existing Emergency Storage in AC	3.5 m^3
Existing Emergency Storage in Pipes	8.0 m^3
Additional Emergency Storage Required	4.8 m^3

It is proposed that the additional emergency storage is provided as online storage as requested by HWC in advice provided on 29th June 2018. This correspondence has been provided in **Appendix A**.

4.0 Options Multi Criteria Analysis

4.1 WATER OPTIONS MULTI CRITERIA ANALYSIS

4.1.1 Technical Constraints

The infrastructure proposed for the development can be constructed and operated within Council's design and operating guidelines.

As detailed in **Section 3.1** none of the proposed options have capacity to service the proposed development to HWC minimum service pressures, however, a combination of Options 2 and 3 would ensure minimum service standards.

4.1.2 Community/Stakeholder Constraints

Options 1 and 4 may reduce the value of the proposed development due to the burden of rainwater tank requirements on each lot.

The construction of a duplicate watermain, water booster pump and reticulation watermains for the proposed development may have temporary traffic and noise impacts to the existing community during construction.

The provision of a duplicate watermain would benefit the whole Killingworth community as it would provide security of supply to the entire township. The provision of a duplicate main may be subject to cost sharing due to the mutual benefit to the proposed additional development area and overall HWC network servicing the greater Killingworth area.

4.1.3 Environmental Constraints

The proposed water infrastructure will be constructed within road reserves in the standard allocation and is therefore not considered to have any significant impacts on the environment nor be subject to any onerous environmental constraints.

Future impacts of climate change have not been accounted for in the rainwater tank analysis. Increases in extreme drought events would reduce the effectiveness of the rainwater tanks.

4.1.4 Cost Comparison

A cost comparison of the investigated options was made by estimating the capital cost of the required infrastructure using Hunter Water's Estimating Guidelines and carrying out a Net Present Value (NPV) assessment. The water capital cost summary can be found in **Table 16** below and a detailed assessment can be found in within **Appendix E**. The NPV assessment considered the following:

- Capital cost of the infrastructure;
- Operation and maintenance costs of the infrastructure; and
- Replacement costs of infrastructure with a finite lifespan.

Based on the above, each option was assessed over a 30 year period at a discount rate of 7%. A sensitivity analysis was also undertaken for discount rates of 4% and 10%. An NPV

summary can be seen in **Table 15**, and a detailed assessment can be found within **Appendix F**.

Table 15: Summary of Community Water Cost Estimates.

Option	Infrastructure	Capital Cost	Total Capital Cost*	NPV (at 7%)
Option 1	Rainwater Tanks	$230,400	$299,520	$418,647**
Option 2***	Trunk Main and Reticulation Mains	$296,669	$385,668	$412,153
Option 3***	Water Booster Pump Station and Reticulation Mains	$386,702	$502,712	$575,513
Option 2&3 combined	Options 2 and 3 as above combined	$629,320	$818,114	$870,261
Option 4***	Reticulation Mains and Firefighting Tanks	$249,665	$324,565	$441,607**

* Includes 30% construction contingency.
**Assumes that tanks do not require replacement within a 30 year timespan, manufacturers advertised warranties range from 20-30 years.
***Options on their own do not meet the HWC servicing standards. A combination of Options 2 and 3 would be required to ensure adequate flow and pressure can be achieved for the additional development area.

Cost sharing may be available with HWC for the duplication of the mains supply to provide security of supply to the entire Killingworth township, however, HWC has indicated that the duplication will not receive funding during the current funding period.

Table 15 indicates that Option 1 has the lowest capital costs, however, due to the high maintenance costs of Option 1, Option 2 has the lowest NPV at a discount rate of 7%.

4.1.5 Social Impact

Options 2, 3 and 4 would provide the opportunity for existing residents adjacent to the proposed development to upgrade from temporary 25mm services to standard connections to the HWC water network. Option 4 would also allow for 13 residents to upgrade to standard connections.

Consideration has been given in the strategic design of Options 2, 3 and 4 to promote cycling of water throughout the network, thus minimising the risk of water age and improving the quality of water provided through the network.

4.1.6 Environmental Impact

The construction of the proposed infrastructure will have minimal impact on the surrounding environment providing adequate environmental controls are considered / implemented during design and construction.

The provision of rainwater tanks has a number of environmental benefits. Rainwater tanks mitigate the impacts of increased stormwater associated with the construction of impervious areas over the proposed development, encourage water saving practices and decreases the overall demand for mains water supply.

4.1.7 Technical Assessment

An assessment of technical matters for the proposed water strategy is provided below:

- **Performance:** Only a combination of a water booster pump and duplicated mains provides water services to the proposed development to HWC's minimum supply pressures under all modelling scenarios.
- **System Reliability:** Looping of internal mains within the proposed infrastructure in options 2, 3 and 4 and the provision of multiple points of connections incorporates an adequate level of security of supply.
- **Flexibility and Adaptability:** Capacity exists within the system for additional connections at an elevation of less than 40m AHD.
- **Constructability:** The proposed infrastructure will utilise standard construction techniques and is therefore expected to have a high level of constructability. Where mains are to be laid across existing sections of road, thrust boring should be implemented to limit disturbance of normal traffic flows.
- **Maintainability:** The proposed infrastructure for Options 2 and 3 is similar to that which exists through HWC's water supply network and therefore it is expected to have a high level of maintainability. Option 1 would require regular maintenance of the rainwater tanks to ensure they operate effectively and can maintain a 30 year lifespan.

4.1.8 Comparison of Options

A detailed comparison of the water servicing options is provided in further detail below.

- Option 1 has the least capital costs associated with the proposed infrastructure but impacts on land values;
- Option 2 provides security of supply for the entire study area but fails to meet peak day, extreme day and fire flow pressures for lots located above 45m AHD;
- While Option 3 meets all HWC's minimum pressure requirements for the proposed development it reduces the pressures in the existing system to below minimum levels in the peak day and fire flow scenarios. This issue can be resolved through the provision of a duplicated mains such as provided in Option 2; and
- Option 4 has a relatively low cost but also has impacts on land values. Option 4 has been assessed as the preferred solution by Hunter Water.

4.2 WASTEWATER OPTION MULTI CRITERIA ANALYSIS

4.2.1 Technical Constraints

The infrastructure proposed for the development can be constructed and operated within HWC's design and operating guidelines. The proposed servicing strategy discussed will adequately service the proposed development. Existing services have not been located adjacent to the proposed emergency storage and sewer main extensions and will need to be considered at the detail design stage.

4.2.2 Community/Stakeholder Constraints

The proposed wastewater servicing strategy requires works in and around existing residential areas. These works will create noise pollution in addition to the potential disruption to roadways. Additionally, connection to the existing sewer gravity main is anticipated to cause temporary traffic disruptions only.

4.2.3 Environmental Constraints

The construction works will require adequate erosion and sedimentation control plans to reduce the effects of the construction on the existing stormwater systems.

The provision of additional emergency storage capacity at Killingworth 2 WWPS will reduce the likely number and volume of sewage overflows.

4.2.4 Costs

Costs of the proposed wastewater servicing infrastructure was made by estimating the capital cost of the required infrastructure using Hunter Water's Estimating Guidelines and carrying out a Net Present Value (NPV) assessment. The wastewater capital cost summary can be found in **Table 16** below and a detailed assessment can be found in within **Appendix E**. The NPV assessment considered the following:

- Capital cost of the infrastructure;
- Operation and maintenance costs of the infrastructure; and
- Replacement costs of infrastructure with a finite lifespan.

Based on the above, each option was assessed over a 30 year period at a discount rate of 7%. A sensitivity analysis was also undertaken for discount rates of 4% and 10%. A NPV summary can be seen in **Table 15**, and a detailed assessment can be found within **Appendix F**.

Table 16: Summary of Wastewater Cost Estimate.

Infrastructure	Capital Cost	Total Capital Cost*	NPV (at 7%)
Emergency Storage Chamber	$30,000	$208,463	$251,653
Gravity Mains	$130,355		

*Includes 30% construction contingency.

The above costs are based on Hunter Water's Estimating Guidelines rates for the internal reticulation and an estimate for emergency storage chambers based on past experience. A detailed assessment of the costs can be found within **Appendix E.**

4.2.5 Social Impact

The construction of reticulated sewer mains along Westcroft Street, The Boulevarde, Stephenson Street and Sackville Street will allow existing residences to make formal, standardised connections into the HWC wastewater network.

The proposed works will involve construction noise that will affect existing residential areas. The works involve potential traffic disruptions in the area when the emergency storage is to be constructed within the road reserve.

4.2.6 Environmental Impact

The construction of the proposed infrastructure will not have an effect on the environment given the appropriate measures are taken such as erosion and sediment control.

4.2.7 Technical Assessment

An assessment of technical matters for each of the regional options is provided below:

- **Performance:** The proposed strategy adequately services the study area. The infrastructure has been sized to cater for the development and to meet all of HWC's guidelines.
- **System Reliability:** Additional emergency storage is proposed to ensure HWC's guidelines have been met.
- **Constructability:** The proposed infrastructure will utilise standard construction techniques and is therefore expected to have a high level of constructability.
- **Maintainability:** The proposed infrastructure is similar to that which exists throughout HWC's existing wastewater networks and is therefore expected to have a high level of maintainability.

5.0 Recommended Option

5.1 WATER STRATEGY RECOMMENDED OPTION

None of the options in isolation meet all of the HWC minimum service requirements all of the time for the provision of main water supply to the site. A combination of Options 2 and 3 would ensure minimum service standards can be accommodated, however, it is recognised that the economic cost of implementation may exceed overall community benefits for the additional development of 24 lots.

Option 1 involving the provision of individual rainwater tanks to each of the proposed lots with no mains water back up may not provide a solution that meets community expectations for provision of water and would also have an effect on the sale price of each lot, however, should mains supply be provided as a backup for periods of low rainfall tanks sizes may be reduced and security of supply provided.

Hunter Water has assessed this strategy and recommends that Option 4 is the preferred servicing strategy for the proposed development. Please note that minimum service pressures are not achieved during peak and extreme conditions and storage tanks will be required for 22 sites to meet minimum RFS firefighting requirements.

5.2 WASTEWATER STRATEGY RECOMMENDED OPTION

The wastewater servicing strategy detailed in **Section 3.2** provides an effective solution to supply wastewater services to the proposed development.

A Net Present Value (NPV) analysis of the infrastructure proposed for the wastewater servicing strategy was undertaken. Over a 30 year period at a discount rate of 7%, indicated the wastewater works have an NPV $251,653.

The proposed wastewater servicing strategy provides an effective solution to service the entire study area whilst meeting the technical requirements as specified in the Sewerage Code of Australia, WSA 02-2002 Version 2.3.

Appendix A

CORRESPONDENCE & BACKGROUND INFORMATION

Appendix B

FIGURES

Appendix C

WATER DETAILED LOAD CALCULATIONS

Appendix D

WWPS & EMERGENCY STORAGE CALCULATIONS

SEWER STORAGE - Proposed

FULL DEVELOPMENT OF 135 ET

STORAGE REQUIRED FOR DEVELOPMENT		4	hrs
ADWF		1.485	ADWF
VOLUME OF STORAGE	ADWF	21.384	m3
OVERFLOW LEVEL	RL	24.57	
FLOOD ALARM LEVEL	RL	22.675	

WET WELL

DIA	1.8	m
HEIGHT	1.9	m
VOLUME	4.8	m3

OFFLINE STORAGE

DIA	2.2	m
HEIGHT	1.3	m
VOLUME	4.8	m3

CARRIER MAINS

LINE 1

AC	INV RL.	AC DIA (m)	PIPE DIA (m)	PIPE LENGTH (m)	STORAGE IN AC (m3)	STORAGE IN PIPE (m3)
CMH	23.135	0.9	0.15	33	0.9	0.6
F2398	23.555	0.9	0.15	37	0.6	0.7
F2399	23.85	0.9	0.15	87	0.5	1.5
F2400	25.925	0.9	0.15	55		1.0
Line 2						
F2374	23.43	0.9	0.15	32	0.7	0.6
F2375	23.74	0.9	0.15	55.5	0.5	1.0
F2378	24.205	0.9	0.15	90.5	0.2	1.6
F2377	24.835	0.9	0.15	64	0.0	1.1
					3.5	8.0 m3

Offline storage Required	**4.8**	**m3**
Total Available Emergency Storage	**21.1**	**m3**

Total Storage Provided
4.0 hrs

Appendix E

WATER & WASTEWATER DETAILED OPTION COSTINGS

Water:

- **Option 1**
- **Option 2**
- **Option 3**
- **Option 4**

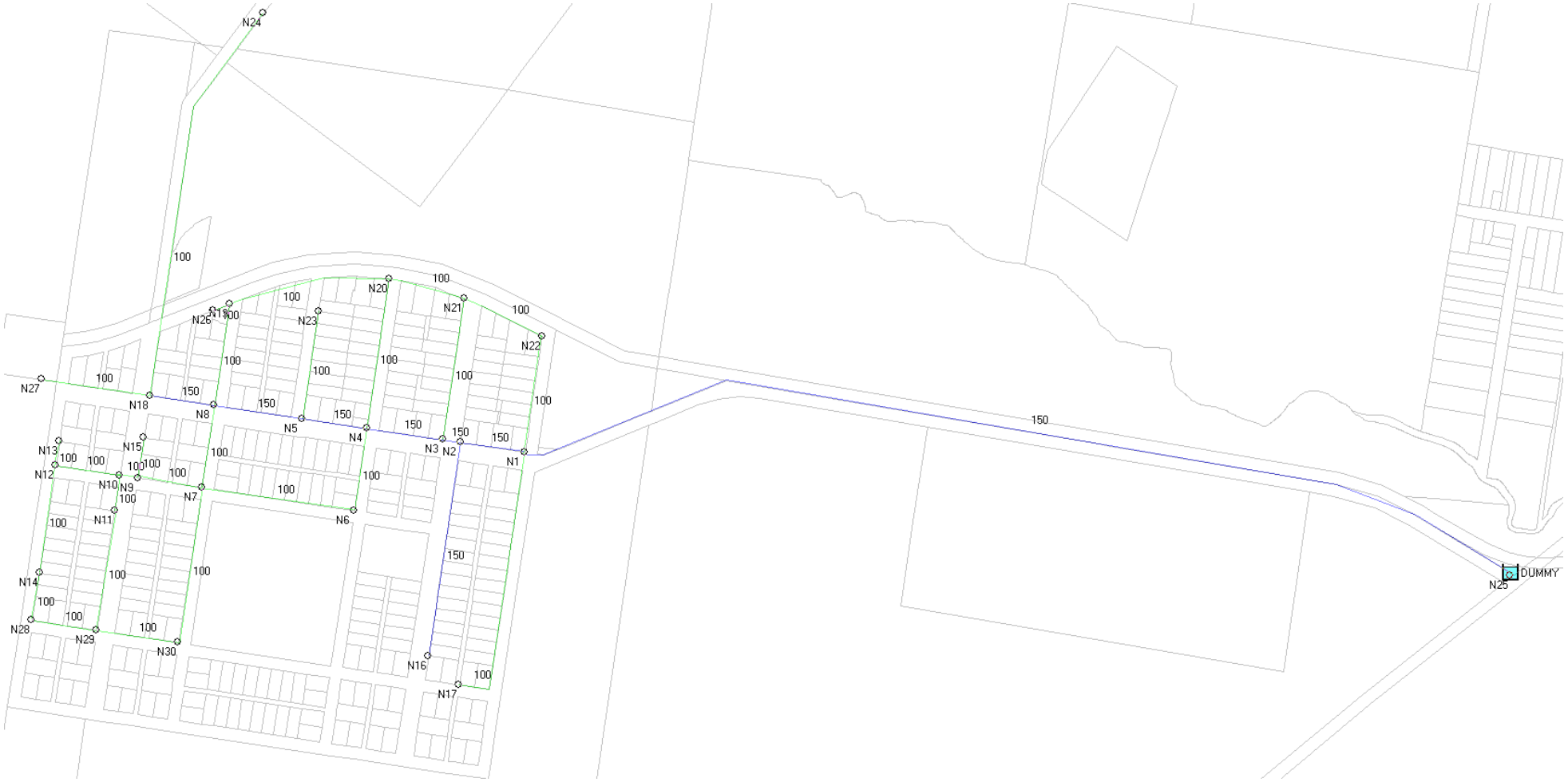
Wastewater

Appendix F

NET PRESENT VALUE ANALYSIS

Appendix G

PIPES++ MODELLING LAYOUT DIAGRAM


N24
N27
N18
N8
N5
N4
N3
N2
N1
N25
DUMMY
N20
N21
N22
N23
N26
N19
N15
N13
N12
N10
N9
N7
N6
N11
N14
N28
N29
N30
N16
N17
100
150

Appendix H

RAINWATER TANK ASSUMPTIONS

Use	Number	Rate	Unit	Duration	Times/day	Total (L)
Shower	3.1	9	L/min	7	1	195
Hand basin	3.1	10	L/min	0	5	47
Toilet half	3.1	3	L/flush		4	37
Toilet full	3.1	6	L/flush		1	19
Cooking	3.1	1	L/each			3
Washing up	3.1	2	L/each			5
Laundry	1.0	25	L/each			25
Irrigation	20.0	1	mm/M2			20
					Total	**350**
					Per person	**113**