Marsden Park

APPENDIX F

WATER SERVICING REPORT (SKM)

Marsden Park Stage 1 Water Servicing Report

Final

April 2012

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Executive Summary

This report outlines the results from an investigation of the feasible options for the provision of potable water to the Stage 1 development of the Marsden Park Precinct, and identifies a preferred servicing option for Stage 1 of the Marsden Park Precinct. The report also discusses how future stages of development of the Marsden Park precinct could be serviced, including the current version of the Sydney Water Ultimate Servicing Strategy.

The key outcomes from the investigation are:

- The preferred servicing solution for Marsden Park Stage 1 is the Minchinbury East Option 2/3. This would service around 3,000 lots with the exact number of lots depending on a number of factors such as growth in water demand by the industrial precinct and the pipe route to be adopted. This servicing solution involves the following components:
  i. Upsize the DN250 pipework that is being installed to service the Marsden Park Industrial Precinct Stage 1 to DN450. As the designs for the DN250 pipe are currently being reviewed by Sydney Water, the upsizing needs to take place immediately.
  ii. Install a DN450 pipe to connect into the upsized Stage 1 MPIP pipework to provide water to Marsden Park Stage 1 along Richmond Rd. Concept and detail design of this pipe should commence following approval of the Services Infrastructure Implementation Plan.
  iii. At a later date, once the capacity of the above is reached, the additional 400 m of pipe can be installed to effectively implement Minchinbury East Option 3. This would provide capacity for a further 250-260 lots at Marsden Park.
- The South Street Development can be serviced by connecting into the new DN450 pipe that will be extended along Richmond Rd (item ii above)
- Future stages of development at Marsden Park (and MPIP) can be serviced with potable water by a variety of options including staged implementation of the current version of the Sydney Water Ultimate Servicing Strategy. The preferred option for servicing future stages of development would be selected at a future date as the preferred option would depend on a number of factors, not least the planned revision of the Sydney Water Ultimate Servicing Strategy.

Contents

Appendices

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Prelim v3	12/10/2011	P Von Huben	P Von Huben	12/10/2011	Internal review
Prelim v6	5/12/2011	P Von Huben	P Von Huben	7/12/2011	Updated model used + EPS model results
Prelim v7	8/12/2011	P Von Huben	P Von Huben	8/12/2011	EPS model run 1A + 1B
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1. Introduction

1.1. Purpose of Report

This report outlines the feasible options for the provision of potable water to the Stage 1 development of the Marsden Park Precinct (MPP), and identifies a preferred servicing option. The report also discusses how future stages of development of the Marsden Park Precinct could be serviced, including the current version of Sydney Water's Ultimate Servicing Strategy.

1.2. Report History

This report has been prepared based on an earlier report that was written by SKM titled "Marsden Park Stage 1 Water Modelling Report". This earlier report focussed specifically on the results of modelling of Sydney Water's water networks. The current report retains and expands on the earlier report with additional information.

1.3. Overview

The Marsden Park Precinct is located in Sydney's North West Growth Centre and is being developed via the Precinct Acceleration Protocol (PAP). The PAP proponent for the Marsden Park Precinct is Winten Property Group.

The Marsden Park Precinct will be developed over a number of stages. This report provides results from an investigation of possible options to provide water services to the initial stage of development of the Marsden Park Precinct (Stage 1), and considers the servicing of future stages of development.

This report, once it has been accepted by Sydney Water, would be used as an input for the production of a Services Infrastructure Implementation Plan (to be prepared by others). The Services Infrastructure Implementation Plan will outline how the Marsden Park Precinct would be serviced by utilities including potable water, wastewater, electricity, gas and telecommunications.

1.4. Other Developments

The Marsden Park Industrial Precinct (MPIP), which shares a border with the Marsden Park Precinct, is also currently being developed via the Precinct Acceleration Protocol by a different developer (APP Corporation). The initial stage of development of the MPIP (Stage 1) will be serviced with potable water by connecting to Sydney Water's existing water system, in particular the Minchinbury System. The servicing of MPIP Stage 1 has been taken into consideration in this study.

In addition, Winten own land within the MPIP known as the South Street Development. This land is zoned for medium density residential development, with a capacity of 250 lots. This study also takes into consideration the servicing of the South Street Development. In particular, the study

investigated the servicing of the South Street Development by extending the water infrastructure that will be installed to service Stage 1 of MPIP.

1.5. Background

In 2010 SKM investigated options for water servicing of an initial stage of development of the Marsden Park Precinct for Winten. That work included running models of Sydney Water's water networks in the Marsden Park area.

Some key changes have occurred since the previous modelling was undertaken, including:

- The previous modelling was undertaken on the basis of Sydney Water's ultimate servicing strategy that was provided in 2009. This outlined the potable water, sewer and recycled water services that would be required to service the ultimate development of both the Marsden Park Precinct and the Marsden Park Industrial Precinct. The ultimate servicing strategy was based on future provision of recycled water, via a large scale centralised dual reticulation system, to the Marsden Park Precinct.
- In early 2011 Sydney Water indicated that they would not construct a large scale centralised recycled water system to service the Marsden Park Precinct as part of the ultimate recycled water servicing strategy. This would mean that to comply with BASIX the new residences at Marsden Park would need to be equipped with rainwater tanks. This decision may also impact on the ultimate potable water servicing strategy.
- In mid 2011 Sydney Water indicated that they would need to revisit the ultimate potable water servicing strategy for the Marsden Park Precinct due to the decision to not provide centralised recycled water facilities. Sydney Water has not yet issued another version of the ultimate servicing strategy. Therefore the 2009 version of the ultimate servicing strategy is the latest version.

Because of the above, modelling for the servicing of the initial stage of development of the Marsden Park Precinct was investigated for two servicing approaches:

- Marsden Park Stage 1 residences equipped with rainwater tanks (to comply with BASIX) and potable water supplied by connection to Sydney Water's existing potable water system.
- Marsden Park Stage 1 residences being supplied recycled water from a community scale recycled water system (to comply with BASIX), and potable water supplied by connection to Sydney Water's existing potable water system.

This approach is adopted because the potable water demands are different for the two servicing approaches, and so the number of lots that can be serviced by any given piece of infrastructure is different.

2. Methodology

2.1. Scope of Work

The following scope of work was followed:

- Confirm with Sydney Water the inputs to be adopted including design criteria, the latest version of the computer model to be used for modelling of Sydney Water's water network, etc
- Confirm with APP Corporation the servicing strategy for Stage 1 of MPIP
- In conjunction with Sydney Water, identify the possible servicing options for Stage 1 of MPP
- Undertake hydraulic models of the water networks and the possible servicing options
- Undertake cost estimation of the possible servicing options
- Select a preferred servicing option
- Document results and findings, including analysis of posible servicing options for future stages of development of MPP

2.2. MPIP Stage 1 and South Street Development

Winten's South Street Development is a medium density residential development of 250 lots that is located along Richmond Road within the MPIP, as shown in **Figure 1**.

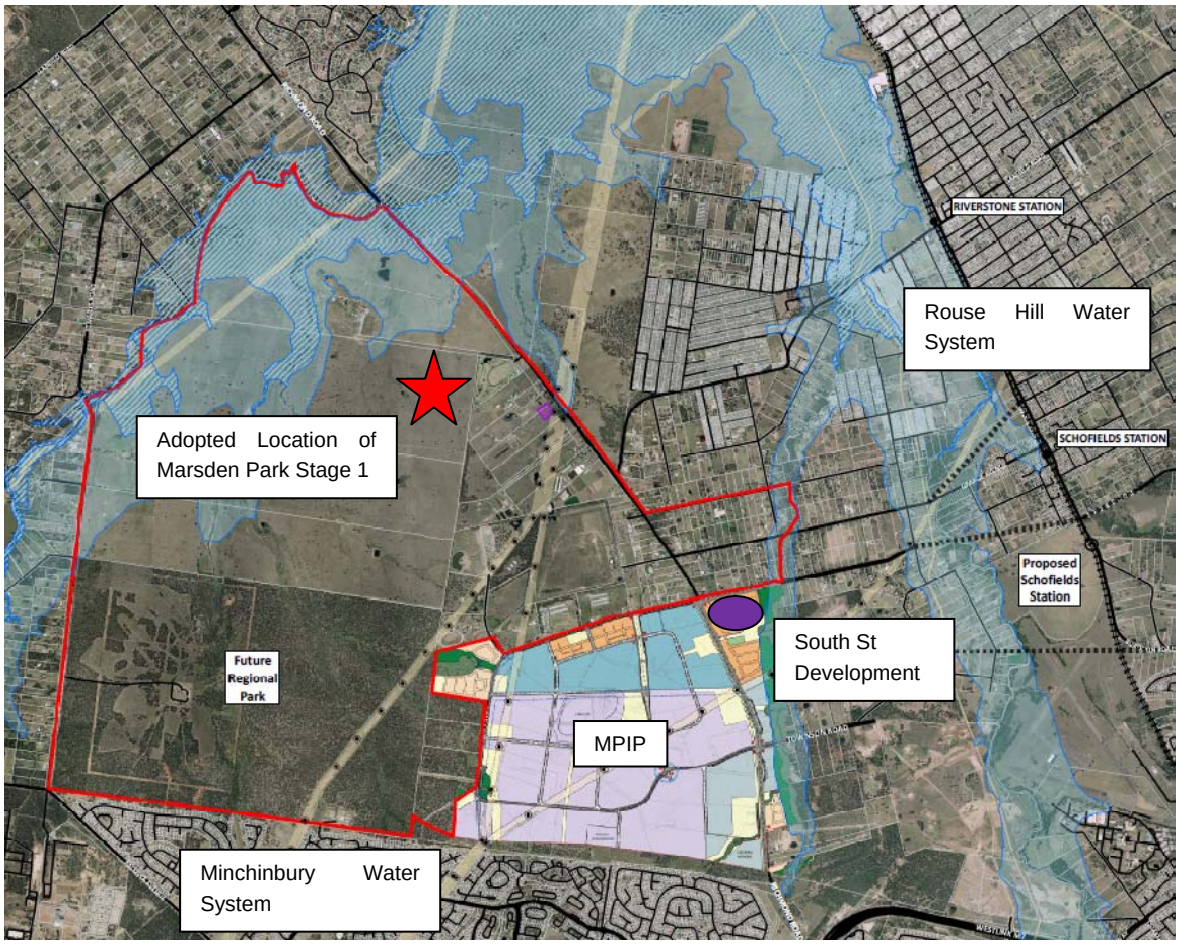
The South Street Development would be serviced by extending the new potable water pipework that will be installed to service the initial stage of development of the MPIP, along Richmond Rd to the South Street Development site. As the initial stage of development of the MPIP will not include recycled water, it has been assumed that the South Street Development would include rainwater tanks to comply with BASIX.

In order to ensure that there is sufficient capacity within Sydney Water's existing water system to service the MPIP including the extension to service the South Street Development, the modelling of the Minchinbury System undertaken in this project included these developments.

2.3. Marsden Park

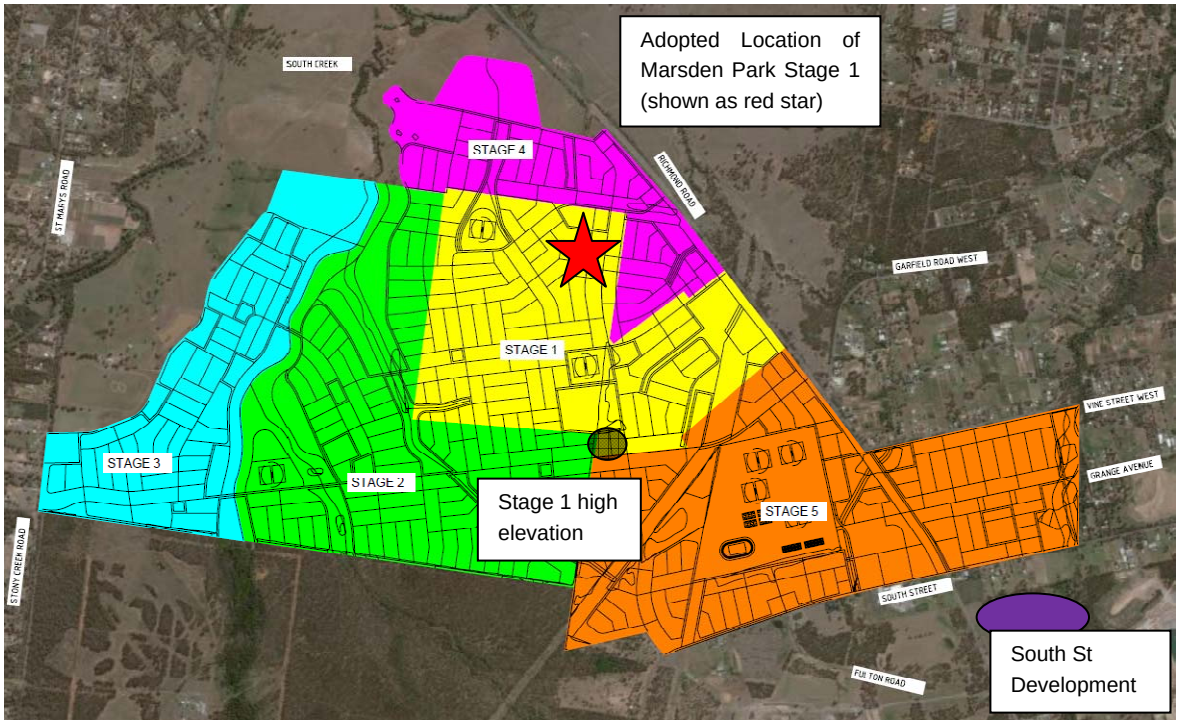
The initial stage of development of Marsden Park is being developed by Stockland. This would consist of low density residential dwellings with approximately 2,500 lots as Stage 1 over a gross area of 163 ha. However the work undertaken in this study would identify how many lots can be serviced as an initial development stage for different servicing options, with an anticipation of a range of 0 – 3,000 lots for different options.

Figure 1 shows the extent of the study area, and identifies the adopted location of the Stage 1 development of Marsden Park.



- **Figure 1 Marsden Park Study Area**

Figure 2 shows the staging plan for Marsden Park including the planned site for Stage 1. For the hydraulic modelling, all of the Stage 1 water demands were attributed to a single point, located as shown by the red star. The ground elevation at this location is RL 30 m. It is noted that the highest ground elevation within the Stage 1 area is around RL 35 m in a small area to the south of Stage 1, as shown in **Figure 2**.



- **Figure 2 Marsden Park Staging Plan**

2.4. Modelling Design Criteria

Design criteria have been confirmed with Sydney Water and are presented in **Appendix A**.

The following approach was adopted for the modelling:

- All options were modelled using a static model run (19:00 for residential demands with the liquid level in the reservoirs assumed to be 2/3 depleted, as outlined in **Appendix A**).
- As requested by Sydney Water, a number of the options were modelled using an extended period simulation (EPS) which involved running the model over a 24 hour period simulation. For the Minchinbury servicing options the EPS takes into account the operation of the existing PRV (pressure reducing valve) that is in the Minchinbury system.

2.5. Demand Estimate

Table 1 below shows the maximum day flow for Marsden Park Stage 1 (for an initial stage of 2,500 lots) and South Street Development (for 250 lots) and **Table 2** shows the maximum hour demands. **Appendix B** provides the discussion relating to Future Max Day Demand Model Build.

- **Table 1 Maximum Day Demands for Marsden Park and South Street Development**

Site	Demand Category	Number of Lots	Max Day Demand Single Retic _ PW (ML/day)	Max Day Demand Dual Retic _ PW (ML/day)
Marsden Park Stage 1	Residential (LD)	2,500	5.5	2.0
South Street	Residential (MD)	250	0.4	

- **Table 2 Maximum Hour Demands for Marsden Park and South Street Development**

Site	Demand Category	Number of Lots	Max Hour Demand Single Retic _ PW (L/s)	Maxi Hour Demand Dual Retic _ PW (ML/day)
Marsden Park Stage 1	Residential (LD)	2,500	159	63
South Street	Residential (MD)	250	10	-

3. MPIP Stage 1 and South Street

3.1. MPIP Stage 1

Stage 1 of the MPIP will be provided with potable water services by installing new pipework that connects into Sydney Waters Minchinbury water network.

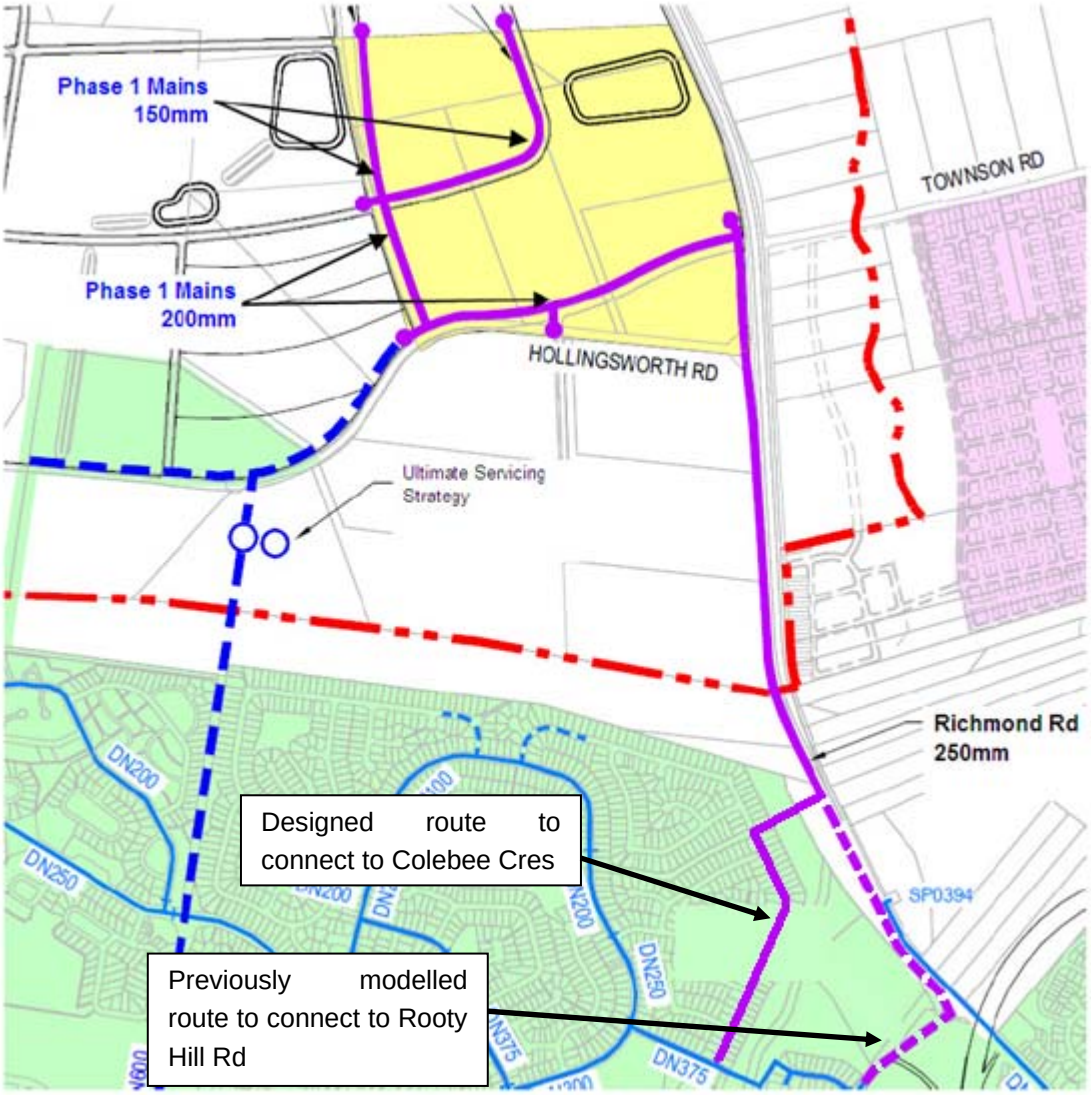
APP Corporation (the developer of MPIP) engaged GHD to undertake water network modelling and design of the pipework to service MPIP Stage 1. The results of the water network modelling were outlined in a report titled "Report for Marsden Business Park Water and Sewer Infrastructure Water Modelling" (GHD, Sept 2009).

Since the time of undertaking the modelling and writing this report, GHD have undertaken design of the pipework. This has resulted in a slight change to the pipe route compared to what was modelled. In particular, the design includes connection of the new DN250 pipe into the existing DN375 in Colebee Crescent, whereas the modelling was based on the new DN250 pipe connecting into a DN450 pipe in Rooty Hill Rd.

The proposed (designed) pipe route is shown in **Figure 3** as a solid line, whereas the modelled pipe route is shown as a broken line.

This difference is only noted in this report to avoid any confusion and to outline that the modelling that was undertaken in this project included changing the connection point for the MPIP Stage 1 pipework to conform with the latest design drawings that were provided by GHD.

We note that SKM has not undertaken a review of the design or modelling of the proposed pipes to service MPIP Stage 1.



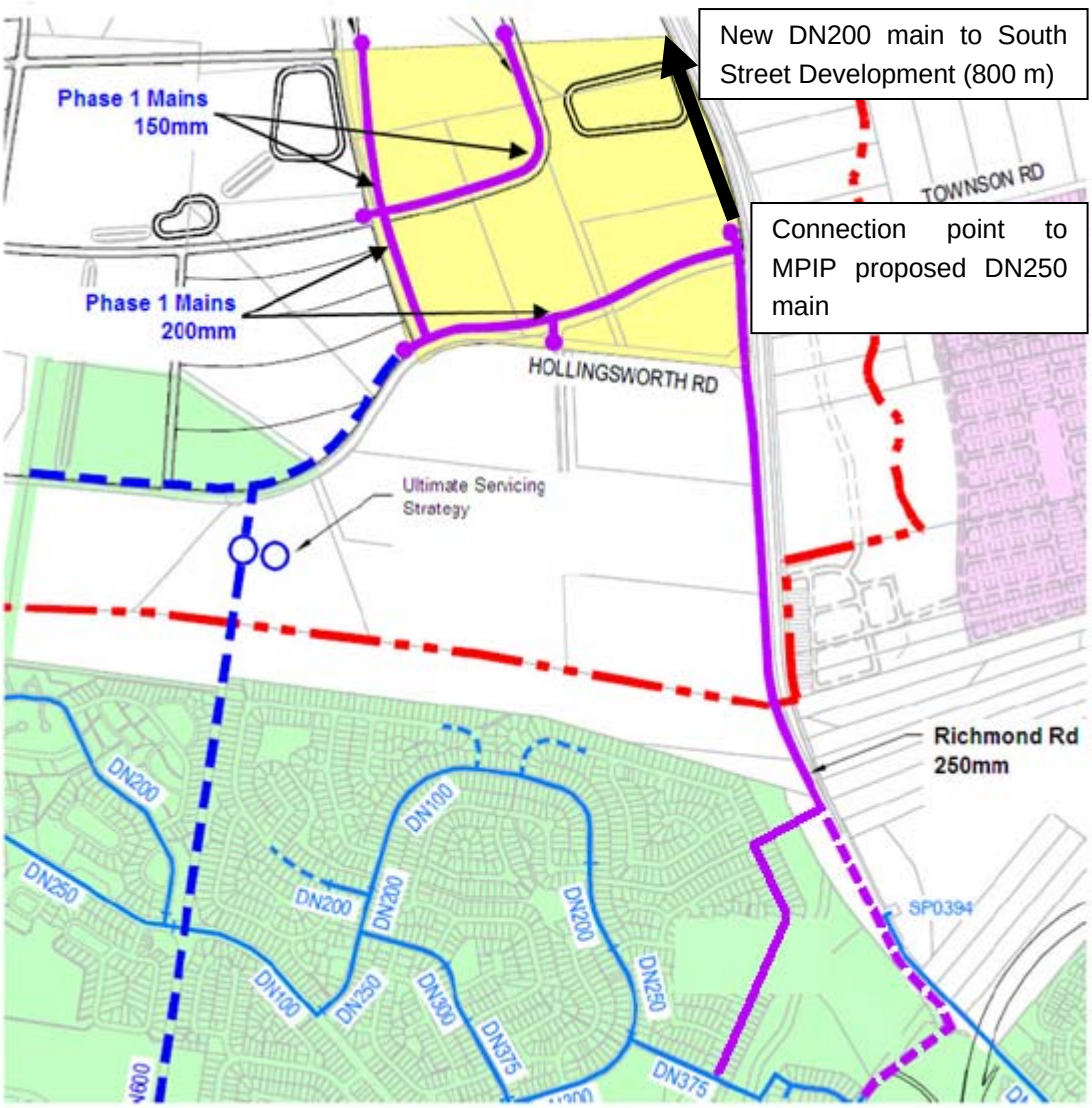
- **Figure 3 MPIP Stage 1 Pipework**

3.2. South Street Development

Servicing of the South Street Development with potable water was investigated in this study. It is proposed that the South Street Development would be serviced by installing an additional pipe that connects to the DN250 pipework that will be installed to service MPIP Stage 1.

The connection point for the proposed extension to service the South Street Development is the northern most section of the new DN250 pipe along Richmond Road at the corner with Townson Rd (**Figure 4**). It is proposed to install an additional DN200 pipe from this point along Richmond Rd to the South Street Development which fronts onto Richmond Rd, which is around 800 m in length.

The modelling undertaken by SKM indicates that, due in part to the different demand profiles for industrial water demand and residential water demand, it is possible to service a 250 lot residential development by the proposed connection shown in **Figure 4**.



- **Figure 4 Servicing the South Street Development**

4. Marsden Park Stage 1

4.1. Servicing Options

Sydney Water's ultimate servicing strategy for the ultimate development of the Marsden Park Precinct is outlined in detail in **Section 6.1**. In short it involves the provision of potable water services to the Marsden Park Precinct (and MPIP) by connection to one of Sydney Water's existing water networks, namely the Minchinbury Water System.

Hence the servicing of Stage 1 of Marsden Park by connection to the Minchinbury Water System was investigated in this study. Two servicing approaches involving connection to the Minchinbury Water System were investigated, referred to as Minchinbury West Connection and Minchinbury East Connection.

In addition, following discussions with Sydney Water, it was identified that another possible servicing approach for Marsden Park Stage 1 is by connection to the Rouse Hill Water System (formerly referred to as Rogans Hill – Castle Hill Water System).

The following servicing approaches were investigated for Marsden Park Stage 1:

- Minchinbury West Connection
- Minchinbury East Connection
- Rouse Hill Connection

For these servicing approaches the water network modelling that was undertaken was limited to modelling the servicing of Marsden Park Stage 1. No water network modelling was undertaken for the Sydney Water ultimate servicing strategy as this is outside the scope of this study.

Details of the analysis undertaken, along with the proposed supply arrangements and infrastructure are presented below.

4.2. Minchinbury Water System

The Minchinbury Water System is divided into 9 sub-systems including Berkshire, Mount Druitt, Plumpton, Glendenning, Rooty Hill, Doonside, Colyton, SEPP59, and Minchinbury. The system is fed by Minchinbury Reservoir WS269, which receives water from Prospect Filtration Plant via Pumping StationWP184A units 4 and 3 (standby). Currently, only one unit at a time is permitted to run as high pressure may cause damage to the reticulation system. The Mt Druitt reservoirs (WS 216 and WS 215, 0.89 ML and 19 ML respectively), which used to supply the Mt Druitt and surrounding areas in early days are now decommissioned. Berkshire Park (which lies to the north-west of Marsden Park) is within Minchinbury Reduced 1 Scheme (refer to **Appendix D**).

The Minchinbury Reservoir has a full service depth of 15 m, so at 2/3 depleted the liquid level in the reservoir would be at a depth of 5 m.

Two approaches were investigated for servicing of Marsden Park Stage 1 from the Minchinbury System:

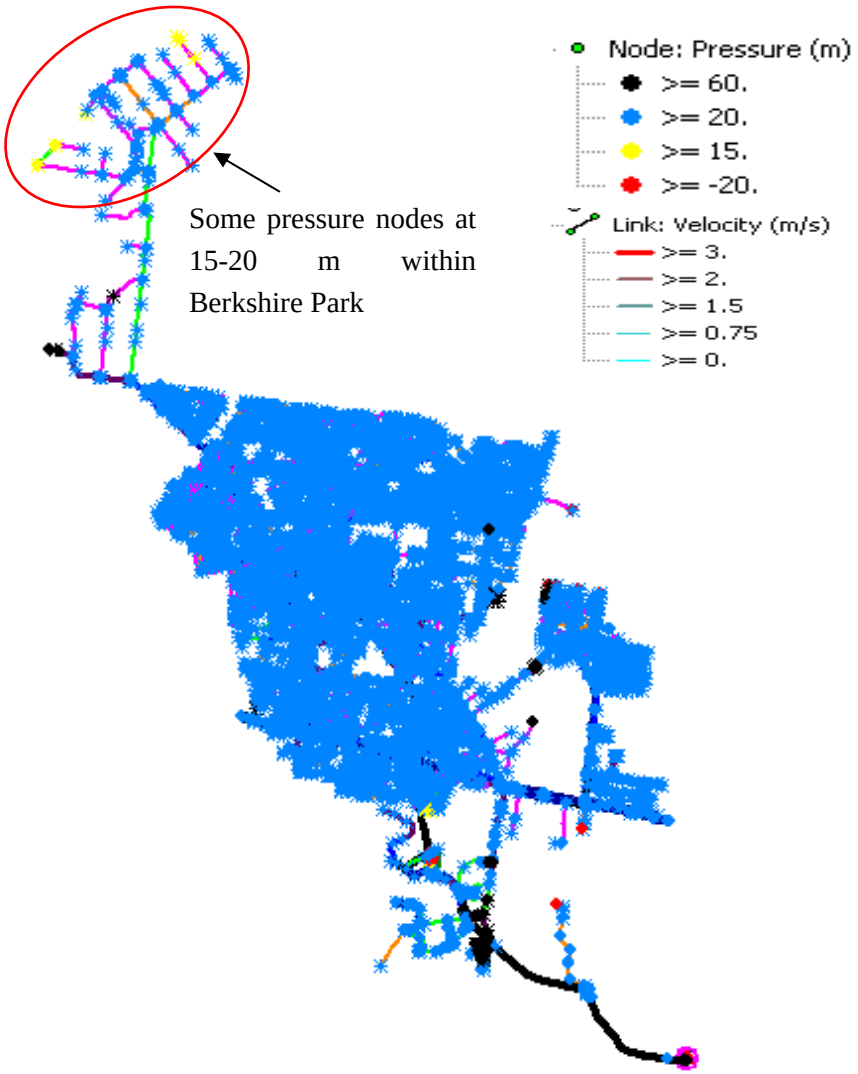
- Minchinbury West Connection (**Section 4.2.2**)
- Minchinbury East Connection (**Section 4.2.3**)

4.2.1. Minchinbury Max Day System Performance

Sydney Water has provided the existing water model for the Minchinbury Supply System. This model was used to identify the performance of the existing network. The InfoWorks WS water model for the Minchinbury System in Sydney Water's *Water Modelling System* was used for this analysis (refer to **Appendix C** for the model and run components used).

The existing Minchinbury model was run for the current water demands, which excludes any demands from MPIP, South Street Development and Marsden Park. The performance of the existing Minchinbury System was modelled under Sydney Water's 'present max day model'. This includes the peak hour flow (PHF) water demands and was modelled using a static model run at 19:00 with the reservoir at 9 m depth. This level is 4 m above the 2/3 depleted level of 5 m. Following discussions with Sydney Water, the model was run with demand scaling version 9.05.

Figure 5 shows the results from the 'present max day model' which indicates that there are some existing nodes with pressures of 15 – 20m within Berkshire Park area, which is north-west of Marsden Park. As low pressure at Berkshire Park is predicted during current water demands, the pressures at Berkshire Park should not be allowed to deteriorate any further. One contributing factor to the low pressures is the headloss in the pipework servicing Berkshire Park.



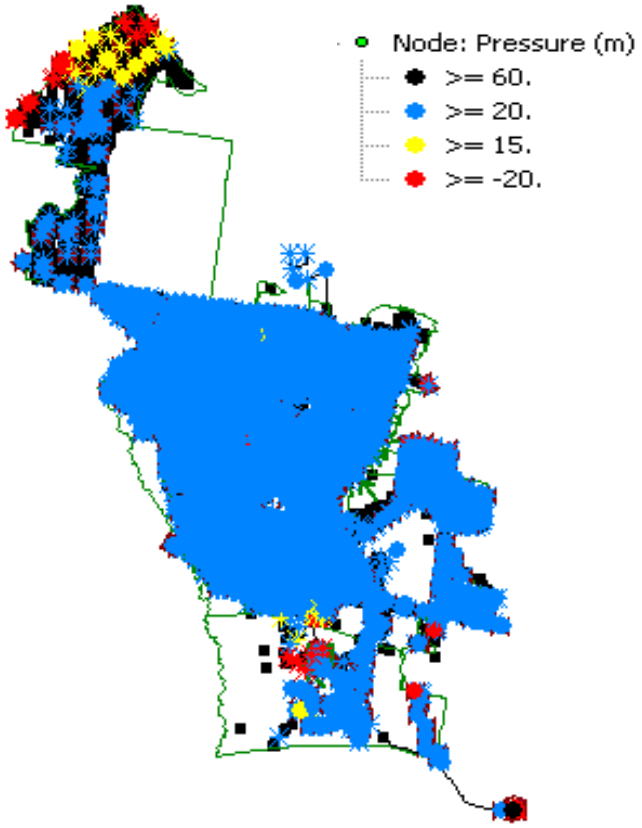
- **Figure 5 Minchinbury Present Max Day Model Results**

To investigate the servicing of the Marsden Park Precinct a Future Max Day Demand (FMDD) model for 2018 was built. The 2018 FMDD model analysis was performed using the alternate demand "WPRP Alt Demand 2018 RainTank" to account for growth within the network and included the Stage 1 of MPIP (with demands as modelled by GHD).

To establish a baseline for comparison of options, the 2018 FMMD model was analysed with no water demands for Marsden Park or the South Street Development. The model was run for peak hour flow (PHF) water demands using a static model run at 19:00 with the reservoir at the 2/3 depleted level (liquid depth of 5 m) and demand scaling version 9.05.

Figure 6 shows the results from the 2018 FMMD model with no demands for Marsden Park or the South Street Development. The model shows that there are a number of nodes with less than 15 m

pressures within Berkshire Park. Key causes of this is the additional loading applied in the 2018 FMMD model and a 2/3 depleted level within the Minchinbury Reservoir (liquid depth of 5 m) as requested by Sydney Water. However, the Sydney Water 'present max day model' is run with a higher liquid level within the reservoir of 9 m. As a result, the 2018 FMMD model presents a more conservative approach for analyzing predicted network performance.



- **Figure 6 Minchinbury 2018 FMMD Model Results**

4.2.2. Minchinbury – West Connection

For connection into the existing Minchinbury water system via the 'west connection' servicing approach, the existing DN375 main at the corner of Palmyra Ave and Captain Cook Dr was identified as a suitable connection point. That is, in this servicing approach a new pipe would need to be constructed from this point to the location of the initial stage of development of Marsden Park (**Figure 7**). The pipe route adopted was based on a rough approximation of the location of local roads within Marsden Park (which was obtained from the Structure Plan). A DN300 pipe was adopted (as the initial option) for the new pipe servicing Marsden Park, with different pipe diameters also modelled as different options.

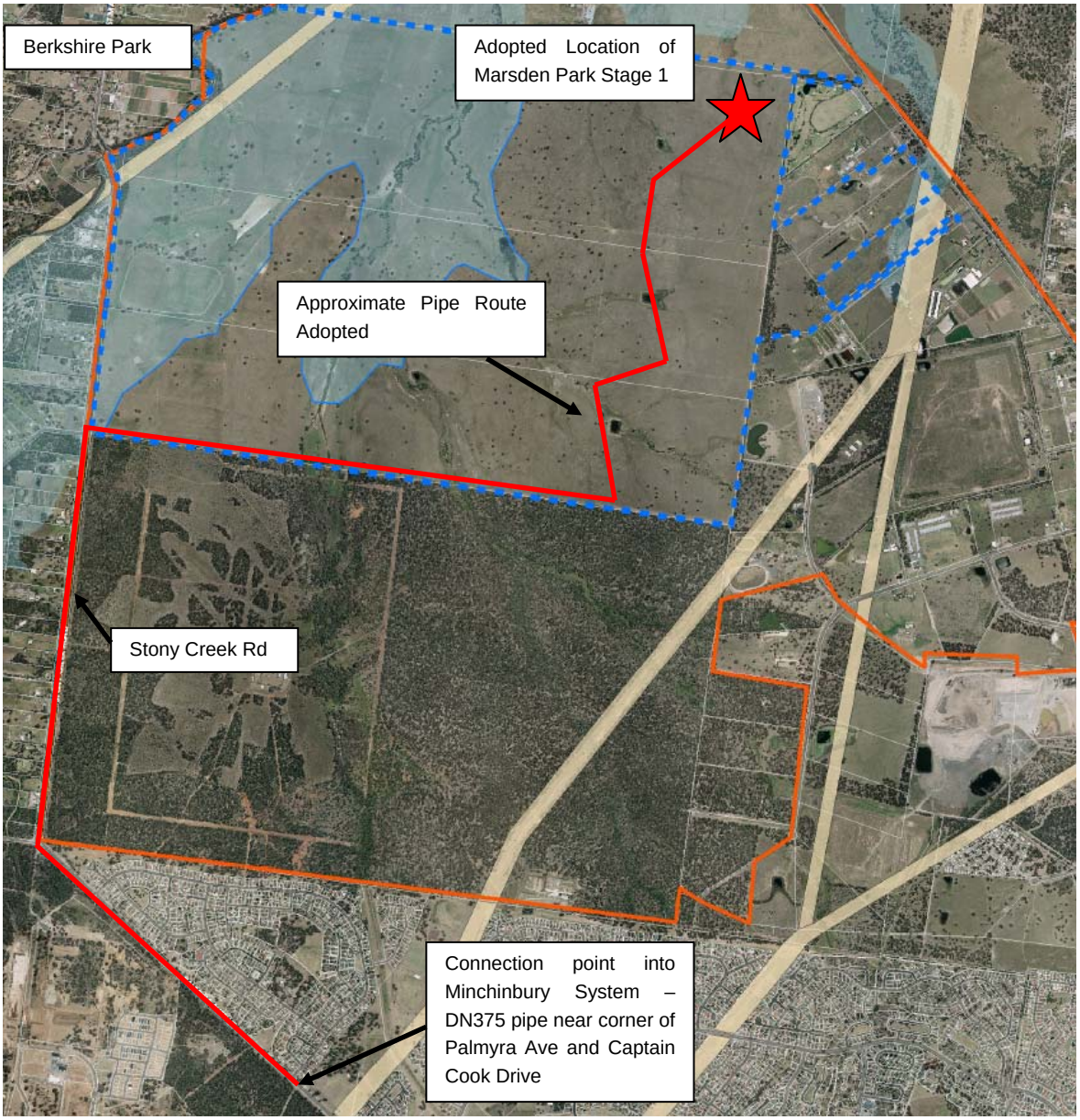


Figure 7 Minchinbury – West Connection Pipe Route to Marsden Park Stage 1

Along this pipe route, the highest ground elevation is at the start of the pipe (at the connection point into the Minchinbury System) with an elevation of around RL 50 m. The ground elevation at the adopted location of Stage 1 of Marsden Park is lower at around RL 30 m, with the highest ground level along the pipe route within Marsden Park of around RL 40 m at the south eastern corner of the site. The lowest ground elevation along the pipe route occurs at the creek crossings within the Marsden Park site.

4.2.2.1. Modelling of Marsden Park Stage 1 – Static Model Runs

Modelling was undertaken to investigate the possible servicing options for Marsden Park Stage 1 from Minchinbury West, and the number of lots that can be serviced for each option.

The 2018 FMMD model was modified to include the new pipework to service Marsden Park Stage 1 and the water demands for Marsden Park Stage 1. A peak hour flow analysis was undertaken to understand the maximum flow (and hence the number of lots) that could be delivered to Marsden Park from the Minchinbury system without significantly affecting the level of service to existing customers, particularly in the Berkshire Park sub-system.

For all options modelled, the pipework to service MPIP Stage 1 was included, along with the proposed DN200 extension to supply South Street (**Figure 4**). South Street was modeled as a medium density residential development with 250 lots with single reticulation (with rainwater tanks to comply with BASIX).

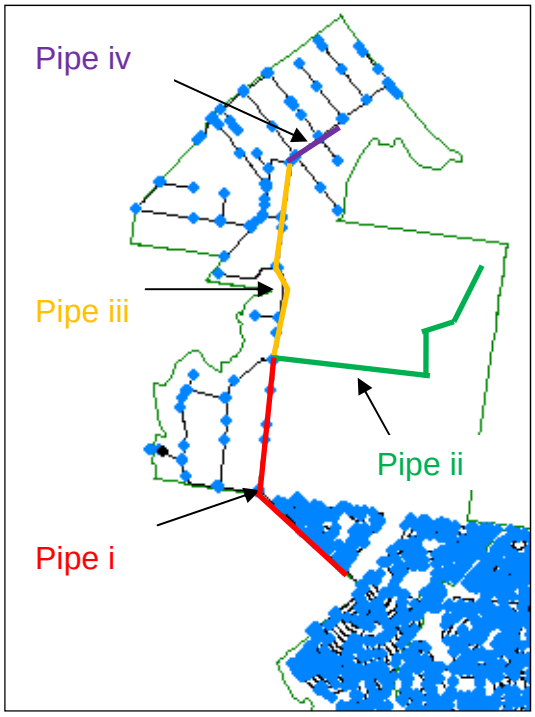
The options that were developed comprised of different pipe sections as outlined below and shown in **Figure 8**:

i. Pipe that connects to the existing DN375 pipe near the corner of Palmyra Ave and Captain Cook Drive, and follows along Palmyra Ave and Stony Creek Rd to the corner of Stony Creek Rd and Shane Park Rd. This section of pipe was modelled as 3.5 km in length, and options included pipe diameters of DN300 and DN375.

ii. Pipe from the corner of Stony Creek Rd and Shane Park Rd to the Marsden Park development. This pipe section was modelled as 4.3 km in length, and options included pipe diameters of DN300 and DN375.

iii. Pipe from the corner of Stony Creek Rd and Shane Park Rd along Stony Creek Rd (which turns into St Marys Rd on the north side of South Creek) to the bend in St Marys Rd. This section of pipe was modelled as 2.9 km in length, and options included pipe diameters of DN200 and DN300.

iv. Pipe from the bend in St Marys Rd to the corner of St Marys Rd and Second Rd. This section of pipe was modelled as 1.0 km in length, and options included pipe diameters of DN200 and DN300.



- **Figure 8 Minchinbury – West Connection Pipe Sections**

New sections of pipe were connected to the existing pipework at both ends of the new pipework.

For each option, two scenarios were analysed for Marsden Park:

- The first scenario analysed for Marsden Park assumed that Marsden Park Stage 1 would be serviced by a single reticulation system (with rainwater tanks to comply with BASIX).
- The second scenario analysed was for Marsden Park serviced by a local dual reticulation system with potable water provided from the Minchinbury System

The options were developed progressively over time, with the first option representing the least amount of new infrastructure provided to service Marsden Park. The options were developed by including additional infrastructure, either increasing the diameters of the new pipework or adding new sections of pipe, to increase the number of lots that can be serviced.

During the modelling it became apparent that one factor that limits the number of lots that can be serviced in Marsden Park Stage 1 is water pressure in Berkshire Park. Berkshire Park is shown in **Figure 5** and **Figure 6** to have a number of nodes where the existing supply pressure is marginal. Hence in some of the options, the number of lots in Marsden Park Stage 1 needs to be limited so that the water demand from these lots is not sufficiently large to cause a reduction in pressures at Berkshire Park.

The following servicing options were investigated:

1) **Option 1**: Construct new DN300 pipe from Corner of Palmyra Ave and Captain Cook Drive to Marsden Park AND provide a cross connection between the new DN300 pipe and the existing DN200 pipe at Connection Point 2 as shown as per **Figure 9**. The cross connection ensures that pipe section i will operate in parallel with the existing pipe between Connection Point 1 and Connection Point 2.

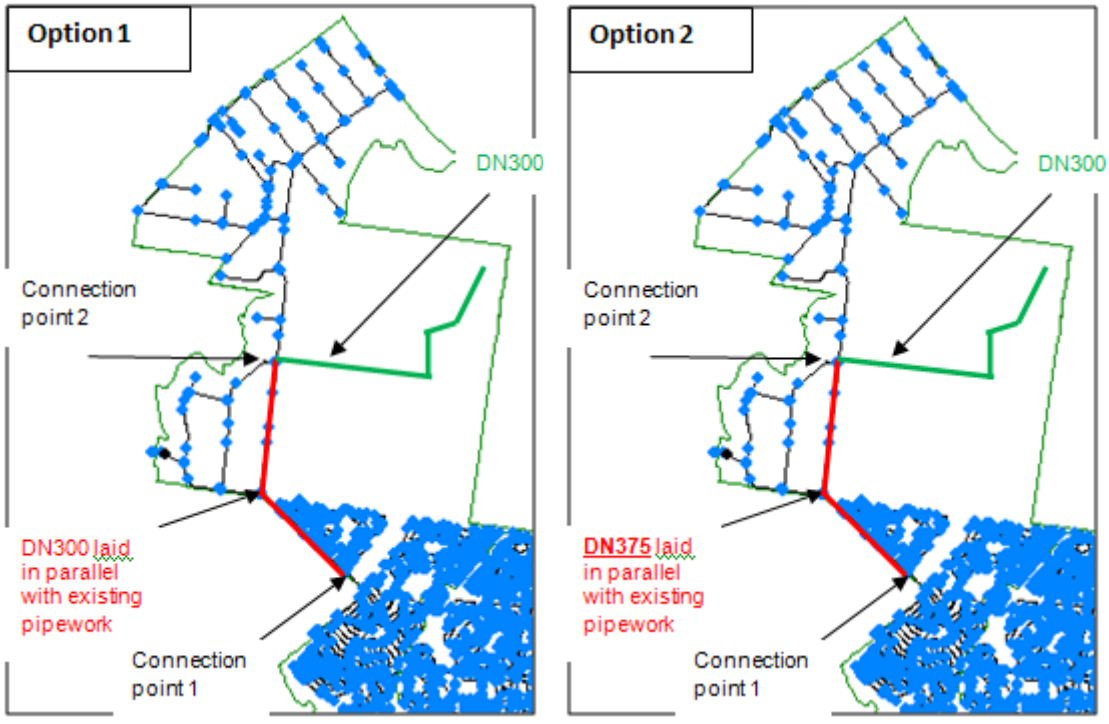
   a) With rainwater tanks at Marsden Park this option services up to 560 lots

   b) With a dual reticulation system at Marsden Park this option services up to 1,430 lots

2) **Option 2**: Construct new DN375/DN300 pipe from Corner of Palmyra Ave and Captain Cook Drive to Marsden Park AND provide a cross connection between the new DN375 pipe and the existing DN200 pipe at Connection Point 2 as shown as per **Figure 9**. This is similar to Option 1 except that the diameter of pipe section i is increased from DN300 to DN375.

   a) With rainwater tanks at Marsden Park this option services up to 800 lots

   b) With a dual reticulation system at Marsden Park this option services up to 2,040 lots



- **Figure 9 Minchinbury – West Connection Options 1 and Option 2**

3) **Option 3**: This option involves undertaking Option 2 AND constructing a new DN200 pipe along Stony Creek Rd (pipe section iii) with connection to existing pipework at Connection Point 3 as shown in **Figure 10**. The limiting factor for this option is low pressure in Marsden Park, rather than low pressures at Berkshire Park.

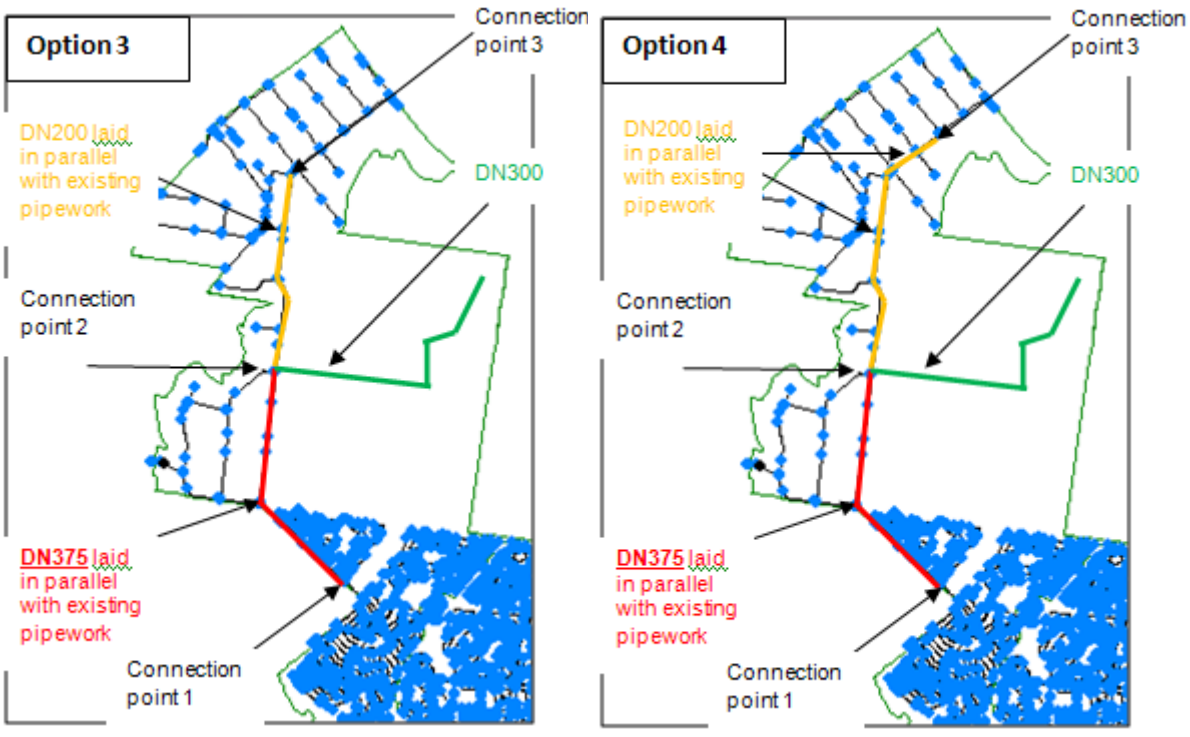
   a) With rainwater tanks at Marsden Park this option services up to 1,100 lots

   b) With a dual reticulation system at Marsden Park this option services up to 2,800 lots

4) **Option 4**: Undertake Option 3 AND extend the new DN200 pipe for pipe section iv with connection to existing pipework at Connection Point 3 as shown in **Figure 10**. This option is essentially Option 3 with extension of the DN200 pipe. However, as the limiting factor for Option 3 was low pressure in Marsden Park, extending the DN200 pipe further into Berkshire Park does not increase the number of lots that can be serviced at Marsden Park. Hence the results for this option are essentially the same as Option 3 and indicate that construction of pipe section iv has no significant beneficial impact.

   a) With rainwater tanks at Marsden Park this option services up to 1,100 lots

   b) With a dual reticulation system at Marsden Park this option services up to 2,800 lots



- **Figure 10 Minchinbury – West Connection Options 3 and Option 4**

5) **Option 5**: This option is similar to Option 4, except that pipe section ii is upsized from DN300 to DN375 to increase the number of lots that can be serviced in Marsden Park. Basically, this option involves the construction of a new DN375 pipe from Corner of Palmyra Ave and Captain Cook Drive to Marsden Park AND construction of a new DN200 pipe along Stony Creek Rd as shown in **Figure 11**.

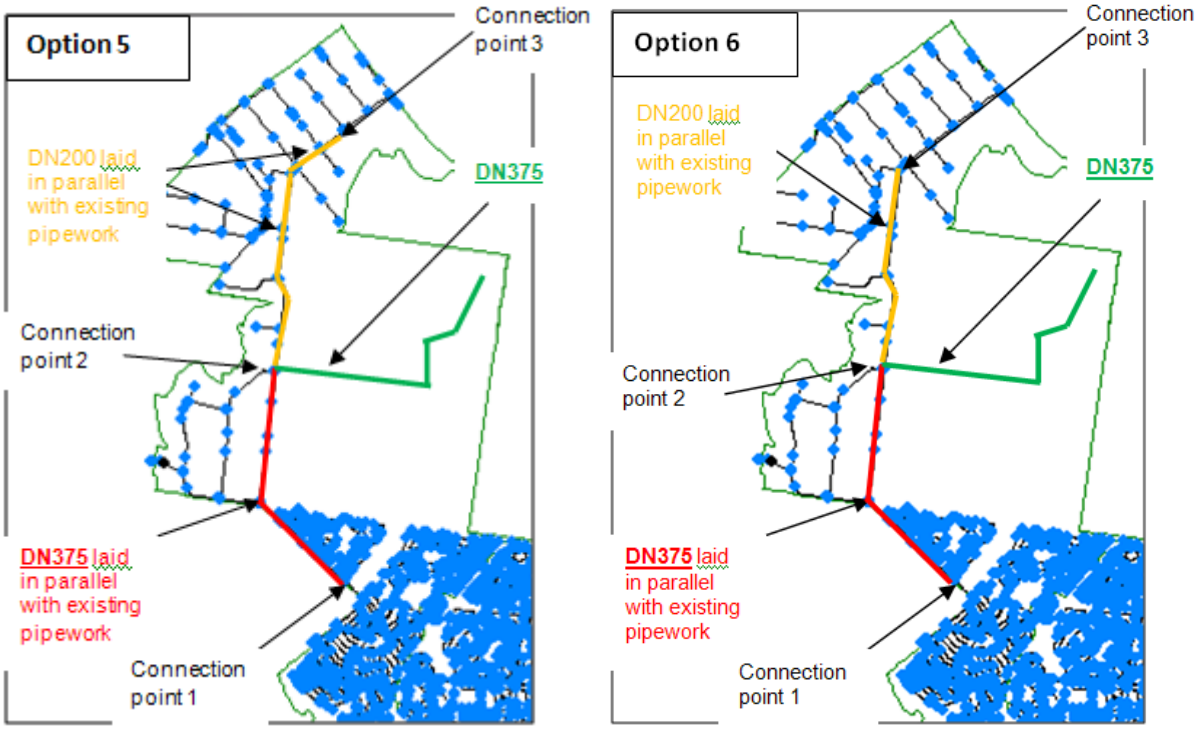
   a) With rainwater tanks at Marsden Park this option services up to 1,290 lots

   b) With a dual reticulation system at Marsden Park this option services up to 3,280 lots

6) **Option 6**: This is the same as Option 5 but with a reduced section of DN200 pipe, as shown in **Figure 11**. Also, this option can be thought of Option 4 but with pipe section ii upsized from DN300 to DN375. The results from this option are the same as for Option 5, indicating that construction of pipe section iv has no significant beneficial impact.

   a) With rainwater tanks at Marsden Park this option services up to 1,290 lots

   b) With a dual reticulation system at Marsden Park this option services up to 3,280 lots

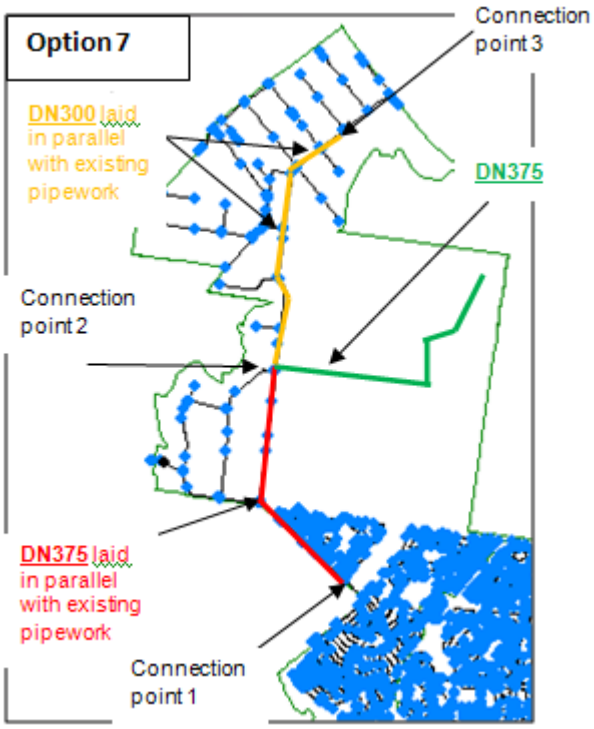


- **Figure 11 Minchinbury – West Connection Options 5 and 6**

7) **Option 7**: This option is the same as Option 5 but with pipe sections iii and iv upsized from DN200 to DN300. Essentially this involves construction of a new DN375 pipe from the Corner of Palmyra Ave and Captain Cook Drive to Marsden Park AND construction of a new DN300 pipe along Stony Creek Rd as shown in **Figure 12**. Compared to Option 5, upsizing pipe sections iii and iv marginally increases the number of lots that can be serviced.

   a) With rainwater tanks at Marsden Park this option services up to 1,370 lots

   b) With a dual reticulation system at Marsden Park this option services up to 3,490 lots



- **Figure 12 Minchinbury – West Connection Option 7**

For each of the options, the model was run a number of times with different numbers of lots being serviced in Marsden Park. The modelling of an option was repeated until the maximum number of lots that can be serviced in Marsden Park, with acceptable water pressures at both Berkshire Park and Marsden Park, were identified.

Table 3 provides a summary of the modelled options and the number of lots that can be serviced by each option, based on the static model runs.

- **Table 3 Minchinbury West – Modelling Results - Static Model Runs**

Option	Rainwater Tanks (RT) / Dual Reticulation (DR)	Number of Lots	Pipe Diameters			
			Pipe Section i	Pipe Section ii	Pipe Section iii	Pipe Section iv
1A	RT	560	300	300	NA	NA
1B	DR	1,430				
2A	RT	800	375	300	NA	NA
2B	DR	2,040				
3A	RT	1,100	375	300	200	NA
3B	DR	2,800				
4A	RT	1,100	375	300	200	200
4B	DR	2,800				
5A	RT	1,290	375	375	200	200
5B	DR	3,280				
6A	RT	1,290	375	375	200	NA
6B	DR	3,280				
7A	RT	1,370	375	375	300	300
7B	DR	3,490				

4.2.2.2. Modelling of Marsden Park Stage 1 – EPS Model Runs

Options 1, 4 and 5 were adopted for modelling using the extended period simulation (EPS) over a 24 hour period with results provided in **Table 4**.

- **Table 4 Minchinbury West – Modelling Results - EPS Model Runs**

Option	Rainwater Tanks (RT) / Dual Reticulation (DR)	Number of Lots	Pipe Diameters			
			Pipe Section i	Pipe Section ii	Pipe Section iii	Pipe Section iv
1A	RT	850	300	300	NA	NA
1B	DR	2,160				
4A	RT	1,300	375	300	200	200
4B	DR	3,310				
5A	RT	1,660	375	375	200	200
5B	DR	4,230				

The results from the EPS model runs indicate a larger number of lots can be serviced than indicated by the static model runs. This is because in the EPS model the liquid level in the reservoir fluctuates, and doesn't stay at the 2/3 depleted level. In addition the EPS model run takes into account the operation of the pressure reducing valves that exist within the Minchinbury System to maintain the water pressure within the desired range. Therefore these factors result in higher

system pressures at Berkshire Park and Marsden Park which can translate into a larger number of lots. In comparison for the static model runs the pressure within the system was dependent on the liquid level within the existing reservoirs, and was based on a conservative assumption of 2/3 depletion of the reservoir level (refer **Appendix A**).

4.2.3. Minchinbury – East Connection

This servicing approach involves the installation of a new water main along Richmond Rd from the corner of Richmond Rd and Townson Rd to the site of Marsden Park Stage 1. This pipe would connect into the new water mains that are being installed to service MPIP Stage 1, and would require upsizing of certain sections of the MPIP Stage 1 pipework.

With reference to **Figure 3** (which shows the proposed water mains to service MPIP Stage 1) this option would require upsizing the proposed new DN250 water main from its connection point to the existing DN375 main in Colebee Crescent to the corner of Richmond Rd and Townson Rd, a total length of around 2.1 km.

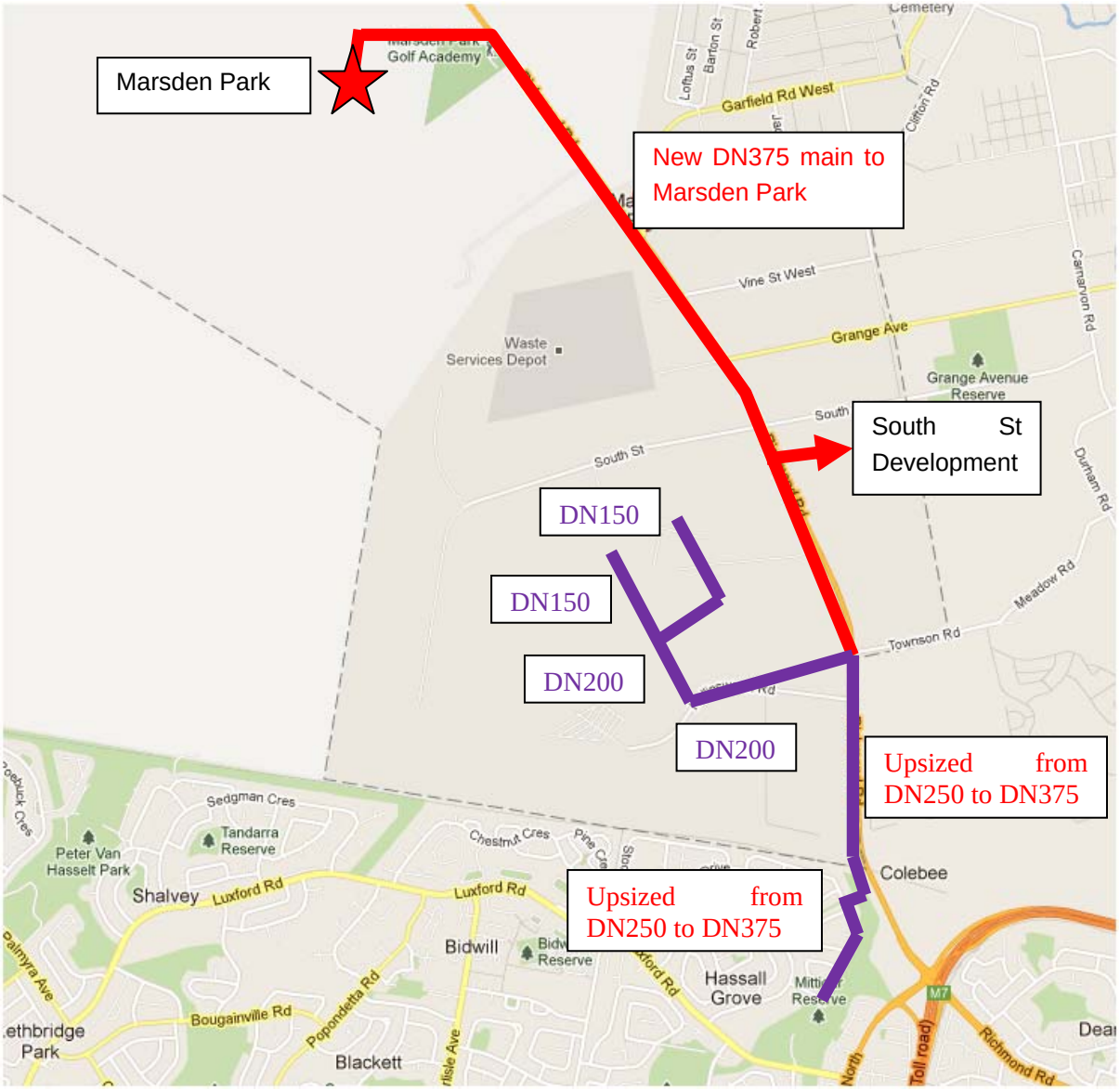
Three options were modelled for servicing Marsden Park Stage 1:

- Option 1 (**Figure 13**):
  - Install DN375 main (5 km length) along Richmond Rd
  - Upsize MPIP main (2.1 km length) from DN250 to DN375
- Option 2 (**Figure 14**):
  - Install DN450 main (5 km length) along Richmond Rd
  - Upsize MPIP main (2.1 km length) from DN250 to DN450
- Option 3 (**Figure 15**), which is essentially Option 2 with an additional section of pipe. The additional section of pipe is shown in **Figure 16** and involves installing a new DN450 pipe that runs in parallel with an existing DN375 pipe from Colebee Crescent to Rooty Hill Rd:
  - Install DN450 main (5 km length) along Richmond Rd
  - Upsize MPIP main from DN250 to DN450
  - Install DN450 main (0.4 km length) from upsized DN450 main in Colebee Crescent to connect to the existing DN450 main in Rooty Hill Rd

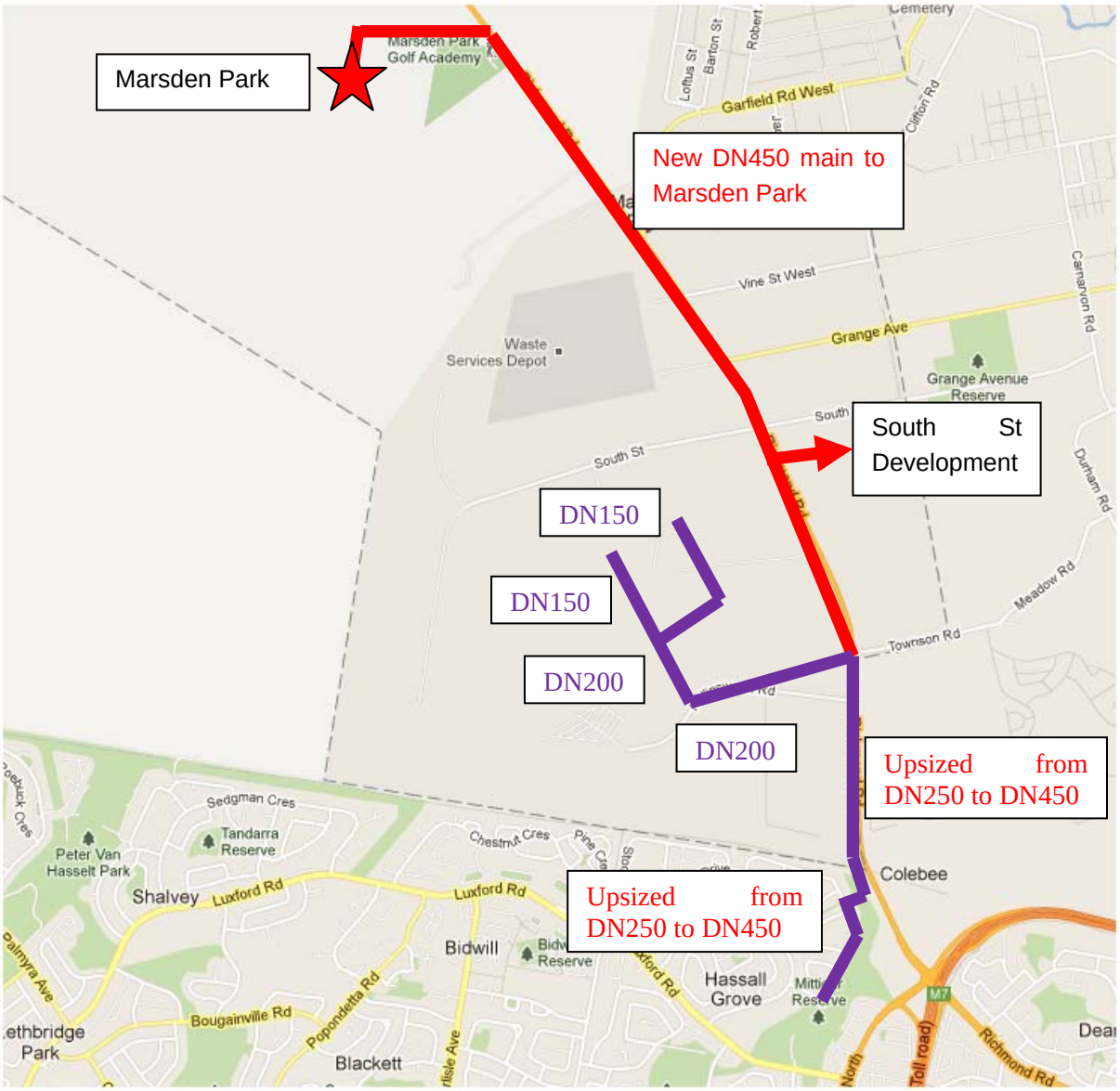
For each option it was assumed that the 250 lots in the South St Development would be serviced by connecting into the new main that is installed along Richmond Rd.

For all options it was assumed that rainwater tanks would be adopted at Marsden Park Stage 1 and South St to meet BASIX requirements (as opposed to recycled water). Static model runs at 19:00 were run with the Minchinbury reservoir at 2/3 depleted level (liquid depth of 5 m).

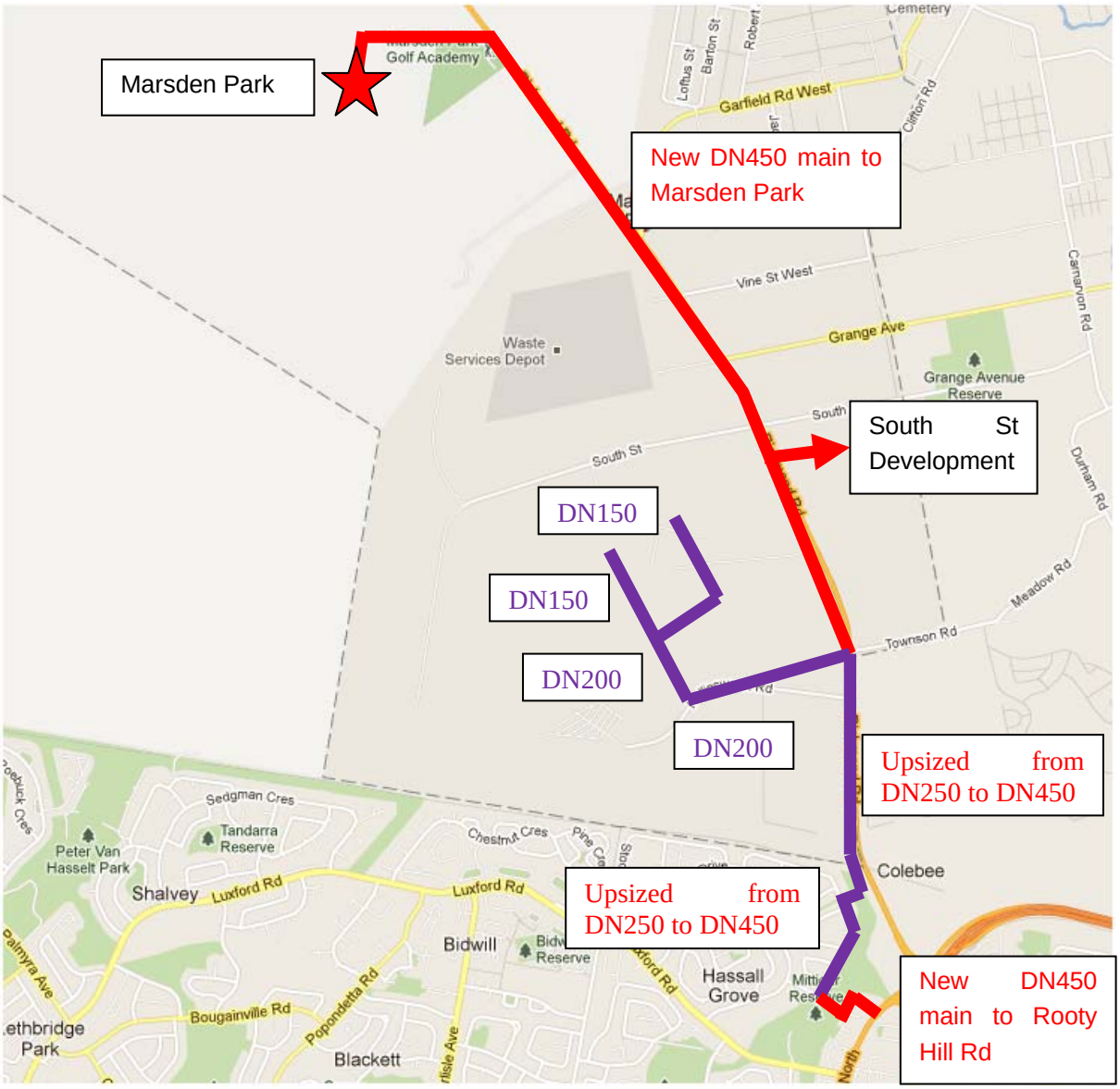
Also, for Options 2 and 3 the impact of different demands within MPIP were modelled by investigating the impact of increasing the MPIP Stage 1 demands by 50% and also 100% increase.



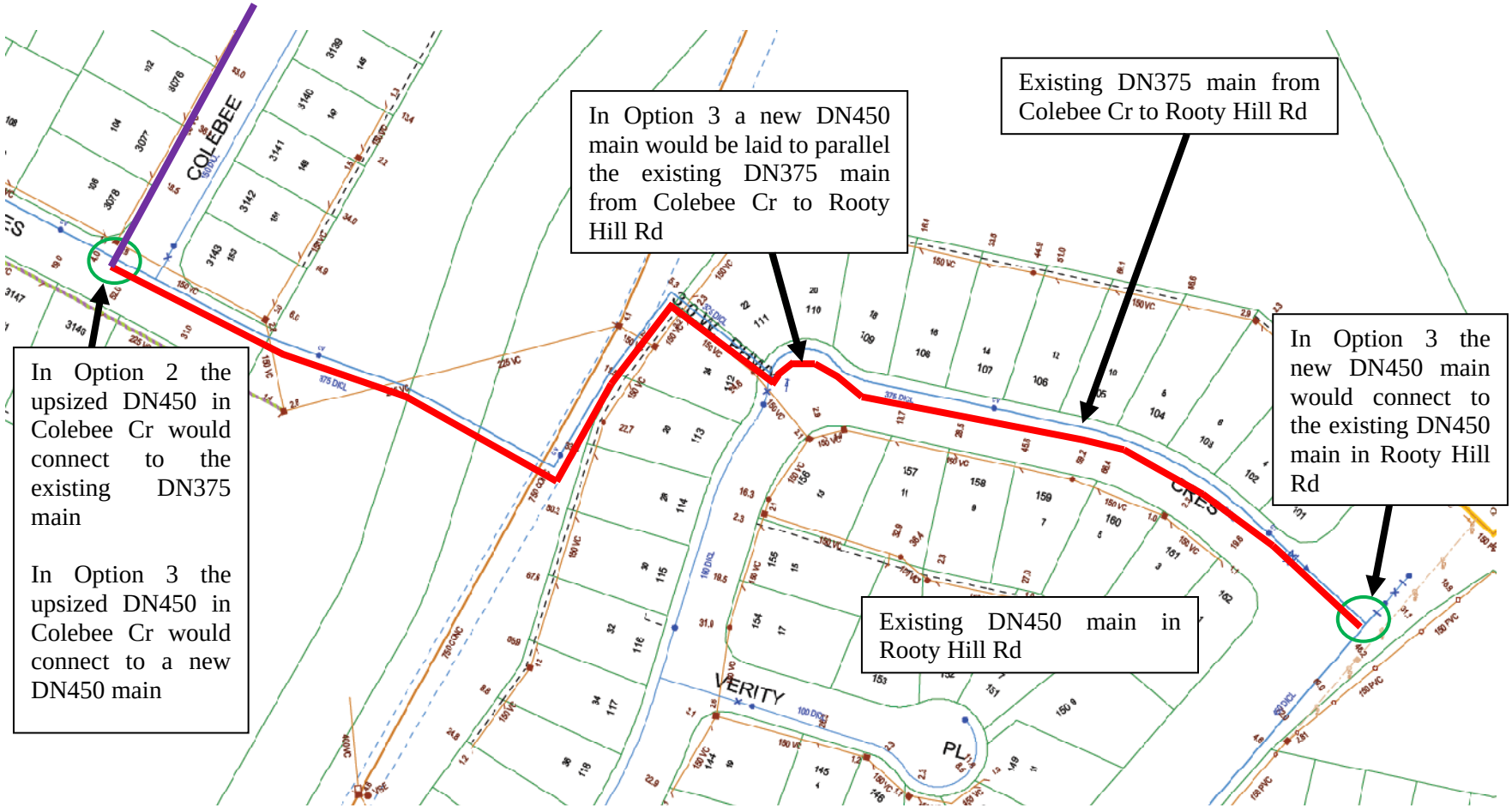
- **Figure 13 Minchinbury – East Connection Option 1**



- **Figure 14 Minchinbury – East Connection Option 2**



- **Figure 15 Minchinbury – East Connection Option 3**



- **Figure 16 Minchinbury – East Connection Option 3 Detail of Additional Section**

4.2.3.1. Modelling of Marsden Park Stage 1 – Static Model Runs

The 2018 FMMD model was modified to upsize the relevant sections of the MPIP Stage 1 pipework and to include the new pipework to service Marsden Park Stage 1, as outlined above for each option.

A peak hour flow analysis was undertaken to understand the maximum flow (and hence the number of lots) that could be delivered to Marsden Park from the Minchinbury system. The model was also run with increased demand within MPIP, by creating water demand at a node that was located at the corner of Richmond Rd and Townson Rd (the point of connection of the new pipe to the MPIP pipe system). The water demand at this node was run at 50% of the demand for MPIP Stage 1, as well as 100%. This demand was in addition to the modelled demand for MPIP Stage 1.

The model results are shown in **Table 5**, with pressures less than 20 m highlighted.

- **Table 5 Minchinbury East - Modelling Results**

Run	Number of Lots		Additional MPIP Stage 1 Water Demand	Pressures (m)		
	MP Stage 1	South St		MP Stage 1	South St	MPIP Node
Option 1 (Upsized to DN375 + DN375 to MP)						
1	2,100	0	None	22.3	39.2	Not recorded
2	2,100	250	None	19.9	36.8	
3	2,300	0	None	15.6	36.1	
Option 2 (Upsized to DN450 + DN450 to MP)						
4	2,000	250	None	38.0	44.1	42.7
5	2,500	250	None	29.8	39.1	38.4
6	3,000	250	None	20.2	33.5	33.5
7	3,500	250	None	9.2	27.1	28.1
8	2,000	250	+ 50%	36.8	43.0	41.6
9	2,500	250	+ 50%	28.5	37.9	37.1
10	3,000	250	+ 50%	18.7	32.1	32.1
11	3,500	250	+ 50%	7.6	25.5	26.5
12	2,000	250	+ 100%	35.7	41.8	40.4
13	2,500	250	+ 100%	27.2	36.6	35.8
14	3,000	250	+ 100%	17.3	30.6	30.6
15	3,500	250	+ 100%	5.9	23.9	24.9
Option 3 (Upsized to DN450 + DN450 to MP + DN450 to Rooty Hill Rd)						
16	2,000	250	None	40.6	46.7	45.3
17	2,500	250	None	33.2	42.6	41.9
18	3,000	250	None	24.6	37.9	37.9
19	3,500	250	None	14.8	32.7	33.6
20	2,000	250	+ 50%	39.7	45.8	44.4
21	2,500	250	+ 50%	32.2	41.6	40.8
22	3,000	250	+ 50%	23.4	36.7	36.8
23	3,500	250	+ 50%	13.3	31.2	32.2
24	2,000	250	+ 100%	38.8	44.9	43.5
25	2,500	250	+ 100%	31.1	40.5	39.8
26	3,000	250	+ 100%	22.2	35.5	35.6
27	3,500	250	+ 100%	12.0	29.9	30.9

The modelling results indicate that the key parameter that restricts the number of lots that can be serviced at Marsden Park is the pressure at Marsden Park. The pressures at the connection to the South Street Development and the connection to MPIP are always significantly higher than the pressures at Marsden Park.

The number of lots that can be serviced at Marsden Park was determined by linear interpolation of the modelling results to give a pressure of 20 m at Marsden Park at shown in **Table 6**. The results include 250 lots at the South Street Development.

- **Table 6 Minchinbury East – Summary of Results**

Option	Number of Lots at MPP Stage 1	Additional MPIP Stage 1 Water Demand	Pressures at MP Stage 1 (m)
Option 1 (Upsized to DN375 + DN375 to MP)			
1	2,080	None	20.0
Option 2 (Upsized to DN450 + DN450 to MP)			
2a	3,010	None	20.0
2b	2,930	+50%	20.0
2c	2,860	+100%	20.0
Option 3 (Upsized to DN450 + DN450 to MP + DN450 to Rooty Hill Rd)			
3a	3,260	None	20.0
3b	3,190	+50%	20.0
3c	3,120	+100%	20.0

In summary, as shown in **Table 6**:

- Doubling the Stage 1 MPIP demand has a relatively minor impact on the number of lots that can be serviced at Marsden Park, reducing the number of lots by around 150 (i.e. comparing 2a to 2c gives a difference of 150 lots, and comparing 3a to 3c gives a difference of 140 lots).
- It is possible to service around 2,080 lots at Marsden Park with Minchinbury East Option 1with no additional demand at MPIP
- With Minchinbury East Option 2 it is possible to service around 2,900 lots at Marsden Park depending on the additional demand within MPIP:
  - Even with a doubling of the Stage 1 MPIP water demand (i.e. an additional +100%), 2,860 lots could be serviced at Marsden Park
- With Minchinbury East Option 3 it is possible to service around 3,200 lots at Marsden Park depending on the additional demand within MPIP:
  - Even with a doubling of the Stage 1 MPIP water demand (i.e. an additional +100%), 3,120 lots could be serviced at Marsden Park
- Minchinbury East Option 3 provides an additional 250 to 260 lots compared to Minchinbury East Option 2. This is attributable to the additional pipe that is installed in Option 3 as shown in **Figure 17**

4.3. Rouse Hill Water System

The Rouse Hill Water System is divided into 2 sub-systems including Marayong and Rogans Hill. The system is fed by Rouse Hill Reservoir WS 476.

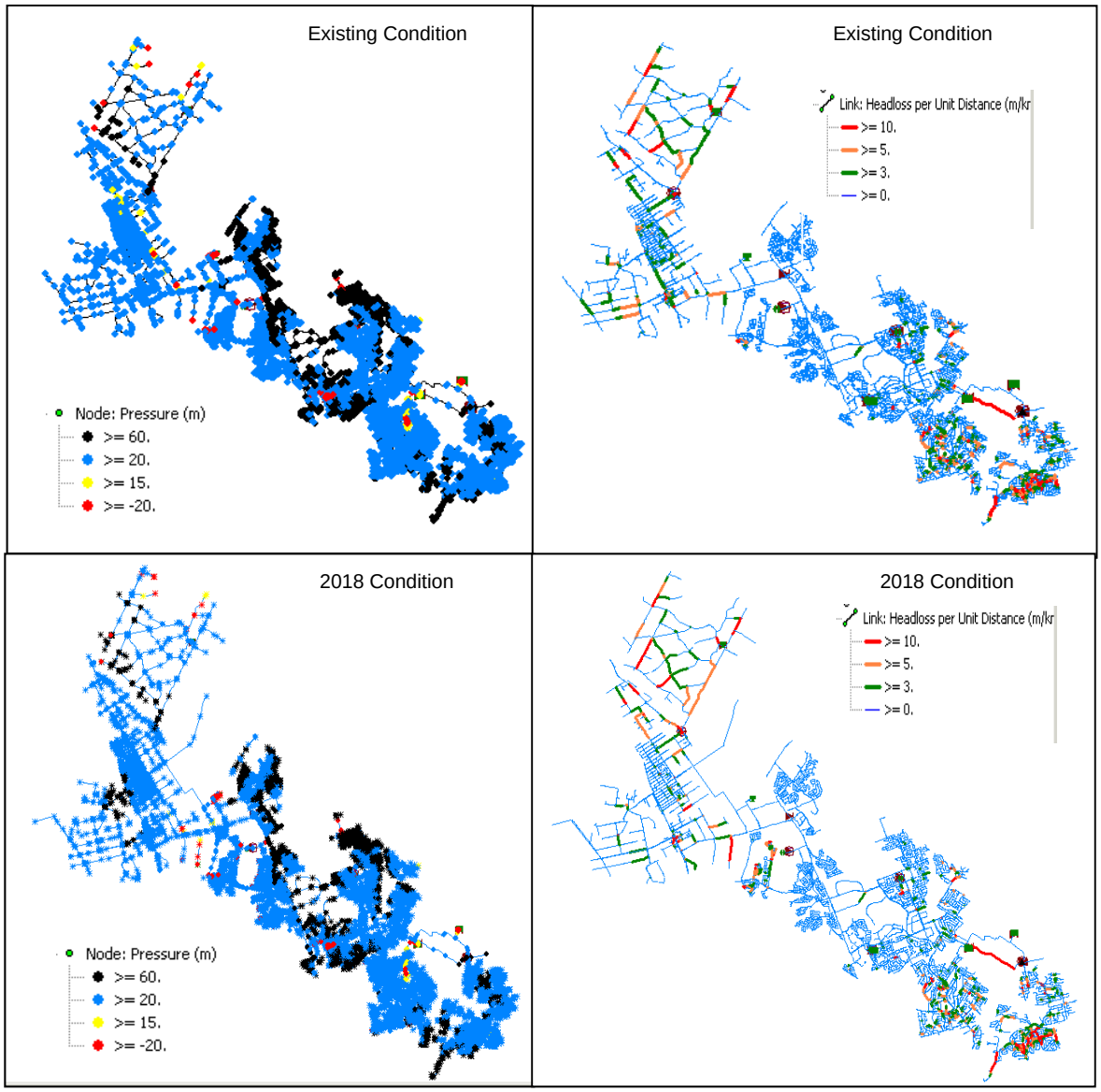
4.3.1. Rouse Hill Max Day System Performance

Sydney Water has provided the existing water model for the Rouse Hill Supply System. The network group is named Rogans Hill – Cudgegon and has the Package 1 works included. To establish baseline conditions for the purpose of determining the impact of maximum day water demands, a Future Max Day Demand (FMDD) model for 2018 including Package 2 works was built and a review of the system performance was undertaken. For reference, the Package 1 works represents the new water infrastructure that has already been installed to service the first release precincts of the North West Growth Centre. Package 2 works are required to service continued growth in Rouse Hill system and will be constructed by the end of 2014. Refer to **Appendix D** for details of the infrastructure associated with Package 1 and Package 2.

As the Package 2 works will be installed by the end of 2014, they were added to the 2018 FMMD model (except for pipe #18 shown in **Appendix D)**. The model was also updated to include the future population growth forecasts for the Baulkham Hills LGA, as provided by Sydney Water.

The InfoWorks WS water model for the Rouse Hill System in Sydney Water's *Water Modelling System* was used for this analysis (refer to **Appendix C** for the model and run components used).

Figure 17 shows the model results for both the existing model and the 2018 FMMD model under peak hour flow (PHF) conditions without any water demand from Marsden Park. It indicates that there are a relatively small number of nodes that experience low pressures in the existing system. In 2018, the inclusion of the Package 2 works offsets population growth resulting in minimal change to the number of nodes with low pressures (88 nodes).



- **Figure 17 Rouse Hill System Performance without Marsden Park**

4.3.2. Rouse Hill Connection

The existing large diameter water mains within the Rouse Hill system lie on the eastern side of the Richmond railway line. Hence any connection to the Rouse Hill system would require crossing the railway, which has a significant time and cost penalty.

Sydney Water have stated that the Package 2 works includes the installation of a DN600 main under the Richmond railway line (see item 46 in the Package 2 works in **Appendix D**) which will end in a pipe stub on the western side of the railway. This main is being installed to facilitate the future development of the land located to the immediate north of the Department of Defence site.

Sydney Water has stated that this DN600 pipe stub would be available for connection for a new main to service Marsden Park Stage 1. Hence for servicing Marsden Park Stage 1 from the Rouse Hill Water System it is proposed to install a new main that connects into the DN600 stub on the western side of the Richmond Railway line. The new main would head north to Grange Avenue and then westwards along Grange Avenue to Richmond Rd, and then north along Richmond Rd is shown in **Figure 18**, a distance of about 7.5 km (depending on the pipe route).

The modelling was undertaken for both a DN375 pipe and a DN450 pipe for the new pipe servicing Marsden Park.

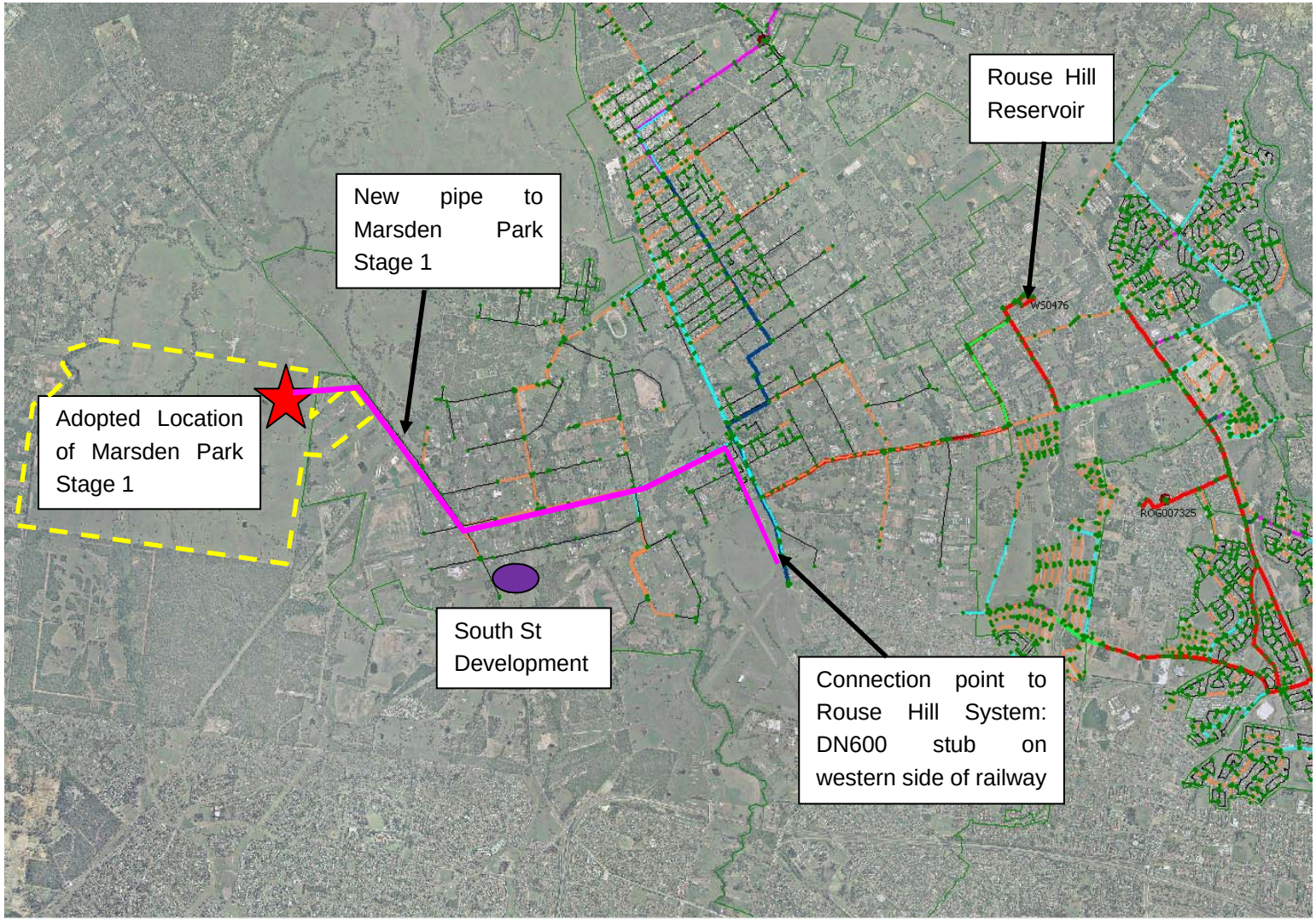
Along the pipe route shown in **Figure 18**, the highest ground level, of around RL40 m, occurs along Richmond Rd: at the corner of Richmond Rd and Grange Ave and again at the corner of Richmond Rd and Garfield Rd West. The ground level at the adopted location of Marsden Park Stage 1 is around RL30 m.

The options that were modelled were for different pipe diameters for the new pipe of DN375, DN450 and DN600.

It is noted that the modelling of the Rouse Hill system assumed that the South Street Development would be serviced by connection to the Minchinbury System as outlined in **Section 3**. Whilst it would be possible to service the South Street Development from the Rouse Hill system via connection to the new pipework shown in **Figure 18**, this approach was not investigated.

Also, it was assumed that Marsden Park Stage 1 would be serviced by a single reticulation system with rainwater tanks to comply with BASIX (rather than a dual reticulation system with recycled water to comply with BASIX).

In the model, a demand equivalent to 1,175 residential lots was allocated to the DN600 pipe stub on the western side of the railway to account for development within Schofields.



- **Figure 18 Connection to Rouse Hill System for Marsden Park Stage 1**

4.3.2.1. Modelling of Marsden Park Stage 1 – Static Model Runs

Using the 2018 model, a peak hour flow analysis was undertaken to understand the maximum amount of flow (or lot equivalent) that could be delivered to Marsden Park from the Rouse Hill System without significantly affecting the level of service to existing customers.

The modelling indicated that the factor that limited the number of lots that can be serviced at Marsden Park is impacts on the upstream system, in particular the number of lots that had pressure less than 15 m.

Table 7 outlines the modelling results and indicates that the pressures at Marsden Park for all modelled options is significantly larger than 20 m. Hence the issue that limits the number of lots that can be serviced is the impact of the Marsden Park water demand on the upstream water network. In particular it reduces the supply pressures within the upstream water network and hence increases the number of nodes that experience less than 15 m pressure.

In particular, comparing model runs 3 and 4 indicates that with 2,000 lots at Marsden Park, changing the diameter of the new pipe from DN450 (model run 3) to DN600 (model run 4) reduces the headloss in the new pipe and hence increases the pressure at Marsden Park. However as the limiting factor is the upstream impacts (i.e. the number of customers within the existing Rouse Hill System that experience low water pressures) upsizing the pipe from DN450 to DN600 doesn't increase the number of lots that can be serviced at Marsden Park Stage 1. In the long term, if Sydney Water addresses the upstream impacts (i.e. additional water infrastructure is constructed to eliminate the low pressure problems in the existing Rouse Hill System), increasing the pipe diameter of the new pipe to Marsden Park would allow more lots to be serviced at Marsden Park.

Note that the FMDD modelling assumes that the supply reservoir is 2/3 depleted at the time of maximum hour demand, and hence is conservative.

- **Table 7 Rouse Hill – Modelling Results**

Model Run	Option	Pipe Diameter for New Pipe	Number of Lots at Marsden Park	Pressure at Marsden Park	Number of Customers with Pressure < 15m
Baseline 2018	-	-	-	-	88
1	1	DN375	1,000	38 m	93
2	2a	DN450	1,600	37 m	97
3	2b	DN450	2,000	36 m	103
4	3	DN600	2,000	40 m	103

5. Stage 1 Options Comparison

5.1. Overview

The key factor to be used for comparison of the options is capital cost.

5.2. Capital Cost

Indicative cost estimates were prepared for each option for the purpose of comparing options. The results are shown in **Table 8** along with the number of lots that can be serviced by each option. For Minchinbury East Option 1 it was assumed that there was no additional demand from MPIP, for Minchinbury East Option 2 it was assumed that there was 50% additional demand from MPIP, and for Minchinbury East Option 3 it was assumed that there was 100% additional demand from MPIP. For all options it was assumed the Marsden Park Stage 1 would be serviced by a single reticulation system (i.e. rainwater tanks would be adopted to meet BASIX requirements).

Table 8 Marsden Park Stage 1 Option Cost Estimates

Option	Pipe Size (DN)	Pipe Lengths (m)	Lots (Static / EPS)	Cost Estimate	Cost Per Lot ($K/lot)
Minchinbury West Option 1	300 / 300	3.5 / 4.3	560 / 850	$9.4 M	11.0
Minchinbury West Option 2	375 / 300	3.5 / 4.3	800	$10.0 M	9.2
Minchinbury West Option 3	375 / 300 / 200	3.5 / 4.3 / 2.9	1,100	$13.3 M	10.2
Minchinbury West Option 4	375 / 300 / 200 / 200	3.5 / 4.3 / 2.9 / 1.0	1,100 / 1,300	$14.2 M	11.0
Minchinbury West Option 5	375 / 375 / 200 / 200	3.5 / 4.3 / 2.9 / 1.0	1,290 / 1,660	$15.0 M	9.1
Minchinbury West Option 6	375 / 375 / 200	3.5 / 4.3 / 2.9	1,290	$14.1 M	8.5
Minchinbury West Option 7	375 / 375 / 300 / 300	3.5 / 4.3 / 2.9 / 1.0	1,370	$15.5 M	8.8
Minchinbury East Option 1	375 / 375	New: 5.0 / Upsize: 2.1	2,080	$10.6 M	5.1
Minchinbury East Option 2b	450 / 450	New: 5.0 / Upsize: 2.1	2,930	$12.8 M	4.4
Minchinbury East Option 3c	450 / 450	New: 5.4 / Upsize: 2.1	3,120	$13.7 M	4.4
Rouse Hill Option 1	375	7.5	1,000	$12.7 M	12.7
Rouse Hill Option 2	450	7.5	2,000	$15.1 M	7.6
Rouse Hill Option 3	600	7.5	2,000	$20.3 M	10.1

The costs include an allowance of 10% for professional services and contingency of 15%. For the Minchinbury East Options and the Rouse Hill Options, as some portion of the pipework would need to be installed along Richmond Rd, the contingency was increased to 30% for the sections of pipe constructed along Richmond Rd. This is to account for the possible impact of the future planned widening of Richmond Road on the pipe design, including impacts on the location and the possible need for certain sections of pipe to be concrete encased. This may be required because the widening of Richmond Rd will require earthworks to cut/fill along the road embankment. Depending on the timing and design of the road widening works in relation to the location of the pipework, there may be additional costs associated with the installation of the water pipe along Richmond Rd.

It is noted that the allowance of 10% for professional services are for costs incurred during the construction phase of the project, such as project management. It does not include professional services costs that would be incurred prior to construction such as survey, geotechnical investigations, environmental investigation and assessment, planning and approvals, engineering design, tender preparation and assessment, and Sydney Water costs.

It should also be noted that the costs for the East Minchinbury Options calculated the differential cost between the proposed DN250 pipe to be installed to service MPIP Stage 1 and the upsized pipe. Hence the cost of the DN250 pipe was subtracted from the cost estimates. The cost of the DN250 pipe was estimated as $2.6 M.

The cost estimates were based on a number of assumptions as outlined in **Appendix E**.

Further work, such as concept design and detail design, would be required to be completed in order to improve the accuracy of the cost estimates.

5.3. Preferred Option

Based on both the cost estimate and the cost per lot, Minchinbury East Options 2 and 3 are the preferred options.

The following approach is proposed for the provision of potable water to Marsden Park Stage 1:

- Implement Minchinbury East Option 2 (**Figure 14**):
  - Work collaboratively with APP Corporation (developer of MPIP) to upsize the DN250 pipework that is being installed to service MPIP Stage 1 to DN450
  - Install a DN450 pipe to connect into the upsized Stage 1 MPIP pipework to provide water to Marsden Park Stage 1
- At a later date, once the capacity of the above is reached, the additional 400 m of DN450 pipe (**Figure 16**) can be installed to effectively implement Minchinbury East Option 3. This would provide capacity for around a further 250 lots at Marsden Park compared to Minchinbury East

Option 2. The number of additional lots that can be serviced at Marsden Park would depend on the growth in water demand within MPIP.

With this approach it would be possible to install a smaller diameter pipe for the 400 m section than DN450 such as DN375. This would be possible because the upsized DN450 pipe would be connected to both the existing DN375 pipe and the future additional 400 m section of pipe. Hence the 400 m section of new pipe would operate in parallel with the existing DN375 pipe, as shown in **Figure 16**. In addition, as this 400 m section of pipe would allow for increased water demands at both MPIP and MPP, a cost sharing arrangement may be appropriate and could be determined at the time that the additional section of pipe is installed.

5.4. Further Investigation of the Preferred Option

The preferred option was further investigated for the following:

- Additional modelling to investigate the impact of the high elevation within Marsden Park Stage 1
- Additional modelling to investigate water age
- Additional costing to investigate the impact of concrete encasement for pipework along Richmond Rd

5.4.1. Additional Modelling – Elevation

As noted previously, in the modelling that was undertaken, it was assumed that all of the Marsden Park Stage 1 water demand occurred at a single node that was located in the north eastern portion of the Marsden Park Precinct. The adopted location for Stage 1 is shown as a star in the figures in this report. The ground level at this location is RL 30 m. With reference to **Figure 2**, within Stage 1 there is some land that is at an elevation of RL 35 m.

To determine the impact of an additional 5 m of elevation, the modelling results for Minchinbury East Options 2 and 3 were interpolated to identify the number of lots that can be serviced at a supply pressure of 25 m at the adopted location for Stage 1 of Marsden Park. In addition, two modelling runs were undertaken:

- Option 2 with 2,680 lots at Marsden Park and 50% additional demand at MPIP
- Option 3 with 2,840 lots at Marsden Park and 100% additional demand at MPIP

The results in **Table 9** indicate that limiting the supply pressure at Marsden Park to 25 m reduces the number of lots that can be serviced by 250-260 lots for Option 2, and 280-290 lots for Option 3.

- **Table 9 Minchinbury East – Additional Investigation for Impact of Higher Elevation**

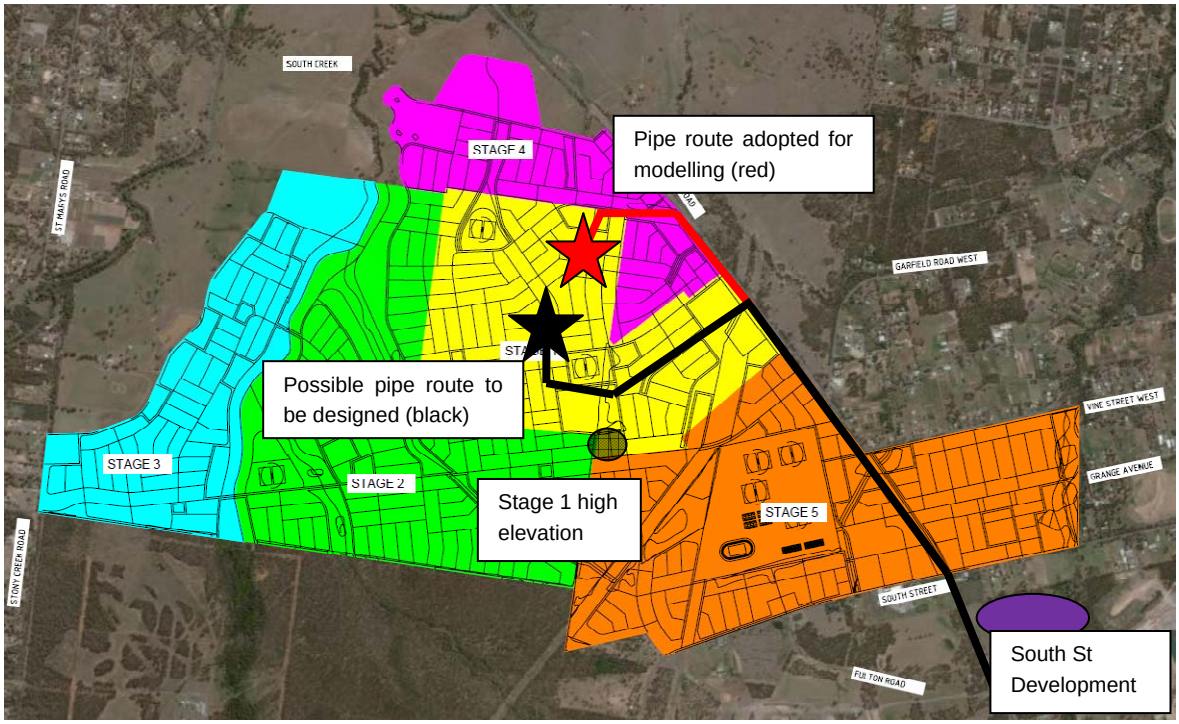
Option	Number of Lots		Additional MPIP Stage 1 Water Demand	Pressures (m)
	MP Stage 1	Difference from previous (20.0 m)		MP Stage 1
Option 2 (Upsized to DN450 + DN450 to MP)				
Results from Interpolation				
2a	2,750	-260	None	25.0
2b	2,680	-250	+50%	25.0
2c	2,610	-250	+100%	25.0
Additional Modelling				
2b	2,680	-250	+50%	25.2
Option 3 (Upsized to DN450 + DN450 to MP + DN450 to Rooty Hill Rd)				
Results from Interpolation				
3a	2,970	-290	None	25.0
3b	2,910	-280	+50%	25.0
3c	2,840	-280	+100%	25.0
Additional Modelling				
3c	2,840	-280	+100%	25.2

In reality, the pipe route that will be adopted to service Marsden Park Stage 1 will not be the same as what was adopted for the modelling. In particular the DN450 pipe is likely to enter the Marsden Park Stage 1 site via the land associated with Stage 1 and hence pass closer to the high point. This will reduce the headlosses in reaching the high point which would help to partly offset the impacts of the higher elevation. A more likely pipe route to service Stage 1 via Minchinbury East Options 2/3 is shown in **Figure 19**. However the pipe route to be adopted would be further investigated during the design phase of the new main (which is outside the scope of this study).

In short the number of lots that can be serviced by the Minchinbury East Options 2 and 3 is likely to range between the results shown in **Table 9** and the results shown in **Table 6**, for example:

- Option 2b with +50% additional demand within MPIP: 2,680 to 2,930 lots
- Option 3c with +100% additional demand within MPIP: 2,840 to 3,120 lots

Option 2c as shown in **Table 9** can service 2,610 lots. This means that even with the worst case modelled additional water for MPIP (of +100%), East Minchinbury Option 2 infrastructure (**Figure 14**) can service the anticipated 2,500 lots of Stage 1 of Marsden Park.



- **Figure 19 Marsden Park Stage 1 – Possible Pipe Routes**

5.4.2. Additional Modelling – Water Age

Additional modelling of the preferred option was undertaken to investigate the predicted water age. The water age was determined by running an EPS over four days (to allow water age to normalise as water age at the beginning of the simulation is zero for all nodes within the network). The water source was defined in the model as the upstream end of the existing Minchinbury Reservoir (the model considers retention within the reservoir). The analysis then predicts the total amount of time it takes to go through the reservoir and to the point of demand. Predicted water age results were observed at the Marsden Park Industrial Park, the proposed South Street development, and Marsden Park Stage 1. The following scenarios were modelled:

- Minchinbury East Option 2 with no demand from the South Street Development, no demand from Marsden Park, and 100% of the Stage 1 MPIP demand (i.e. no additional demand):
  - The predicted maximum water age leaving the reservoir is 28.1 hrs
  - The predicted maximum water age at MPIP was 41.1 hrs
- Minchinbury East Option 2 with 250 lots at South Street Development, 2,680 lots at Marsden Park, and 150% of the Stage 1 MPIP demand (i.e. +50% additional demand)::
  - The predicted maximum water age leaving the reservoir is 27.6 hrs
  - The predicted maximum water age at MPIP was 32.2 hrs

- The predicted maximum water age at the South Street Development was 33.1 hrs
- The predicted maximum water age at Marsden Park Stage 1 was 36.7 hrs

- Minchinbury East Option 3 with 250 lots at South Street Development, 2,840 lots at Marsden Park, and 200% of the Stage 1 MPIP demand (i.e. +100% additional demand):
  - The predicted maximum water age leaving the reservoir is 27.3 hrs
  - The predicted maximum water age at MPIP was 31.1 hrs
  - The predicted maximum water age at the South Street Development was 32.5 hrs
  - The predicted maximum water age at Marsden Park Stage 1 was 35.6 hrs

The Water Supply Code of Australia Sydney Water Edition (Water Services Association of Australia) states that "Unless advised otherwise, the total travel time through or retention time within the system (water age) from the last disinfection facility should be less than 72 hours under all demand conditions (i.e. to maintain chlorine residuals at an effective level). Sydney Water must be consulted on alternative options where the system configuration will result in a water age, based on average day demand, of more than 48 hours."

The modelling that was undertaken indicates that the maximum water age (which would occur during the minimum water demand period) is less than 48 hours (measured from the input to Minchinbury Reservoir). The location of the last disinfection facility would be Prospect Water Filtration Plant, unless a disinfection facility is installed at the Minchinbury Reservoir. Hence the water age since the last disinfection point would need to include the retention time through the transfer system from Prospect Water Filtration Plant to the Minchinbury Reservoir. This transfer system is not included in Sydney Water's Minchinbury System model and hence was not modelled.

From the modelling undertaken, the largest predicted maximum water age was 41 hours. Therefore as long as the water age in the transfer system from Prospect Water Filtration Plant to the Minchinbury Reservoir is less than 31 hours, the total water age would be less than 72 hours from the last point of disinfection. If this is not the case, a possible mitigation measure is to install disinfection facilities at Minchinbury Reservoir.

During start-up of any development the water demands are less than for full development. Hence the water age during start-up is higher than the water age for full development. One potential issue with this is leaching of the cement lining of the water pipe into the water. This can elevate the pH of the water and affect its chemical composition and taste. This can occur with excessive water age (10 - 20 days). To mitigate against such a scenario, standard practice is to either use plastic water pipes (and hence avoid the use of cement linings), or to use pipes with cement lining but to coat the cement lining with a temporary seal which lasts for around the first 10-20 years of operation. Tyco can add a temporary seal (known as Interline 876) to the pipe for a relatively low cost.

5.4.3. Additional Costing

Installing a DN450 pipe along Richmond Rd from the MPIP Stage 1 pipework to Marsden Park Stage 1 faces risks of increased costs due to the future road widening works that will be undertaken on Richmond Rd after the pipe has been installed. As mentioned previously, the cost estimates undertaken in **Section 5.2** made an allowance for these additional costs by adopting a 30% contingency for the pipes along Richmond Rd.

For Minchinbury East Options 2 and 3 an indicative cost estimate was undertaken for the additional cost associated with concrete encasement of the sections of pipe along Richmond Rd (not including the upsized MPIP Stage 1 pipework which will be installed during the upgrade of that portion of Richmond Rd). The costing has included additional traffic management costs to account for longer construction time, as well as the additional costs associated with the concrete encasement and the additional costs associated with SCL pipe instead of DICL pipe. Because additional costs were added, the contingency was reduced back to the same as that adopted for all other pipe options (15%). For the additional cost estimate, the same pipe route was adopted as was used for the modelling (**Figure 14**) and the cost estimates in **Section 5.2**.

The indicative cost estimate indicates that concrete encasement of the DN450 pipe along Richmond Rd would cost an additional $1.1 M for Minchinbury East Options 2 and 3 compared to the cost estimates given in **Table 8**, giving estimates of:

- Minchinbury East Option 2: $13.9 M (based on the differential cost for upsizing the DN250 pipe to DN450)
- Minchinbury East Option 3: $14.8 M (based on the differential cost for upsizing the DN250 pipe to DN450)

The cost estimates were based on a number of assumptions as outlined in **Appendix E**.

Further work, such as concept design and detail design, would be required to be completed in order to improve the accuracy of the cost estimates.

6. Future Stages of Marsden Park

6.1. Sydney Water Ultimate Servicing Strategy

Sydney Water has developed an Ultimate Water Servicing Strategy (Ultimate Strategy) (SWC, July 2008) which describes the preferred Sydney Water servicing strategy and indicative infrastructure required for the provision of potable water services to the Marsden Park Precinct.

The Ultimate Strategy outlines what infrastructure is required to provide potable water services to the ultimate development of both the Marsden Park Precinct and the Marsden Park Industrial Precinct. The Ultimate Strategy outlines that the potable water demands of both Precincts would be supplied by extension of the Minchinbury system:

- The existing Mt Druitt surface reservoir will be re-commissioned to form part of the Minchinbury system. The Mt Druitt reservoir has not been operational for some time and requires some refurbishment to re-commission it.
- From the Mt Druitt reservoir site a DN600 transfer main will be laid approximately 3.9 kilometres to a new surface and elevated reservoirs located in the Marsden Park Industrial Precinct.
- The new Marsden Park surface reservoir would have a capacity of 20 ML and the new Marsden Park elevated reservoir would be 4 ML.
- A pump station would be installed at the Mt Druitt reservoir site to feed to the new Marsden Park surface reservoir from the Mt Druitt reservoir. This pump station is required because the new Marsden Park reservoir would be at a higher elevation than the Mt Druitt reservoir and hence, at times depending on the relative water levels in the reservoirs, would require pumping to fill. Also a pump station would be installed at the Marsden Park reservoir site to feed the elevated reservoir from the surface reservoir.
- Mains will then be laid from the new reservoir site throughout the Marsden Park Precinct and the Marsden Park Industrial Precinct to service development. **Figure 20** details the Sydney Water proposed ultimate water infrastructure.

Sydney Water has acknowledged that the ultimate infrastructure would need to be provided in a staged manner. However, when Sydney Water produced the Ultimate Strategy they did not consider how best to stage the infrastructure. Hence the Ultimate Strategy only outlines the preferred ultimate servicing strategy and does not outline a preferred staging approach of how to implement it.

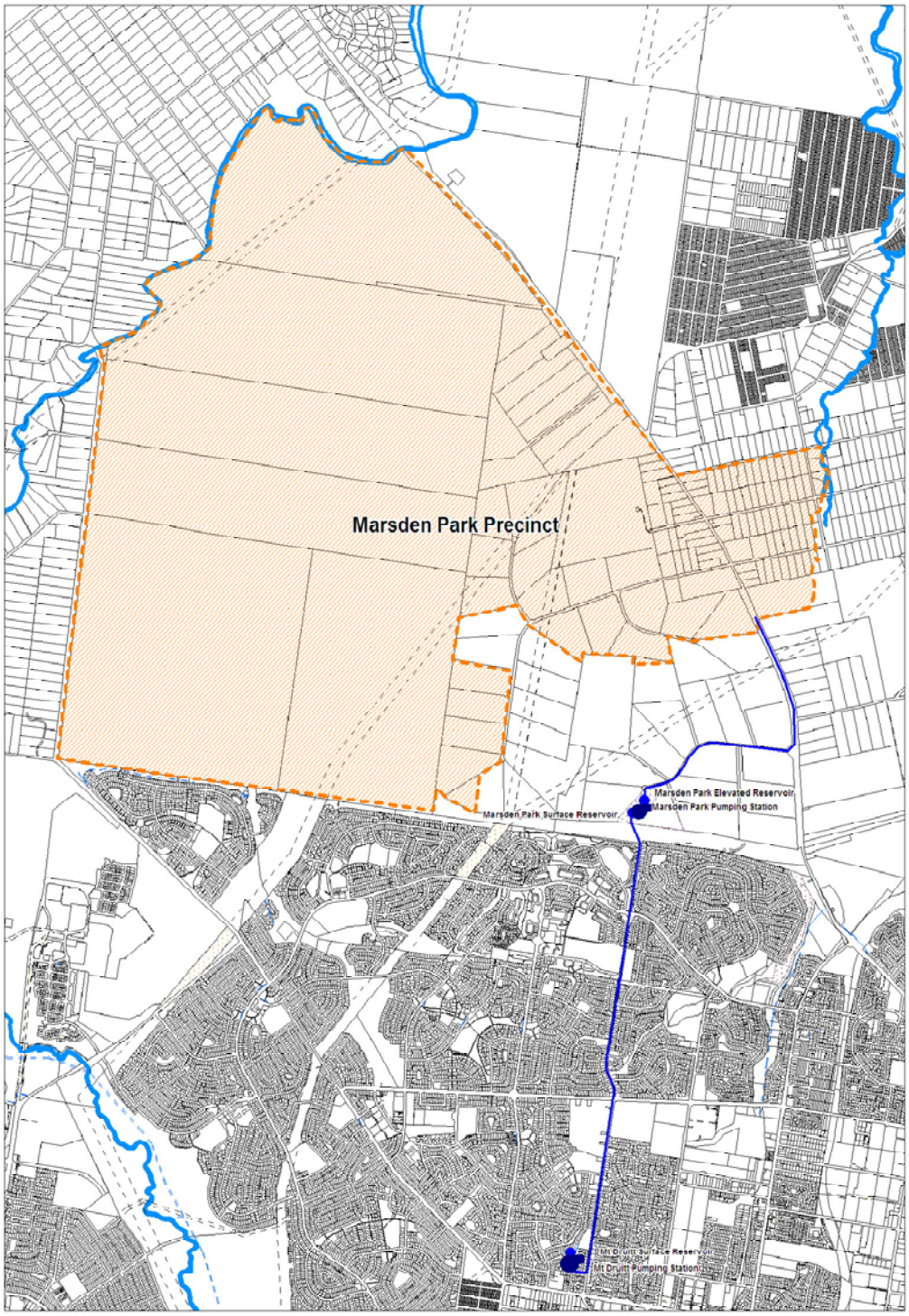
It is also understood that the ultimate potable water infrastructure identified in the Ultimate Strategy is dependent on the provision of recycled water to both the Marsden Park Precinct and the Marsden Park Industrial Precinct. As noted previously, since the development of the Ultimate

Strategy in 2008 Sydney Water have announced that they no longer intended to provide recycled water services to the Marsden Park Precinct and the Marsden Park Industrial Precinct. Hence the Sydney Water has indicated that they would review Ultimate Strategy at some time in the future. Up until that time, the current version of the Ultimate Strategy will be adopted.

6.2. Preferred Option and Ultimate Servicing Strategy

The preferred option for servicing of Marsden Park Stage 1 is Minchinbury East Option 2/3: initially construct Option 2 which would later be converted to Option 3. This is consistent with the adopted servicing strategy of MPIP Stage 1 as it upsizes and connects to the new pipes that will be installed to supply MPIP Stage 1.

In addition, the preferred option for Marsden Park Stage 1 is consistent with Sydney Water's ultimate servicing strategy as both form part of the Minchinbury Water Network. The new pipes to be installed to service Marsden Park Stage 1 would in the future be connected to the reservoirs that will be constructed within the MPIP as part of the Ultimate Strategy. When GHD developed the servicing strategy for MPIP Stage 1 they took into account the Ultimate Strategy. In particular the location of the future reservoirs, as per the Ultimate Strategy, are shown in **Figure 3** along with future pipework that would connect the MPIP Stage 1 pipework to the future reservoirs. As the preferred option for Marsden Park Stage 1 amplifies and builds onto the MPIP Stage 1 pipework, it inherently includes this functionality and future flexibility to connect to the Ultimate Strategy.



- **Figure 20 Sydney Water Ultimate Strategy**

(Source: Ultimate Water Servicing Strategy, SWC, July 2008)

6.3. Possible Servicing Options for Future Stages of Marsden Park

Once the capacity of the Marsden Park Stage 1 infrastructure (i.e. the Minchinbury East Option 2/3) is reached, additional potable water infrastructure would need to be installed to allow for additional development.

This section outlines a range of possible options for the additional potable water infrastructure, but does not attempt to identify a preferred option. This is because by the time the future infrastructure is required, other changes are likely to have occurred which could impact on the preferred solution. Hence this section of the report will outline the range of possible options, to inform all parties of the possible future solutions:

- It would be possible to construct one of the other Stage 1 servicing options, such as a Minchinbury West option or a Rouse Hill option:
  - Minchinbury West options: The number of lots that can be serviced by (and hence the feasibility of) the Minchinbury West options is impacted by low pressure problems within Berkshire Park. These may get worse (due to increased demand) or better (due to new infrastructure or reduce demands) in the future. It is noted that some of Sydney Water's ultimate servicing strategy documents show that in the future there would be a water main that connects from 'east Minchinbury' to 'west Minchinbury' through Marsden Park. Hence constructing one of the Minchinbury West options to connect into the Stage 1 Minchinbury East Option 2/3 would complete this loop and form part of the Ultimate Strategy. The size of this main may be dependent on future water demands due to development within the Shanes Park Precinct. Hence the timing and scale of development within Shanes Park may influence the size and timing of this servicing approach. It could be that initially this pipe would carry water north from the Minchinbury System to Marsden Park, and in the future when Shanes Park is developed this main could carry water west to Shanes Park from the new reservoirs to be constructed within MPIP, via Marsden Park. One benefit of this approach is that Stages 2 and 3 of Marsden Park are located on the western side of the Marsden Park Precinct, hence the Minchinbury West options would initially require less pipework than was modelled for Stage 1.
  - Rouse Hill options: It would be possible to construct one of the Rouse Hill options to bring water to Marsden Park from the Rouse Hill water network. This would provide a connection between the two water networks, which provides operational benefits and flexibility to Sydney Water. This would require the construction of a second main along certain portions of Richmond Rd. The complexity and cost of this would depend on the relative timing of the new water main and the amplification of that portion of Richmond Rd. As the number of lots that could be serviced in Marsden Park by this option was influenced by upstream impacts, particularly the number of customers experiencing low pressures within the Rouse Hill water network, the feasibility of this option would depend

on the growth in water demand within the Rouse Hill water network and any amplifications that are undertaken by Sydney Water.

- An alternate approach to service future stages of development within the Marsden Park precinct is to construct the Ultimate Strategy, in stages. One possible approach to install the Ultimate Strategy in stages is outlined below. It is noted that other staging approaches are possible, and the preferred staging approach for the Ultimate Strategy would need to be considered during any review of the Ultimate Strategy:
  - Stage A:
    - Refurbish and re-commission the Mt Druitt surface reservoir
    - Install a DN600 (or other appropriate size) water main from the Mt Druitt surface reservoir to the location of the proposed future reservoirs within MPIP
    - Install a DN600 (or other appropriate size) water main from the proposed location of the future reservoirs within MPIP to Marsden Park. As stages 2 and 3 of Marsden Park are located on the western side of the Marsden Park Precinct, the route for this new pipe may not follow along Richmond Rd but instead would head north west from the future reservoir site to Marsden Park. Such a route would also provide water to the western portion of MPIP which could connect into this main.
  - Stage B:
    - Construct new reservoirs at the proposed location within MPIP (refer to **Figure 3**). Ultimately both a surface reservoir and an elevated reservoir would be required. However the elevated reservoir is only required to service the high elevation areas within MPIP so it could possibly be constructed at a later date.
    - Construct a pump station at the Mt Druitt reservoir site to feed water from the Mt Druitt reservoir to the new reservoir constructed within MPIP.
    - If the new elevated reservoir is constructed at MPIP, a pump station would be required to feed water from the surface reservoir to the elevated reservoir. Hence this pump station is only required when the elevated reservoir is constructed.
  - Stage C/D/E etc:
    - Install new mains from the new reservoirs at MPIP to service future stages of development at Marsden Park and MPIP, as well as other precincts (e.g. Shanes Park, Marsden Park North)

Whilst no modelling has been undertaken of the Ultimate Strategy, preliminary calculations were undertaken to gain an indication of the magnitude of development that could be serviced by the above stages of development of the Ultimate Strategy, as well as preliminary costs. The identified lots are additional to the lots that are serviced by the proposed Marsden Park Stage 1 infrastructure.

The results (**Table 10**) indicate that there is a significant cost associated with Stage A due to the long length of large diameter main (DN600) involved. Stage B involves construction of the reservoirs and pump stations and provides some additional lots through the pipework that was installed in Stage B. However, once the reservoirs are constructed they provide a relatively low cost servicing approach as the new pipework would connect into these reservoirs. Hence the cost per lot for Stages C/D/E etc are comparatively low. The actual costs for these future stages would really depend on the length and diameter of the required mains, which depends on the location and scale of the development and any synergies that can be gained from pipework that is existing at that time.

Table 10 Possible Staging of Ultimate Servicing Strategy

Stage of Ultimate Strategy	Summary of Infrastructure	Estimate of Additional Lots at Marsden Park	Cost Estimate	Cost Per Lot ($K/lot)
A	Refurbish existing Mt Druitt Reservoir, install DN600 pipe (3.9 km) to future reservoir site, install DN600 (5.8 km) to Marsden Park Stage 2/3	5,000	$32.6 M	6.5
B	Construct surface and elevated reservoirs at future reservoir site, install pump station at Mt Druitt reservoir site, install pump station for new elevated reservoir	1,000	$15.0 M	15.0
C/D/E etc	Install additional DN600 pipes (5.8 km) to Marsden Park Stage 2/3	6,000	$16.1 M	2.7

The lot estimates and cost estimates in **Table 10** were based on a number of assumptions:

- All lots would be serviced by rainwater tank
- Cost of $4.5 M to refurbish the Mt Druitt reservoirs (Stage A)
- DN600 pipe adopted for all pipes (Stage A, C/D/E etc)
- Pipe distance of 5.8 km from future reservoir site within MPIP to development (Stage A, C/D/E etc)
- Cost of $4.0 M for the new surface reservoir within MPIP (Stage B)
- Cost of $4.0 M for the new elevated reservoir within MPIP (Stage B)
- Cost of $0.5 M for the new pump station at Mt Druitt reservoir (Stage B)
- Cost of $0.5 M for the new pump station at new reservoirs (Stage B)
- Land acquisition cost for new reservoirs of $1.0 M (Stage B)
- 30% contingency applied to all costs as well as 5% for site establishment and 10% for professional services

7. Conclusion

The key outcomes from the investigation are:

- The preferred servicing solution for Marsden Park Stage 1 is the Minchinbury East Option 2/3. This would service around 3,000 lots with the exact number of lots depending on a number of factors such as growth in water demand by the industrial precinct and the pipe route adopted for the pipe sections within Marsden Park Stage 1. This servicing solution involves the following components:
  i. Upsize the DN250 pipework that is being installed to service MPIP Stage 1 to DN450. As the designs for the DN250 pipe are currently being reviewed by Sydney Water, the upsizing needs to take place immediately.
  ii. Install a DN450 pipe to connect into the upsized Stage 1 MPIP pipework to provide water to Marsden Park Stage 1 along Richmond Rd. Concept and detail design of this pipe should commence following approval of the Services Infrastructure Implementation Plan.
  iii. At a later date, once the capacity of the above is reached, the additional 400 m of pipe can be installed to effectively implement Minchinbury East Option 3. This would provide capacity for a further 250-260 lots at Marsden Park.
- The South Street Development can be serviced by connecting into the new DN450 pipe that will be extended along Richmond Rd (item ii above)
- Future stages of development at Marsden Park (and MPIP) can be serviced with potable water. There are a variety of options available including staged implementation of the current version of the Sydney Water Ultimate Servicing Strategy. The preferred option for servicing future stages of development would be selected at a future date as the preferred option would depend on a number of factors, not least the planned revision of the Sydney Water Ultimate Servicing Strategy.

Appendix A

Design Criteria

Design Criteria

Overview

Outlined below are the relevant Design Criteria adopted for Marsden Park. These were based on the latest *Water Supply Code of Australia* and Sydney Water's *Planning Design Criteria Guide.*

Demand Projection

Table A1 shows the consumption rate per residential dwelling type for both single reticulation with rain water tank and dual reticulation potable water under the maximum day demand conditions.

Table A1 Specific Potable Consumptions

Demand Category	Dwelling Type	Maximum Day Single Retic - PW (kL/dwelling/day)	Maximum Day Dual Retic _ PW (kL/dwelling/day)
Residential (LD)	Single Dwelling	2.2	0.8
Residential (MD)	Town House <30 units/net ha	1.6	-

System Performance

Table A2 outlines system performance targets that should be achieved in planning the reticulation scheme.

Table A2 System Requirements for Dual Reticulation Scheme

Primary Criteria	
Minimum Water Pressure	20m
Maximum Water Pressure	80m (60m preferable)
Secondary Criteria	
Target Unit Headloss	<5m/km for pipes <= 150mm; <3m/km for pipes > 150mm
Maximum Velocity	1.7 m/s

Pipe Sizing

Sizing of mains is based on expected peak hour flows in the system and performance criteria as defined in Table A2. The following hydraulic parameters are adopted for all proposed new pipes (potable and recycled water reticulation)

- Friction Type – Colebrook White (CW)
- Pipe roughness (CW-k) – 0.3
- Assumed Internal Diameters

  – DN200 – 200mm

  – DN250 – 250mm

  – DN300 – 300mm

  – DN375 – 375mm

  – DN450 – 450mm

  – DN600 – 600mm

Peaking Factors

Table A3 shows the adopted peaking factors for calculating design flows within the Marsden Park and South Street development. These factors were derived based on:

- *Maximum Day to Peak Hour* as per the Demand Patterns used in Marsden Park Potable and Recycled Water models within Sydney Water's *Water Modelling System (WMS)*.

  – Single reticulation potable: *Residential (LD)*

  – Single reticulation potable: *Residential (MD)*

  – Dual reticulation potable: *Dual Retic Potable Residential (LD)*

Table A3 Peaking Factor

Dwelling Type	Single Retic _ PW	Dual Retic _ PW
Residential (LD)	2.5	2.7
Residential (MD)	2.2	-

Hydraulic Modelling Scenarios and Boundary Conditions

The following model scenarios, with their corresponding boundary conditions, were adopted in planning the Marsden Park supply scheme.

- Maximum Day Peak Hour Flow (PHF) – Static simulation run

  – Time step: 19:00 Hours (Residential)

  – Time step: 13:00 Hours (Industrial)

  – Boundary Conditions: Reservoirs are 2/3 depleted

PHF is used for sizing the pipes and analysis of network for minimum pressures, and pipe maximum unit headloss and velocity.

- Maximum Day Extended Period Simulation (EPS) – 24 Hr simulation run

  – Boundary Conditions: Time controlled PRV, between 6am and 11pm, pressure setting is 30m, otherwise 25m

Appendix B

Demand Estimate

Demand Estimate

Overview

Sydney Water has provided the existing model for the Minchinbury System and has advised that it is more appropriate to use the 2018 model for assessing the impact of Marsden Park to the Minchinbury System. As such, the 2018 model was built using,

- Existing Minchinbury WMS model.
- OACIS - Penrith and Blacktown LGA Property database, derived from 2008-09 MDP Housing Supply Forecast Model (HSFM).
- Minchinbury Water System Plan for Industrial and Commercial growth.

Residential Growth

The OACIS database contains population growth for the years 2013, 2018 and 2035. To obtain demands from population, the demand per capita is required. **Table B1** lists the demand per capita for each planning horizon using 5% reduction in per capita consumption achieved by 2031. This also applies to existing residential properties, giving a -0.6% demand growth in 2013, -1.6% in 2018, and -5% in 2035.

Table B1 Demand per Capita

Demand Category	Population - OACIS	Avg Demand - WMS Model (L/day)	Demand per Capita Existing (L/day)	Demand per Capita 2013 (L/day)	Demand per Capita 2018 (L/day)	Demand per Capita 2035 (L/day)
Residential (LD)	97,185	19,613,232	202	201	199	192
Residential (HD)	8,166	1,908,014	234	232	230	222

Industrial Growth

Due to the extensive industrial growth that is forecasted for Minchinbury, industrial growth was allocated to specific areas representing tight clusters of industrial vacant lots. The following table presents the industrial vacant lot area in each industrial growth area along with the growth in industrial demand forecasted for that area. Year 2018 has been linearly interpolated from years 2016 and 2031.

Table B2 Growth in Industrial Demand by Industrial Growth Area

Industrial Growth Area	Industrial Vacant Lot Area (Ha)	Demand Growth (ML/D)		
		Y2016	Y2018	Y2031
KURRAJONG	3.29	0.13	0.142	0.217
GLENDENNING	63.51	2.58	2.798	4.192
PHILLIP	0.97	0.04	0.043	0.064
NORTH	16.94	0.69	0.747	1.118
CONTAPLAS	3.01	0.12	0.131	0.199
HORLBECHE	2.43	0.10	0.108	0.160
LIDCO	0.38	0.02	0.021	0.025
GREAT WESTERN	17.28	0.70	0.759	1.141
STERLING	4.93	0.20	0.217	0.326
SARGENTS	1.76	0.07	0.076	0.116
COLYTON	0.26	0.01	0.011	0.017
SEPP59	487.56	19.80	21.453	32.199
JOHN HINES	9.47	0.38	0.413	0.625
ARCHIBOLD	0.37	0.01	0.012	0.024
TOTAL	**612.48**	**24.86**	**5.473**	**40.42**

Minchinbury Demand

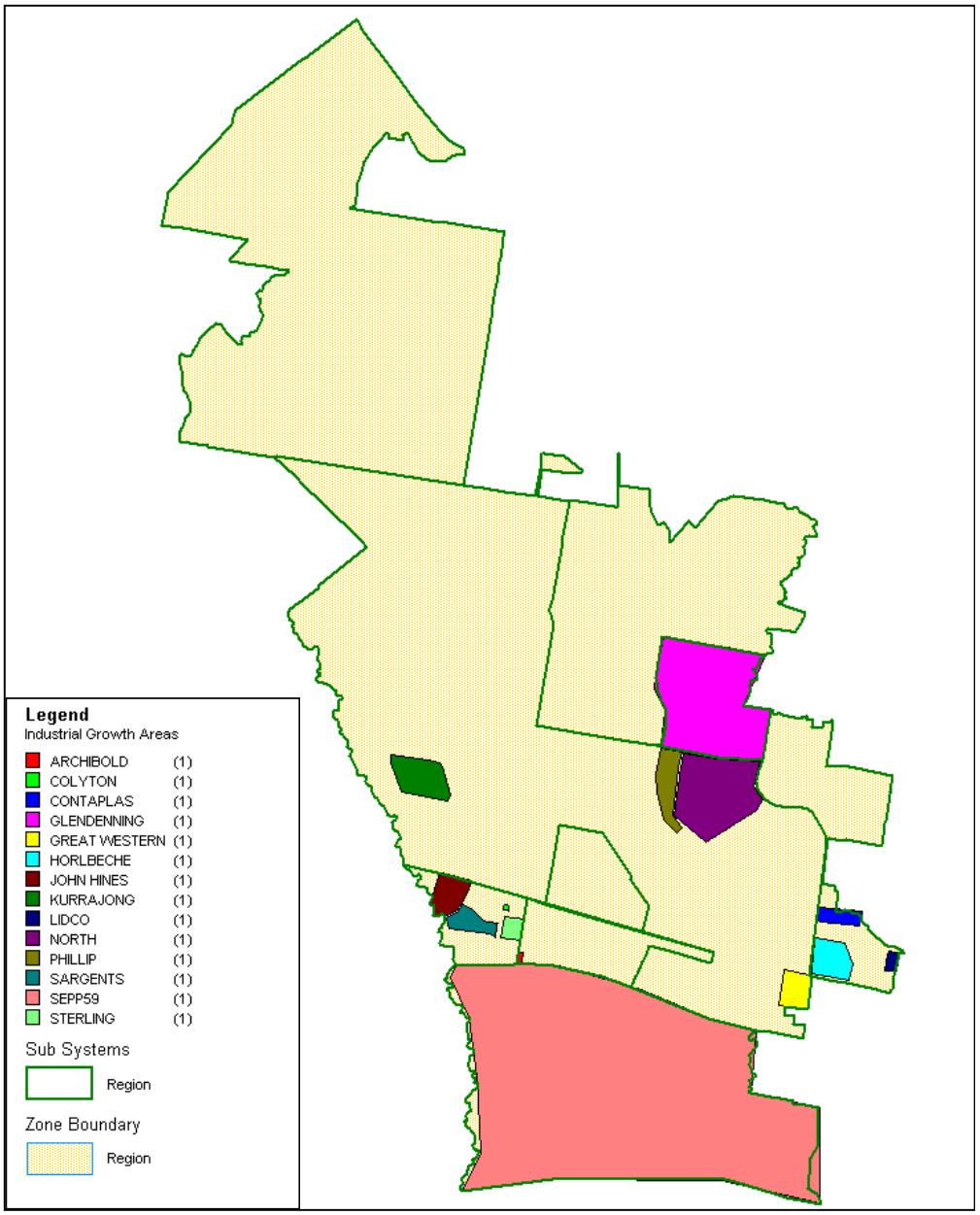
Table B3 Max Day Minchinbery Demand (ML/D)

Year	Res (LD)	Res (HD)	Commercial	Industrial	Other	Total
2011	54.87	4.83	6.27	14.67	5.67	86.90
2018[1]	56.26	4.76	6.33	41.6	6.25	115.20
2018[2]	58.46	4.76	6.33	43.08	6.25	119.29

Note: [1] stands for Minchinbury System w/o MPRP and MPIP

[2] stands for Minchinbury System w/ MPRP and MPIP, rain tank scenario, 1000 lots

FIGURE B1 Industrial Growth Areas in Minchinbury Supply Zone



Appendix C

WMS Model Used in the Analysis

Minchinbury Potable Network Model

Rogans Hill – Cudgegon Potable Network Model

Table C1 Model Group and Run Scenarios

Model	Network	Control	Alternate Demand	Demand Diagram	Demand Scaling	Run
Minchinbury Network						
Existing Condition	Minchinbury Network 9.17	Minchinbury Control Max Day 9.09	N/A	Minchinbury Max Day Demand Diagram 9.03	Minchinbury FMDD Demand Scaling 9.05	Minchinbery Max Day 9.10
2018 Condition Deficiency Run	Marsden Park 1000 & 250 lots_RainTank>w/o Marsden Park	MPIP - WPRP Control 1.01	MPIP - WPRP Alternative Demand 2018 MtD	MPIP & WPRP	MPIP - WPRP FMDD Demand Scaling 1.02	2018 Base Model Deficiency Run
Minchinbury West Connection						
2018 Condition Amplification Run Option 1 Peak Hour	w/ Marsden Park 1000 & 250 lots_RainTank>800 & 250 lots_RainTank_Amp_XC_PVH>800 & 250 lots_RainTank_Amp_Card1=PVH4>800 & 250 lots_RainTank_Amp_PVH1	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH1
2018 Condition Amplification Run Option 2 Peak Hour	800 & 250 lots_RainTank_Amp_PVH2	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH2
2018 Condition Amplification Run Option 3 Peak Hour	800 & 250 lots_RainTank_Amp_PVH4	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH3

Model	Network	Control	Alternate Demand	Demand Diagram	Demand Scaling	Run
2018 Condition Amplification Run Option 4 Peak Hour	800 & 250 lots_RainTank_Amp_PVH3	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH4
2018 Condition Amplification Run Option 5 Peak Hour	800 & 250 lots_RainTank_Amp_PVH5	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH5
2018 Condition Amplification Run Option 6 Peak Hour	800 & 250 lots_RainTank_Amp_PVH6	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH6
2018 Condition Amplification Run Option 7 Peak Hour	800 & 250 lots_RainTank_Amp_PVH7	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 19hr_PVH7
2018 Condition Amplification Run Option 1 EPS 24 Hour	800 & 250 lots_RainTank_Amp_PVH1	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 24hr_PVH1
2018 Condition Amplification Run Option 4 EPS 24 Hour	800 & 250 lots_RainTank_Amp_PVH4	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 24hr_PVH4
2018 Condition Amplification Run Option 5 EPS 24 Hour	800 & 250 lots_RainTank_Amp_PVH5	MPIP - WPRP Control 1.01	WPRP Alt Demand 2018 RainTank	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	RainTank 300mm 560 & 250 lots Amp Run 24hr_PVH5
Minchinbury East Connection						
	01	MPIP - WPRP Control 1.01	O1 SS250 MPIP1 MP2000 O1 SS250 MPIP1 MP2500 O1 SS250 MPIP1 MP3000 O1 SS250 MPIP1 MP3500	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	Option 1

Model	Network	Control	Alternate Demand	Demand Diagram	Demand Scaling	Run
			O1 SS250 MPIP1.5 MP2000 O1 SS250 MPIP1.5 MP2500 O1 SS250 MPIP1.5 MP3000 O1 SS250 MPIP1.5 MP3500 O1 SS250 MPIP2 MP2000 O1 SS250 MPIP2 MP2500 O1 SS250 MPIP2 MP3000 O1 SS250 MPIP2 MP3500 O1 SS250 MPIP1.5 MP_iterate			
	02	MPIP - WPRP Control 1.01	O2 SS250 MPIP1 MP2000 O2 SS250 MPIP1 MP2500 O2 SS250 MPIP1 MP3000 O2 SS250 MPIP1 MP3500 O2 SS250 MPIP1.5 MP2000 O2 SS250 MPIP1.5 MP2500 O2 SS250 MPIP1.5 MP3000 O2 SS250 MPIP1.5 MP3500 O2 SS250 MPIP2 MP2000 O2 SS250 MPIP2 MP2500 O2 SS250 MPIP2 MP3000 O2 SS250 MPIP2 MP3500 O2 SS250 MPIP2 MP_iterate	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	Option 2
Minchinbury East Connection – Water Age						
		MPIP - WPRP Control 1.01 WQ	O1 SS0 MPIP1 MP0 O1 SS250 MPIP1.5 MP_iterate	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	Option 1
		MPIP - WPRP Control 1.01 WQ	O2 SS250 MPIP2 MP_iterate	MPIP & WPRP	Minchinbury FMDD Demand Scaling 9.05	Option 2

Model	Network	Control	Alternate Demand	Demand Diagram	Demand Scaling	Run
Rouse Hill (Rogans Hill – Cudgegon) Network						
Existing Condition	Rogans Hill_Cudgegon Network 1.0>Rogans Hill_Cudgegon Network 1.2> Network for WPRP Study	MPIP_WPRP Max Day Control 1.01	N/A	Rogans Hill_Cudgegon Max Day Demand Diagram 1.1	Rogans Hill_Cudgegon Demand Scaling 1.1	Existing Condition
2018 Condition Deficiency Run	Rogans Hill_Cudgegon Network 1.0>Rogans Hill_Cudgegon Network 1.2> max lots_RainTank w/ pkg2	MPIP_WPRP Max Day Control 1.01	Rogans Hill Alternative Demand 2018 1.01	Rogans Hill_Cudgegon Max Day Demand Diagram 1.1	Rogans Hill_Cudgegon Demand Scaling 1.1	2018 Baseline w/ pgk2
2018 RainTank 1000 lots	Rogans Hill_Cudgegon Network 1.0>Rogans Hill_Cudgegon Network 1.2> max lots_RainTank w/ pkg2	MPIP_WPRP Max Day Control 1.01	Rogans Hill Alternative Demand 2018 1.01	Rogans Hill_Cudgegon Max Day Demand Diagram 1.1	Rogans Hill_Cudgegon Demand Scaling 1.1	1000 lots_RainTank w/ pkg2
2018 RainTank 2000 lots	Rogans Hill_Cudgegon Network 1.0>Rogans Hill_Cudgegon Network 1.2> max lots_RainTank w/ pkg2	MPIP_WPRP Max Day Control 1.01	Rogans Hill Alternative Demand 2018 1.01	Rogans Hill_Cudgegon Max Day Demand Diagram 1.1	Rogans Hill_Cudgegon Demand Scaling 1.1	2000 lots_RainTank w/ pkg2

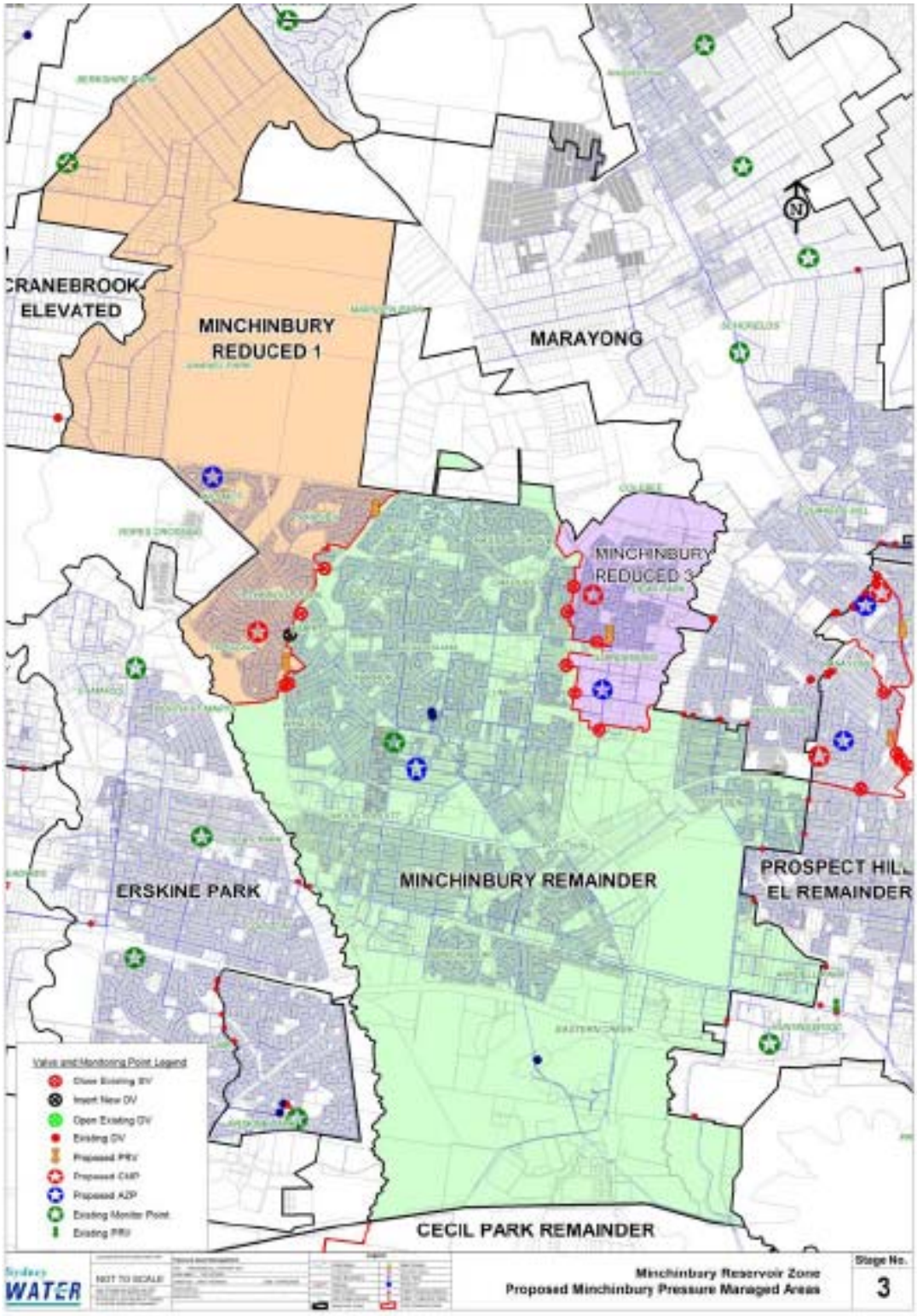
Appendix D

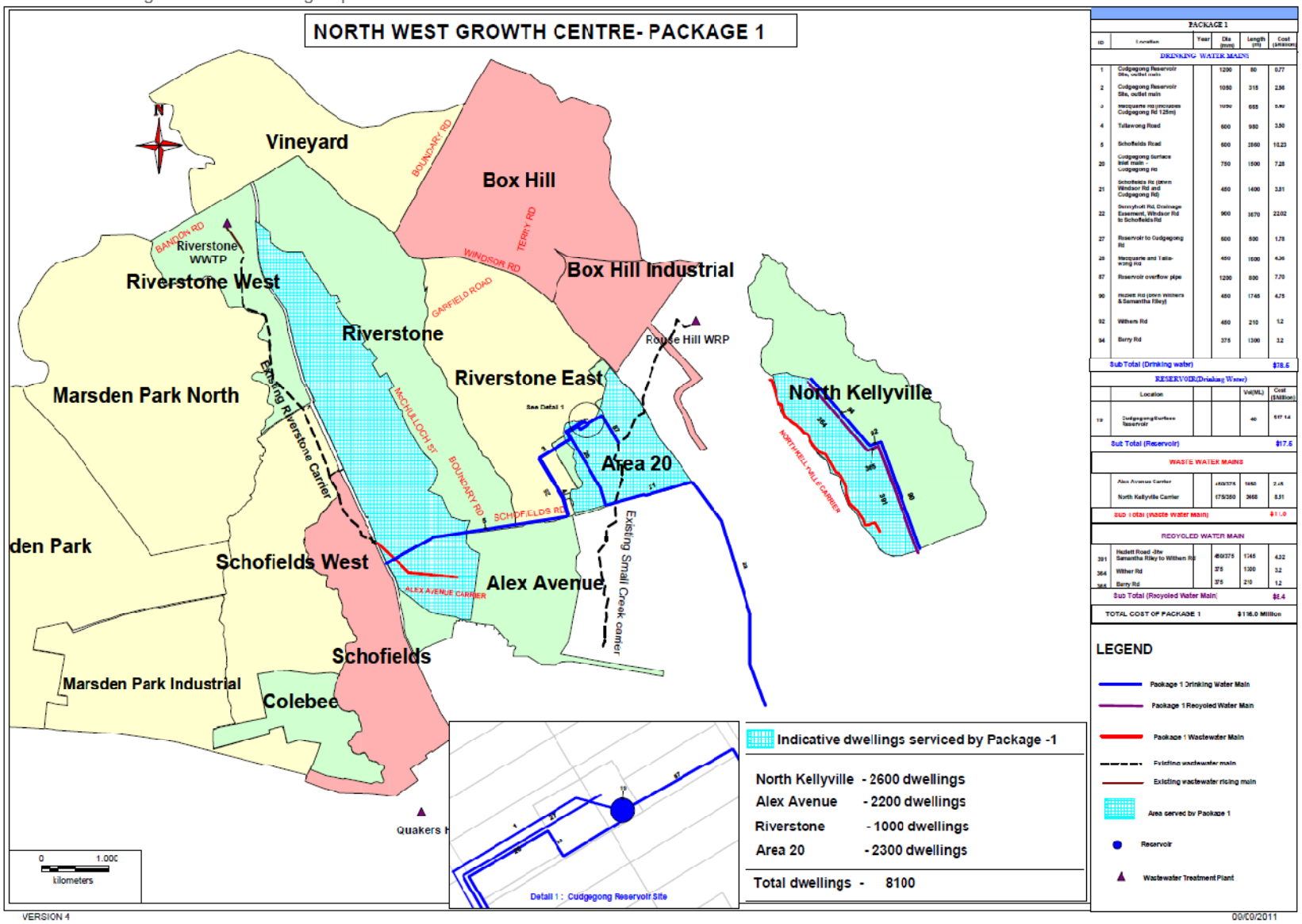
MAPS

Minchinbury Reduced 1 Scheme

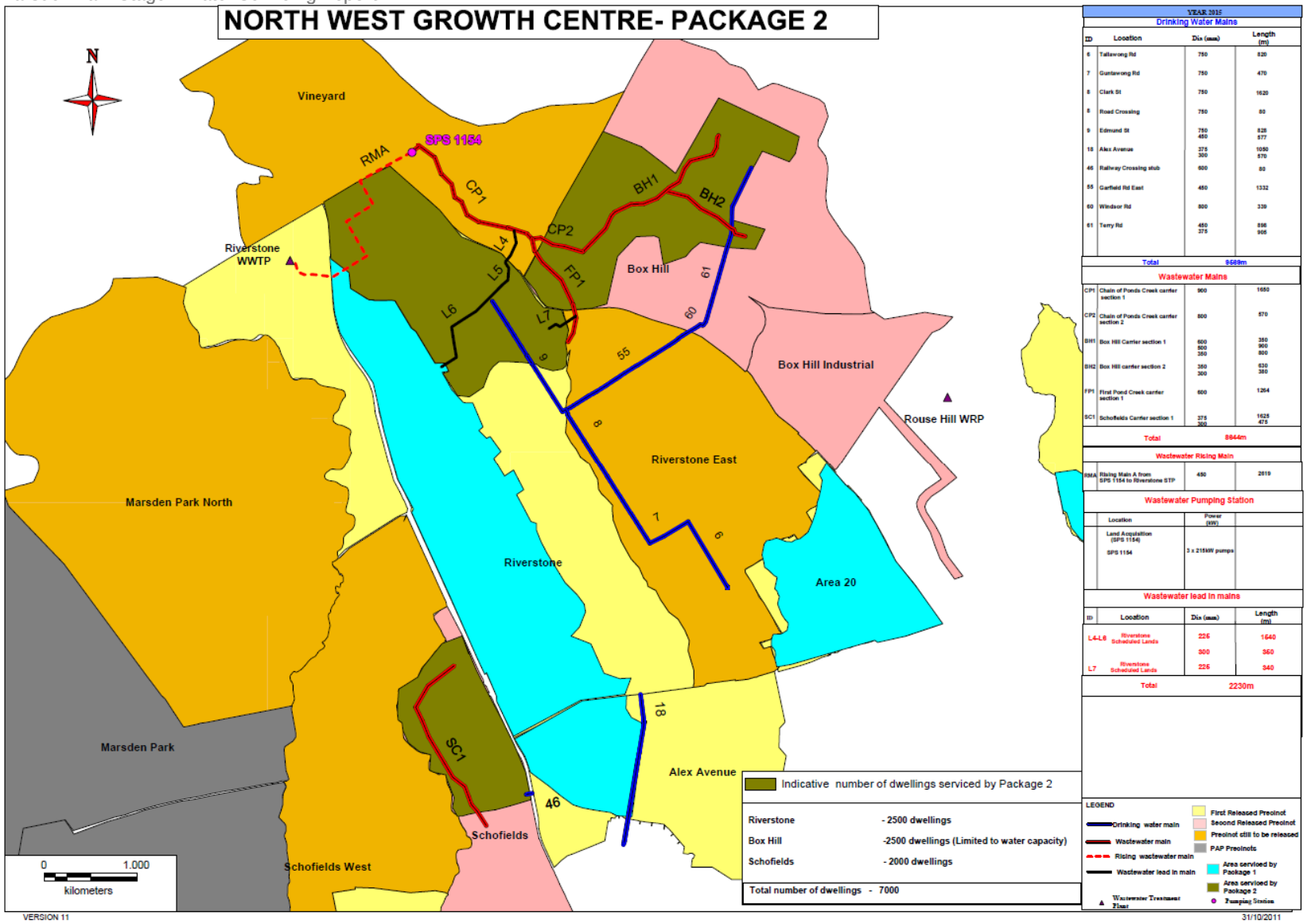
North West Growth Centre Package 1

North West Growth Centre Package 2


CRANEBROOK
ELEVATED
MINCHINBURY
REDUCED 1
MARAYONG
MINCHINBURY
REDUCED 3
ERSKINE PARK
MINCHINBURY REMAINDER
PROSPECT HIL
EL REMAINDER
CECIL PARK REMAINDER
N
Valve and Monitoring Point Legend
Close Existing BV
Insert New DV
Open Existing DV
Existing DV
Proposed PRV
Proposed CMP
Proposed AZP
Existing Monitor Point
Existing PRV
Sydney WATER
NOT TO SCALE
Minchinbury Reservoir Zone
Proposed Minchinbury Pressure Managed Areas
Stage No.
3



SINCLAIR KNIGHT MERZ



SINCLAIR KNIGHT MERZ

Appendix E

COST ESTIMATES

Cost Estimates

The cost estimates developed for this project are for the purposes of option comparison.

The following approach was adopted for developing the cost estimate:

- General costs:
  - Site establishment: 5% of water main installation cost
  - Traffic management:
    - $1,500 per day for construction in road
    - $500 per day for construction in verge
- Water main installation costs:
  - Costs of purchase and installation of pipes based on unit rates as outlined in **Table D1**
  - Directional drill: $1,500 per m for DN200, $2,500 for other
  - Thrust bore intersection: $50 K per intersection
  - Thrust bore general: $1,250 per m
  - Trenched intersection: $4 K per intersection
  - Property easements: $2 M per ha with 5 m wide easement
- Other:
  - Service protection: 5% of water main installation cost
  - Spoil disposal: $112 per m^3
- Professional services of 10% of the water main installation costs. This is for professional service costs incurred during the construction phase of the project, such as project management. It does not include professional services costs that would be incurred prior to construction such as survey, geotechnical investigations, environmental investigation and assessment, planning and approvals, engineering design, tender preparation and assessment, and Sydney Water costs.
- Contingency:
  - Generally of 15% of sub-total
  - For the Minchinbury East Options and the Rouse Hill Options, as some portion of the pipework would need to be installed along Richmond Rd, the contingency was increased to 30% for the sections of pipe constructed along Richmond Rd. This is to account for the possible impact of the future planned widening of Richmond Road on the pipe design, including impacts on the location and the possible need for certain sections of pipe to be

concrete encased. This may be required because the widening of Richmond Rd will require earthworks to cut/fill along the road embankment. Depending on the timing and design of the road widening works in relation to the location of the pipework, there may be additional costs associated with the installation of the water pipe along Richmond Rd.

It should also be noted that the costs for the East Minchinbury Options calculated the differential cost between the proposed DN250 pipe to be installed to service MPIP Stage 1 and the upsized pipe. Hence the cost of the DN250 pipe was subtracted from the cost estimates. The cost of the DN250 pipe was estimated as $2.6 M.

Table D1 Pipe Unit Cost Rates

Pipe Diameter	Pipe Installed in Grass ($/m)	Pipe Installed in Verge ($/m)	Pipe Installed in Road ($/m additional to 'verge cost')
DN200	644	-	-
DN250	702	805	-
DN300	759	874	-
DN375	874	989	+ 250
DN450	1070	1173	+ 275
DN450 concrete encased	1392	1495	+ 275
DN600	1449	1668	+ 300
DN600 excluding valves	1260	1450	+ 300