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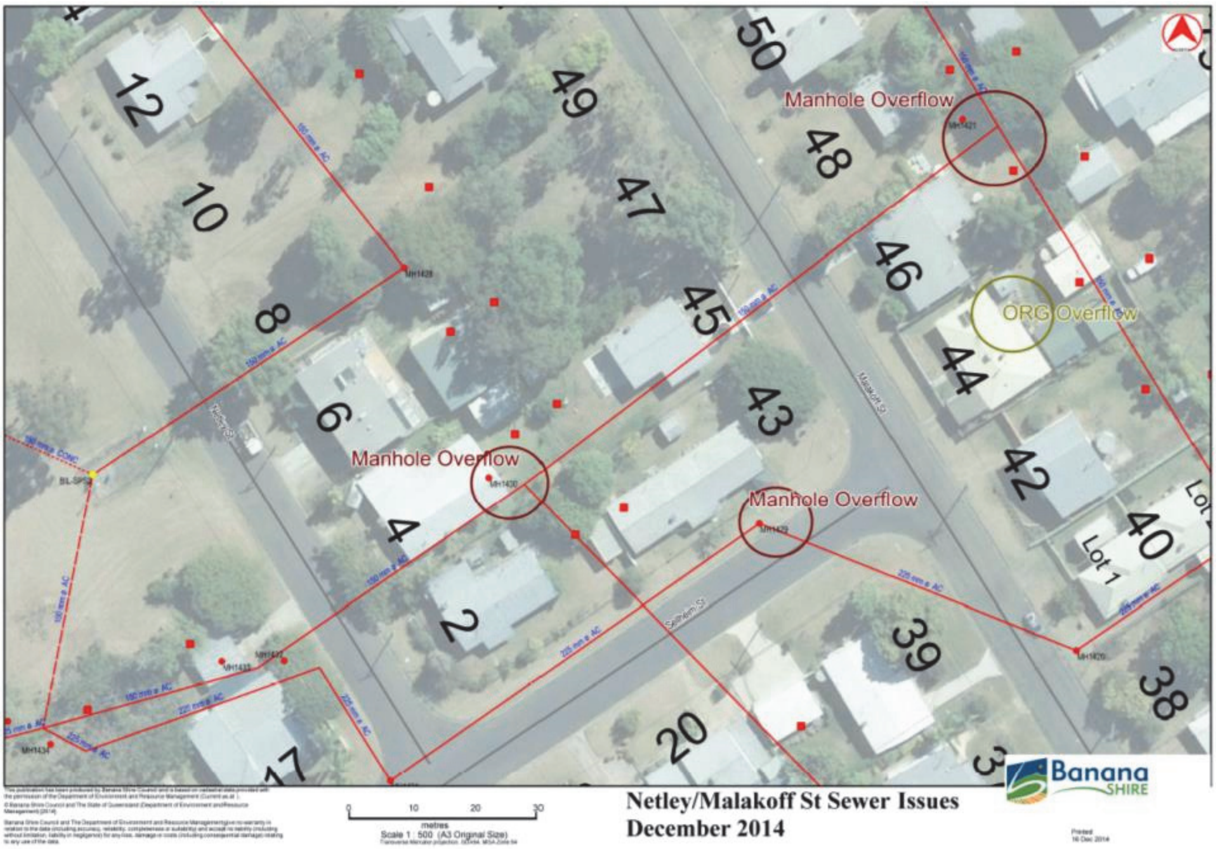

Investigation into Sewer Overflows

Malakoff St Area, Biloela

Prepared for Banana Shire Council

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Ver. 3

Document Control Sheet

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Version history

Version No.	Date	Changed By	Nature of Amendment
1	26 Jan '15		DRAFT – INTERIM For Comment Only
2	07 Feb '15	CDM	DRAFT
3	11 Feb '15	CDM	FINAL

Executive Summary

For roughly the last 30 years, the residents of 4 Netley St, Biloela have been experiencing flooding of their property's backyard, due to storm related wastewater overflows.

Following the storm events of December 2014, a detailed assessment of the sewer network was undertaken in order to develop a solution to the issue and endeavour to prevent future overflow events from occurring.

The assessment indicates that neither Pump Station 1 nor Pump Station 2 comply with the current construction specifications, due to inadequate storage capacities.

Four (4) possible solution have been identified, ranging in indicative costs from $845,000 to $1,255,000. Other options were also identified, and whilst they were less expensive, they do not alleviate the overflow issue.

The recommended option (Option 7) is to:

- Redirect flows from the 225mmdia trunk main to PS 2
- Convert PS2 to into a large access chamber
- Gravitate flows from this large access chamber (PS2) to PS1
- Augment PS1 with new pump sets, electrical works and storage

at an indicative cost of $845,000.

Further assessment of this option should be undertaken as part of the detailed design. This assessment should include a detailed life cycle cost analysis.

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Tables

1 Introduction

The general area of Malakoff St / Netley St, Biloea was sewered in the late 1960's, with 150mm and 225mm diameter Asbestos Cement pipes.

Over the last 30 years, indicative evidence (staff comments) is that overflows during periods of rainfall are a regular occurrence in this area, and in particular at 4 Netley St, Biloela. These overflows are inconvenient to the residents, as well being a health issue. Despite the endeavours of Council to rectify the site when these overflows have occurred, the residents of 4 Netley St are required to vacate the premises for a period due to health concerns.

Following the rainfall events of December 2014, Banana Shire Council re-commenced investigations into the cause of these overflows with a strong view to the elimination of future events.

A desktop assessment of the site, has identified a number of possible options available to remedy the situation. These include:

- Diverting Sellheim St flow away from 4 Netley St
- Divert Malakoff St flow away from 4 Netley St
- Divert high level flows from 4 Netley St to Pump Station 2
- Divert Trunk Main flow to Pump Station 2
- Divert Trunk Main & PS2 to PS1 via gravity sewer

2 Assumptions and Data Sources

A mixture of data and reference sources have been utilised to obtain the necessary data to undertake this 'static' model of the wastewater network. These include:

- Council's GIS Database.
- Council Plans (Design and As-Constructed), where available
- Field Survey (December 2014)
- Hardies Pipeline Design Manual
- Vinidex Design Flow Charts

Where no grade is identified, the minimum allowable grades are utilised as this will provide the worst case scenario, and not provide any adverse interpretations

No sewer gauging information is available, therefore standard theoretical flow values, and peaking factors are utilised.

The calculation of assets capacities is based on historic formula and base data provided by the Planning Guidelines for Water Supply and Sewerage as issued by the Department of Energy and Water Supply.

Table 1 – Calculation Assumptions

Calculation Assumptions	
Residential Density (Lots/ha)	10
Flow (L/EP/day)	225
EP per ET	2.6
PWWF / ADWF	5
Daily Maximum Flow to Average Dry Weather Flow	2.8
Emergency Storage (Hours)	4
Storage of ADWF	1
Boundaries are Sewer Catchment Boundaries not Water Zone Boundaries	
All vacant sewer connections are residential blocks, ie. 1ET	
All new development based on 1 lot being equal to 1 ET.	
Gravity Network	
Actual grades of existing sewer reticulated mains are used (where available)	
New Mains - Use Minimum Grades	
Upgrade Mains - Use Existing Grades	
Realignments - Use Minimum Grades	
Capacities based on Max Flows and Scour Criteria	
Pressure Network	
PS Storage Volume taken as volume above start level to Overflow level,	
Emergency Storage (Hours) (as per CMDG)	4
Pump Flow Rate is matched to Peak Wet Weather Flow	
Minimum Velocity in RM is 0.7m/s, preferred minimum is 0.9m/s	
Maximum Velocity in RM is 1.5m/s	
Minimum well diameter is to be 2.4m	
Maximum Head loss on Pressure mains is to be 1m/100m (preferred)	
New Pressure Pipe is based on PVC-M PN12	
Poly SDR 13.6, PE 100	
Pump Sizing obtained from WebCaps	

Table 2 – Requirements for Scouring Gravity Networks

Minimum Criteria for Scouring				
PIPE DIA (mm)	MINIMUM GRADE (1:X)	MINIMUM DEPTH OF FLOW (mm)	MINIMUM No OF TENEMENTS	MINIMUM PUMPED FLOW - L/S
150	150	25	4	2
225	290	40	170	5
300	420	50	270	8
375	570	70	530	15
450	730	80	690	19
525	900	95	970	27
600	1000	110	1360	36

Table 3 – Allowable Flows in Gravity Networks

Maximum Allowable Flows (in Equivalent Tenements)							
	Diameter						
Grade	150	225	300	375	450	525	600
1000							3852
950							3965
900						2727	4089
850						2817	4224
800						2916	4372
750						3025	4535
730					1922		
700					1969	3146	4716
650					2054	3281	4918
600					2150	3434	5147
570				1271			
550				1297	2259	3608	5407
500				1369	2385	3808	5707
450				1454	2532	4043	6059
420			766				
400			787	1555	2708	4323	6477
350			850	1678	2921	4663	6986
300			928	1832	3189	5089	7623
290		458					
250		493	1030	2033	3537	5643	
200		551	1170	2308	4015	6404	
150	215	636	1379	2719			
125	236	697	1530	3016			
100	264	779	1738	3424			
75	305	900	2047	4032			
50	373	1102	2579	5075			

3 Site Details

The area of Netley and Malakoff St is located in close proximity to Pump Station No 2, and the property which is mainly affected by overflows (4 Netley Street), has a sewer main which services a relatively large catchment passing through it. Figure 1 - Site Overview provides an overview of the site.

As can be seen in Figure 2 – December Overflow Locations, the site is located in close proximity to Pump Station No. 2. The access chamber marked MH1430 has the lowest surface level in the immediate area, and also has the smallest depth to the invert of the sewer. This is the 'low' point for the area in question. Accordingly, this location is the most prone to overflow in period of high flow or localised blockages.

The natural terrain of the site is such that any overflow from the access chamber follows a path to the North West, being the natural drainage channel for the greater area. This flow path passes through the entire back yard of both 4 and 6 Netley St.

In the immediate area, the ORG at 44 Malakoff St (Site marked by the ORG Overflow), is the next lowest point followed by MH1429 (43 Malakoff St) and MH 1421 (48 Malakoff St). These three locations have surface levels which are 0.818m, 1.055m and 1.165 m higher respectively than the 'low' point.

The 150mmØ sewer main passing through 4 Netley St (the "problem area"), services a relatively small catchment, being the area between Malakoff St, State Farm Road and Washpool St.

The 225mmØ sewer main along Sellheim St services a much larger area, being all lots to the North/East of State Farm Road.

It should be noted that this 225mmØ sewer main is currently 'built-over' by the dwelling located at 17 Sellheim St.

These two sewer mains combine at the same location as the discharge for Pump Station No. 2.

4 December Events

While the events of early December 2014 were not particularly large events, they did produce overflows to a number of access chambers, as well as property overflow relief gullies (ORG).

These rain events occurred at least twice at the beginning of the month. Following the first overflow event of the month, Council engaged a Surveying firm to undertake a site survey of the area, specifically obtaining access chamber surface levels and pipe invert levels.

A second overflow event occurred in the morning of the commencement of the site survey. During the investigation immediately following this overflow, the scope of the survey was expanded to include a path between pump station 2 and pump station 1 and the alignment of the 225mmØ main from pump station 2 to 36 Don Street. Also included was some private property ORG's.

The observed overflow locations are displayed in Figure 2 – December Overflow Locations.

5 Inspections / Assessments

Council staff and M1 Consulting have undertaken a number of site inspections both during and after the overflow events. This has included the further survey of access chambers and Pump Station familiarisation.

The survey data has confirmed the basic issues for the overflows, ie poor surface/ground elevation in relation to the grade of the sewer mains. It has also indicated that there is fall between PS2 and PS1.

A review of Council records (plans) has also been undertaken in an attempt to locate the required data to make a thorough technical assessment.

5.1 Current Situation

5.1.1 Gravity Mains

The discharge loading for these sewers has been identified by an assessment of Council's GIS system, being the Lot details and an application of the Equivalent Tenements for these lots. The ET (Equivalent Tenements) has been estimated by the application of theoretical factors and the known utilisation of the identified lots. Figure 3 – Identified Sub-Catchments identifies the various sub-catchments for each assessed length of sewer main.

Council's GIS system contains data relating to the sewer size, materials and length. This, in addition to the obtained survey data have been utilised to identify the theoretical grade of the existing sewers. These results have been provided in Table 5 - Sewer Grading.

As can be seen in this table, there are a number of sewers which have been laid flatter than theoretical allowable. Council staff have also stated that CCTV investigations in this area indicate that the sewer has also experienced some vertical deflection, as would be expected in the clay soils of Biloela. This creates a ponding effect within the sewer

This ponding effect is confirmed by the constant presence of 'standing water' in the access chamber at 4 Netley St.

It is expected that these flat grades, expansive soils and deflected grade result in the sewer experiencing a 'backflow' type event during high flows. That is, when the sewer is operating under high flow situations, these flat grade areas become overloaded, and water builds up. This water would build up until it reaches a relief point, typically an overflow location.

As such, the cause location of the overflows is not the immediate access chamber, nor its immediate downstream sewer main, but areas further downstream, being the 225mm Ø trunk sewer main.

As can be seen in Table 7 - Current Capacity of Gravity Network, to reduce the 'over capacity' status of the 225mmØ sewer mains (SM246, 247, 248 and 252 being the most critical lines), 121ET of discharge is required to be diverted into another part of the network.

5.1.2 Pump Stations

The data available for Pump Stations 1 and 2 is somewhat limited. The main limiting factor in the determination of the current capacity of the stations is the actual flow rate of the pumps.

An assumed flow rate has been adopted based on some very broad quantity and time values obtained.

Table 4 – Existing Pump Station Capacities identifies the main limiting factors for the existing stations, i.e. pump flow rate, operational storage and emergency storage. The main limiting factor on the pump station existing capacity is the emergency storage capacity required. It should be noted that when the pump stations were designed and built, the current requirements for emergency storage were not as stringent or large as they are currently

Table 4 – Existing Pump Station Capacities

Pump Station	Discharge Pipe/Pump Set					
	Pipe	Velocity (m/s)	Assumed Pumped Flowrate (l/s)	Pipe Loss Per Meter	Total Head (m)	Flow ET's
1	150 AC	0.34	6.0	0.051	48.03	177
2	100 AC	0.32	2.5	0.01	4.17	74

Pump Station	Pump Station					Emergency Storage	
	Required Pump Storage Capacity (KL)	Actual Well Size (Kl)	Difference (KL)	Total Retention Time (hrs)	Current Actual Well ET	Emergency Storage Capacity (kL)	Current Storage ET
1	0.86	0.80	-0.06	3.68	165	4.02	41
2	0.36	0.51	0.15	0.46	105	1.88	19

Pump Station	Capacity		
	Capacity (ET) (maximum)	Current ET's	Theoretical Available ET's
1	41	274	**-233**
2	19	25	**-6**

As can be seen, both pumping stations are theoretically overloaded with the current served population.

This is reflected in the low number of identified pump station high level alarm scenarios experienced.

Table 5 - Sewer Grading

Assets Number	Size	Grade 1:X	Flattest Theoretical Grade 1 : X	Comment
SM622	150	156	150	Too Flat
SM623	150	43	150	OK
SM625	150	48	150	OK
SM624	150	134	150	OK
SM626	150	39	150	OK
SM627	150	91	150	OK
SM628	150	132	150	OK
SM629	150	26	150	OK
SM631	150	161	150	Too Flat
SM630	150	189	150	Too Flat
SM633	150	150	150	Assumed Grade
SM632	150	150	150	Assumed Grade
SM619	150	152	150	Too Flat
SM621	150	179	150	Too Flat
SM620	150	142	150	OK
SM257	225	243	290	OK
SM256	225	282	290	OK
SM255	225	197	290	OK
SM254	225	104	290	OK
SM309	225	779	290	Too Flat
SM746	150	80	150	OK
SRM874	100			Rising Main
SM308	225	296	290	Too Flat
SM253	225	224	290	OK
SM252	225	329	290	Too Flat
SM251	225	292	290	Too Flat
SM307	225	320	290	Too Flat
SM250	225	289	290	OK
SM249	225	288	290	OK
SM248	225	289	290	OK
SM247	225	290	290	Assumed Grade
SM246	225	291	290	Too Flat
SM245	300	418	420	OK
SM244	300	421	420	Too Flat
SM243	300	421	420	Too Flat
SM242	300	422	420	Too Flat
SM870	150	150	150	Assumed Grade

5.2 Option1 - Divert Sellheim St flow

An assessment of the levels of the mains SM614 and SM256 indicate that it is possible to divert sewer main SM614 into SM256. (See Figure 4 – Option 1)

This removes 51ET from the sewer main which passes through 4 Netley St. However, the assessment of the entire area shows that sections of the trunk main (225mmØ) is still overloaded. (See Table 8 - Option 1 Gravity Network Capacity)

As such this option does not provide any improvement in the operation of the gravity sewer mains.

This option does not make any alteration to the catchments for either Pump Station 1 or 2, and therefore no assessment of the pump station sis required.

5.3 Option 2 - Divert Malakoff St Flows

This option has the effect of reducing the ET discharge through the problem area by 82 ET. (See Figure 5 – Option 2). This however, increases the discharge to PS 2 to 102 ET, which is approximately a 460% increase over the current discharge. This results in significant augmentations being required to the Pump Station.

In order for this option to reduce the loading to the 'problem mains', the Pump Station discharge is required to also be diverted away from the existing discharge location in the 225mmØ main. Due to the low spare capacity of the Trunk Main, as identified in Table 7 - Current Capacity of Gravity Network, the closest diversion to be investigated is to divert the flow to Catchment 11.

The assessment of the gravity network in catchments 11 to 20 indicates that the majority of the network has adequate capacity for this additional flow. It is noted that the last two lines are slightly overloaded. However, due to the observed surface fall from the residential area to the pump station, it is expected that the grade of the sewer is better than the minimum allowable grade which has been utilised in this assessment. As such, the mains would be adequate.

As this diversion is increasing the flows to Pump Station 1 by 102 ET (almost 40% increase), the capacity of this pump station and rising main arrangement are required to be undertaken.

5.3.1 Pump Station Assessment

Table 13 - Option 2 - Pump Station Assessment provides details of the calculations performed in the site assessment for both Pump Station 1 and 2.

5.3.1.1 Pump Station 1

As can be seen, the Operational and Storage capacities of the site are insufficient. (The operational capacity can be accommodated in the existing well, however the emergency storage capacity is significantly deficient).

The existing rising main has suitable capacity in this option, and does not require any augmentation.

Due to the increased flow to Pump Station 1, the pump set is required to be increased. This pump set is nominally 2kW units capable of 13l/s @5m head.

5.3.1.2 Pump Station 2

Similar to Pump Station 1, this site has inadequate storage capacities, however, as the discharge for the pump station is proposed to be into a different catchment to currently, a new rising main is also required to be provided.

Due to the increased flow to Pump Station 2, the pump set is required to be increased. This pump set is nominally 2.2kW units capable of 4l/s @10m head.

5.4 Option 3 - Divert Malakoff St 'High Level' Flows

This option involves the diversion of the 'High Level' flows from the 150mm ∅ sewer into Pump Station 2, and the diversion of PS 2 to catchment 11. (Figure 6 – Option 3)

Due to the static nature of the assessment, the partial diversion of flows is difficult to determine, as the actual flow contained in a 'full pipe' situation is not identified (see 5.1 Current Situation) due to the flat grade of downstream sewers.

However, as the diverted flow is less than the identified 121ET required to reduce the overflows, this option does not provide a clear solution, and not further gravity assessment has been conducted.

This option would also require augmentations to Pump Station 2, and possibly Pump Station 1. However, due to the same issues identified above, this Pump Station assessment has not been conducted.

5.5 Option 4 - Divert 150∅ & 225∅ Trunk Sewer

This option diverts all the flow from the 225mm∅ trunk sewer at Netley St (intercept MH1432) and the 150mm∅ sewer main from 4 Netley St (new Manhole to be built at intersection of both mains) into Pump Station 2. (Figure 7 – Option 4)

This diversion has the added benefit of abandoning the existing sewer mains which pass under the dwelling at 17 Sellheim St. This is considered to be a long term risk reduction action.

This option diverts 529ET of flow away from the problem area.

Table 10 - Option 4 Gravity Network Capacity provides details of this options assessment. In summary, this option has the following issues:

- Catchments 11 to 20 are significantly overloaded.
- Upsizing catchment 11 to 20 to 225∅ generally solves the overload issue.
- Downstream of problem area (D/S SM309) has very high spare capacity.
- Downstream area does not provide adequate flow to achieve theoretical scour velocity.
- PS 2 will require significant upgrades.
- PS 1 will require significant upgrades.

It is noted that the 225mmØ trunk main (SM254 and downstream) was relined in 2006, and the internal diameter is likely to be approximately 210mm, and the available flow would be less than identified here.

Whilst this option removes the high flow volumes from the problem area, it does result in an area which is likely to have significant operational requirements to ensure that blockages due to 'settlement' do not occur.

5.5.1 Pump Station Assessment

Table 14 - Option 4 - Pump Station Assessment provides details of the calculations performed in the site assessment for both Pump Station 1 and 2.

5.5.1.1 Pump Station 1

As can be seen, the Operational and Storage capacities of the site are insufficient. (The operational capacity can be accommodated in the existing well, however the emergency storage capacity is significantly deficient).

The existing rising main experiences flow velocities higher than desirable. This would result in higher power input requirements and result in higher long term operational costs. It is identified that a new 150 PVC rising main is to be installed.

Due to the increased flow to Pump Station 1, the pump set is required to be increased. This pump set is nominally 5.5kW units capable of 27l/s @12m head.

5.5.1.2 Pump Station 2

Similar to Pump Station 1, this site has inadequate storage capacities (existing emergency storage is insufficient for new operational storage).

As the discharge for the pump station is proposed to be into a different catchment to currently, a new rising main is also required to be provided. The identified optimum main size is 100PVC.

Due to the increased flow to Pump Station 2, the pump set is required to be increased. This pump set is nominally 2.2kW units capable of 18l/s @7.5m head.

5.6 Option 5 - Divert only Trunk Main flow to PS2

This option is similar to Option 4, however, the trunk diversion line is installed at a lower depth than the existing 150mmØ sewer main, and does not intercept this flow at all. (Figure 8 – Option 5)

This option diverts 392ET of flow away from the problem area, and maintains a flow of 143ET into the 'trunk' main sewer. This trunk main flow is not sufficient to meet the theoretical scour flows, however, it is within 30 ET of this flow. As such, any maintenance regime on this length of main would be lower than in Option 4.

Table 11 - Option 5 Gravity Network Capacity provides the gravity network calculations,

The assessment of this option indicates the following issues:

- Catchments 11 to 20 are significantly overloaded.
- Upsizing catchment 11 to 20 to 225Ø solves the overload issue.
- Downstream area (trunk main) provides close to the required flow to achieve theoretical scour velocity.
- PS 2 will require significant upgrades.
- PS 1 will require significant upgrades.

5.6.1 Pump Station Assessment

Table 15 - Option 5 - Pump Station Assessment provides details of the calculations performed in the site assessment for both Pump Station 1 and 2.

5.6.1.1 Pump Station 1

As can be seen, the Operational and Storage capacities of the site are insufficient. (The operational capacity can be accommodated in the existing well, however the emergency storage capacity is significantly deficient).

The existing rising main is adequate for the proposed flows.

Due to the increased flow to Pump Station 1, the pump set is required to be increased. This pump set is nominally 7.5kW units capable of 23l/s @15m head.

5.6.1.2 Pump Station 2

Similar to Pump Station 1, this site has inadequate storage capacities (existing emergency storage is insufficient for new operational storage).

As the discharge for the pump station is proposed to be into a different catchment to currently, a new rising main is also required to be provided. The identified optimum main size is 100PVC.

Due to the increased flow to Pump Station 2, the pump set is required to be increased. This pump set is nominally 2.2kW units capable of 14l/s @5m head.

5.7 Option 6 - Divert PS 2 discharge into downstream Trunk Main

This option is similar to Option 5, however the diversion of the Pump Station discharge is to a location further downstream than present on the current 225mmØ Trunk Main. (Figure 9 – Option 6)

Due to the load applied by the pump station (370ET) onto the trunk main, the closest location which has sufficient downstream capacity for this discharge is at the upstream access chamber (MH1365) to Main SM245. This is the start of 300mmØ trunk main.

Pump Station 2 will require an upgrade as per Option 5. The length of the rising main is not able to be determined until the survey is conducted, and an assessment of the gravity trunk main is conducted.

5.7.1 Pump Station Assessment

Table 16 - Option 6 - Pump Station Assessment provides details of the calculations performed in the site assessment for both Pump Station 1 and 2.

5.7.1.1 Pump Station 1

This site is not impacted by any of these works, and as such, there is no direct requirement to augment the site.

However, the calculations do indicate that there are storage deficiencies, undersized pump sets, and an oversized rising main. (Although, it should be noted that the existing pump set capacities have been assumed only).

If works were to be conducted on this site, the following notes are applicable.

As can be seen, the Operational and Storage capacities of the site are insufficient. (The operational capacity can be accommodated in the existing well, however the emergency storage capacity is significantly deficient).

The existing rising main is adequate for the proposed flows, although the flows are likely to result in settlement within the pipe, and the associated issues. It is recommended that a 100PVC main be utilised to replace the existing main.

The pump set is required to be increased. This pump set is nominally 3kW units capable of 10l/s @10m head.

5.7.1.2 Pump Station 2

This site has inadequate storage capacities (existing emergency storage is insufficient for new operational storage). Total required storage 40kL.

As the discharge for the pump station is proposed to be to a location further along the trunk main, a new rising main is also required to be provided. The identified optimum main size is 100PVC.

Due to the increased flow to Pump Station 2, the pump set is required to be increased. This pump set is nominally 7.5kW units capable of 14l/s @21.5m head.

5.8 Option 7 - Gravitate Pump Station 2 to Pump Station 1.

An assessment of the invert levels, grades and surface levels indicates that it is possible to gravitate flows from the existing Pump Station 2 to Pump Station 1 and achieve an average grade of approximately 1 in 85, whilst maintaining appropriate levels of cover. (Figure 10 – Option 7).

This option involves the diversion of the ‘trunk mains’ at MH1432 into the existing PS2, and the existing 150mm “problem mains” continuing into the trunk main, as per Option 6.

However, PS 2 would be required to be converted to an access chamber (remove all pumps, pipes, switchboard, etc), and a gravity main to be installed to PS 1.

This would require the installation of a 225mmØ gravity main which would have an available/spare capacity of approximately 480ET.

This option enables to permanent removal of a pump station (and its associated annual operational and maintenance costs).

In addition to the installation of approximately 710m of 225mmØ sewer main, pump station 1 would require augmentation.

5.8.1 Pump Station Assessment

Table 17 - Option 7 - Pump Station Assessment provides details of the calculations performed in the site assessment for Pump Station 1.

5.8.1.1 Pump Station 1

The calculations indicate that there are storage deficiencies and undersized pump sets, for this scenario.

As can be seen in the relevant table, the Operational and Storage capacities of the site are insufficient. (The operational capacity can be accommodated in the existing well, however the emergency storage capacity is significantly deficient).

The existing rising main is adequate for the proposed flows, and the flow velocity is within the desired range to minimise operational issues.

The pump set is required to be increased. This pump set is nominally 7.5kW units capable of 23l/s @15m head.

6 Option Costings

Indicative costing of each of the option assessed has been conducted. These indicative costs have been sourced for previous construction activities conducted around Queensland (relevant location factors and site constraints have also been applied).

It should be noted that options 4 to 7 reduce the likelihood of overflows, as they provide adequate capacity within the network for the identified flows.

Table 6 - Indicative Options Costings

		Gravity Mains	PS Storage	Rising Mains	Pump Sets	Total
Option 1	Manhole Install	$15,000	$0	$0	$0	**$15,000**
Option 2	Divert Malakoff St	$65,000	$370,000	$60,000	$70,000	**$565,000**
Option 4	Divert 150 Main & 225 Trunk Main	$415,000	$640,000	$380,000	$150,000	**$1,585,000**
Option 5	Divert only 225 Trunk Main	$415,000	$575,000	$60,000	$175,000	**$1,225,000**
Option 6	Divert PS2 discharge further downstream	$0	$450,000	$490,000	$190,000	**$1,130,000**
Option 7	Gravitate PS2 to PS1	$380,000	$325,000	$0	$140,000	**$845,000**

If the refurbishment of Pump Station 1 was not conducted as part of Option 6, the cost of option 6 is reduced to $610,000.

7 Recommendations

<u>Operational</u>

- When Access Chamber MH1429 (43 Malakoff St) or Access Chamber MH1421 (46 Malakoff St) are known to overflow, it is necessary to also inspect and remediate the ORG at 44 Malakoff St.

<u>Optimum Solution</u>

Based on these identified options and their indicative construction costs, Option 6 and 7 are the preferred solutions.

Further investigation (detailed design) of these two options should be conducted to clarify the costs involved in each option, as well as conduct a full life cycle cost assessment of the options. It is expected that as Option7 results in the removal of 1 pump station, the life cycles costs of this option may be lower than Option 6.

Appendix A – Images

Figure 1 - Site Overview

Figure 2 – December Overflow Locations

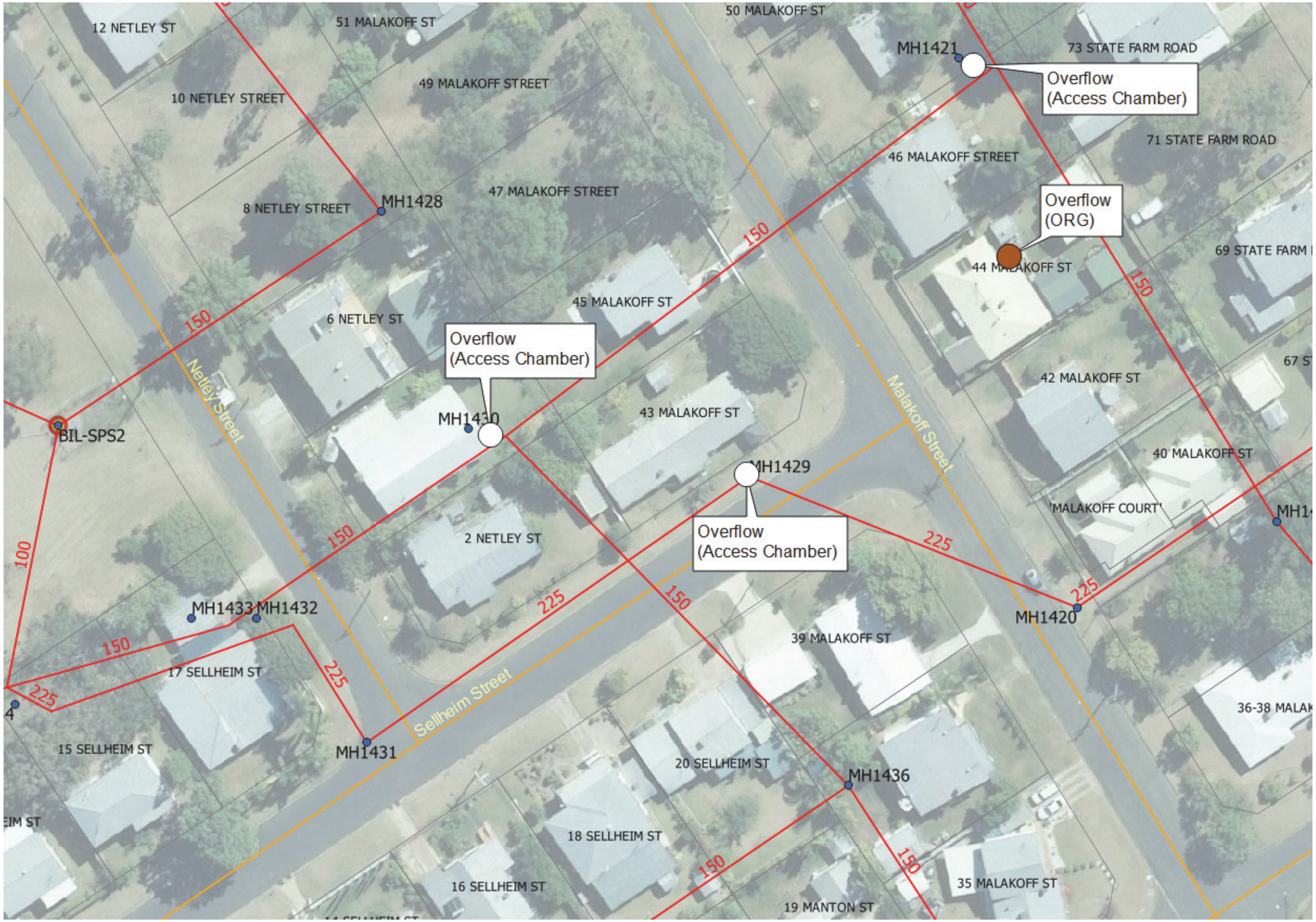

Figure 3 – Identified Sub-Catchments

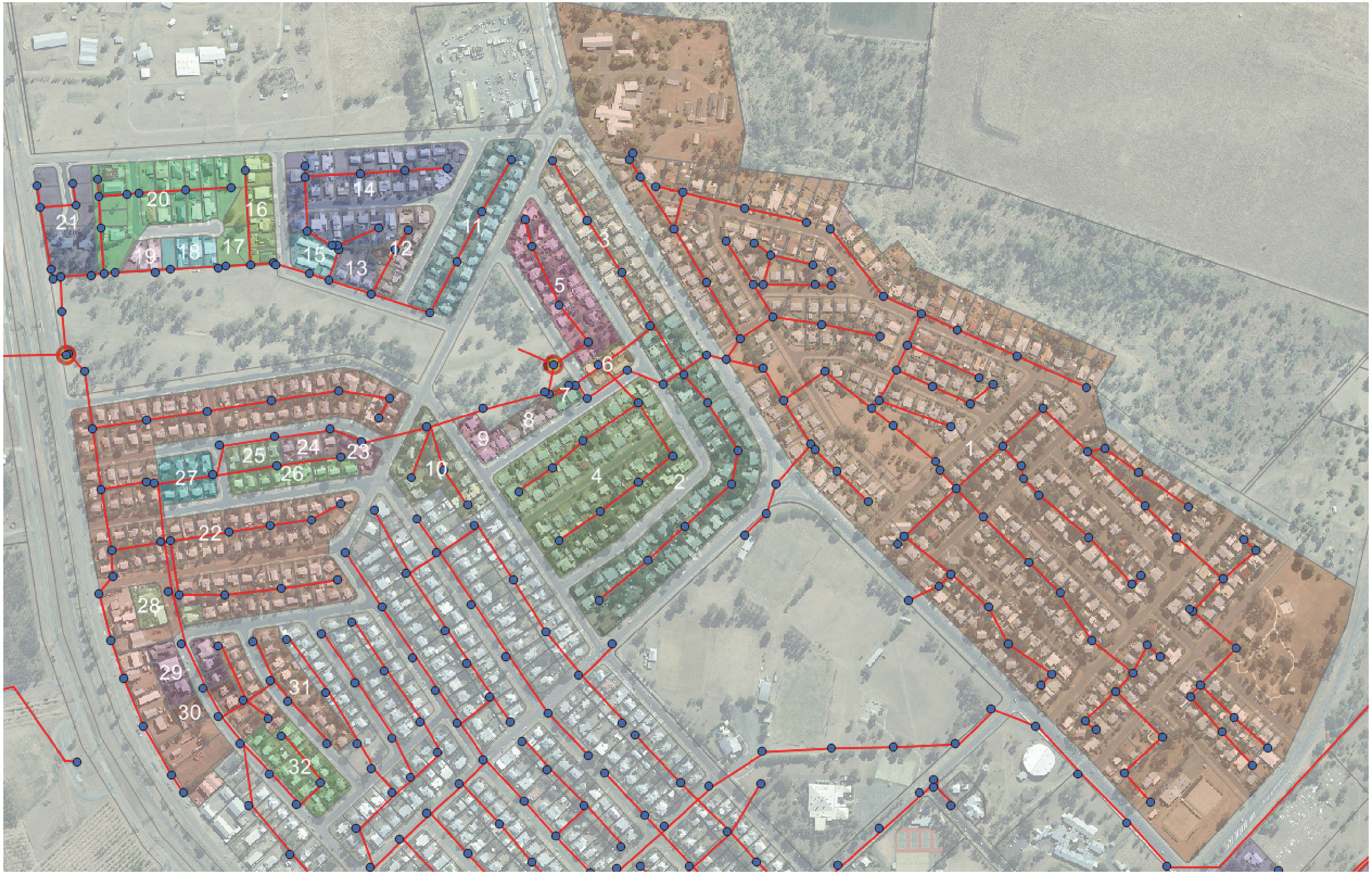

Figure 4 – Option 1

Figure 5 – Option 2

Figure 6 – Option 3

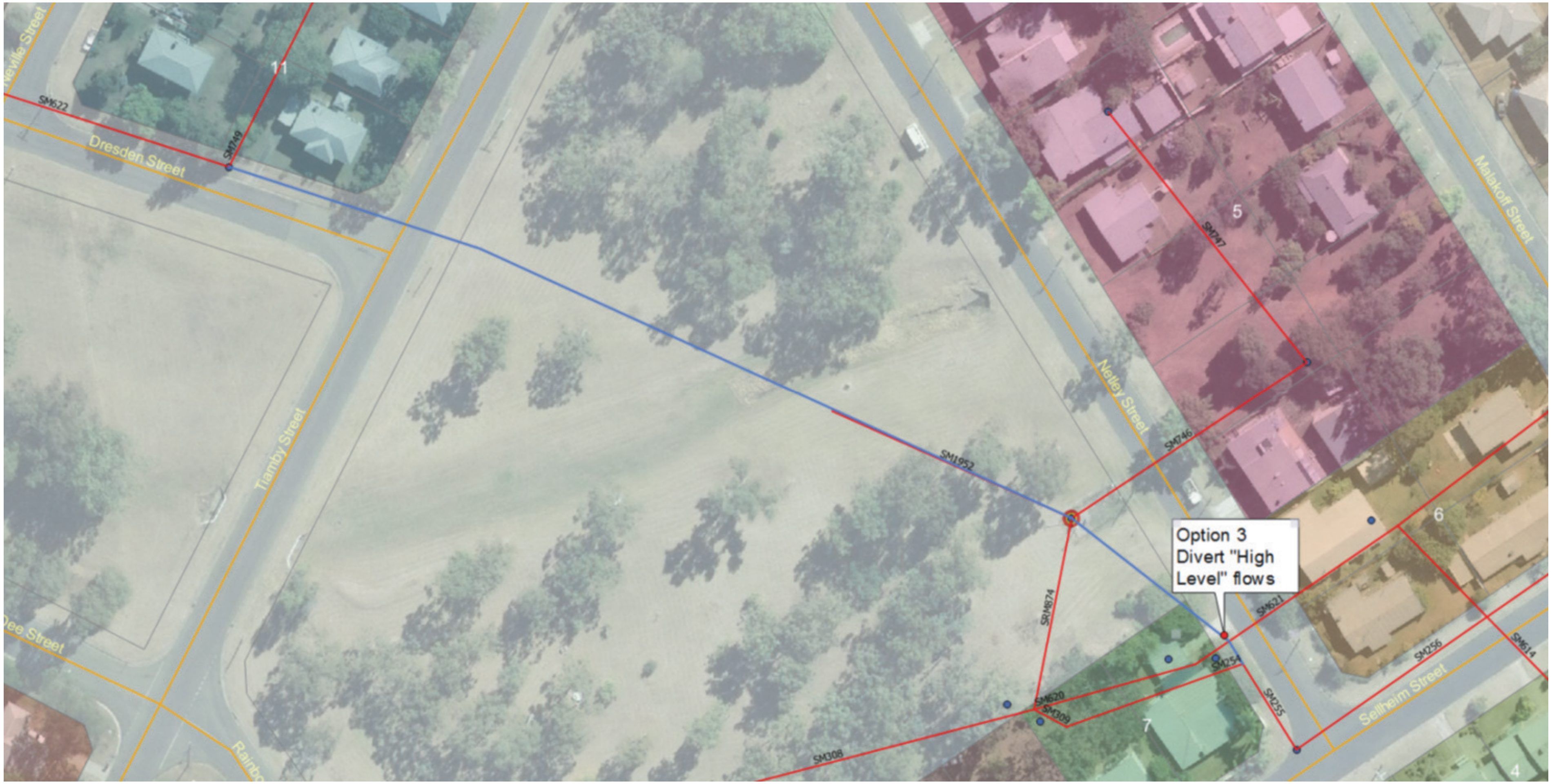

Figure 7 – Option 4

Figure 8 – Option 5

Figure 9 – Option 6

Figure 10 – Option 7

Appendix B – Tables

Table 7 - Current Capacity of Gravity Network

Current Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	156	26	210	184	87.62
12	SM623	150	43	33	410	377	91.95
13 & 14	SM625	150	48	67	380	313	82.37
15	SM624	150	134	73	230	157	68.26
	SM626	150	39	73	430	357	83.02
16	SM627	150	91	81	280	199	71.07
17	SM628	150	132	83	230	147	63.91
18	SM629	150	26	87	530	443	83.58
19	SM631	150	161	89	210	121	57.62
20	SM630	150	189	114	190	76	40.00
21	SM633	150	150	122	220	98	44.55
	SM632	150	150	122	220	98	44.55
4	SM619	150	152	82	210	128	60.95
	SM621	150	179	137	200	63	31.50
	SM620	150	142	137	220	83	37.73
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	370	460	90	19.57
	SM255	225	197	370	560	190	33.93
	SM254	225	104	372	770	398	51.69
	SM309	225	779	372	280	-92	-32.86
5	SM746	150	80	22	300	278	92.67
	SRM874	100					
7	SM308	225	296	535	450	-85	-18.89
8	SM253	225	224	539	520	-19	-3.65
9 & 10	SM252	225	329	551	430	-121	-28.14
	SM251	225	292	554	460	-94	-20.43
	SM307	225	320	559	440	-119	-27.05
	SM250	225	289	563	460	-103	-22.39
	SM249	225	288	563	460	-103	-22.39
	SM248	225	289	581	460	-121	-26.30
	SM247	225	290	581	460	-121	-26.30
	SM246	225	291	581	460	-121	-26.30
	SM245	300	418	584	770	186	24.16
	SM244	300	421	590	770	180	23.38
	SM243	300	421	593	770	177	22.99
	SM242	300	422	613	760	147	19.34
	SM870	150	150	140	220	80	36.36

Table 8 - Option 1 Gravity Network Capacity

Option 1 Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	156	26	210	184	87.62
12	SM623	150	43	33	410	377	91.95
13 & 14	SM625	150	48	67	380	313	82.37
15	SM624	150	134	73	230	157	68.26
	SM626	150	39	73	430	357	83.02
16	SM627	150	91	81	280	199	71.07
17	SM628	150	132	83	230	147	63.91
18	SM629	150	26	87	530	443	83.58
19	SM631	150	161	89	210	121	57.62
20	SM630	150	189	114	190	76	40.00
21	SM633	150	150	122	220	98	44.55
	SM632	150	150	122	220	98	44.55
4	SM619	150	152	82	210	128	60.95
	SM621	150	179	86	200	114	57.00
	SM620	150	142	86	220	134	60.91
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	421	460	39	8.48
	SM255	225	197	421	560	139	24.82
	SM254	225	104	423	770	347	45.06
	SM309	225	779	423	280	-143	-51.07
5	SM746	150	80	22	300	278	92.67
	SRM874	100					
7	SM308	225	296	535	450	-85	-18.89
8	SM253	225	224	539	520	-19	-3.65
9 & 10	SM252	225	329	551	430	-121	-28.14
	SM251	225	292	554	460	-94	-20.43
	SM307	225	320	559	440	-119	-27.05
	SM250	225	289	563	460	-103	-22.39
	SM249	225	288	563	460	-103	-22.39
	SM248	225	289	581	460	-121	-26.30
	SM247	225	290	581	460	-121	-26.30
	SM246	225	291	581	460	-121	-26.30
	SM245	300	418	584	770	186	24.16
	SM244	300	421	590	770	180	23.38
	SM243	300	421	593	770	177	22.99
	SM242	300	422	613	760	147	19.34
	SM870	150	150	140	220	80	36.36

Table 9 - Option 2 Gravity Network Capacity

Option 2 Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	150	128	220	92	41.82
12	SM623	150	150	135	220	85	38.64
13 & 14	SM625	150	150	169	220	51	23.18
15	SM624	150	150	175	220	45	20.45
	SM626	150	150	175	220	45	20.45
16	SM627	150	150	183	220	37	16.82
17	SM628	150	150	185	220	35	15.91
18	SM629	150	150	189	220	31	14.09
19	SM631	150	150	191	220	29	13.18
20	SM630	150	150	216	220	4	1.82
21	SM633	150	150	224	220	-4	-1.82
	SM632	150	150	224	220	-4	-1.82
4	SM619	150	152	2	210	208	99.05
	SM621	150	179	57	200	143	71.50
	SM620	150	142	57	220	163	74.09
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	370	460	90	19.57
	SM255	225	197	370	560	190	33.93
	SM254	225	104	372	770	398	51.69
	SM309	225	779	372	280	-92	-32.86
5	PROPA	150	90	80	280	200	71.43
	SM746	150	80	102	300	198	66.00
	SRM874	100		102			
7	SM308	225	296	433	450	17	3.78
8	SM253	225	224	437	520	83	15.96
9 & 10	SM252	225	329	449	430	-19	-4.42
	SM251	225	290	449	460	11	2.39
	SM870	150	150	140	220	80	36.36

Table 10 - Option 4 Gravity Network Capacity

Option 4 Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	150	555	220	-335	-152.27
12	SM623	150	150	562	220	-342	-155.45
13 & 14	SM625	150	150	596	220	-376	-170.91
15	SM624	150	150	602	220	-382	-173.64
	SM626	150	150	602	220	-382	-173.64
16	SM627	150	150	610	220	-390	-177.27
17	SM628	150	150	612	220	-392	-178.18
18	SM629	150	150	616	220	-396	-180.00
19	SM631	150	150	618	220	-398	-180.91
20	SM630	150	150	643	220	-423	-192.27
21	SM633	150	150	651	220	-431	-195.91
	SM632	150	150	651	220	-431	-195.91
4	SM619	150	152	82	210	128	60.95
	SM621	150	179	137	200	63	31.50
	SM620	150	142	0	220	220	100.00
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	370	460	90	19.57
	SM255	225	197	370	560	190	33.93
	SM254	225	104	2	770	768	99.74
	SM309	225	779	2	280	278	99.29
5	SM746	150	80	22	300	278	92.67
	SRM874	100		529			
7	SM308	225	296	6	450	444	98.67
8	SM253	225	224	10	520	510	98.08
9 & 10	SM252	225	329	22	430	408	94.88
	SM251	225	290	22	460	438	95.22
	SM870	150	150	140	220	80	36.36

Table 11 - Option 5 Gravity Network Capacity

Option 5 Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	150	418	220	-198	-90.00
12	SM623	150	150	425	220	-205	-93.18
13 & 14	SM625	150	150	459	220	-239	-108.64
15	SM624	150	150	465	220	-245	-111.36
	SM626	150	150	465	220	-245	-111.36
16	SM627	150	150	473	220	-253	-115.00
17	SM628	150	150	475	220	-255	-115.91
18	SM629	150	150	479	220	-259	-117.73
19	SM631	150	150	481	220	-261	-118.64
20	SM630	150	150	506	220	-286	-130.00
21	SM633	150	150	514	220	-294	-133.64
	SM632	150	150	514	220	-294	-133.64
4	SM619	150	152	82	210	128	60.95
	SM621	150	179	137	200	63	31.50
	SM620	150	142	137	220	83	37.73
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	370	460	90	19.57
	SM255	225	197	370	560	190	33.93
	SM254	225	104	2	770	768	99.74
	SM309	225	779	2	280	278	99.29
5	SM746	150	80	22	300	278	92.67
	SRM874	100		392			
7	SM308	225	296	143	450	307	68.22
8	SM253	225	224	147	520	373	71.73
9 & 10	SM252	225	329	159	430	271	63.02
	SM251	225	290	159	460	301	65.43
	SM870	150	150	140	220	80	36.36

Table 12 - Option 7 Gravity Network Capacity

Option 7 Capacity							
Catchment	Assets Number	Size	Grade 1:X	Equivalent Tenancy (ET)	Max Allowable ET (Curves)	Available Capacity	Capacity Remaining (%)
11	SM622	150	150	26	220	194	88.18
12	SM623	150	150	33	220	187	85.00
13 & 14	SM625	150	150	67	220	153	69.55
15	SM624	150	150	73	220	147	66.82
	SM626	150	150	73	220	147	66.82
16	SM627	150	150	81	220	139	63.18
17	SM628	150	150	83	220	137	62.27
18	SM629	150	150	87	220	133	60.45
19	SM631	150	150	89	220	131	59.55
20	SM630	150	150	114	220	106	48.18
21	SM633	150	150	122	220	98	44.55
	SM632	150	150	122	220	98	44.55
4	SM619	150	152	82	210	128	60.95
	SM621	150	179	137	200	63	31.50
	SM620	150	142	137	220	83	37.73
1	SM257	225	243	370	500	130	26.00
	SM256	225	282	370	460	90	19.57
	SM255	225	197	370	560	190	33.93
	SM254	225	104	2	770	768	99.74
	SM309	225	779	2	280	278	99.29
5	SM746	150	80	22	300	278	92.67
	SRM874	100		392			
7	SM308	225	296	143	450	307	68.22
8	SM253	225	224	147	520	373	71.73
9 & 10	SM252	225	329	159	430	271	63.02
	SM251	225	290	159	460	301	65.43
	PropM1	225	82	392	870	478	54.94
	SM870	225	7	532	3000	2468	82.27

Table 13 - Option 2 - Pump Station Assessment

Option 2 Summary

Pump Station	Current Pipe Diameter (mm)	Pipe Needed	Velocity (m/s)	Flowrate PWWF (L/s)	Pipe Loss (m/m)	Total Head (m)	Required Operational Storage Capacity (KL)	Required Emergency Storage (kL)	Start Level (Above Stop)	Overflow Level (Above Stop)	Retention time (hrs)	ET's	Upgrades Required			
													Pumps	Rising Main	Operational Storage	Emergency Storage
1	150	Current	0.736	13	0.1706	4.918	1.87	35.49	110	2080	1.810	364	YES		YES	YES
2	100	75 Poly	1.28	4	8.0000	9.84	0.58	9.95	40	600	0.42	102	YES	YES	YES	YES

Option 2 Calculations

Pump Station 1

Preferred Option	1			Pump Power Sizing	2 kW
ET's	364	Static Head (m)	4.47	Total Storage Cost	$235,000
PWWF (l/s)	13	Required Operational Storage Capacity (kL)	1.9	Mech/Elec Cost	$35,000
ADWF (kL/day)	224.64	Actual Operational Storage (kL)	0.8	RM Cost	$0
Starts per Hour	5	Current Emergency Storage (kL)	4.0	**Total Cost**	**$270,000**
Rising Main Length (m)	853	Required Emergency Storage (kL)	35.5		

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
Current	150	**0.74**	0.0002	0.17	10	0.28	4.92	15.1	1.81	Upgrade Storage
100 PVC-M	113	1.30	**0.0220**	18.77	10	0.86	24.09	8.6	1.11	Upgrade Pumps
150 PVC-M	163.8	**0.62**	0.0040	3.41	10	0.19	8.08	18.0	2.12	

Pump Station 2

Preferred Option	1			Pump Power Sizing	2 kW
ET's	102	Static Head (m)	1.00	Total Storage Cost	$135,000
PWWF (l/s)	4	Required Operational Storage Capacity (kL)	0.6	Mech/Elec Cost	$35,000
ADWF (kL/day)	69.12	Actual Operational Storage (kL)	0.5	RM Cost	$60,000
Starts per Hour	5	Current Emergency Storage (kL)	1.9	**Total Cost**	**$230,000**
Rising Main Length (m)	200	Required Emergency Storage (kL)	9.9		

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
75 Poly	63	1.28	**0.0400**	8.00	10	0.84	9.84	0.6	0.42	Upgrade Storage
90 Poly	76	**0.88**	**0.0150**	3.00	10	0.40	4.40	0.9	0.52	Upgrade Storage
100 PVC-M	113	**0.40**	0.0025	0.50	10	0.08	1.58	2.0	0.90	

Table 14 - Option 4 - Pump Station Assessment

Option 4 Summary

Pump Station	Current Pipe Diameter (mm)	Pipe Needed	Velocity (m/s)	Flowrate PWWF (L/s)	Pipe Loss (m/m)	Total Head (m)	Required Operational Storage Capacity (KL)	Required Emergency Storage (kL)	Start Level (Above Stop)	Overflow Level (Above Stop)	Retention time (hrs)	ET's	Upgrades Required: Pumps	Rising Main	Operational Storage	Emergency Storage
1	150	150 PVC-M	1.281	27	6.824	12.132	3.89	77.12	220	4490	1.124	791	YES	YES	YES	YES
2	100	100 PVC-M	1.79	18	4.7000	7.34	2.59	51.58	150	3010	0.36	529	YES	YES	YES	YES

Option 4 Calculations

Pump Station 1

Preferred Option	3			Pump Power Sizing	5.5 kW
ET's	791	Static Head (m)	4.47	Total Storage Cost	$360,000
PWWF (l/s)	27	Required Operational Storage Capacity (kL)	3.9	Mech/Elec Cost	$115,000
ADWF (kL/day)	466.56	Actual Operational Storage (kL)	0.8	RM Cost	$320,000
Starts per Hour	5	Current Emergency Storage (kL)	4.0	**Total Cost**	**$795,000**
Rising Main Length (m)	853	Required Emergency Storage (kL)	77.1		

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
Current	150	1.53	0.0150	12.80	10	1.19	18.46	15.1	0.98	Upgrade Storage
100 PVC-M	113	2.69	0.0520	44.36	10	3.69	52.52	8.6	0.64	Upgrade Pumps
150 PVC-M	163.8	1.28	0.0080	6.82	10	0.84	12.13	18.0	1.12	
200 PVC-M	214.9	0.74	0.0018	1.54	10	0.28	6.29	30.9	1.79	

Pump Station 2

Preferred Option	**2**			Pump Power Sizing	2.2 kW
ET's	529	Static Head (m)	1.00	Total Storage Cost	$280,000
PWWF (l/s)	18	Required Operational Storage Capacity (kL)	2.6	Mech/Elec Cost	$35,000
ADWF (kL/day)	311.04	Actual Operational Storage (kL)	0.5	RM Cost	$60,000
Starts per Hour	5	Current Emergency Storage (kL)	1.9	**Total Cost**	**$375,000**
Rising Main Length (m)	200	Required Emergency Storage (kL)	51.6		

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
125 Poly	106	2.04	0.0420	8.40	10	2.12	11.52	1.8	0.34	Upgrade Pumps
100 PVC-M	113	1.79	0.0235	4.70	10	1.64	7.34	2.0	0.36	Upgrade Storage
150 PVC-M	163.8	0.85	0.0036	0.72	10	0.37	2.09	4.2	0.52	

Table 15 - Option 5 - Pump Station Assessment

Option 5 Summary

Pump Station	Current Pipe Diameter (mm)	Pipe Needed	Velocity (m/s)	Flowrate PWWF (L/s)	Pipe Loss (m/m)	Total Head (m)	Required Operational Storage Capacity (KL)	Required Emergency Storage (kL)	Start Level (Above Stop)	Overflow Level (Above Stop)	Retention time (hrs)	ET's	Upgrades Required: Pumps	Upgrades Required: Rising Main	Upgrades Required: Operational Storage	Upgrades Required: Emergency Storage
1	150	Current	1.302	23	9.383	14.718	3.31	63.77	190	3720	1.110	654	YES		YES	YES
2	100	100 PVC-M	1.40	14	2.9000	4.89	2.02	38.22	120	2240	0.40	392	YES	YES	YES	YES

Option 5 Calculations

Pump Station 1 — Preferred Option: 1

ET's	654
PWWF (l/s)	23
ADWF (kL/day)	397.44
Starts per Hour	5
Rising Main Length (m)	853
Static Head (m)	4.47
Required Operational Storage Capacity (kL)	3.3
Actual Operational Storage (kL)	0.8
Current Emergency Storage (kL)	4.0
Required Emergency Storage (kL)	63.8
Pump Power Sizing	7.5 kW
Total Storage Cost	$325,000
Mech/Elec Cost	$140,000
RM Cost	$0
Total Cost	**$465,000**

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
Current	150	1.30	0.0110	9.38	10	0.86	14.72	15.1	1.11	Upgrade Storage
100 PVC-M	113	**2.29**	0.0380	32.41	10	2.68	39.57	8.6	0.72	Upgrade Pumps
150 PVC-M	163.8	1.09	0.0058	4.95	10	0.61	10.03	18.0	1.29	
200 PVC-M	214.9	**0.63**	0.0014	1.15	10	0.20	5.83	30.9	2.07	

Pump Station 2 — **Preferred Option: 2**

ET's	392
PWWF (l/s)	14
ADWF (kL/day)	241.92
Starts per Hour	5
Rising Main Length (m)	200
Static Head (m)	1.00
Required Operational Storage Capacity (kL)	2.0
Actual Operational Storage (kL)	0.5
Current Emergency Storage (kL)	1.9
Required Emergency Storage (kL)	38.2
Pump Power Sizing	1.5 kW
Total Storage Cost	$250,000
Mech/Elec Cost	$35,000
RM Cost	$60,000
Total Cost	**$345,000**

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
125 Poly	106	**1.59**	0.0260	5.20	10	1.28	7.48	1.8	0.37	Upgrade Pumps
100 PVC-M	113	1.40	0.0145	2.90	10	0.99	4.89	2.0	0.40	Upgrade Storage
150 PVC-M	163.8	**0.66**	0.0022	0.44	10	0.22	1.66	4.2	0.62	

Table 16 - Option 6 - Pump Station Assessment

Option 6 Summary

Pump Station	Current Pipe Diameter (mm)	Pipe Needed	Velocity (m/s)	Flowrate PWWF (L/s)	Pipe Loss (m/m)	Total Head (m)	Required Operational Storage Capacity (KL)	Required Emergency Storage (kL)	Start Level (Above Stop)	Overflow Level (Above Stop)	Retention time (hrs)	ET's	Upgrades Required: Pumps	Upgrades Required: Rising Main	Upgrades Required: Operational Storage	Upgrades Required: Emergency Storage
1	150	100 PVC-M	0.997	10	4.9474	9.926	1.44	26.72	90	1580	1.388	274	YES	YES	YES	YES
2	100	100 PVC-M	1.40	14	10.4400	21.43	2.02	38.22	120	2240	0.92	392	YES	YES	YES	YES

Option 6 Calculations

Pump Station 1 — Preferred Option: 3

ET's	274	Static Head (m)	4.47	Pump Power Sizing	3 kW
PWWF (l/s)	10	Required Operational Storage Capacity (kL)	1.4	Total Storage Cost	$200,000
ADWF (kL/day)	172.8	Actual Operational Storage (kL)	0.8	Mech/Elec Cost	$75,000
Starts per Hour	5	Current Emergency Storage (kL)	4.0	RM Cost	$245,000
Rising Main Length (m)	853	Required Emergency Storage (kL)	26.7	**Total Cost**	**$520,000**

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
Current	150	**0.57**	0.0110	9.38	10	0.16	14.02	15.1	2.29	Upgrade Storage
125 Poly	106	1.13	0.0380	32.41	10	0.65	37.54	7.5	1.25	Upgrade Pumps
100 PVC-M	113	1.00	0.0058	4.95	10	0.51	9.93	8.6	1.39	
150 PVC-M	163.8	**0.47**	0.0014	1.15	10	0.11	5.74	18.0	2.70	

Pump Station 2 — **Preferred Option: 2**

ET's	392	Static Head (m)	10.00	Pump Power Sizing	7.5 kW
PWWF (l/s)	14	Required Operational Storage Capacity (kL)	2.0	Total Storage Cost	$250,000
ADWF (kL/day)	241.92	Actual Operational Storage (kL)	0.5	Mech/Elec Cost	$115,000
Starts per Hour	5	Current Emergency Storage (kL)	1.9	RM Cost	$245,000
Rising Main Length (m)	720	Required Emergency Storage (kL)	38.2	**Total Cost**	**$610,000**

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
125 Poly	106	**1.59**	0.0260	18.72	10	1.28	30.00	6.4	0.83	Upgrade Pumps
100 PVC-M	113	1.40	0.0145	10.44	10	0.99	21.43	7.2	0.92	Upgrade Storage
150 PVC-M	163.8	**0.66**	0.0022	1.58	10	0.22	11.81	15.2	1.70	

Table 17 - Option 7 - Pump Station Assessment

Option 7 Summary

Pump Station	Current Pipe Diameter (mm)	Pipe Needed	Velocity (m/s)	Flowrate PWWF (L/s)	Pipe Loss (m/m)	Total Head (m)	Required Operational Storage Capacity (KL)	Required Emergency Storage (kL)	Start Level (Above Stop)	Overflow Level (Above Stop)	Retention time (hrs)	ETs	Upgrades Required			
													Pumps	Rising Main	Operational Storage	Emergency Storage
1	150	Current	1.302	23	9.383	14.718	3.31	63.77	190	3720	1.110	654	YES		YES	YES

Option 7 Calculations

Pump Station 1

Preferred Option	1			Pump Power Sizing	7.5 kW
ETs	654	Static Head (m)	4.47	Total Storage Cost	$325,000
PWWF (l/s)	23	Required Operational Storage Capacity (kL)	3.31	Mech/Elec Cost	$140,000
ADWF (kL/day)	397.44	Actual Operational Storage (kL)	0.80	RM Cost	$0
Starts per Hour	5	Current Emergency Storage (kL)	4.02	**Total Cost**	**$465,000**
Rising Main Length (m)	853	Required Emergency Storage (kL)	63.77		

Pipe Size	Pipe Diameter (mm)	Velocity (m/s)	Pipe Loss Per Meter	Pipe Loss (m)	Fitting (k)	Total Friction Fitting Loss (m)	Total Head (m)	Pipe Volume (KL)	Average Retention time (hrs)	
Current	150	1.30	0.0110	9.38	10	0.86	14.72	15.07	1.11	Upgrade Storage
100 PVC-M	113	**2.29**	0.0380	32.41	10	2.68	39.57	8.55	0.72	Upgrade Pumps
150 PVC-M	163.8	1.09	0.0058	4.95	10	0.61	10.03	17.97	1.29	
200 PVC-M	214.9	**0.63**	0.0014	1.15	10	0.20	5.83	30.94	2.07	