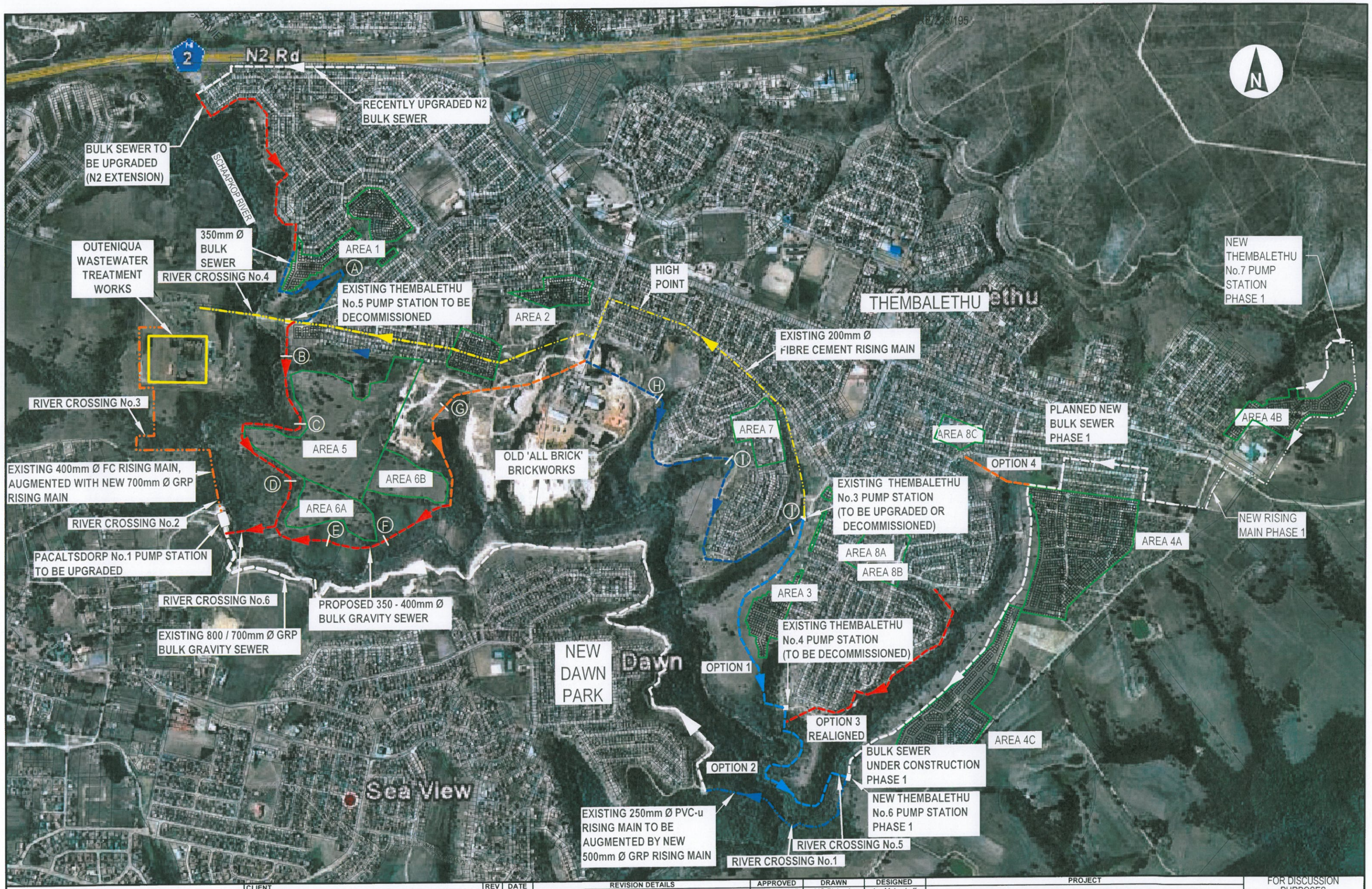

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CLIENT: GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
B	05/2013	RIVER CROSSINGS ADDED	A van Molendorff
C	06/2013	STREAM CROSSINGS ADDED	A van Molendorff
D	07/2013	RIVER CROSSING No. 5 ADDED	A van Molendorff
E	07/2013	RIVER CROSSING No. 6 ADDED	A van Molendorff
F	08/2013	ENLARGED SCALE	A van Molendorff
G	11/2013	LAYOUT REVISED	A van Molendorff
H	11/2013	OPTION 3 REALIGNED	A van Molendorff
I	11/2013	LAYOUT REVISED	A van Molendorff

DRAWN	DESIGNED
MC Richards	A v Molendorff

CHECKED: A v Molendorff

APPROVED: NAME D.Jacobs; SIGNATURE; DATE 13/11/13

PROJECT: THEMBALETHU HOUSING PROJECT

TITLE: REVISED BULK SEWER MAIN PROPOSALS

FOR DISCUSSION PURPOSES

PROJECT No.	
108429	
SCALE	SIZE
1 : 12 750	A3
DRAWING No.	REV
108429 GE 400	I

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26 August 2013

Our Ref: 108429/13.22b AvM/mvw

Department: Civil Engineering Services
George Municipality
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Attention: Ms Lindsay Mooiman/ Mr Nico Liebenberg

Madam/Sir,

GEORGE MUNICIPALITY: THEMBALETHU UISP PROJECT: REVISED BULK SEWER PROPOSALS: Revision 3: TECHNICAL REPORT FOR ENVIRONMENTAL AUTHORISATION PROCESS

1. Introduction:

Due to recent changes in the MIG allocation to the George Municipality, the municipality requested that Aurecon review the current proposals regarding the bulk sewer services required for the Thembalethu UISP project. The George Municipality requested Aurecon to look into possible alternative programmes to service the new housing areas in a practical way, these alternatives must be closely aligned to the available funding at the Municipality, as well as aligning with the UISP housing project to avoid any implementation delays.

We therefore take this opportunity to suggest an alternative programme for the bulk sewer infrastructure required in Pacaltsdorp and Thembalethu for the Thembalethu UISP Housing Project. All discussions will need to be read in conjunction with drawing No. 108429 GE 400 Revision F.

The proposal now proposed includes the following:

1) Proposed Bulk Gravity Sewers catering for sewerage flows around Area 3 ranging from approximately 10 ℓ/s to 92ℓ/s: (1200m long 300mm diameter and 630m long 350mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer Class 34 (heavy duty) pipelines,

2) Proposed 60m concrete pipe-bridge, for 500mm diameter gravity sewer, over the Schaapkop River tributary,

3) Major upgrade of Pacaltsdorp No. 1 Sewer Pump station; design flow increases from current 125 ℓ/s to interim design flow of 345 ℓ/s, with design consideration for a final design flow of 780 ℓ/s at the pump station with future developments), with a new 4m wide paved access road (approximately 500m long) also included,

4) Upgrade 1100 m long Pacaltsdorp No. 1 Pump station rising main with an additional 700mm diameter GRP (Glass Reinforced Polyester), sewer rising main adjacent to the existing 400mm diameter fibre cement rising main, with two (2) minor span concrete pipe bridges,

5) Proposed 30m post-tensioned concrete pipe-bridge, for 500mm diameter gravity sewer, over the Schaapkop River (New proposal) adjacent to Pacaltsdorp No. 1 sewer pump station,

6) Upgrade 710 m long Thembalethu No. 6 Pump station rising main with an additional 500mm diameter GRP (Glass Reinforced Resin), Class 16 sewer rising main adjacent to the existing 250mm diameter PVC-u rising main,

7) Major upgrade of Thembalethu No. 6 Sewer Pump station; current design flow increases from 60 ℓ/s to approximately 185 ℓ/s with design consideration for a final design flow of 380 ℓ/s at the pump station with future developments, with a new 320 ℓ/s inlet works, with mechanical screens, with a new 1.5 MVA emergency power generator. The existing 350kVA emergency generator will then be installed in the next most critical sewerage pump station as part of this contract,

8) New Bulk Gravity Sewers for UISP Areas 1, 5, 6A, 6B and 2; in two sections, catering for sewerage flows from 10 ℓ/s to 115 ℓ/s: First section approximately 2985m long (950m long 200mm diameter, 250m long 250mm diameter, 475m long 300mm diameter and 825m long 400mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer pipeline (Class 34 (heavy duty)) and 485m long 450mm diameter GRP (Glass Reinforced Resin), Class 6 sewer pipelines). Second section approximately 975m long (725m long 200mm diameter and 200m long 250mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer pipeline (Class 34 (heavy duty)),

9) De-commission Thembalethu sewer pump stations No. 4 (15 ℓ/s), No. 3 (45 ℓ/s) and No. 5 (15 ℓ/s),

The proposed programme will see the construction of Items 1 to 4 in the 2013/2014 financial year, with Items 5 to 9 being completed in the 2014/2015 and 2015/2016 financial years. The above options are now discussed in more detail below:

1. Proposed Bulk Gravity Sewers catering for sewerage flows around Area 3 and associated Pipe bridge

The proposed bulk sewer pipeline is indicated in blue as option 1 on the attached drawing, drawing No. 108429 GE 400 Rev F. This pipeline is urgently required to allow the housing project to proceed in the next financial year. By installing the pipeline Area 3 of the Thembalethu UISP project can be serviced. Thembalethu sewerage pump station No. 6 currently only has 15 l/s spare capacity, until it is upgraded in the 2014/2015 financial year. This means that only the new developments can be linked to the new bulk sewer until such time that both Pacaltsdorp No.1 and Thembalethu No. 6 Sewerage Pump stations' upgrades are completed.

The proposed bulk gravity sewerage pipelines will be designed to accommodate the expected sewerage flows around Area 3 ranging from approximately 10 ℓ/s to 92ℓ/s: (1200m long 300mm diameter and 630m long 350mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer Class 34 (heavy duty) pipelines. Initially the pipeline will only be handling a flow of less than 15 ℓ/s until the Thembalethu No.6 sewerage pump station is upgraded. The bulk sewer drains to this pump station, which currently has a design capacity of 60 ℓ/s of which 75% is already committed to Area 4 of the UISP project.

slope. The bench will also allow the Municipality to maintain this asset, by providing a safe access track for maintenance work on the pipeline route. Manholes will be provided every 80m to allow proper maintenance to be carried out.

2. Proposed 60m concrete pipe-bridge, for 500mm diameter gravity sewer, over the Schaapkop River tributary

The proposed bulk sewer pipeline servicing Area 3, discussed in Item 1 above, requires a 60m concrete pipe bridge to accommodate the 500mm diameter bulk gravity sewer, as this pipeline needs to cross the Schaapkop River tributary. The position of this crossing is indicated as River crossing No. 5 on the attached drawing, drawing No. 108429 GE 400 Rev F. A 500mm diameter pipeline will be installed in the pipe bridge, which is over and above the initially required diameter of 350mm. This will allow the pipelines to be upgraded to the pipe bridge in the future to accommodate the increasing flows from the area as Thembalethu develops.

A concrete pipe bridge is considered prudent, as the recently completed steel pipe bridge over the Schaapkop River has already been vandalised, only months after being completed. The River valley is also very deep at the crossing point and 13m high piers will be required to support the pipe bridge. This does have the advantage that the pipe bridge is in no danger from flooding. The pipe bridge is proposed to have a 1m x 1m square section, with reinforcing being placed around the perimeter, while the pipeline will be placed in the middle of the concrete section.

3. Proposed Upgrade of Pacaltsdorp Sewerage Pump station No.1 and Rising main

3.1 Design flows

The design was based on the following design flows:

- Current inflow = 125 ℓ/s
- Interim flow scenario = 345 ℓ/s
- Future flow scenario = 780 ℓ/s

3.2 Optimisation

The existing rising main is a DN 400 pipeline. An additional rising main needs to be constructed to accommodate the future flows.

A pipeline optimisation was performed for the future rising main to calculate the effective diameter that would result in the lowest net present value (NPV). The optimisation was performed by developing a costing model to calculate the net present values (NPVs) for various pipeline diameters. The NPV takes into account capital, operating and maintenance costs for the ultimate design flow to determine the cost benefits for the various rising main pipe diameter options.

Table 4 below summarises the NPVs calculated for the various pipe diameters. It should be noted that the NPVs do not reflect the construction cost.

Table 4: NPVs for Pacaltsdorp rising main

Pipe diameter (mm)	NPV @ 4% discount	NPV @ 8% discount
600	45,344,237	38,668,924
700	41,992,560	35,982,063
800	40,641,160	34,912,456
900	40,429,949	34,822,313
1000	40,556,017	35,003,919

It is evident from **Table 4** that a rising main with an effective internal diameter of 900 mm would be the optimum solution. The effective diameter is, however, the combined diameter between the existing DN 400 rising main and the future rising main. **Table 5** shows the options that were considered for a future rising main diameter:

Table 5: Options for Pacaltsdorp future rising main

Existing pipe diameter (mm)	Future pipe diameter (mm)	Combined pipe diameter (mm)
400	700	757
400	800	847

3.3 Pump type selection

The design of the existing pump station makes provision for the installation of four (4) pumps, i.e. three duty and one standby. The initial pump selection was therefore based on three duty pumps.

Figure 5 shows the pipeline characteristic curves for DN 400, DN 700 and DN 800 pipelines, as well as the pump curves for an ABS XFP 250 pump, fitted with a 465 mm impeller, and a 200 kW motor operating at 1480 RPM.

Figure 6 shows the pipeline characteristic curves for DN 400 & DN 700, and DN 400 & DN 800, pipelines in parallel, as well as the pump curves for an ABS XFP 250 pump, fitted with a 465 mm impeller, and a 200 kW motor operating at 1480 RPM.

The following should be noted from **Figure 5** (additional comments are provided in italics where required):

- Flow in DN 400 (HW = 110) with one pump operating = 220 ℓ/s (v = 1.75 m/s). *The minimum flow that must be achieved with the pump (i.e. based on its allowable operating range) should be 70 ℓ/s. The pump will therefore operate satisfactorily in the DN 400 pipeline.*
- Flow in DN 700 (HW = 110) with one pump operating = 290 ℓ/s (v = 0.75 m/s)
- Flow in DN 800 (HW = 110) with one pump operating = 300 ℓ/s (v = 0.60 m/s). *The velocity in the DN 800 pipe is lower than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 700 (HW = 110) with three pumps operating = 760 ℓ/s (v = 1.97 m/s).
- Flow in DN 800 (HW = 110) with three pumps operating = 830 ℓ/s (v = 1.65 m/s)

The following should be noted from **Figure 6** (additional comments are provided in italics where required):

- Flow in DN 400 & DN 700 (HW = 110) with one pump operating = 295 ℓ/s (v = 0.66 m/s). *The velocity in the combined DN 400 and DN 700 pipelines is marginally less than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 400 & DN 800 (HW = 110) with one pump operating = 300 ℓ/s (v = 0.53 m/s). *The velocity in the combined DN 400 and DN 800 pipelines will be much lower than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 400 & DN 700 (HW = 110) with three pumps operating = 810 ℓ/s (v = 1.80 m/s). *Three pumps in parallel in an aged DN 400 and DN 700 pipeline would deliver a flow that's higher than the future design flow of 780 ℓ/s.*
- Flow in DN 400 & DN 800 (HW = 110) with three pumps operating = 845 ℓ/s (v = 1.50 m/s).
- Flow in DN 400 & DN 700 (HW = 140) with three pumps operating = 840 ℓ/s (v = 1.87 m/s)
- Flow in DN 400 & DN 800 (HW = 140) with three pumps operating = 860 ℓ/s (v = 1.53 m/s)

It is evident from **Figures 5 and 6** that the minimum required cleaning velocities would not be achieved in a DN 800 rising main with only one pump operational, especially when the existing DN 400 pipeline is operated in parallel with the DN 800 pipeline. The future rising main should therefore be a DN 700 pipeline.

3.4 Rising Main Recommendation

It appears that a DN 700 rising main would be the optimal pipe diameter for the proposed 1100m rising main. This rising main will be constructed approximately 4m parallel to the existing 400mm diameter fibre-cement rising main. The routes would be the same, with the only exception being that the proposed 700mm diameter rising main will be crossing the two streams (see river crossing no. 2 and 3 on the attached drawing, drawing no. 108429 GE 400) in concrete pipe bridges. The two streams have relatively steep sides, which cannot be easily accommodated by this large diameter pipeline. Therefore a concrete pipe bridge is proposed for these relatively short spans. Due to the large diameter of the proposed rising main a square section of approximately 1.2m x 1.2m will be required for the pipe bridge. Concrete piers will be provided to support the bridge at both ends. The pipe bridge has been designed to be above the 1:100 year flood level. Air- and scour-valves will be provided to allow the pipeline to operate efficiently. The rising main will stop at the entrance to the Outeniqua Wastewater Treatment Works and the flow will be split between the existing inlet works and the proposed new inlet works. The upgrading of the Outeniqua Wastewater Treatment Works falls outside the scope of this report, but we can report that the works will be upgraded over the next three to four years to accommodate the Thembalethu UISP project (4939 erven), as well as the newly proposed Syferfontein Housing Project (7700 erven).

3.5 Pump station Upgrades required

Currently the pump station handles a flow of 125 ℓ/s. The bulk gravity sewer draining to the pump station and the inlet works was upgraded by the Municipality in 2009 to accommodate the ultimate future design flow of 780 ℓ/s. The inlet works was fitted with front-rake screens (one duty, one

standby). At the same time a 1 MVA emergency power supply generator was installed to allow the pump station to remain operational during prolonged power failures. No additional upgrading work is required at these components.

The flow passes through the inlet works and then split between two duty sumps, with a third sump provided. The third sump is currently been filled with a weak mix mortar. The existing flow is accommodated by two pump sets consisting of two pumps each, connected in series. These pumps cannot be re-used and will be sold for scrap. They have been in operation for 14 years and are of no use to the Municipality. The closed vane impellors of these pumps have also been a source of high maintenance due to frequent blockages caused by the pumps' limited solids handling capacity.

The proposal now is to construct a larger sump adjacent to the existing three sumps. The two (2) proposed approximately 2.5 ton pumps, which will have a height of approximately 2.4m, will be temporarily installed into this new sump. The pumps will be capable of pumping approximately 300 ℓ/s each and will be linked temporarily to the existing rising main. Due to the existing 400mm diameter rising main's fairly limited capacity, the new pump's flow will initially be throttled back by the VSD drive to approximately 150 ℓ/s. At the same time a new separate Motor Control Circuit (MCC) panel room will be constructed adjacent to the main pump dry well. This room will be air-conditioned to cool the variable speed drives (VSD) required for the pumps approximately 200kW motors, which will be housed in the MCC panel.

Once the MCC room is completed the new panel will be installed and connected to the new pumps located in the new sump. This will be a temporary installation, for as soon as the new pumps (one duty and one standby, are put in operation this will allow the existing pumps and the concrete floor between the two pumps connected in series to be demolished. This will then provide the space required for the permanent installation of the new pumps in the dry well, as well as allow the completion of the new upgraded pipework required for the higher design flows. A new 3-ton gantry will be installed to service the new pumps, while the existing two (2) 2-ton gantries will be retained to move the proposed new larger diameter valves around in the dry well for installation and in the future for servicing purposes.

At the same time the existing three sumps division walls will be removed and the sumps will be re-divided into two (2) enlarged sumps required for the higher flows. Once this is completed one of the new pumps will be removed from the sump initially constructed and installed in the newly modified dry well. Once the installation is completed the pump will be tested and put into service, thereby allowing the second pump to be installed and put in service in the dry well. The initial sump constructed will then be modified to accommodate the third pump required in the future. The MCC panel will have the electronics required for this third pump already installed, pending the approval of the Municipality.

The new pumps will also need to be connected to the new 700mm diameter rising main, which will work in conjunction with the existing 400mm diameter rising main to accommodate the future design flows expected at this pumps station. The cross connections required for this pipework will be completed once the new rising main is completed and tested. This will complete the upgrading

currently required at the Pacaltsdorp No. 1 sewerage pump station and allow the completion of the full Thembalethu 4939 erven UISP project.

4. Proposed 30m post-tensioned concrete pipe-bridge, for 500mm diameter gravity sewer, over the Schaapkop River adjacent to Pacaltsdorp No. 1 sewer pump station

The proposed bulk sewer pipeline servicing Areas 1, 5, 6A, 6B and Area 2 requires a 30m post tensioned concrete pipe bridge to accommodate the 500mm diameter bulk gravity sewer, as this pipeline needs to cross the Schaapkop River adjacent to the Pacaltsdorp No. 1 Sewerage Pump station. The position of this crossing is indicated as River crossing No. 6 on the attached drawing, drawing No. 108429 GE 400 Rev F. A 500mm diameter pipeline will be installed in the pipe bridge, which is over and above the initially required diameter of 450mm. This will allow the pipelines to be upgraded to the pipe bridge in the future to accommodate the increasing flows from the area as Thembalethu develops.

A post-tensioned concrete pipe bridge is considered prudent, as the recently completed steel pipe bridge over the Schaapkop River has already been vandalised, only months after being completed. The Schaapkop River flood plain is also shallow at the crossing point and the 30m span is required to provide a clear span over the flood-plain, thereby not providing any obstructions in the 1:100 flood levels that are below the bridge level. A concrete span this long can only be achieved by providing post-tensioning in the concrete structure and as discussed above this does have the advantage that the pipe bridge is in no danger from flooding. The pipe bridge is proposed to have a 1.1m x 1.1 m square section, with the reinforcing and the post-tensioning cables being placed around the perimeter, while the pipeline will be placed in the middle of the concrete section.

The bridge supports will be constructed on concrete piles that have been driven into the rock formations below the river bed. The piling position will be outside the 1:100 year flood-plain. The river banks around the piles will be protected with gabions. The adjacent pump station is protected by gabions on the river bank and the intention is merely to extend this protection to the pipe bridge support positions.

5. Proposed Upgrade of Thembalethu Sewerage Pump station No. 6 and Rising main

5.1 Design flows

The design was based on the following design flows:

- Current inflow = 60 ℓ/s
- Interim flow scenario = 220 ℓ/s
- Future flow scenario = 342 ℓ/s

5.2 Optimisation

The existing rising main is a DN 250 pipeline. An additional rising main needs to be constructed to accommodate the future flows.

A pipeline optimisation was performed for the future rising main to calculate the effective diameter that would result in the lowest net present value (NPV). The optimisation was performed by developing a costing model to calculate the net present values (NPVs) for various pipeline diameters. The NPV takes into account capital, operating and maintenance costs for the ultimate design flow to determine the cost benefits for the various rising main pipe diameter options.

Table 1 below summarises the NPVs calculated for the various pipe diameters. It should be noted that the NPVs do not reflect the construction cost.

Table 1: NPVs for Thembalethu rising main

Pipe diameter (mm)	NPV @ 4% discount	NPV @ 8% discount
350	25,447,419	21,741,411
400	22,373,407	19,180,586
450	21,140,834	18,185,561
500	20,635,925	17,799,704
600	20,777,822	18,028,356
700	21,498,019	18,760,310
800	21,888,580	19,153,389

It is evident from **Table 1** that a rising main with an effective internal diameter of 500 mm would be the optimum solution. The effective diameter is, however, the combined diameter between the existing DN 250 rising main and the future rising main. **Table 2** shows the options that were considered for a future rising main diameter:

Table 2: Options for Thembalethu future rising main

Existing pipe diameter (mm)	Future pipe diameter (mm)	Combined pipe diameter (mm)
250	450	484
250	500	529

5.3 Pump type selection

The design of the existing pump station makes provision for the installation of four (4) pumps, i.e. three duty and one standby. The initial pump selection was therefore based on three duty pumps.

Figure 1 shows the pipeline characteristic curves for DN 250, DN 450 and DN 500 pipelines, as well as the pump curves for an ABS XFP 200 pump, fitted with a 427 mm impeller, and a 132 kW motor operating at 1480 RPM.

Figure 2 shows the pipeline characteristic curves for DN 250 & DN 450, and DN 250 & DN 500, pipelines in parallel, as well as the pump curves for an ABS XFP 200 pump, fitted with a 427 mm impeller, and a 132 kW motor operating at 1480 RPM.

The following should be noted from **Figure 1** (additional comments are provided in italics where required):

- Flow in DN 250 (HW = 110) with one pump operating = 80 ℓ/s (v = 1.63 m/s). *The minimum flow that must be achieved with the pump (i.e. based on its allowable operating range) should be 42 ℓ/s. The pump will therefore operate satisfactorily in the DN 250 pipeline.*
- Flow in DN 450 (HW = 110) with one pump operating = 130 ℓ/s (v = 0.82 m/s)
- Flow in DN 500 (HW = 110) with one pump operating = 135 ℓ/s (v = 0.69 m/s). *The velocity in the DN 500 pipe is marginally lower than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 450 (HW = 110) with three pumps operating = 300 ℓ/s (v = 1.89 m/s).
- Flow in DN 500 (HW = 110) with three pumps operating = 335 ℓ/s (v = 1.71 m/s)

The following should be noted from **Figure 2** (additional comments are provided in italics where required):

- Flow in DN 250 & DN 450 (HW = 110) with one pump operating = 133 ℓ/s (v = 0.72 m/s)
- Flow in DN 250 & DN 500 (HW = 110) with one pump operating = 137 ℓ/s (v = 0.62 m/s). *The velocity in the combined DN 250 and DN 500 pipelines will be less than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 250 & DN 450 (HW = 110) with three pumps operating = 327 ℓ/s (v = 1.77 m/s). *Three pumps in parallel in an aged DN 250 and DN 450 pipeline would deliver a flow that's slightly lower than the future design flow of 342 ℓ/s.*
- Flow in DN 250 & DN 500 (HW = 110) with three pumps operating = 350 ℓ/s (v = 1.59 m/s). *Three pumps in parallel in an aged DN 250 and DN 500 pipeline would deliver the future design flow of 342 ℓ/s.*
- Flow in DN 250 & DN 450 (HW = 140) with three pumps operating = 350 ℓ/s (v = 1.90 m/s)
- Flow in DN 250 & DN 500 (HW = 140) with three pumps operating = 370 ℓ/s (v = 1.68 m/s)

It is evident from **Figures 1 and 2** that the minimum required cleaning velocities would not be achieved in a DN 500 rising main with only one pump operational, especially when the existing DN 250 pipeline is operated in parallel with the DN 500 pipeline.

The option to install two pumps was also evaluated. **Figure 3** shows the pipeline characteristic curves for DN 250, DN 450 and DN 500 pipelines, as well as the pump curves for an ABS XFP 200 pump, fitted with a 450 mm impeller, and a 160 kW motor operating at 1480 RPM.

Figure 4 shows the pipeline characteristic curves for DN 250 & DN 450, and DN 250 & DN 500, pipelines in parallel, as well as the pump curves for an ABS XFP 200 pump, fitted with a 450 mm impeller, and a 160 kW motor operating at 1480 RPM.

The following should be noted from **Figure 3** (additional comments are provided in italics where required):

- Flow in DN 250 (HW = 110) with one pump operating = 105 ℓ/s (v = 2.14 m/s). *The minimum flow that must be achieved with the pump (i.e. based on its allowable operating range) should be 42 ℓ/s. The pump will therefore operate satisfactorily in the DN 250 pipeline.*
- Flow in DN 450 (HW = 110) with one pump operating = 180 ℓ/s (v = 1.13 m/s)
- Flow in DN 500 (HW = 110) with one pump operating = 185 ℓ/s (v = 0.94 m/s). *The velocity in the DN 500 pipe is higher than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 450 (HW = 110) with two pumps operating = 310 ℓ/s (v = 1.95 m/s).
- Flow in DN 500 (HW = 110) with two pumps operating = 335 ℓ/s (v = 1.71 m/s)

The following should be noted from **Figure 4** (additional comments are provided in italics where required):

- Flow in DN 250 & DN 450 (HW = 110) with one pump operating = 183 ℓ/s (v = 0.99 m/s)
- Flow in DN 250 & DN 500 (HW = 110) with one pump operating = 187 ℓ/s (v = 0.85 m/s). *The velocity in the combined DN 250 and DN 500 pipelines will be higher than the minimum recommended cleaning velocity of 0.7 m/s.*
- Flow in DN 250 & DN 450 (HW = 110) with two pumps operating = 330 ℓ/s (v = 1.79 m/s). *Two pumps in parallel in an aged DN 250 and DN 450 pipeline would deliver a flow that's slightly lower than the future design flow of 342 ℓ/s.*
- Flow in DN 250 & DN 500 (HW = 110) with two pumps operating = 345 ℓ/s (v = 1.57 m/s). *Two pumps in parallel in an aged DN 250 and DN 500 pipeline would deliver the future design flow of 342 ℓ/s.*
- Flow in DN 250 & DN 450 (HW = 140) with two pumps operating = 345 ℓ/s (v = 1.88 m/s)
- Flow in DN 250 & DN 500 (HW = 140) with two pumps operating = 360 ℓ/s (v = 1.64 m/s)

It is evident from **Figures 3 and 4** that the option with two pumps will be feasible when using a new DN 450 or DN 500 rising main. The DN 500 rising main would deliver approximately 4% more flow compared to the DN 450 rising main.

5.4 Recommendation

Based on the cost estimate provided in **Table 3**, it appears that the option with two pumps and a DN 500 rising main would be the most economical option. It would also be possible to install a DN 450 rising main together with two pumps at an approximate saving of R 200 000 (excluding VAT), but this would also result in a reduction in flow capacity of 4%. The rising main will be approximately 710m long.

This rising main will be constructed approximately 4m parallel to the existing 250mm diameter PVC-U rising main. A bench will be created in the slope above the existing 250mm rising main and the slope will be stabilised with gabions, where required. The route would be the same, with the proposed 500mm diameter rising main using the existing 30m steel pipe bridge to cross the Schaapkop River (see river crossing no. 1 on the attached drawing, drawing no. 108429 GE 400). The original pipe bridge design made provision for the future 500mm diameter rising main and the pipeline will be installed in the existing cradle provided for the rising main. The existing pipe bridge has been designed to be above the 1:100 year flood level. Air- and scour-valves will be provided on the new rising main to allow the pipeline to operate efficiently. The rising main will stop at the existing transfer manhole, where an existing connection point has been provided for this rising main. The sewerage then gravitates through the existing approximately 3.5km 700/800mm diameter Pacaltsdorp bulk sewerage main to the Pacaltsdorp Sewerage Pump station No.1. The proposed 500mm and existing 250mm diameter rising mains will be able to handle the flow generated by the UISP housing project draining to the Thembalethu No. 6 sewerage pump station.

5.5 Pump station Upgrades required

Currently the pump station handles a design flow of 60 ℓ/s, although a 25% spare capacity currently exists. A bulk gravity sewer draining Area 4 of the UISP housing project, the pump station and the inlet works was constructed by the Municipality in 2012 to accommodate Area 4. The pump station was designed to be upgradeable the ultimate future design flow of 380 ℓ/s. The existing 100 ℓ/s inlet works was fitted with front-rake screens (one duty, one standby). At the same time a 350 kVA emergency power supply generator was installed to allow the pump station to remain operational during prolonged power failures.

The pump station will now be upgraded to handle an interim design flow of 220 ℓ/s. This will require that the inlet works be upgraded and possibly an additional inlet works will need to be constructed to accommodate this increased flow. A new 700 mm diameter bulk sewer inlet pipeline will be constructed to accommodate the increased flow to the pump station.

The existing 350kVA emergency power generator will also then be replaced with a 1.5MVA unit, but this will be simply accomplished by swopping out the existing unit with the new unit. The existing 350kVA unit will then be installed at one of the Municipality's other sewerage pump stations, at this stage it is proposed that the unit be installed at the Eden sewerage pump station.

The existing flow passes through the inlet works and then discharges into one os the two existing sumps. Two additional sumps will now be constructed adjacent to the existing sumps. The existing flow is accommodated by two pump sets (one duty, one standby). These pumps will be re-used at one of the Municipality's existing sewerage pump stations, which require an upgrade. This will be finalised later in conjunction with the Municipality. They have only been in operation for 1 year and are a valuable asset to the Municipality.

The proposed flow of 220 ℓ/s will make use of three of the four sumps, but the additional sump needs to be constructed to allow the construction of the dry well building to proceed. A new dry

well building will be constructed below the sumps for the installation of the three (3) new pumpsets (two duty, one standby). Each of the pumps will be able to handle a flow of approximately 183 ℓ/s, therefore to handle the design flow of 220 ℓ/s two pumpsets are required, under VSD control, to pump the proposed flow. The pumps will be linked to the new and existing rising mains to pump the required flow of 220 ℓ/s. At the same time a new Motor Control Circuit (MCC) panel will be installed adjacent to the existing pump's MCC panel. This room will be air-conditioned to cool the variable speed drives (VSD) required for the new pumps, which will be housed in the MCC panel. The MCC panel will have the electronics required for the future fourth pump already installed, pending the approval of the Municipality. The existing MCC panel will remain in operation until the new pump installation comes on-line. The existing pumps and MCC panel will then be moved to a new sewerage pump station, yet to be determined.

A new 2-ton gantry crane will be installed to service the new pumps and valves around in the dry well during installation and in the future for servicing purposes.

The new pumps will be connected to the new 500mm diameter rising main, which will work in conjunction with the existing 250mm diameter rising main to accommodate the future design flows expected at this pumps station. The cross connections required for this pipework will be completed once the new rising main is completed and tested. This will complete the upgrading currently required at the Thembalethu No. 6 sewerage pump station and allow the completion of the Thembalethu UISP project Areas draining to this pump station. This will also allow the connection of the existing sewer network to the new bulk sewer constructed under Item 1 of this project, which drains to the Thembalethu No. 6 sewerage pump station and allow the Municipality to de-commission the existing Thembalethu No. 4 (15 ℓ/s) and Thembalethu No. 3 (35 ℓ/s) sewerage pump stations, thereby reducing the maintenance burden on the municipality.

6. Proposed Bulk Gravity Sewers catering for sewerage flows around Area 1, 5, 6A, 6B and 2; and associated stream crossings

The proposed Bulk Gravity Sewers for UISP Areas 1, 5, 6A, 6B and 2;will be constructed in two sections (catering for sewerage flows from 10 ℓ/s to 115 ℓ/s). The proposed bulk sewer pipelines are indicated in blue and red around Areas 1, 5, 6A and 6B on the attached drawing, drawing No. 108429 GE 400 Rev F. The first section draining UISP Areas 1, 5 and a portion of Area 6A will be approximately 2985m long (950m long 200mm diameter, 250m long 250mm diameter, 475m long 300mm diameter and 825m long 400mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer pipeline (Class 34 (heavy duty)) and 485m long 450mm diameter GRP (Glass Reinforced Resin), Class 6 sewer pipelines). The second section draining the rest of Area 6A, 6B and Area 2 will be approximately 975m long (725m long 200mm diameter and 200m long 250mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer pipeline (Class 34 (heavy duty)).

The bulk sewer will be benched into the steep side slope over most of its length and the intention is to use gabions to stabilise the cut slope, which will limit the visual impact of the bench on the slope. The bench will also allow the Municipality to maintain this asset, by providing a safe access track for maintenance work on the pipeline route. Manholes will be provided every 80m to allow proper maintenance to be carried out.

Together with the second section of the bulk sewer, a number of bottlenecks in the Thembalethu connector sewer network have been identified by the Municipality's sewer section, around the housing areas, which will need to be addressed to ensure that the complete system is able to handle the additional flow added into the existing sewerage system. A number of critical areas have been identified, which means that approximately 4965m of existing connector sewers will need to be upgraded (2380m long 160mm diameter, 1325m long 200mm diameter and 1260m long 250mm diameter PVC-u (Un-plasticised Polyvinyl Chloride) sewer pipeline (Class 34: heavy duty), to remove any potential bottlenecks in the existing sewer reticulation network.

Stream crossings

The bulk sewers will all drain to the post tensioned concrete pipe-bridge described under Item 4 above. Indicated as River crossing No. 6 on the attached drawing, drawing No. 108429 GE 400 Rev F. The preliminarily proposed stream crossings, labelled A to J are also indicated on the attached drawing. As not all the routes have been surveyed yet, additional stream crossings could be identified at a later stage. If this occurs, The Department of Water Affairs (DWA) will be notified and the application will be amended to reflect these areas. The proposed River and Stream crossings information are provided in the table below:

Table 4: River and Stream crossing details

Crossing No.	X	Y	River	Owner	1:100 Flood Flow (m^3/s)
A	3 764 159.089	48 977.187	Tributary to Schaapkop River	George Municipality	8.26
B	3 764 472.953	49 188.043	Tributary to Schaapkop River	George Municipality (Being expropriated from private land owner)	2.7
C	3 764 729.369	49 136.819	Tributary to Schaapkop River	George Municipality (Being expropriated from private land owner)	0.68
D	3 764 944.101	49 174.105	Tributary to Schaapkop River	George Municipality / Province	0.06
E	3 765 169.697	49 031.841	Tributary to Schaapkop River	George Municipality / Province	0.19
F	3 765 170.226	48 813.941	Tributary to Schaapkop River	George Municipality / Province	0.06
G	3 765 067.995	48 457.658	Tributary to Schaapkop River	George Municipality / Province	1.00
H	3 765 120.916	47 937.106	Tributary to Schaapkop River	George Municipality / Province	3.50
I	3 765 072.815	47 744.988	Tributary to Schaapkop River	George Municipality / Province	2.14
J	3 765 143.369	47 280.331	Tributary to Schaapkop River	George Municipality / Province	6.00
1	3 766 259.09	47 286.601	Schaapkop River	George Municipality / Province	160.00
2	3 765 014.246	49 445.006	Schaapkop River	George Municipality	35.00
3	3 764 770.032	49 719.900	Tributary to Schaapkop River	George Municipality	31.00
4	3 764 310.182	49 314.732	Tributary to Schaapkop River	George Municipality	124.00
5	3 766 065.883	47 103.521	Tributary to Schaapkop River	George Municipality / Province	10.46
6	3 765 132.358	49 356.519	Schaapkop River	George Municipality / Province	130.00

As per DWA's instructions each of these stream crossings has been provisionally designed for a 1:100 year flood event. Attached please find preliminary design proposals for each of these river and stream crossings. Although these are preliminary design proposals, these should be indicative of the final proposals been prepared for this work. The river crossings have been described separately as part of the programme for the works, but the proposed stream crossings will be discussed in more detail in the text below.

The system we are proposing has been successfully implemented in the previous Pacaltsdorp bulk sewer project, completed in 2009. The system for handling stream crossings is described below.

i) The temporary berm is constructed in the stream, which is used to divert the existing flow to a pipeline installed to divert the normal flow past the construction area. The flow is discharged below the construction area and passes through two sets of silt-traps. The silt-traps are required to minimise the loss of silt caused by the construction activities.
ii) Box culverts are installed on a concrete surface bed in the stream bed. The box culverts are sized to accommodate the 1:100 year flood requirements, as per DWA's requirements.

iii) Two gabion walls are constructed parallel to each other, with a 3m distance between the inner faces of the gabion wall. The gabion walls are constructed perpendicularly over the stream over the box-culverts. The two walls are tied together with wire gabion mesh at each 1m height interval. The area in between the gabion walls is then filled with G7 road material to form an access track, which is then used by the Municipality to gain access and maintain the sewer pipeline along its entire length.

iv) The bulk sewer is laid to the correct levels in between the two gabion walls in the road fill material. This removes the need for steel pipe bridges to span over the stream, which are prone to vandalism and theft. The pipeline is now protected between the gabions under the road in-fill material, protecting it from any potential damage from vandals. Access to the bulk sewer and associated manholes is now possible from one convenient access route aligned alongside and above the existing sewer pipeline, which avoids the need for numerous access tracks down the slope to reach the sewer pipeline alignment for maintenance purposes.

v) Reno-mattresses are provided ahead and below the gabion walls to prevent under-mining and erosion of the soil on either side of the structure. Gabion walls are also constructed 5 to 10m downstream of the structure in the stream bed to prevent the river cutting back to the gabion structure and under-mining it in the future.

vi) Once the structure is complete the river flow is diverted through the box-culvert. Once the flow has stabilised the silt behind the silt traps is removed and used to rehabilitate the construction area. Once the flow stabilises the silt traps are then removed.

SUMMARY OF MAIN PROPOSAL

The above-mentioned upgrades will give the most feasible long term solution to the Municipality, but the phasing and sequencing will be adjusted to conform to the Municipalities funding requirements, since the upgrading of the two pump stations (Pacaltsdorp No. 1 and Thembalethu No. 6) and related rising mains would require the bulk of this expenditure, it does make the management of these proposals very critical for the next two financial years. This report attempts to go some way in explaining what will be required and why, before the next housing phases begin. A provisional cash-flow and programme is attached for discussion and planning purposes.

ALTERNATIVE PROPOSALS INVESTIGATED

Various other alternatives were investigated to fit the available capital flows and are discussed below, however these have been rejected as being wasteful expenditure and having no major environmental advantage. Contrarily these options have higher energy ouputs, with more pump stations being required to handle the flow.

1. Upgrading of Thembalethu Pump station No. 3:

As an intermediate upgrade proposal the existing Thembalethu pump station No. 3 can be upgraded. This would open up an additional 700 erven (Areas 3, 7 and 8) for development in the next housing phases, but this is not considered the best use of funds. The reasons behind this statement are discussed in more detail later on in this section.

The existing 200mm diameter fibre cement rising main conveys sewage from Pumpstation No. 3 to the Outeniqua Wastewater Treatment Works. The existing 200mm diameter rising main is indicated in yellow on the attached drawing, drawing No. 108429 GE 400 Rev F. The existing Thembalethu sewerage Pump station No. 3 currently has a pumping capacity of approximately 32 ℓ/s, while we estimate (using the "red-book" design guidelines) the existing flow could be as high as 45 ℓ/s, and therefore both the pump station and rising main are already at or over their design capacity. The pumpstation will have to be upgraded to handle a flow of approximately 65 ℓ/s, to provide for the additional serviced erven created by the new UISP housing project phases in the area (Housing Areas 3, 7 and 8A). This pump station currently has only one functional pump, but was due to receive urgent attention. Upgrading of the pump station would consist of a new inlet works, the installation of two new pumps in a new sump, mechanical screens, a back-up generator installation and related electrical supplies, as well as a telemetry system. Initially the basic items will be upgraded, with more costly items like the standby generator being added later. The existing pump station building and sump will have to be extended and provision made for the upgraded access road, stormwater provision and a new security fence. Two alternatives can be considered regarding the rising main for Pump station No. 3, as described below:

1.1 Alternative 1:

One option would be for a 3,8km long 250mm diameter PVC-u rising main, pumping sewage from Pump station No. 3 to the transfer manhole at the Outeniqua Wastewater Treatment Works. The intention is to follow a route that will intersect the least existing services, such as water, stormwater and sewer pipelines, electrical and Telkom cables and existing roads and sidewalks, as well as avoiding certain high points along the route. This proposal is indicated in dark blue below the existing 200mm diameter rising main which is indicated in yellow on the attached drawing, drawing No. 108429 GE 400 Rev F. The existing rising main has a high point in the first third of its length and then flows under siphon action to the Outeniqua WWTW. The new rising main will operate alongside the existing 200mm diameter fibre cement rising main, but will avoid having a siphon action by ensuring the rising main high point is at the Outeniqua WWTW.

This option results in a lengthy rising main, which will have a relatively high pumping head. This requires powerful pumps which will consequently have a reasonably high operating cost, as well as relatively high initial capital expenses.

1.2 Alternative 2:

This option is linked to the upgrading of Thembalethu Pump station No. 5, as described in the next section, and would see a 315mm diameter PVC-u rising main from Pumpstation No. 3 to a point connecting to the proposed 350 – 400 mm diameter bulk gravity sewer proposed to drain the housing Areas 5, 6A and 6B. Please note that the bulk gravity sewer around Area 5, 6A and 6B would need a larger diameter to accommodate the increased flow generated by the rising main discharging the flow from Pump station No. 3 into this bulk sewer. This option would result in a lower pumping head, with consequently smaller pumps, which will be more cost effective in terms of operating costs as well as initial capital expense. The shorter length of rising main will also be more economical to operate, as opposed to the 250mm diameter rising main described in the previous paragraph. This alternative will allow the Municipality to service a much larger amount of erven, as well as saving on operating costs.

2. Upgrading of Pumpstation No. 5:

The existing Thembalethu Pump station No. 5 will have to be upgraded and re-built at a position lower down the slope. This will allow the upgraded northern bulk sewer (draining Area 1) to gravitate to the new pump station. The current bulk sewer has insufficient fall in places and needs to be re-aligned and upgraded to drain Area 1 (288 erven) of the UISP housing project. Pump station No. 5 currently has a capacity of 15 ℓ/s, and will have to be upgraded to cater for sewer flows of up to 180 ℓ/s. This made up of the existing expected flow of 55 ℓ/s for Pump station No.5, the additional flow of 10 ℓ/s from Housing Area No.1, the flow of 40 ℓ/s from Areas No. 2, 5 and 6, the flow of 60 ℓ/s from Pump station No.3, as well as giving the option of Pump station No.4's flow of 15 ℓ/s to be diverted here as well. By diverting Pump station No.4's flow to the new Pump station No, 5, we allow the new Pump station No.7 which is currently under construction to accommodate 600 existing erven's flow, thereby reducing the stress on the bulk sewer draining to Pump station No. 2 and also improving the operating conditions at the pump station as well.

The upgrade will entail a new inlet works, a new pumpstation building, new pumps and mechanical screens, provision for a back-up generator and associated electrical reticulation upgrades, as well as some gabion work, an access road, a telemetry system and a new fence.

The upgrading of Pump station No. 5 will allow the proposed housing Areas 2, 5, 6A and 6B to be serviced (1 792 UISP erven) and allow the flow from the upgraded Pump station No. 3 to be accommodated at the newly upgraded pump station. The development of these housing areas is however subject to the expropriation of the land on which the development of Areas 5 and 6 is to take place. The process of the expropriation of the portion of land in question has commenced, as part of the housing project. A short section (approximately 555m) of 400 mm diameter sewer rising main will join the upgraded Pump station No. 5, with the existing transfer manhole at the Outeniqua WWTW.

The proposed rising mains servicing Pump stations 3 and 5, discussed in Item 1 and 2 above, requires a 50m concrete pipe bridge to accommodate the 450mm diameter rising main, as this pipeline needs to cross the Schaapkop River. The position of this crossing is indicated as River crossing No. 4 on the attached drawing, drawing No. 108429 GE 400 Rev F. A 450mm diameter pipeline will be installed in the pipe bridge, which is over and above the initially required diameter of 400mm. This will allow the pipelines to be upgraded to the pipe bridge in the future to accommodate the increasing flows from the area as Thembalethu develops.

A concrete pipe bridge is considered prudent, as the recently completed steel pipe bridge over the Schaapkop River has already been vandalised, only months after being completed. The River valley is wide at the crossing point and piers will be required to support the pipe bridge. These piers would need to be designed to withstand the 1:100 year flood waters. The pipe bridge is proposed to have a 1m x 1m square section, with reinforcing being placed around the perimeter, while the pipeline will be placed in the middle of the concrete section.

The complete upgrade of Pump station No. 5 will have to include the construction of a 2,5 km long 350 – 400mm diameter gravity sewer to Pumpstation No. 5, draining housing Areas 2, 5, 6A and 6B, as well as the short section of 315mm diameter rising main from Pumpstation No. 3, which links to the new bulk sewer. This will include the upgrade of the sewer line described in paragraph 3.1 below. This alternative will however, as mentioned before, serve significantly more erven, provided the expropriation process receives priority.

2.1 Upgrading of northern Thembalethu bulk sewer pipeline:

The Emergency Rehabilitation of Thembalethu Sewer Pipeline along the N2 national road was completed in June 2009. Only a short section at the upstream end of the bulk sewer was upgraded at the time due to cost constraints. A complete upgrade of the bulk sewer line that extends from this pipeline is necessary to accommodate Area 1 of the housing project. Operational difficulties (blockages due to flat gradients) exist further downstream in the bulk sewers alignment to the existing Thembalethu Pump station No.5. Area 1 of the UISP housing project is located adjacent and over the existing pipeline alignment, which would require the realignment of the bulk sewer to accommodate the UISP housing development. The existing 1560m pipeline will need to be rerouted to accommodate the development. The newly realigned sewer would be unable to connect to the existing Pump station No. 5 due to the

required improved gradient required, resulting in the bulk sewer pipeline ending below the existing pump station incoming invert level.

We recommend that consideration be given to realigning the section from Manhole No.TA35 to the Pump station No.5 to remove any problems with the vertical alignment and to accommodate Area 1 of the UISP housing project.

This will also allow the gradual improvement of the sewer pipelines feeding into the bulk sewer main, as and when funding becomes available. To achieve this, the existing sewer main will be upgraded by installing 930m of 250mmØ and 850m of 200mmØ heavy duty PVC-U sewer pipes, with associated manholes. Manholes will be spaced at a maximum distance of 80m and at all changes in direction or gradient. All existing erf connections will be re-connected into the new sewer main. Minimal disruption of the existing sewerage flow is expected.

The above proposals provide a short-term solution, but due to further development proposed in Thembalethu (Possible sewerage link of Kraaibosch and Victoria Bay areas to Thembalethu) and around the Pacaltsdorp (Syferfontein 7 000 to 15 000 housing development), which could see the need to upgrade the Pacaltsdorp No. 1 pump station and the Thembalethu No. 6 sewerage pump stations in the near future, we feel that the upgrading of the Pacaltsdorp No.1 and Thembalethu No.6 sewerage pump stations must receive priority.

We trust that you find the foregoing acceptable. If you have any queries, please do not hesitate to contact us.

Yours faithfully

AJ VAN MOLENDORFF Pr Tech Eng
Project Manager
pp Aurecon

BJ H JACOBS Pr Eng
Office Manager
pp Aurecon

Enclosed: 108429GE400 REV E: Revised Bulk Sewer Main Proposals

Annexure

Existing Gabion Stream Crossing photographs

Concrete Pipe Bridge Photos (for illustration purposes)

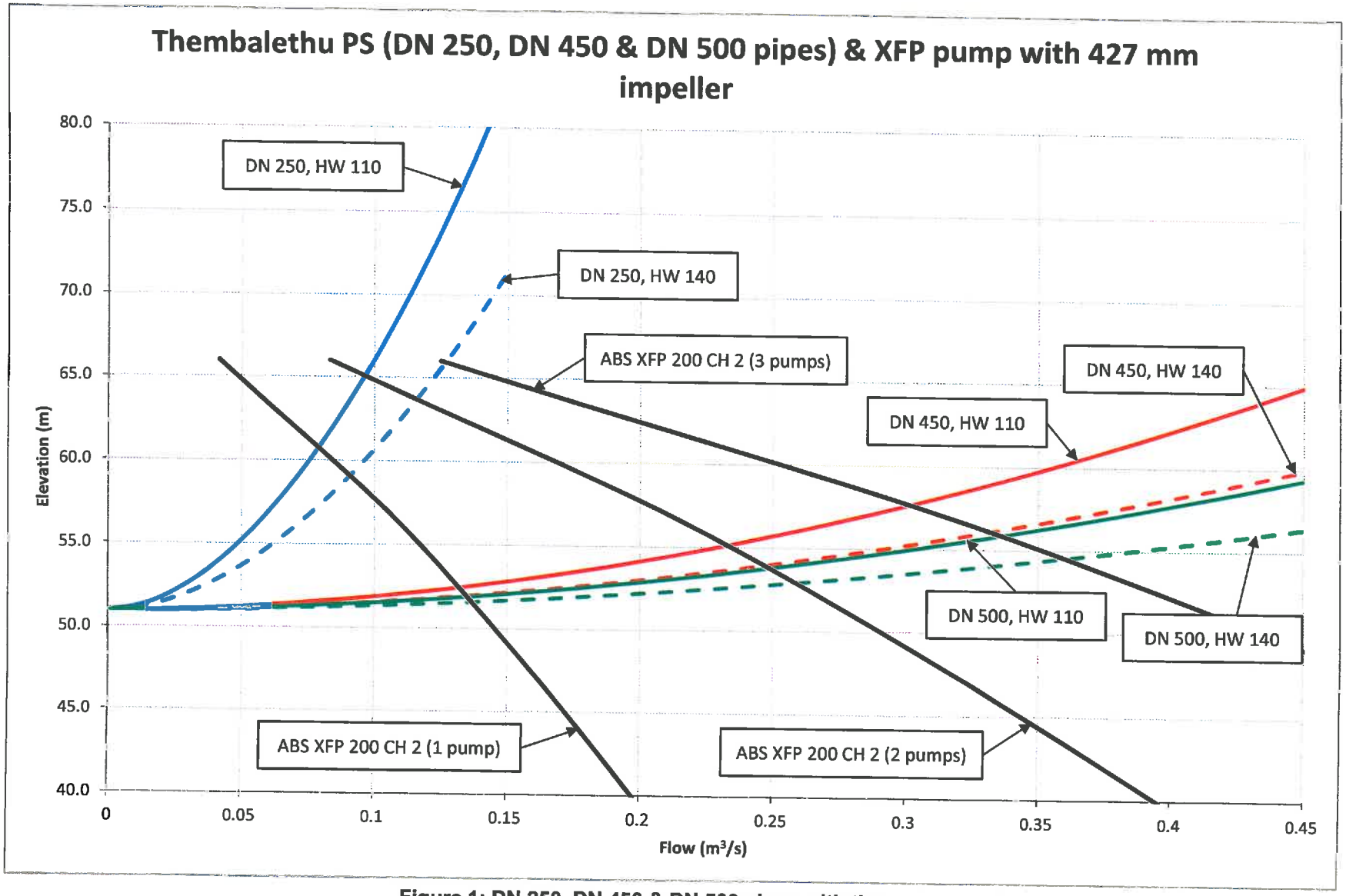


Figure 1: DN 250, DN 450 & DN 500 pipes with three pump option

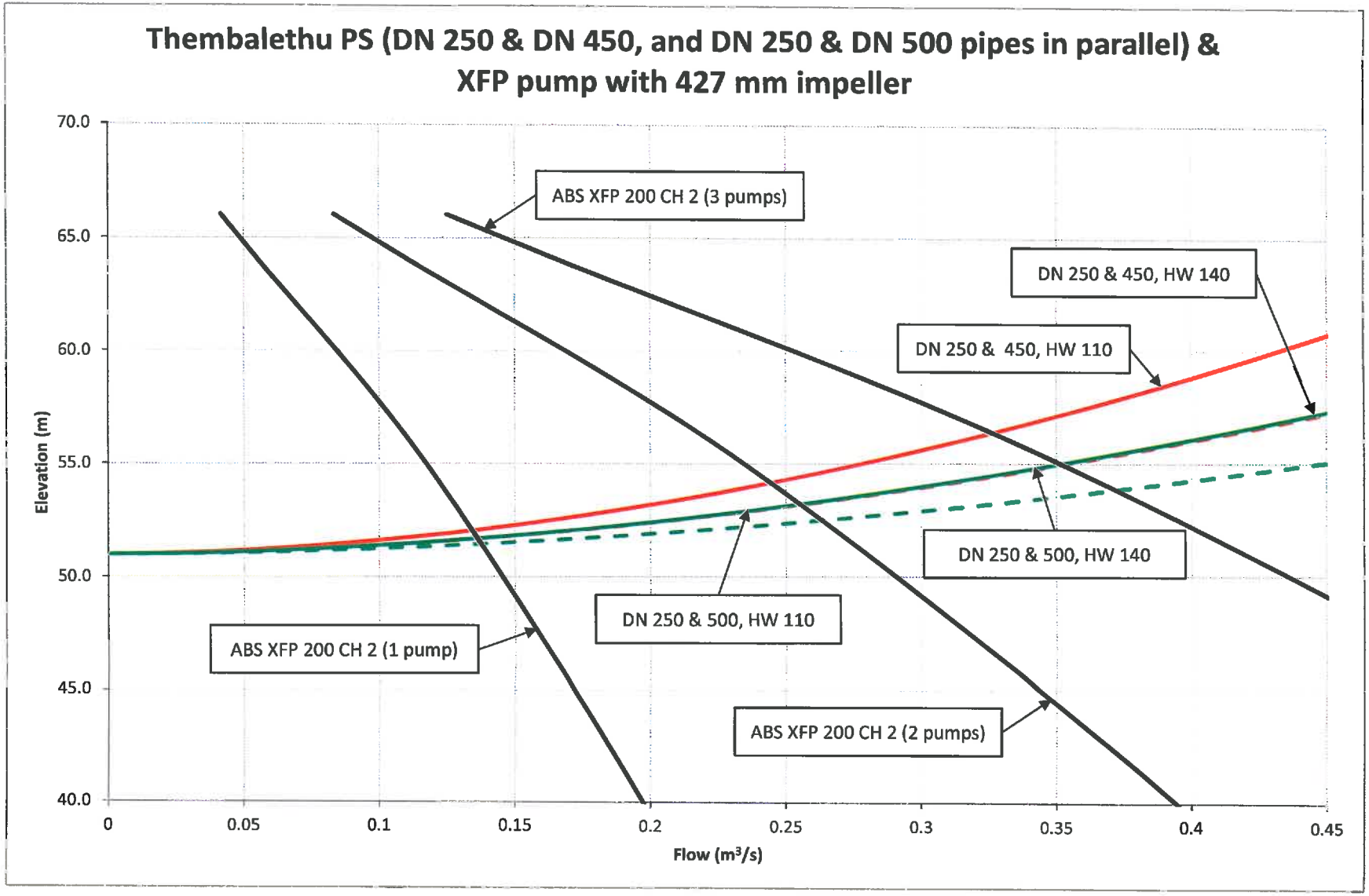


Figure 2: DN 250 & DN 450 and DN 250 & DN 500 pipes in parallel with three pump option

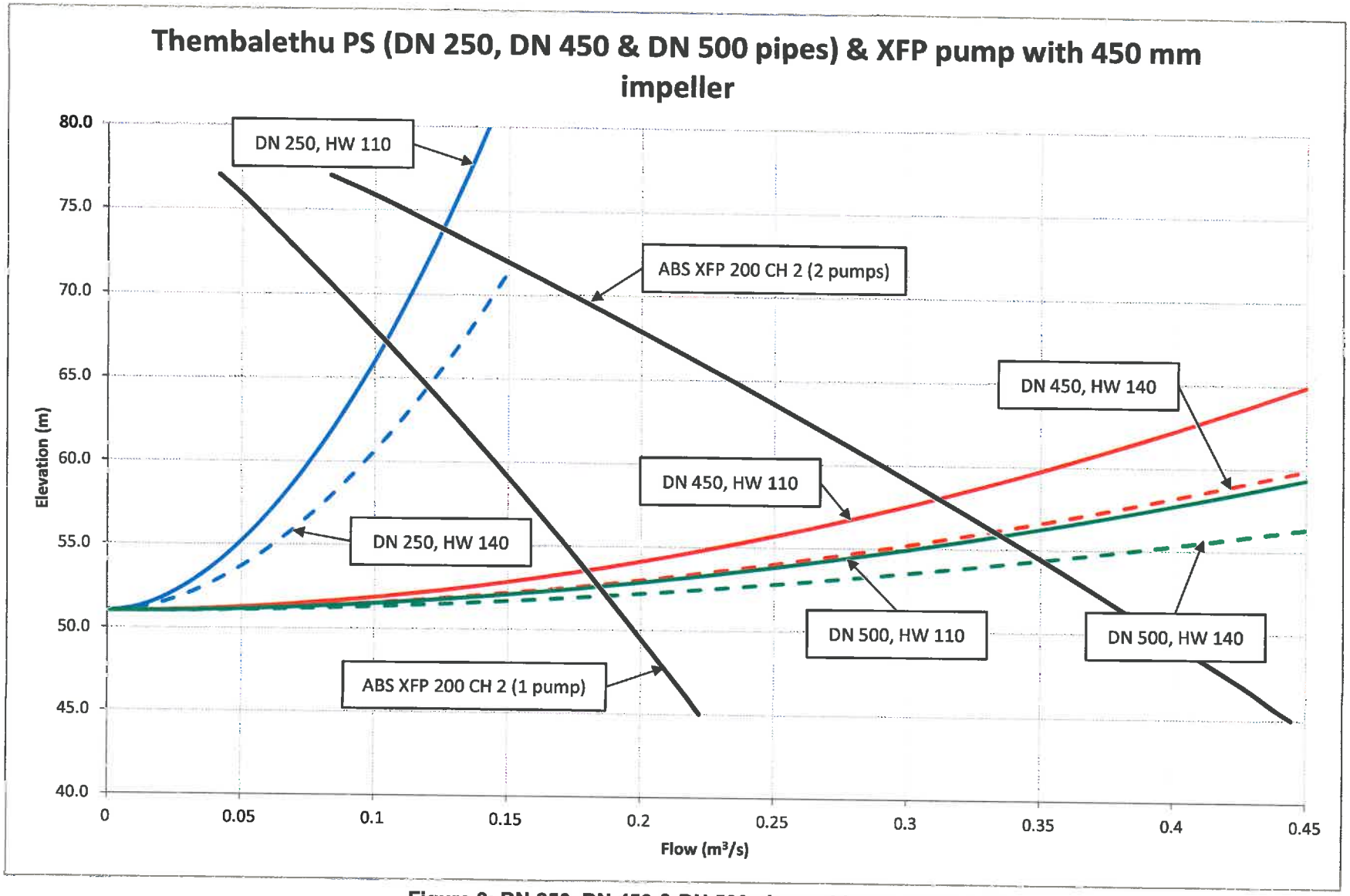


Figure 3: DN 250, DN 450 & DN 500 pipes with two pump option

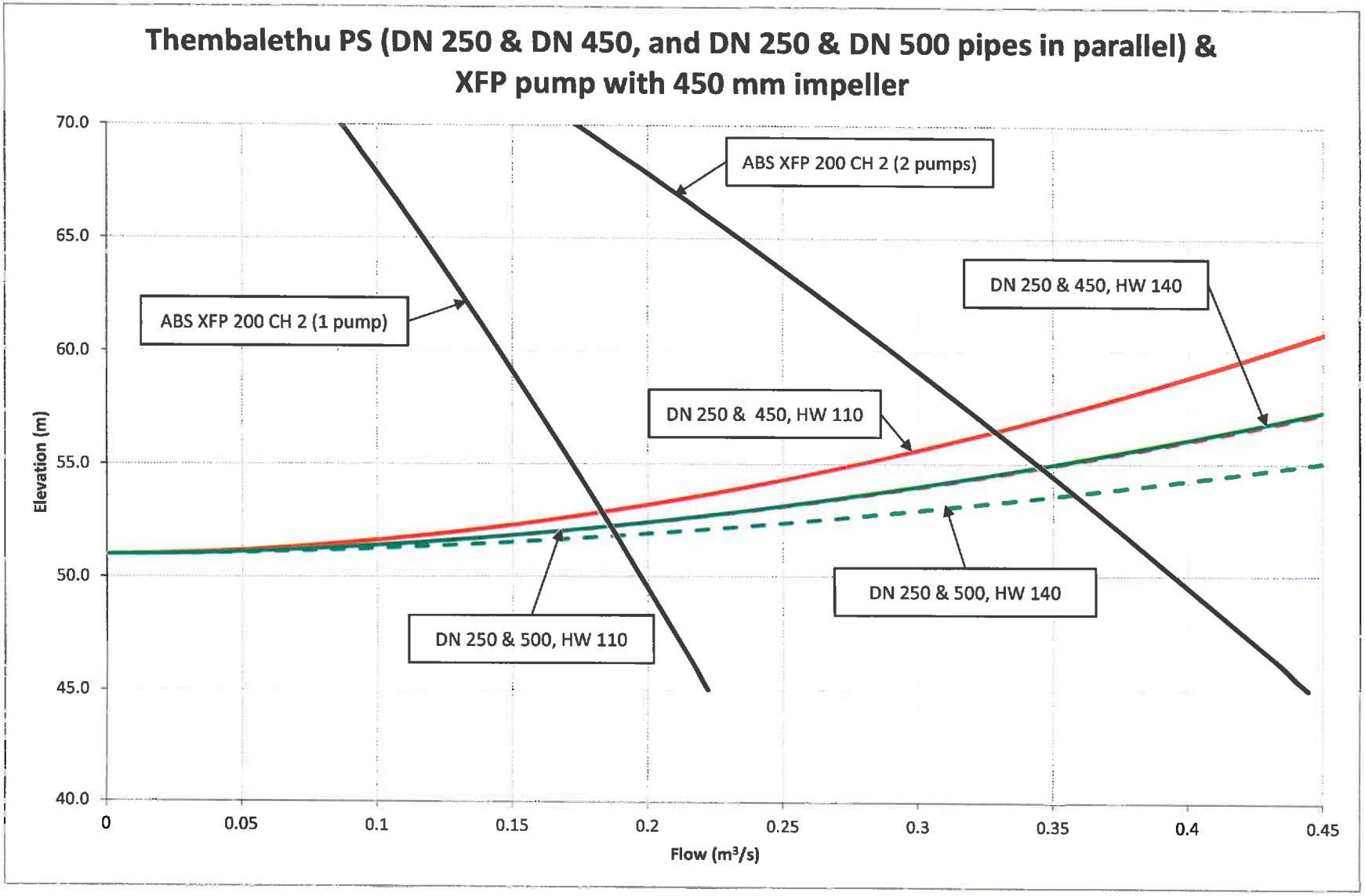


Figure 4: DN 250 & DN 450 and DN 250 & DN 500 pipes in parallel with two pump option

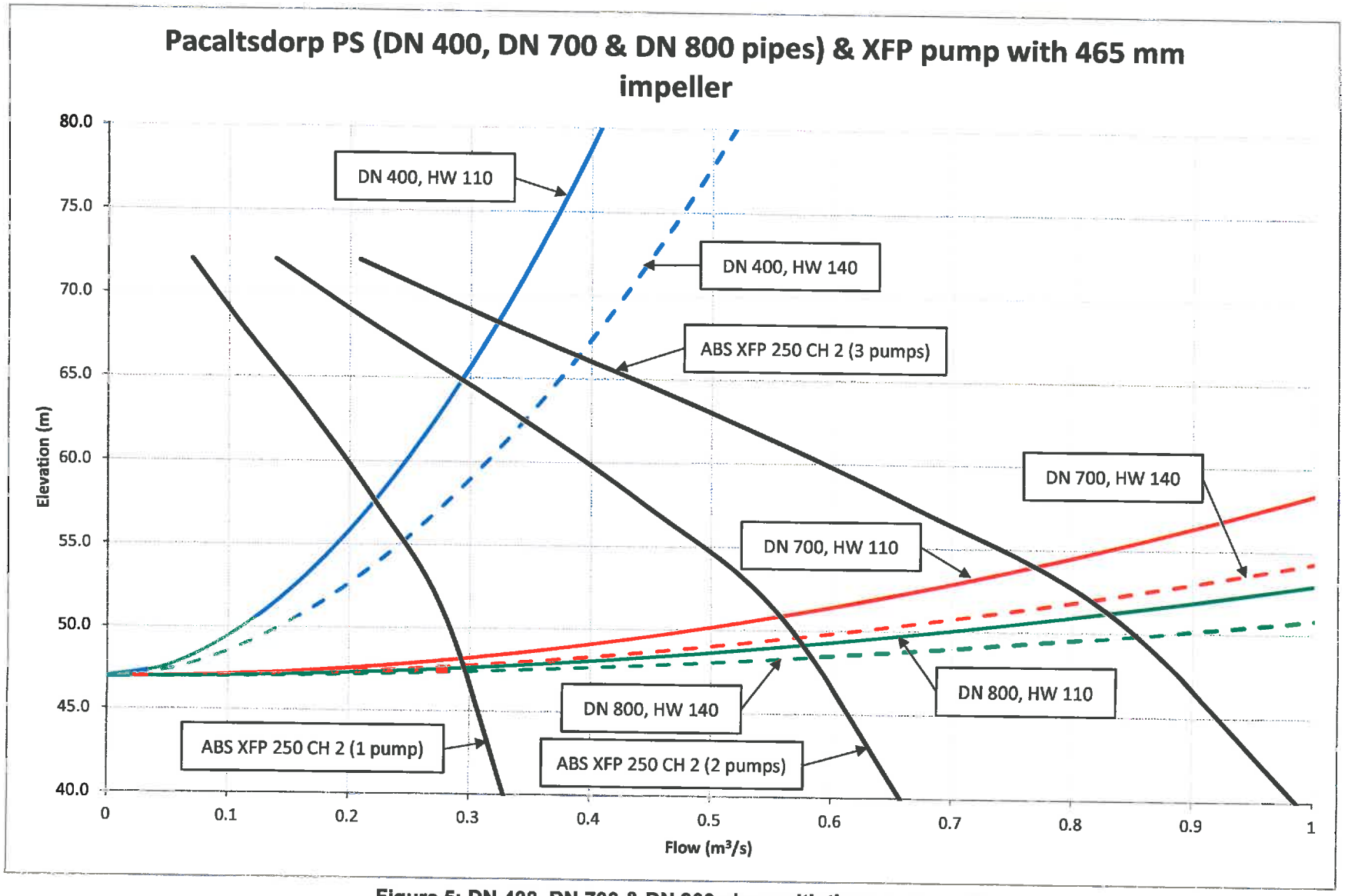


Figure 5: DN 400, DN 700 & DN 800 pipes with three pump option

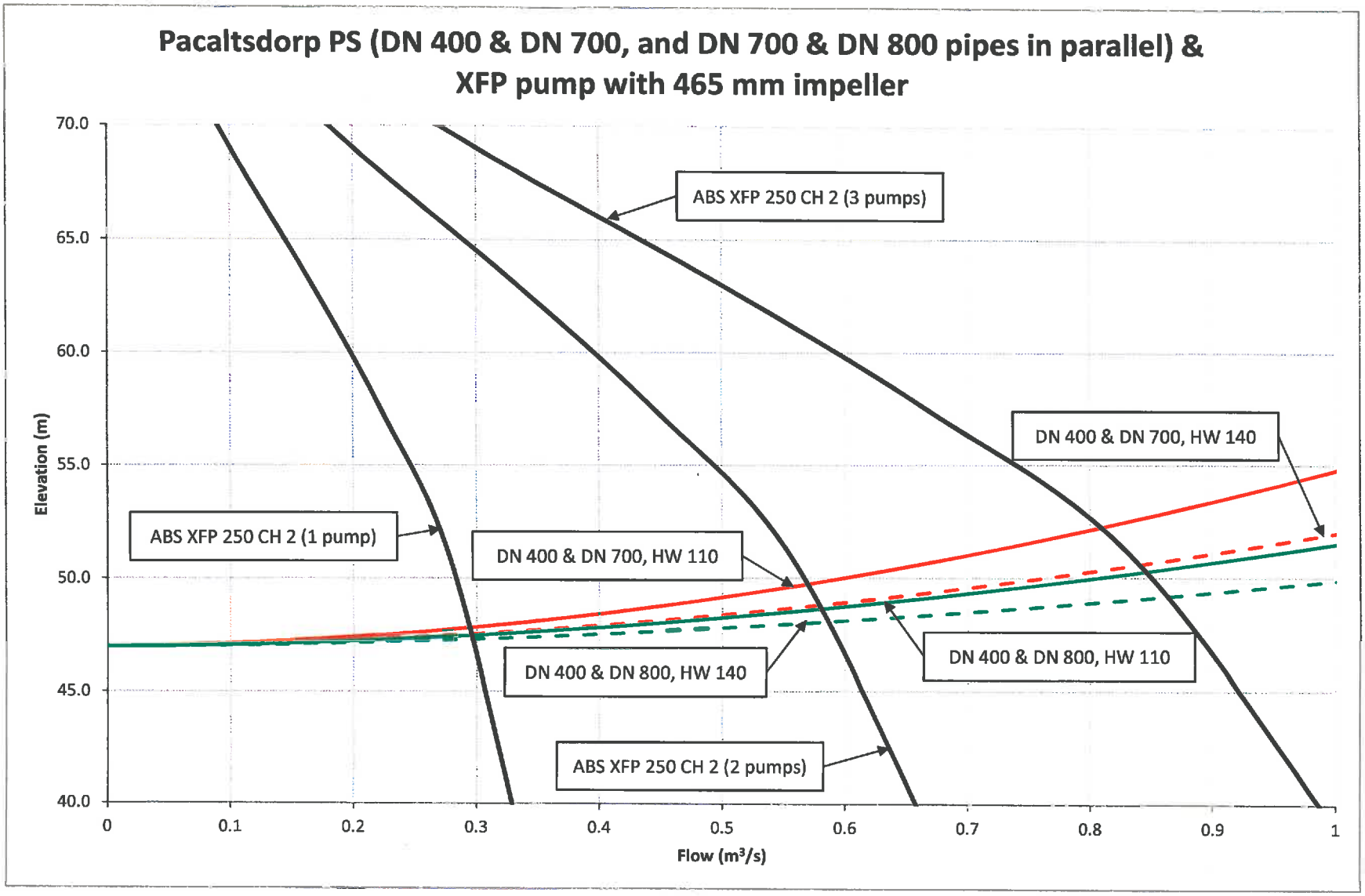
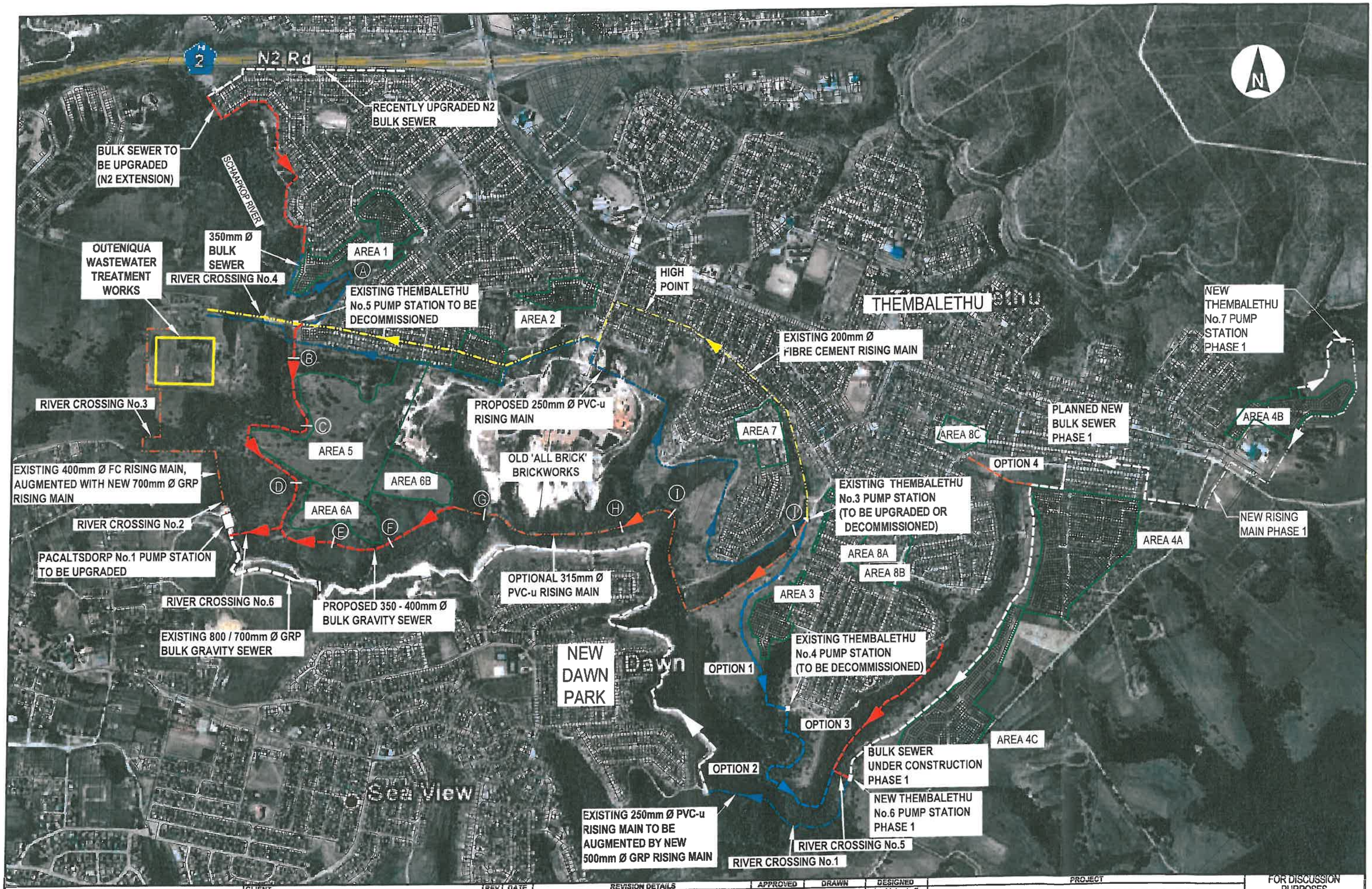


Figure 6: DN 400 & DN 700 and DN 400 & DN 800 pipes in parallel with three pump option



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CLIENT: GEORGE MUNICIPALITY

REV	DATE	REVISION DETAILS	APPROVED
A	04/2013	FOR DISCUSSION PURPOSES	A van Molendorff
B	05/2013	RIVER CROSSINGS ADDED	A van Molendorff
C	06/2013	STREAM CROSSINGS ADDED	A van Molendorff
D	07/2013	RIVER CROSSING No. 5 ADDED	A van Molendorff
E	07/2013	RIVER CROSSING No. 8 ADDED	A van Molendorff
F	08/2013	ENLARGED SCALE	A van Molendorff

DRAWN	DESIGNED
VC Oudejans	A v Molendorff

CHECKED: A v Molendorff

APPROVED: NAME D Jacobs; SIGNATURE; DATE 25/6/13

PROJECT: THEMBALETHU HOUSING PROJECT

TITLE: REVISED BULK SEWER MAIN PROPOSALS

FOR DISCUSSION PURPOSES

PROJECT No.	
108429	
SCALE	SIZE
1 : 12 750	A3
DRAWING No.	REV
108429 GE 400	F