South Golden Beach Flood Pumping Station

Byron Shire Council

Investigation into Operational Issues

Revision | 5

11 September 2018

Document history and status

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South Golden Beach Flood Pumping Station

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1. Introduction

South Golden Beach is a housing estate built on low lying land, and is bisected by the Capricornia Canal. The Eastern side of the estate is protected by a levy on the bank of the canal. Storm water drains fitted with non-return flood gates pass through the levy. When the canal water level is high and the flood gates are closed, the estate is protected by a flood pumping station near the Western end of Gloria Street.

Byron Shire Council (BSC) are responsible for maintaining and operating the pumping station. However, the flood pumping station has had a number of operational issues since its initial construction in 2009, the most concerning being the pump cycling on and off rapidly during small to medium flood events, and thus tripping out on motor thermal overload. This causes the flood pump to be ineffective in all but the largest flood events. Anecdotally the flood pump has been observed to operate without any issues for eight to ten hours during the post Tropical Cyclone Debbie weather event of 2017; this suggesting that the main pump and electrical infrastructure is sound.

Preliminary investigations and analysis suggest the inlet drainage system leading to the pump suction is hydraulically constrained, allowing the pumping station to reach the pump stop level in a matter of seconds and thus rapidly cycle on and off.

This report documents an options investigation into the potential solutions to resolve the existing issues at the pumping station. Due to the significant potential property losses and community safety issues involved the project drivers are to ensure the pumping station reliability and safety are at acceptable levels.

2. Existing Situation

The Gloria Street flood pumping station was constructed around an existing 900mm Reinforced Concrete stormwater Pipe (RCP) discharging through the levy, with a 1.8 metre section removed and converted to a side discharge weir entering the new pump station structure. When the flood gate closes and the storm water level in the 900mm RCP rises, the water flows over the weir into the pump station structure. Previous written evidence mentions the pumping station internal weir being modified to a lower crest height of RL 0.688m.

Upstream of the pumping station, the drainage system consists of approximately 21 metres of 900mm RCP, approximately 59 metres of 1200x900mm Reinforced Concrete Box Culvert (RCBC), an inlet bar screen and headwall and an open channel beyond. The pump station structure has basically no live volume available to the pump and fully depends on the inlet drainage system to deliver water to the pump suction inlet at the pumped rate. The inlet bar screen consists of 16mm diameter bars at 125mm spacing, and has a total of 1.08 square metres of cross-sectional area perpendicular to the channel flow.

The main pump is a KSB Amacan submersible axial propeller pump mounted in a vertical sleeve; the design basis flow is 1000L/sec however due to the low static lift height (between 1.9 and 2.6 metres), the pump is running at approximately 1170L/sec at the pump stop level and 1220L/sec at the pump start level. The main pump is fitted with a soft start motor starter and a 5-minute pump start delay has been configured in the pump controls.

In addition to the main pump, BSC have installed a 150mm submersible sewerage pump, set to run during smaller flows. If the water level in the pumping station structure continues to rise, the main pump will start. Details of the secondary pump were unavailable.

The pumping station is controlled via the signal from a suspended type hydrostatic level transmitter, with the main pump starting at RL 1.5m water level and stopping at RL 0.8m water level. At a water level of RL 2.0m the flood waters will spread out from the main drainage channel over a much larger portion of the catchment and at RL 2.23m significant flooding of properties will occur as indicated by the image below.

Figure 1: South Golden Beach Flood Extent Map, RL 2.23m

The pumping station has a Remote Terminal Unit (RTU) connected to the BSC SCADA network. The pumping station does not include a backup power generator, and safe access to the pumping station during flood events may not be possible.

3. Basis of Design and Investigation

In consultation with BSC staff, and advice from the pump vendor, the basis of the design and investigation has been compiled as described below:

- Hydraulics design: to Queensland Urban Drainage Manual (QUDM) as referred by AUS-SPEC Stormwater Drainage Design Specification D5 (standard for Byron Shire Council)
- Flow rate: 1000L/sec
- Maximum allowable head water level: RL 2.0 m AHD
- Maximum pump starts per hour: 10 (Advised by KSB with or without soft start)
- Minimum suction submergence for existing pump: 1.15m (height from water free surface to PS floor; ref KSB)
- Existing pump suction level: RL -0.35m AHD
- Total system losses at 1000L/sec must be less than 700mm (pump start/stop level difference) minus a 200mm surge margin (if required)
- Maximum allowable velocity at the intake screen is 1m/sec under a 50% blocked condition to allow egress of persons trapped on the screen (ref, QUDM)

4. Pumping Station Inlet Hydraulics

Hydraulic analysis of the pumping station inlet drainage system was conducted for a number of cases, including the 1000L/sec design basis and the 1220L/sec actual flow to verify the assumed hydraulic constraints mentioned previously.

The analyses found that the change in head over the internal weir section at pump stop level is up to approximately 0.44m and the loss in the remaining upstream structures is approximately 0.76m. At a total system loss of 1.2m, the upstream channel water level would need to be RL 2.0m at the pump stop condition to achieve the pumped flow rate, i.e. once below RL 2.0m water is unable to enter the pumping station at the pumping flow rate.

At the pump start condition the upstream channel water level required to achieve the pumped flow rate would be approximately RL 2.26m; this being an unacceptable upstream flood level. The existing pumping station inlet hydraulic structures are incapable of delivering water to the pump at the required rate whilst the inlet channel is at the existing pump start level.

A number of issues have been found to contribute to the existing situation of the pump starting and stopping rapidly:

- The pump is running beyond the design basis flow rate (up to approximately 1220L/sec)
- The pump start and stop levels are only 700mm apart
- There is no volume of still water available at the pump suction
- Total intake system losses are approximately 1.2m at 1220L/sec
- Upsurge from water flowing into the pumping station structure after pump stop is very likely to reach the pump start level; however, this is currently mitigated by a 5-minute pump start delay
- The pumping station level transmitter is located in a high velocity, turbulent, vertical drop section with potential air entrainment. It is currently unknown if the transmitter is housed in a stilling tube, but inaccurate pump starts and stops are likely
- Anecdotal evidence that the inlet screen blocks rapidly with debris during large storm events

If the inlet drainage system cannot be made to deliver water to the pump well at the pumped flow rate, buffer storage of approximately 90m^3 is required near to the pump suction to ensure the maximum pump starts per hour is not exceeded.

4.1 Inlet Screen

The risk of the main inlet screen blinding during large flood events is a risk to the system as a whole. Additionally, the velocity into the screen in a 50% blocked condition is approximately 1.85 m/sec which is too high for egress of a person trapped on the screen (ref QUDM).

It is suggested the screen is enlarged in accordance with the AUS-SPEC Stormwater Drainage Design Specification D5 and the Queensland Urban Drainage Manual (QUDM) and that the bar spacing is modified to suit the final pump selection, if this differs from the existing.

5. Alternatives Investigated

A number of possible solutions to ensure the pumping station can cover all catchment inflow rates up to the design flow rate of 1000L/sec were formulated and assessed. The long list of options and preliminary qualitative assessment is presented in Section 5.1.

5.1 Long List of Options

Table 1: Options Long List

Option	Option Description	Relative Capital Cost	Relative Benefit	Site Impacts / Complexity	Risks/Concerns
1.	- New wet well, 6x3x3m near to existing - New 6m long weir overflow - 3xDuty, 1xStandby smaller pumps in new sleeves - New DN800 manifold and discharge pipe - New switchboard (4 x soft start drives)	Very High	Very High	Medium	· Requires new electrical system · Solids passing size of pumps is slightly smaller and may present more issues with pumps blocking than present case
2.	- New wet well, 6x3x3m near to existing - New 6m long weir overflow - Relocate main pump in new sleeve - Limit pump to max 1000L/sec via new discharge pipe	High	High	Medium	· Utilising aged existing equipment · No equipment redundancy
3.	- Provide 5m long extension to overflow weir and pump well to limit losses - Limit pump to max 1000L/sec via outlet restrictor	High	High	High	· Complex tie in and modification of existing pump station structure · Switchboard would need to be relocated to allow excavation · No equipment redundancy
4.	- Duplicate existing 1200mm box culvert and inlet screen - Replace 900RCP with 2 x 1200mm box culvert - Limit pump to max 1000L/sec via outlet restrictor	Very High	High	High	· Switchboard would need to be relocated to allow excavation · No equipment redundancy
5.	- Add “flat” buffer storage near to pump inlet; 90kL, 6x21.5m x 700mm - Limit pump to max 1000L/sec via outlet restrictor	High	Low	High	· System losses at 1000L/sec remain marginal during constant running (large flood event) · Switchboard would need to be relocated to allow excavation · No equipment redundancy

Option	Option Description	Relative Capital Cost	Relative Benefit	Site Impacts / Complexity	Risks/Concerns
6.	- Limit pump to max 1000L/sec via outlet restrictor - Add Variable Speed Drive to trim flow based on channel water level	Medium	Low	Low	· System losses at 1000L/sec are still greater than design basis · Addition of VSD will require modification of existing switchboard · Existing pump can only turn down to approximately 700L/sec · No equipment redundancy
7.	-Change to smaller centrifugal or mixed flow pump (max 1000L/sec) -Add Variable Speed Drive to trim flow based on channel water level	Medium	Low	Low	· System losses at 1000L/sec still greater than design basis · Addition of VSD will require modification of existing switchboard · Limited suitable pumps available for low head application · No equipment redundancy
8.	Add a remote manual reset function via SCADA to reset pump after thermal overload	Low	Low	Low	· Typically limited to 2 x remote resets, after which system would fail as per existing situation (fatal flaw) · No equipment redundancy
9.	Raise the pump start level to RL 1.8m	Low	Low	Low	· Existing system will still reach pump stop condition in a short time (fatal flaw) · No equipment redundancy
10.	Raise the pump start level to RL 2.0m	Low	Low	High	· Existing system will still reach pump stop condition in a short time (fatal flaw) · RL 2.0m provides no margin prior to flooding of private property (fatal flaw) · No equipment redundancy

5.2 Short Listing of Options

Duplicating the existing 1200mm box culvert and replacing the 900mm RCP with box culverts in Option 4 will solve the intake hydraulic constraints however this will be a very costly and disruptive solution with a very large site footprint. Option 5 will have similar issues of requiring a large site footprint essentially adjoining private property boundaries.

Options 8, 9 and 10 do not achieve an acceptable number of pump starts per hour, and thus present a risk of pump failure as per the existing situation.

Option 3 proposes extending the existing side discharge weir to resolve the large intake system losses by extending the pump station structure. This solution poses some risk due to the complex integration with the existing structure. Additionally, the existing switchboard would need to be relocated to allow these works.

Option 2 provides an extended weir configuration in a new pump station wet well approximately 5 metres upstream from the existing pump station structure. This option does not require the switchboard to be relocated, but does require re-termination of the pump in its new location. The Option 2 cost is likely to be of similar magnitude to Option 3 but with lower risk of cost overrun due to integration with existing structures.

Option 1 includes a new wet well pump station as per Option 2, but with 3 duty and 1 standby pump. This option is likely significantly more expensive than the other viable options, due to the additional equipment and required new electrical system. Option 1 will however provide some equipment redundancy and allow one pump to be removed for maintenance as required.

Options 6 and 7 do not achieve the design basis flow of 1000L/sec under all upstream water level conditions, but they do avoid the need for significant civil works and associated costs. Instead however, the flow is modulated via VSD based on the water level upstream of the pump station and the theoretical hydraulic characteristics of the existing structures to minimise the risk of the pump tripping out due to repeated starts and stops. This solution has been discussed with BSC staff and considered to be an acceptable ‘intermediate’ solution despite not meeting the design basis. Option 7 is likely more expensive than option 6 and suitable pumps are limited, thus option 7 will not be carried forward.

Options 1, 2, 3 and 6 have been shortlisted and will be discussed further in the sections below.

5.3 Option 1 Details, Risks and Benefits

Option 1 includes a new pump station wet well near to but separate from the existing. The wet well dimensions will be in the order of 6 metres long, 3 metres wide and 3 metres deep; these dimensions will accommodate the required 6 metre side discharge weir, and also provide some beneficial adjustment to the pump stop RL whilst maintaining the pump suction submergence required. The new wet well will include baffles to protect the pump suctions from air entrained by the weir discharge. The weir level will be set to preferentially utilise the existing pump station structure and existing secondary pump for smaller flood events, and reserving the new pumps for events where the secondary pump is under capacity.

Option 1 will utilise three new duty pumps and one new standby pump in the new wet well. The existing secondary pump will be retained in the existing pump station structure with the existing dedicated discharge pipeline. The existing main pump will be decommissioned. New pumps would likely be equivalent to KSB Amacan PA4 600-350/16-6, vertical mounted axial flow pumps and will be mounted in stainless steel discharge tubes as per the existing pump arrangement.

The four new pumps will be connected via a DN800 MSCL manifold discharge pipe with DN600 swing check or in-line duckbill resilient check valves. The discharge main will terminate at the existing levy bank scour protection slab leading to the canal. An arrangement including a discharge channel and separate bellmouth pump outlets may be proven feasible in the concept design phase which could negate the need for a manifold and check valves.

Option 1 will require a new sump pump and new level transmitter in the new well.

Option 1 will require a new main switchboard with 4 x 18kW soft start drives and will require integration with the existing BSC SCADA system.

Residual Risks:

- Solids passing size of the new pumps (65mm) is slightly smaller and may present more issues with pumps blocking than present case (80mm).

System Benefits:

- Option 1 improves on the existing inlet drainage system by extending the weir and allowing water to flow to the pump station at the required rate
- The pump starts per hour will not exceed manufacturer's recommendations (10 starts per hour max.)
- Provides a volume of low velocity water to the pump suction with lower risk of entrainment of air
- Includes one standby pump for redundancy and allows a single pump (including the existing secondary pump) to be out of service for maintenance at any time
- Proposed pumps weigh approximately 480kg (relative to approx. 1200kg for existing pump) and thus may allow use of a smaller mobile crane or truck mounted crane arm for installation and removal

5.4 Option 2 Details, Risks and Benefits

Option 2 includes a new pump station wet well as per Option 1, but will utilise the existing main pump and associated electrical system.

The main pump will be relocated to the new well in a new stainless steel discharge tube as per the existing installation, albeit with a new MSCL discharge pipe at say 8 metres long discharging to the existing levy bank scour protection. The new discharge pipe diameter will be sized to bring the maximum flow of the existing pump back to 1000L/sec. The secondary pump will remain in the existing pump station structure.

Additionally, Option 2 will require a new sump pump and new level transmitter in the new well.

Residual Risks:

- No equipment redundancy
- Utilising existing equipment (condition unknown)

System Benefits:

- Option 2 improves on the existing inlet drainage system by extending the weir and allowing water to flow to the main pump at the required rate
- The pump starts per hour will not exceed manufacturer's recommendations (10 starts per hour max.)
- Provides a volume of low velocity water to the pump suction with lower risk of entrainment of air

5.5 Option 3 Details, Risks and Benefits

Option 3 includes a 5 metre extension to the existing side discharge weir and pump station structure to compensate for the high head loss experienced over the existing 1.8 metre weir. To achieve this however requires the new structure to be connected directly and dowelled to the existing structure. The two structures will be hydraulically connected by cutting an opening in the dividing wall, near to the pump suction at floor level. There is some inherent risk in this design due to the potential of differential settlement between the structures and also due to the modifications and reinstatement of reinforcement cover thickness in the existing modified structure.

It is recommended in this situation to relocate the existing level transmitter into a stilling tube at a location in still water, away from the weir discharge.

Residual Risks:

- Technically complex structural modifications
- Potential for differential settlement
- No equipment redundancy
- Utilising existing equipment (condition unknown)

System Benefits:

- Option 3 improves on the existing inlet drainage system by extending the weir and allowing water to flow to the main pump at the required rate
- The pump starts per hour will not exceed manufacturer’s recommendations (10 starts per hour max.)

5.6 Option 6 Details, Risks and Benefits

Option 6 includes adding a custom fabricated 950mm high discharge tube extension to the top of the existing 800mm diameter pump discharge tube to create an additional static head. In combination with this, a variable speed drive and new level transmitter will be provided to control the pump flow based on the water level upstream of the pump station and the theoretical hydraulic characteristics of the existing structures.

The discharge tube extension will protrude approximately 400mm above the existing top slab of the pump station. Water will be directed to spill over the top of the pump station structure and down a new splash pan (to minimise splashing noise) to the existing scour protection on the bank of the canal. The discharge tube extension will be bolted to the pump station top slab and will be similar to the standard KSB 'DG' design (refer figure below) but with an open top and removable safety bars on the discharge. The discharge tube and splash pan would likely be made of 316L stainless steel, and be pickled and passivated after fabrication to prevent corrosion.

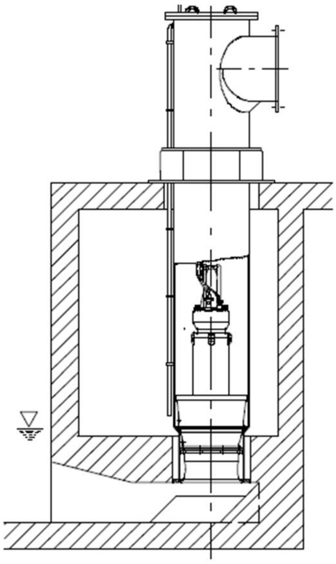


Figure 2: DG Style Pump Discharge Tube

The new variable speed drive will likely be mounted in a new lockable cabinet adjacent to the existing switchboard. The VSD cabinet may need solar heat shields and be fan cooled, and/or the VSD may need to be de-rated in case of high temperatures. The VSD will be set with a soft starting function and be limited to a maximum of approximately 47Hz which equates to a maximum of around 70% of the pump full load power. This arrangement will limit the maximum current draw thus likely allow re-use of the existing switchboard. The controls design should investigate the possibility of an intermittent cleaning cycle at 1000L/sec (46.6Hz) to mitigate the risk of the pump clogging during prolonged low speed operation.

The new level transmitter will be a suspended hydrostatic type, and will be installed in a PVC stilling tube in the first inlet box upstream of the pump station (approx. 20m). The cabling to the new instrument will be installed below ground in a PVC conduit and any exposed above ground cabling protected by a galvanised steel conduit.

Below is a table of suggested maximum flow rates and corresponding pump / VSD speeds related to certain water levels in the upstream channel system (near inlet screen). The controls design would need to incorporate this and include a maximum 1000L/sec (46.6Hz) upper limit on pump speed.

Table 2: VSD Speed Lookup Table

Upstream Channel Water Level (m RL)	Max Allowable Flow (L/sec)	Corresponding Water Level at Inlet Box #1 (m RL)	Pump Speed (rpm)	VSD Freq. (Hz)
1.50	700	1.36	600	40.8
1.60	790	1.42	600	40.8
1.70	870	1.49	640	43.5
1.80	950	1.54	670	45.6
1.90	1000	1.62	685	46.6
2.00	1000	1.72	685	46.6

Residual Risks:

- No equipment redundancy
- Utilising existing equipment (condition unknown)
- Will not meet 1000L/sec design basis under all upstream conditions
- Re-use of existing switchboard would depend on compliance check to AS3000
- Risk of pump clogging due to continued low speed operation (investigate cleaning cycle in controls design)

System Benefits:

- No major civil/structural works and associated costs
- Minimal impact to nearby residents during construction
- Relatively short implementation duration

6. Options Analysis

6.1 Preliminary Capital Cost Estimates

“Ballpark” costs have been formulated for Options 1, 2, 3 and 6. The costs are only preliminary in nature but include all preliminaries, design, risk contingency of 30% and allowances for internal management and corporate costs (BSC internal costs). All estimates also include modifying the existing inlet bar screen.

The approximate total project cost including contingency for Option 1 is $1,219,000 excl. GST.

The approximate total project cost including contingency for Option 2 is $654,000 excl. GST.

The approximate total project cost including contingency for Option 3 is $629,000 excl. GST.

The approximate total project cost including contingency for Option 6 is $146,000 excl. GST.

Cost estimate sheets are provided in Appendix A

6.2 Options Analysis

Option 1 is obviously significantly costlier than Options 2 and 3 but does provide a level of redundancy in equipment and flexibility to allow maintenance at any time. Option 1 also provides an opportunity for renewal of partially aged equipment. Utilising multiple smaller pumps will allow the station to operate effectively in all inflow situations. Option 1 is similar to the configuration that would normally be chosen on a greenfield project however BSC would need to weigh up the expenditure versus the apparent advantages of this option at an existing facility.

The likely capital cost of Options 2 and 3 are close and choosing between them based on cost alone may not arrive at an optimal outcome.

As mentioned previously, Option 3 presents some amount of risk due to the complex tie-in of the new and old structures. Additionally, both options 2 and 3 do not provide the redundancy and flexibility of Option 1.

Option 6 is significantly cheaper than the other options, however as previously mentioned does not meet the minimum design criteria for flood protection. This risk has previously been discussed with BSC staff and was considered acceptable as an intermediate cost solution, but which may not provide flood protection in all situations.

6.3 Conclusions and Recommendations

If BSC have adequate funding available, it is recommended to pursue Option 1 further. Failing this, and if the residual risk is assessed and considered acceptable by BSC, BSC may pursue design and implementation of Option 6.

It is recommended to extend the existing station inlet screen to the full width of the existing channel headwall (approx. 4 metres wide) to minimise intake velocities and reduce the risk of the screen blinding.

Regardless of the final solution implemented, there will always be a risk of blockage or restriction of the pumping station inlet due to large solids, and a maintenance regime is recommended to ensure the main channel leading to the pumping station is reasonably clear of debris.

6.4 Recommendations for Further Work

Initial further work should include the following:

- Optimisation and design of Option 1 (if funding permits)
- Optimisation and design of Option 6 (alternative to Option 1)
- Existing switchboard electrical compliance inspection to AS3000
- Electrical and controls design of Option 6
- Cost estimation of Option 6 to +/-30% accuracy.

The hydraulic characteristics of the secondary pump were unavailable at the time of writing, however being an ex-sewerage service pump; this pump is potentially operating beyond the end of its allowable operating curve in this very low head application. It is recommended the secondary pump hydraulic characteristics are investigated to ensure this pump is not at risk of premature failure.

Appendix A. Capital Cost Estimate Sheets

Capital Project Costing Sheet

Total Capex: $1,219,044

Project Reference: BSC

Project Title: South Golden Beach FPS

Project Author: Oliver Manhire

	Item	Unit Rate	Units	Qty	Capital Amount
		$/unit		no.	$'000
	Project Planning				
	Project Approvals				
	Internal Project Design (including D&C contracts)				
	Design Management (internal resource)	% of item 2		8.0%	$60,432
	Preliminaries				
	General Preliminaries	% of item 2		5.0%	$37,770
	Contractor mobilisation				$10,000
	Materials and equipment delivery transport				$5,000
1	**Sub-total Planning and Preliminaries**				**$113,202**
	Project Delivery and Construction				
	Design (External - if Required)				
	Detailed Design	$ 180	per hour	800	$144,000
	Sub-total external design				$144,000
	Civil				
	6x3x3m wet well, concrete caison, 250mm walls			1	$239,000
	Replace existing 900 RCP with 1200 RCBC, 8 metres			1	$27,200
	New pump sleeves, stainless steel, 600mm	$ 10,000	each	4	$40,000
	Discharge pipe, DN800 MSCL, flanged manifold			1	$12,000
	New inlet screen, (5x1.5m), galvanised steel	$ 5,000	each	1	$5,000
	Sub-total civil construction				$323,200
	Mechanical				
	New sump pump and small bore piping			1	$2,000
	New pumps (KSB Amacan P A4 600-350 16/6)	$ 30,000	each	4	$120,000
	New DI swing check valves, DN600	$ 12,300	each	4	$49,200
	Sub-total mechanical construction				$171,200
	Electrical				
	New main switchboard, 4 x 18kW soft start drives			1	$100,000
	Electrical installation works	$ 150	per hour	80	$12,000
	Sub-total electrical construction				$112,000
	Control System				
	New level transmitter			1	$2,000
	Install new LT and configure controls	$ 150	per hour	20	$3,000
	Sub-total control system construction				$5,000
2	**Sub-total Project Design and Construction**				**$755,400**
	Other				
	Risk Contingency	% of item 2		30%	$226,620
	As Constructed drawings	$ 100	per hour	80	$8,000
	O&M Manuals	$ 100	per hour	20	$2,000
	Commissioning and testing	$ 150	per hour	20	$3,000
	Sub-total Other				$239,620
3	**Sub-total Project Delivery**				**$1,108,222**
	Project Management and Overheads				
	Project and Contract Management	% of item 3		5%	$55,411
	Corporate Overhead	% of item 3		5%	$55,411
4	**Sub-total Project Management and Overheads**				**$110,822**
	Total Project Cost			**TOTAL**	**$1,219,044**

Capital Project Costing Sheet

Total Capex:	$654,342

Project Reference: BSC

Project Title: South Golden Beach FPS

Project Author: Oliver Manhire

	Item	Unit Rate	Units	Qty	Capital Amount
		$/unit		no.	$'000
	Project Planning				
	Project Approvals				
	Internal Project Design (including D&C contracts)				
	Design Management (internal resource)	% of item 2		8.0%	$31,936
	Preliminaries				
	General Preliminaries	% of item 2		5.0%	$19,960
	Contractor mobilisation				$10,000
	Materials and equipment delivery transport				$5,000
1	**Sub-total Planning and Preliminaries**				**$66,896**
	Project Delivery and Construction				
	Design (External - if Required)				
	Detailed Design	$ 180	per hour	500	$90,000
	Sub-total external design				$90,000
	Civil				
	6x3x3m wet well, concrete caison, 250mm walls				$239,000
	Replace existing 900 RCP with 1200 RCBC, 8 metres				$27,200
	New pump sleeve, stainless steel, 800mm				$20,000
	Discharge pipe, DN600 DICL, flanged				$5,000
	New inlet screen, (5x1.5m), galvanised steel	$ 5,000	each	1	$5,000
	Sub-total civil construction				$296,200
	Mechanical				
	New sump pump and small bore piping				$2,000
	Sub-total mechanical construction				$2,000
	Electrical				
	Re-terminate main pump	$ 150	per hour	20	$3,000
	Terminate new sump pump	$ 150	per hour	20	$3,000
	Sub-total electrical construction				$6,000
	Control System				
	New level transmitter				$2,000
	Terminate new LT and reconfigure controls	$ 150	per hour	20	$3,000
	Sub-total control system construction				$5,000
2	**Sub-total Project Design and Construction**				**$399,200**
	Other				
	Risk Contingency	% of item 2		30%	$119,760
	As Constructed drawings	$ 100	per hour	40	$4,000
	O&M Manuals				$0
	Commissioning and testing				$5,000
	Sub-total Other				$128,760
3	**Sub-total Project Delivery**				**$594,856**
	Project Management and Overheads				
	Project and Contract Management	% of item 3		5%	$29,743
	Corporate Overhead	% of item 3		5%	$29,743
4	**Sub-total Project Management and Overheads**				**$59,486**
	Total Project Cost			**TOTAL**	**$654,342**

Capital Project Costing Sheet

Total Capex: $628,860

Project Reference: BSC

Project Title: South Golden Beach FPS

Project Author: Oliver Manhire

	Item	Unit Rate	Units	Qty	Capital Amount
		$/unit		no.	$'000
	Project Planning				
	Project Approvals				
	Internal Project Design (including D&C contracts)				
	Design Management (internal resource)	% of item 2		8.0%	$30,640
	Preliminaries				
	General Preliminaries	% of item 2		5.0%	$19,150
	Contractor mobilisation				$10,000
	Materials and equipment delivery transport				$5,000
1	**Sub-total Planning and Preliminaries**				**$64,790**
	Project Delivery and Construction				
	Design (External - if Required)				
	Detailed Design	$ 180	per hour	500	$90,000
	Sub-total external design				$90,000
	Civil				
	4x3x4m pump station structural extension, poured on site, 250mm walls				$212,000
	Replace existing 900 RCP with 1200 RCBC, 18 metres				$60,000
	New switchboard slab and conduits				$10,000
	New inlet screen, (5x1.5m), galvanised steel	$ 5,000	each	1	$5,000
	Sub-total civil construction				$287,000
	Mechanical				
	Sub-total mechanical construction				$0
	Electrical				
	Relocate switchboard and re-terminate	$ 150	per hour	20	$3,000
	Sub-total electrical construction				$3,000
	Control System				
	Relocate and re-terminate level transmitter	$ 150	per hour	20	$3,000
	Sub-total control system construction				$3,000
2	**Sub-total Project Design and Construction**				**$383,000**
	Other				
	Risk Contingency	% of item 2		30%	$114,900
	As Constructed drawings	$ 100	per hour	40	$4,000
	O&M Manuals				$0
	Commissioning and testing				$5,000
	Sub-total Other				$123,900
3	**Sub-total Project Delivery**				**$571,690**
	Project Management and Overheads				
	Project and Contract Management	% of item 3		5%	$28,585
	Corporate Overhead	% of item 3		5%	$28,585
4	**Sub-total Project Management and Overheads**				**$57,170**
	Total Project Cost			**TOTAL**	**$628,860**

Capital Project Costing Sheet

Total Capex: $145,618

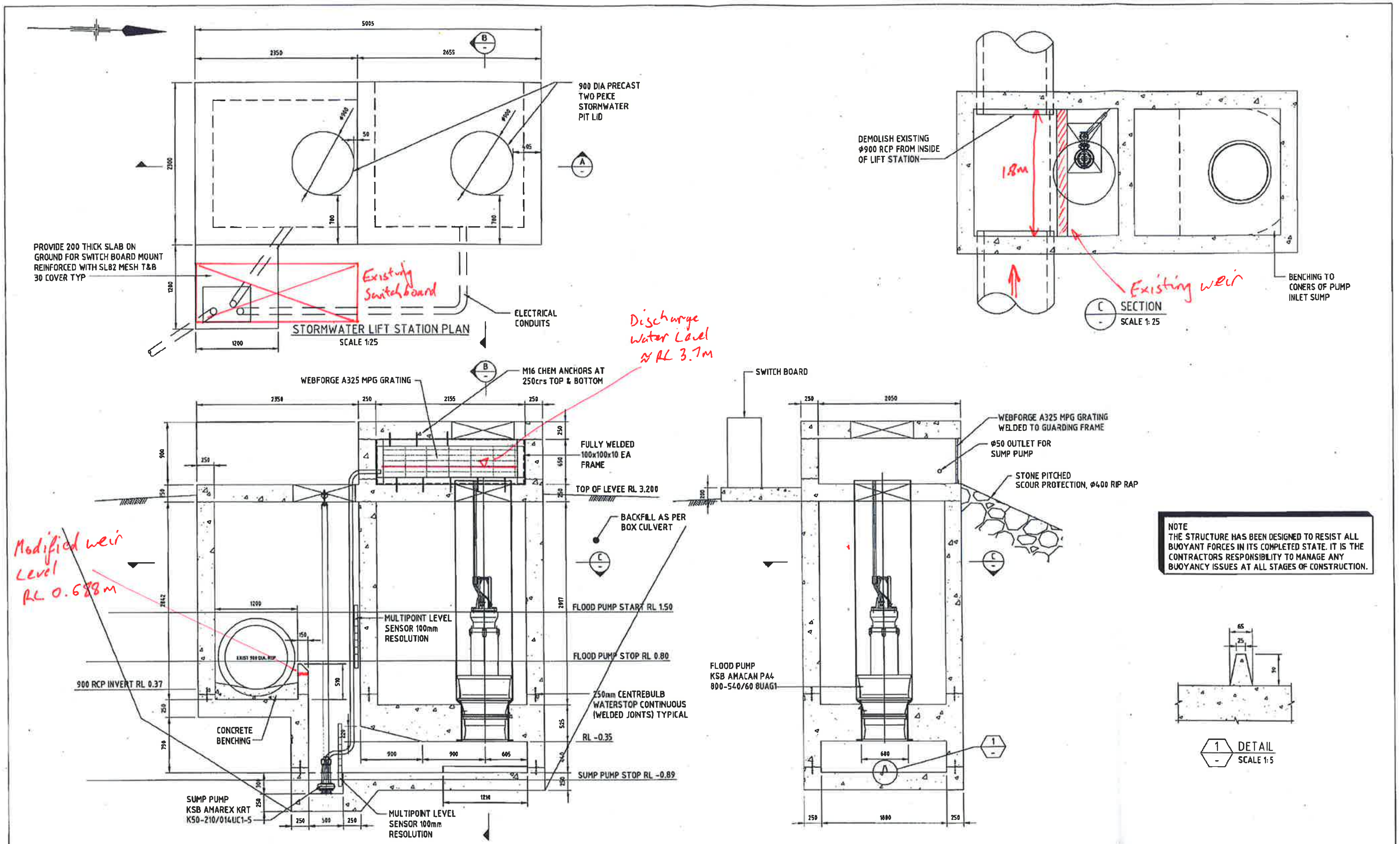
Project Reference: BSC

Project Title: South Golden Beach FPS

Project Author: Oliver Manhire

	Item	Unit Rate	Units	Qty	Capital Amount
		$/unit		no.	$'000
	Project Planning				
	Project Approvals				
	Internal Project Design (including D&C contracts)				
	Design Management (internal resource)	% of item 2		8.0%	$6,880
	Preliminaries				
	General Preliminaries	% of item 2		5.0%	$4,300
	Contractor mobilisation				$1,000
	Materials and equipment delivery transport				$1,000
1	**Sub-total Planning and Preliminaries**				**$13,180**
	Project Delivery and Construction				
	Design (External - if Required)				
	Detailed Design	$ 180	per hour	160	$28,800
	Sub-total external design				$28,800
	Civil				
	Trenching and conduits for LT (20 metres), 5 tonne excavator	$ 500	per hour	8	$4,000
	New inlet screen, (5x1.5m), galvanised steel	$ 5,000	each	1	$5,000
	Sub-total civil construction				$9,000
	Mechanical				
	Stainless steel discharge tube extension and splash pan	$ 10,000	each	1	$10,000
	Sub-total mechanical construction				$10,000
	Electrical				
	AS3000 compliance inspection	$ 150	per hour	8	$1,200
	Electrical installation and SB modification works	$ 150	per hour	80	$12,000
	60kW VSD, lockable cabinet, heat shields and cooling fan	$ 20,000	each	1	$20,000
	Sub-total electrical construction				$33,200
	Control System				
	New level transmitter			1	$2,000
	Install new LT and configure controls	$ 150	per hour	20	$3,000
	Sub-total control system construction				$5,000
2	**Sub-total Project Design and Construction**				**$86,000**
	Other				
	Risk Contingency	% of item 2		30%	$25,800
	As Constructed drawings	$ 100	per hour	24	$2,400
	O&M Manuals	$ 100	per hour	20	$2,000
	Commissioning and testing	$ 150	per hour	20	$3,000
	Sub-total Other				$33,200
3	**Sub-total Project Delivery**				**$132,380**
	Project Management and Overheads				
	Project and Contract Management	% of item 3		5%	$6,619
	Corporate Overhead	% of item 3		5%	$6,619
4	**Sub-total Project Management and Overheads**				**$13,238**
	Total Project Cost			**TOTAL**	**$145,618**

Appendix B. Existing Site Sketch



A SECTION
SCALE 1:25

B SECTION
SCALE 1:25

NOTES:
FOR ALL RELEVANT CONSTRUCTION NOTES REFER DRAWING 41-15632-S001
FOR REINFORCEMENT DETAILS REFER DRAWING 41-15632-S003
FOR LIFT STATION SITE LAYOUT REFER 41-15632-C001

No	Revision	Drawn	Checked	Approved	Date
0	ISSUED FOR TENDER	AGB	CAJ	GJS	04.10.06

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 250 500 750 1000 1250mm
SCALE 1:25 AT ORIGINAL SIZE

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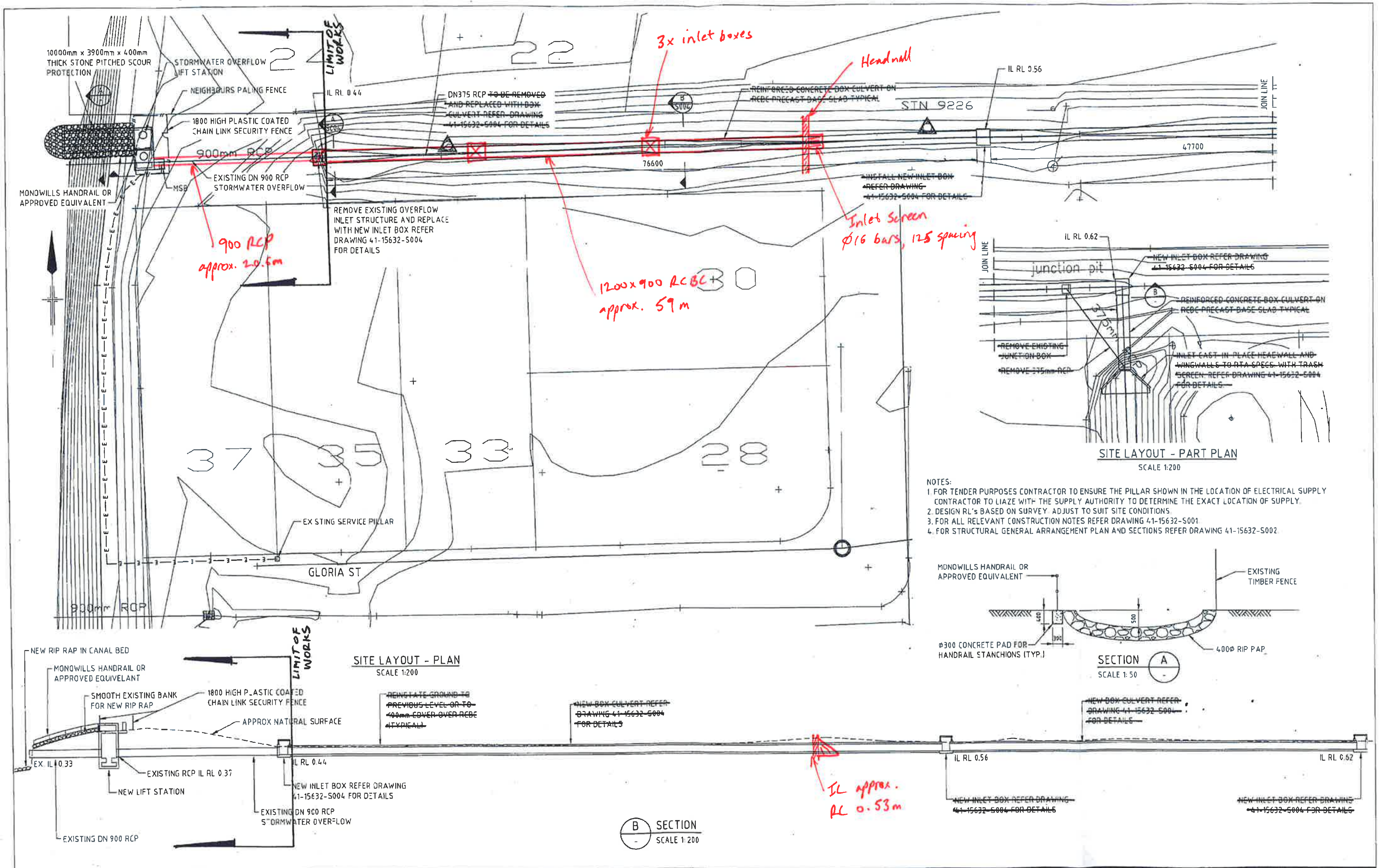
Drawn	A.BASTICK	Designed	N.ZHAN.
Drafting Check	NK.EDULJEE	Design Check	U.CHAUDHARI.
Approved	C. JOHNSTON		
Date	04.05.06		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: BYRON SHIRE COUNCIL
Project: SOUTH GOLDEN BEACH PUMPSTATION
Title: STORMWATER LIFT STATION GENERAL ARRANGEMENT PLAN AND SECTIONS

Original Size: A1 | Drawing No: 41-15632-S002 | Rev: 0

Plot Date: 04 October, 2006 - 2:33 PM

ISSUED FOR TENDER - CONTRACTOR TO SUPPLY W.A.E.



NOTES:
1. FOR TENDER PURPOSES CONTRACTOR TO ENSURE THE PILLAR SHOWN IN THE LOCATION OF ELECTRICAL SUPPLY CONTRACTOR TO LIAZE WITH THE SUPPLY AUTHORITY TO DETERMINE THE EXACT LOCATION OF SUPPLY.
2. DESIGN RL's BASED ON SURVEY. ADJUST TO SUIT SITE CONDITIONS.
3. FOR ALL RELEVANT CONSTRUCTION NOTES REFER DRAWING 41-15632-S001
4. FOR STRUCTURAL GENERAL ARRANGEMENT PLAN AND SECTIONS REFER DRAWING 41-15632-S002

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0 2 4 6 8 10m
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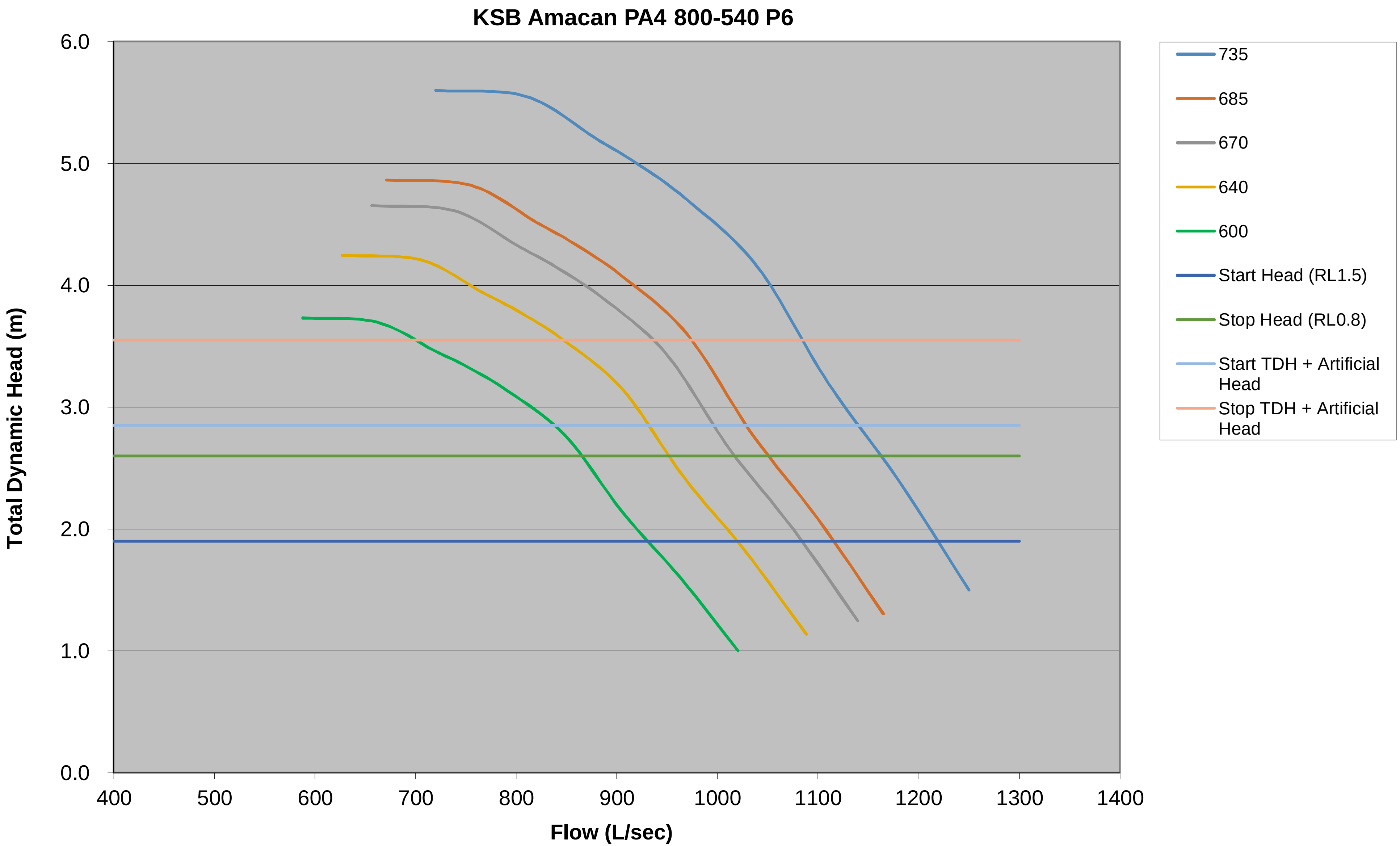
Drawn	B. LANG	Designed	H.J.LEWIS
Drafting Check	NIK EDULJEE	Design Check	B. VIVIAN
Approved	C.JOHNSTON		
Date	10.08.06		
Scale	AS SHOWN		This Drawing must not be used for Construction unless signed as Approved

Client: BYRON SHIRE COUNCIL
Project: SOUTH GOLDEN BEACH PUMPSTATION
Title: STORMWATER LIFT STATION SITE LAYOUT PLAN

Original Size: A1 Drawing No: 41-15632-C001 Rev: 0

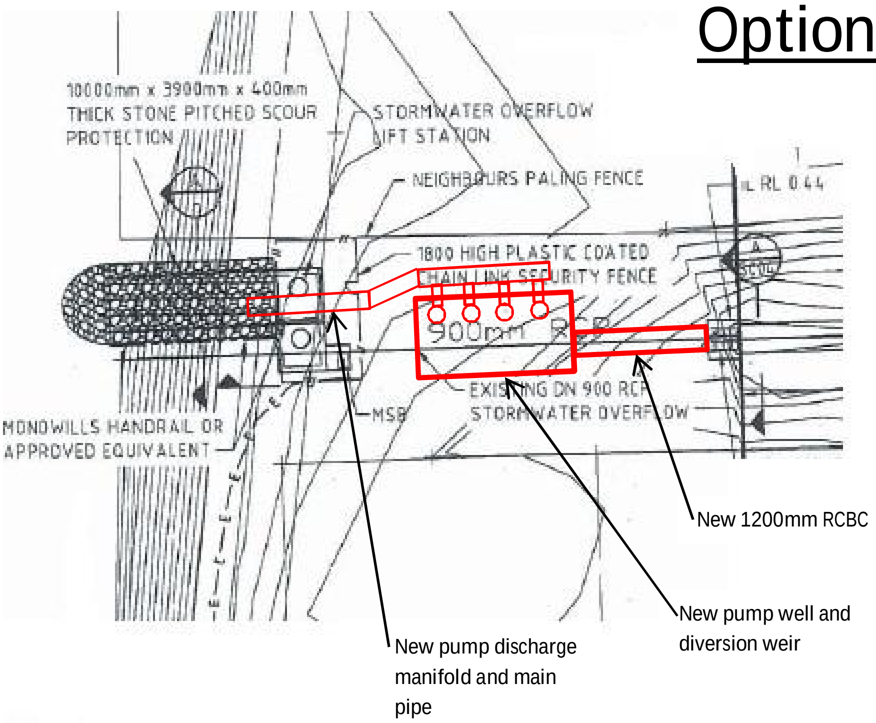
Plot Date: 05 October, 2006 - 11:30 AM Cad File No: G:\41\15632\CADD\Drawings\Structural\15632-C001-REV0.dwg

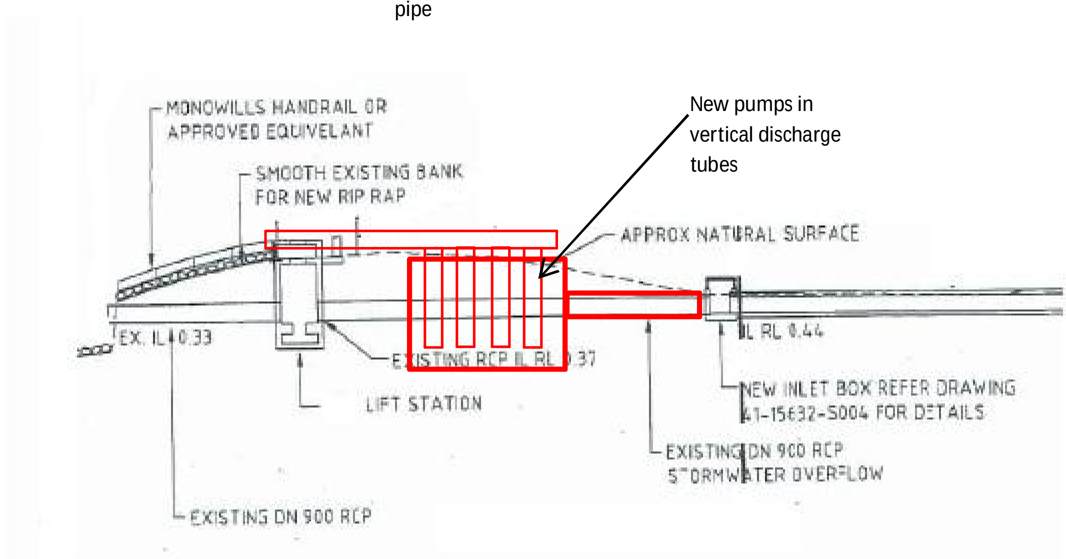
Appendix C. Variable Speed Pump Curves


KSB Amacan PA4 800-540 P6
Total Dynamic Head (m)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
400
500
600
700
800
900
1000
1100
1200
1300
1400
Flow (L/sec)
735
685
670
640
600
Start Head (RL1.5)
Stop Head (RL0.8)
Start TDH + Artificial Head
Stop TDH + Artificial Head

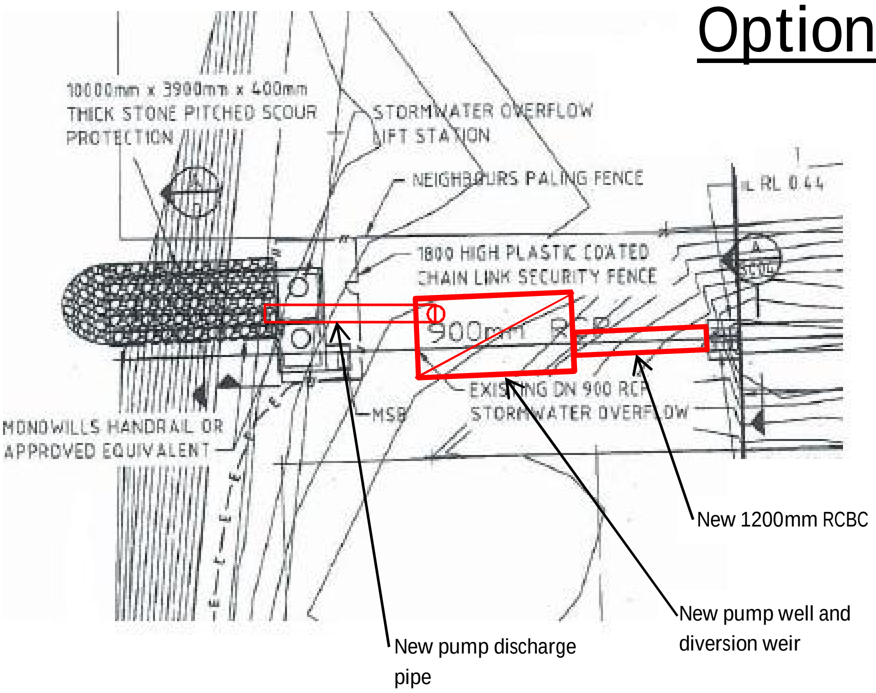
Appendix D. Option Sketches

Option 1

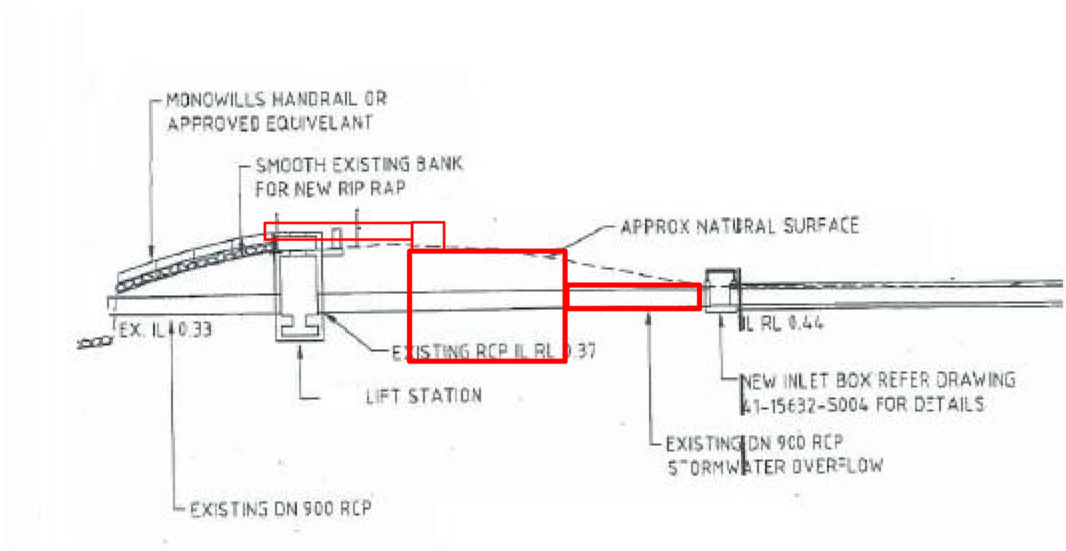

10000mm x 3900mm x 400mm THICK STONE PITCHED SCOUR PROTECTION
STORMWATER OVERFLOW LIFT STATION
NEIGHBOURS PALING FENCE
IL RL 0.44
1800 HIGH PLASTIC COATED CHAIN LINK SECURITY FENCE
900mm RCP
MONOWILLS HANDRAIL OR APPROVED EQUIVALENT
MSB
EXISTING DN 900 RCP STORMWATER OVERFLOW
New 1200mm RCBC
New pump well and diversion weir
New pump discharge manifold and main pipe


New pumps in vertical discharge tubes
MONOWILLS HANDRAIL OR APPROVED EQUIVELANT
SMOOTH EXISTING BANK FOR NEW RIP RAP
APPROX NATURAL SURFACE
EX. IL 0.33
IL RL 0.44
EXISTING RCP IL RL 0.37
LIFT STATION
NEW INLET BOX REFER DRAWING 41-15632-5004 FOR DETAILS
EXISTING DN 900 RCP STORMWATER OVERFLOW
EXISTING DN 900 RCP

Option 2

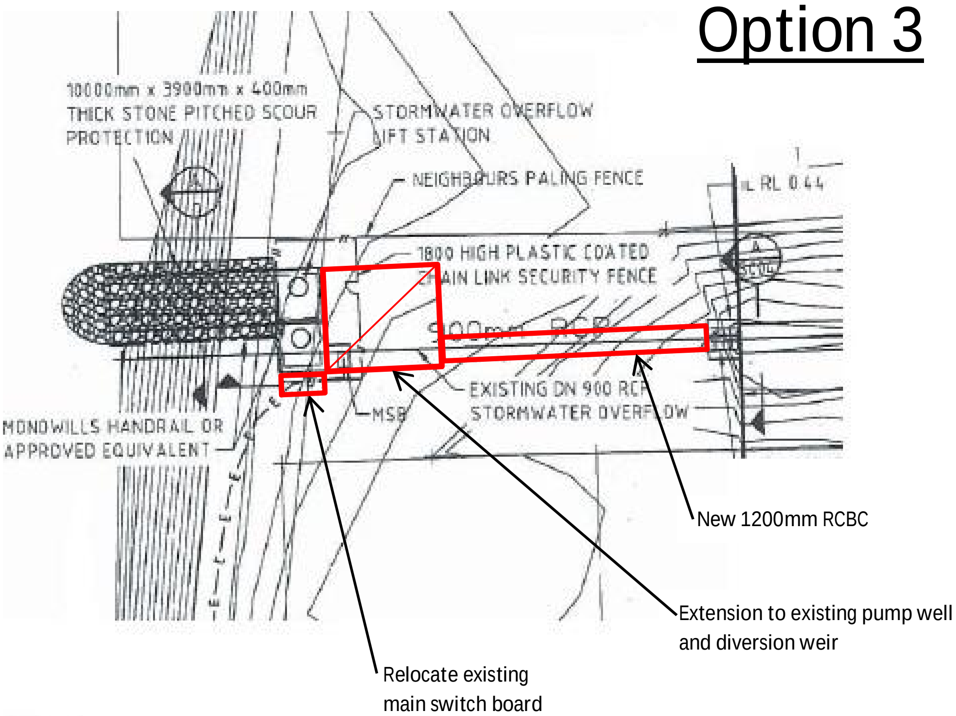


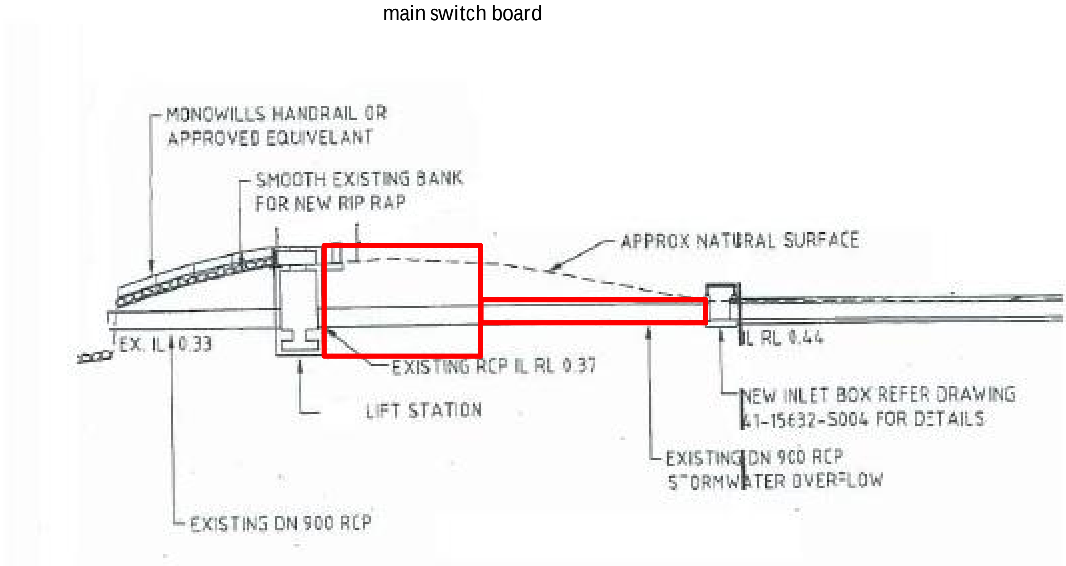
10000mm x 3900mm x 400mm
THICK STONE PITCHED SCOUR
PROTECTION
STORMWATER OVERFLOW
LIFT STATION
NEIGHBOURS PALING FENCE
IL RL 0.44
1800 HIGH PLASTIC COATED
CHAIN LINK SECURITY FENCE
900mm RCP
EXISTING DN 900 RCP
STORMWATER OVERFLOW
MSB
MONOWILLS HANDRAIL OR
APPROVED EQUIVALENT
New 1200mm RCBC
New pump well and
diversion weir
New pump discharge
pipe

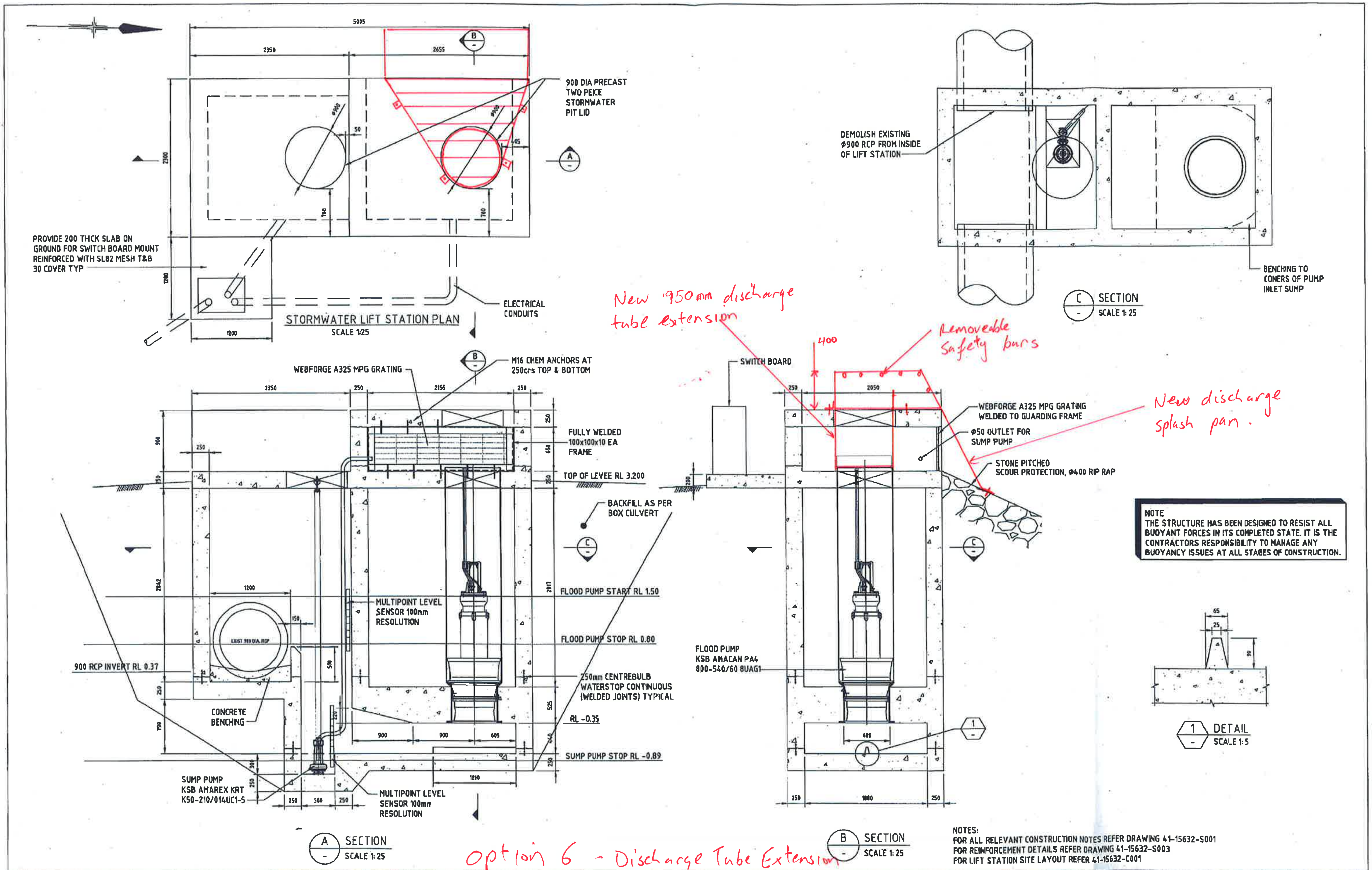


MONOWILLS HANDRAIL OR
APPROVED EQUIVELANT
SMOOTH EXISTING BANK
FOR NEW RIP RAP
APPROX NATURAL SURFACE
EX. IL 0.33
EXISTING RCP IL RL 0.37
LIFT STATION
IL RL 0.44
NEW INLET BOX REFER DRAWING
41-15632-S004 FOR DETAILS
EXISTING DN 900 RCP
STORMWATER OVERFLOW
EXISTING DN 900 RCP

Option 3


10000mm x 3900mm x 400mm
THICK STONE PITCHED SCOUR
PROTECTION
STORMWATER OVERFLOW
LIFT STATION
NEIGHBOURS PALING FENCE
IL RL 0.44
1800 HIGH PLASTIC COATED
CHAIN LINK SECURITY FENCE
900mm RCP
EXISTING DN 900 RCP
STORMWATER OVERFLOW
MSB
MONOWILLS HANDRAIL OR
APPROVED EQUIVALENT
New 1200mm RCBC
Extension to existing pump well
and diversion weir
Relocate existing
main switch board


MONOWILLS HANDRAIL OR
APPROVED EQUIVELANT
SMOOTH EXISTING BANK
FOR NEW RIP RAP
APPROX NATURAL SURFACE
EX. IL 0.33
IL RL 0.44
EXISTING RCP IL RL 0.37
LIFT STATION
NEW INLET BOX REFER DRAWING
41-15632-S004 FOR DETAILS
EXISTING DN 900 RCP
STORMWATER OVERFLOW
EXISTING DN 900 RCP



NOTE
THE STRUCTURE HAS BEEN DESIGNED TO RESIST ALL BUOYANT FORCES IN ITS COMPLETED STATE. IT IS THE CONTRACTORS RESPONSIBILITY TO MANAGE ANY BUOYANCY ISSUES AT ALL STAGES OF CONSTRUCTION.

NOTES:
FOR ALL RELEVANT CONSTRUCTION NOTES REFER DRAWING 41-15632-S001
FOR REINFORCEMENT DETAILS REFER DRAWING 41-15632-S003
FOR LIFT STATION SITE LAYOUT REFER 41-15632-C001

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Drafting Check	NIK EDULJEE	Design Check	U.CHAUDHARI
Approved	C. JOHNSTON		
Date	04.05.06		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

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Title: STORMWATER LIFT STATION GENERAL ARRANGEMENT PLAN AND SECTIONS

Original Size A1 Drawing No: 41-15632-S002 Rev: 0