Carnarvon Ministerial Advisory Committee

Carnarvon Water Supply System Assessment of Current Operations

DRAFT for discussion

June 2014

1 Contents

2 Background

Carnarvon is a coastal town located approximately 900 km north of Perth. The town includes Carnarvon Horticulture District, one of the major fruit and vegetable growing regions in Western Australia.

The Carnarvon Water Supply Scheme provides public drinking water to the Town and irrigation water to the Gascoyne Water Co-operative (GWC). The GWC have upgraded their irrigation distribution network in 2012-2013 to meet the current and ultimate irrigation demands. The layout of the pipe upgrades is shown in Figure 1.

Since the pipes were upgraded, the GWC have been unable to provide a continuous water supply to the growers and consequently a significant number of growers are receiving no or low intermittent supply. Currently, there are a total of 182 irrigators being supplied off this irrigation supply system.

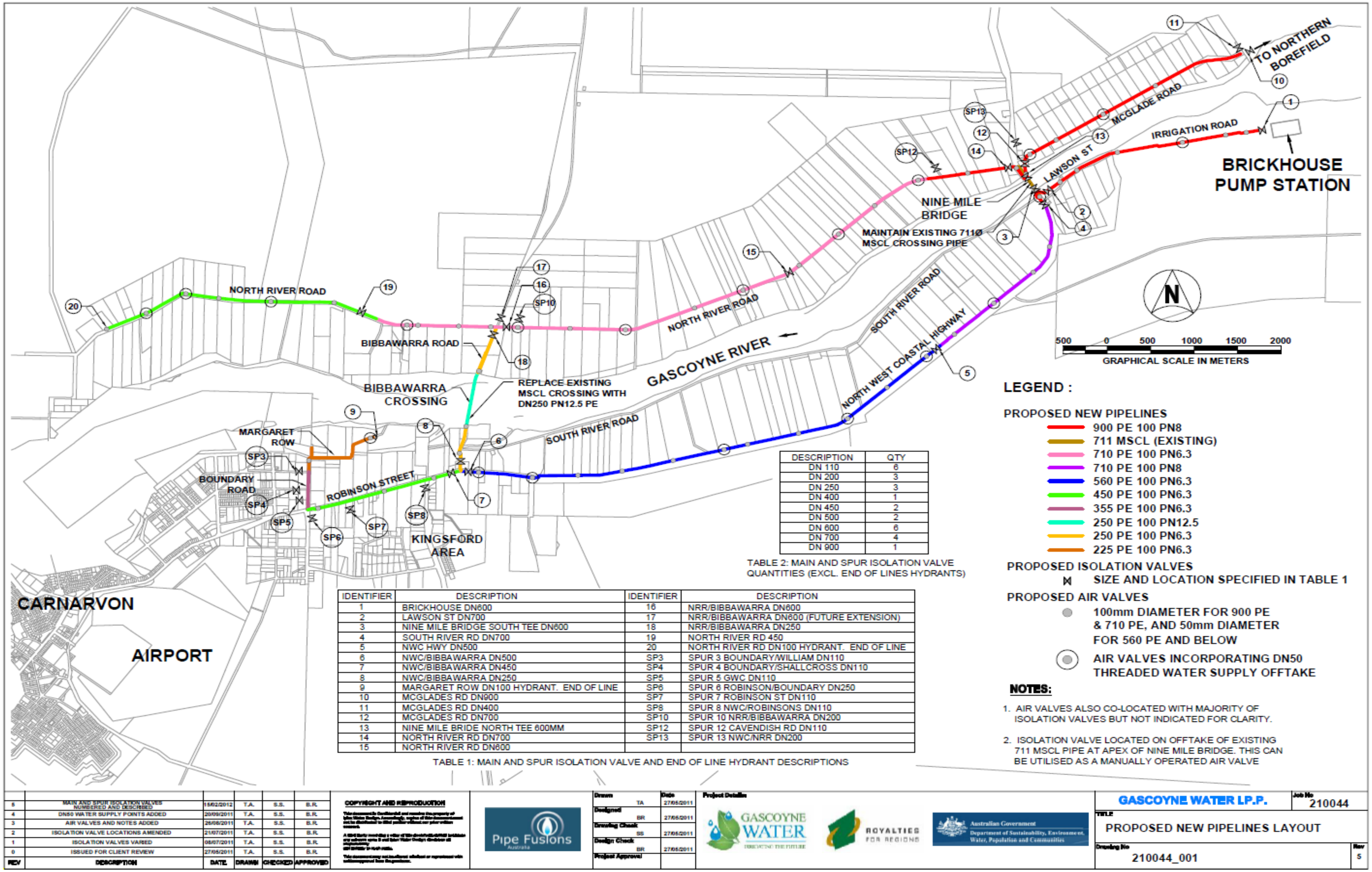
The Water Corporation has been requested to investigate the possible causes of this supply issue and possibly recommend a solution. This report outlines the findings of the hydraulic investigation and the outcomes of solution.

This report is to be read in conjunction with the Mid-Term Report prepared for the Carnarvon Ministerial Advisory Committee.

3 Methodology

This study was undertaken based on the following approach:

- Information and data regarding the Carnarvon Water Supply Scheme, including the GWC irrigation assets, have been sourced from various areas. The Water Corporation has considerable information on its own assets and this was augmented with significant information from GWC on their northern borefield and Irrigation Supply Main.
- Key stakeholders were consulted to understand the key operational issues associated with the current supply system.
- A hydraulic model (Hydnet/Watsys Model) of the total existing water supply scheme was created and used in the operational analysis of the system.
  - Operational problems identified by stakeholders were collaborated.
  - Potential solutions to these problems were identified.
- High level capital and operational costings were undertaken.
- Recommendations on optimisation of the scheme identified.



DESCRIPTION	QTY
DN 110	6
DN 200	3
DN 250	3
DN 400	1
DN 450	2
DN 500	2
DN 600	6
DN 700	4
DN 900	1

TABLE 2: MAIN AND SPUR ISOLATION VALVE QUANTITIES (EXCL. END OF LINES HYDRANTS)

IDENTIFIER	DESCRIPTION	IDENTIFIER	DESCRIPTION
1	BRICKHOUSE DN600	16	NRR/BIBBAWARRA DN600
2	LAWSON ST DN700	17	NRR/BIBBAWARRA DN600 (FUTURE EXTENSION)
3	NINE MILE BRIDGE SOUTH TEE DN600	18	NRR/BIBBAWARRA DN250
4	SOUTH RIVER RD DN700	19	NORTH RIVER RD 450
5	NWC HWY DN500	20	NORTH RIVER RD DN100 HYDRANT. END OF LINE
6	NWC/BIBBAWARRA DN500	SP3	SPUR 3 BOUNDARY/WILLIAM DN110
7	NWC/BIBBAWARRA DN450	SP4	SPUR 4 BOUNDARY/SHALLCROSS DN110
8	NWC/BIBBAWARRA DN250	SP5	SPUR 5 GWC DN110
9	MARGARET ROW DN100 HYDRANT. END OF LINE	SP6	SPUR 6 ROBINSON/BOUNDARY DN250
10	MCGLADES RD DN900	SP7	SPUR 7 ROBINSON ST DN110
11	MCGLADES RD DN400	SP8	SPUR 8 NWC/ROBINSONS DN110
12	MCGLADES RD DN700	SP10	SPUR 10 NRR/BIBBAWARRA DN200
13	NINE MILE BRIDE NORTH TEE 600MM	SP12	SPUR 12 CAVENDISH RD DN110
14	NORTH RIVER RD DN700	SP13	SPUR 13 NWC/NRR DN200
15	NORTH RIVER RD DN600		

TABLE 1: MAIN AND SPUR ISOLATION VALVE AND END OF LINE HYDRANT DESCRIPTIONS

REV	DESCRIPTION	DATE	DRAWN	CHECKED	APPROVED
5	MAIN AND SPUR ISOLATION VALVES NUMBERED AND DESCRIBED	15/02/2012	T.A.	S.S.	B.R.
4	DN50 WATER SUPPLY POINTS ADDED	20/09/2011	T.A.	S.S.	B.R.
3	AIR VALVES AND NOTES ADDED	26/08/2011	T.A.	S.S.	B.R.
2	ISOLATION VALVE LOCATIONS AMENDED	21/07/2011	T.A.	S.S.	B.R.
1	ISOLATION VALVES VARIED	08/07/2011	T.A.	S.S.	B.R.
0	ISSUED FOR CLIENT REVIEW	27/05/2011	T.A.	S.S.	B.R.

Figure 1: Plan of the Irrigation Supply Pipeline upgrade carried out by GWC in 2012 - 2013

4 Scheme Information

4.1 Information

The Water Corporation used information and data from its own assets. This was supplemented by information from GWC, as per below.

- As constructed drawings of the new Irrigation Supply Pipeline
- Individual off-take connection details (details of the Irrigator's tanks were not available)
- Irrigation maximum allocation flow details
- Design report prepared by Pipe Fusion for the system upgrades completed in 2011
- Northern Borefield operating strategy document
- Documents outlining the operating strategy for the Northern Borefield
- Borefield layout plans, typical headwork details and location plans
- Over use of water entitlement policy and procedure documents
- Asset register and commissioning flows & pressure documents
- Annual consumption details per property from 2009 – 2013

4.2 Modelling Assumptions

A hydraulic model of the Irrigators' Supply Pipeline was built to incorporate all 182 irrigator services with individual offtakes, tanks and the Northern Borefield network. Hydraulic modelling and analysis was carried out based on the following assumptions:

- All irrigator's storage tanks are assumed as 2 metres in height (based on perception during the site visit and due to lack of individual tank details).
- All irrigators are drawing water from the system at the same time (reflects the worst case scenario in the absence of irrigators consumption and cropping patterns), reflecting a peak demand scenario.
- Supply rate of 28 ML/d from the WC's Southern Borefield.
- Supply rate of 7.5 ML/d from the GWC's Northern Borefield.

5 Existing Irrigation Scheme

5.1 Northern Borefield

There are a total of 9 production bores on the Northern side of the Gascoyne River which are owned by GWAMCO and operated by the GWC. The Northern Borefield Operating Strategy document mentions that the maximum abstraction license for this Borefield is 2.78 GL per annum (7.620 ML/day). These bores pump water into the collector main, which feeds directly into the irrigation supply pipeline. The details of these production bores are provided in Appendix 1.

5.2 Southern Borefield

There are a total of 41 production bores on the Southern side of the Gascoyne River, which are owned and operated by the Water Corporation.

The current irrigation water contract (which expired in July 2013) with the WC entitles the GWC to receive a maximum flow of 22 ML/d (5 GL/yr) during non-drought periods and 28 ML/d (8.6 GL/yr) during drought periods from the Southern Borefield. It is stated in the contract that the town water supply has priority over the irrigators' water supply.

5.3 Brickhouse Tanks and Pump Station Complex

A schematic layout of the system at the Brickhouse complex is shown in Figure 2.

The recommended operating strategy for this complex was for water from the Southern Borefield to be pumped into Tanks 1 and 2 from which it is gravity supplied to the irrigators. This supply is meant to be boosted by the Brickhouse Booster Pumps when the pressure in the irrigators main drops below a set point.

However, the operating strategy more recently adopted was for a direct supply from the borefield collector main, bypassing Tank 1 and Tank 2 and the pump station. The flow rate (of 22 ML/d or 28 ML/d) to the irrigators was controlled by throttling the valve downstream of the Brickhouse complex.

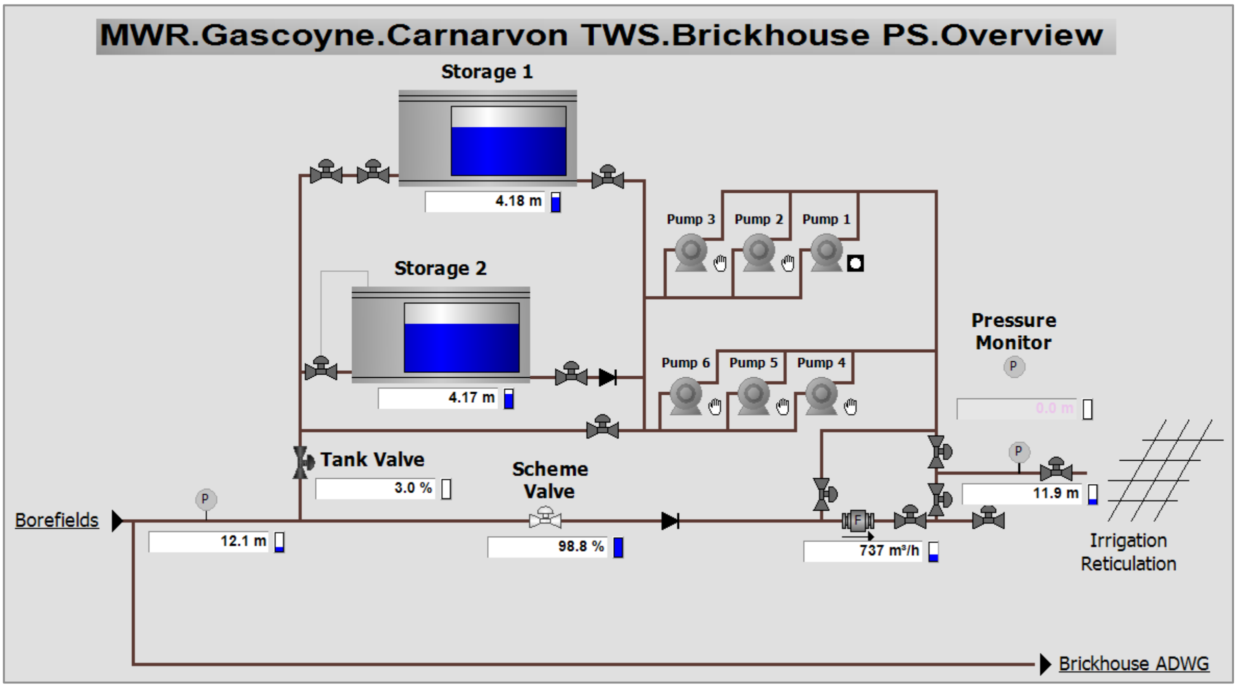


Figure 2: Schematic of the Brickhouse Tanks and Pump Station Complex

5.4 Irrigation mains and off-takes

As mentioned above, the GWC built a new Irrigation Supply Pipeline in 2012/13 to cater for future demands. There are two main supply routes, one on the northern and one on the southern side of the Gascoyne River respectively.

The new pipe alignment has remained unchanged from the old pipe alignment except between the Nine Mile Bridge crossing and Bibbawarra bridge crossing (Figure 1). The old pipe alignment between the two crossings was along the banks of the river and adjacent to the irrigators' tanks. However, the new pipe alignment was altered to follow the North West Coastal Highway on the southern side and the North River Road on the northern side, to be better accessed during/after a large flood. Long offtakes with small diameter pipes were connected from these new mains to the irrigators' tanks, which remained at their original locations. Some of these small diameter offtake pipes extend up to 1km in length. The major issue with this arrangement is the increased pressure losses in these pipelines further exacerbating the low pressure problems.

As part of this upgrade, the GWC installed flow control valves (FCV's) which ranged from DN50 – DN150 on all the offtakes to the irrigators. It was later found that most of the smaller FCV's were not operating as expected and consequently all the DN50 FCV's were removed from the network with the remaining larger FCV's set to fully open.

As a result of this, the entire irrigation network is now being operated as an open system without any flow control. The individual flow rate in these offtakes to the irrigators' tanks is entirely dependent on the pressure available in the distribution mains.

The GWC confirmed that all the off-takes are connected to irrigator tanks and there are no direct feeds from distribution network to the farms. The refill into most of these tanks is controlled by a float valve which shuts when the tank is full. It is to be noted that many people live at their farms and utilise the irrigation water from their tanks for in-house uses.

5.5 System Hydraulic Modelling Analysis

The hydraulic model was set up as an open system (ie. no flow/pressure control) with the following borefield outputs:

- Southern Borefield – Supply of 28 ML/d (324 L/s)
- Northern Borefield – Supply of 7.5 ML/d (87 L/s)

It was assumed that all irrigators are drawing water from the system at the same time, that is, a peak demand scenario.

Figure 3 shows the hydraulic pressures in the Irrigators' Supply Pipeline for both legs of the pipeline from start to finish.

It indicates that there is insufficient pressure in the system to supply water to all the irrigators. Pressures in the main of 1 - 4 metres are seen. This is minimal and highlights that the irrigators at the start of the irrigation main (ie. Near McGlade Road and Irrigation Road), and along North River Road and North West Coastal Highway, also face insufficient pressure. This concurs with the observations made by the GWC during the draught period of 2013-2014.

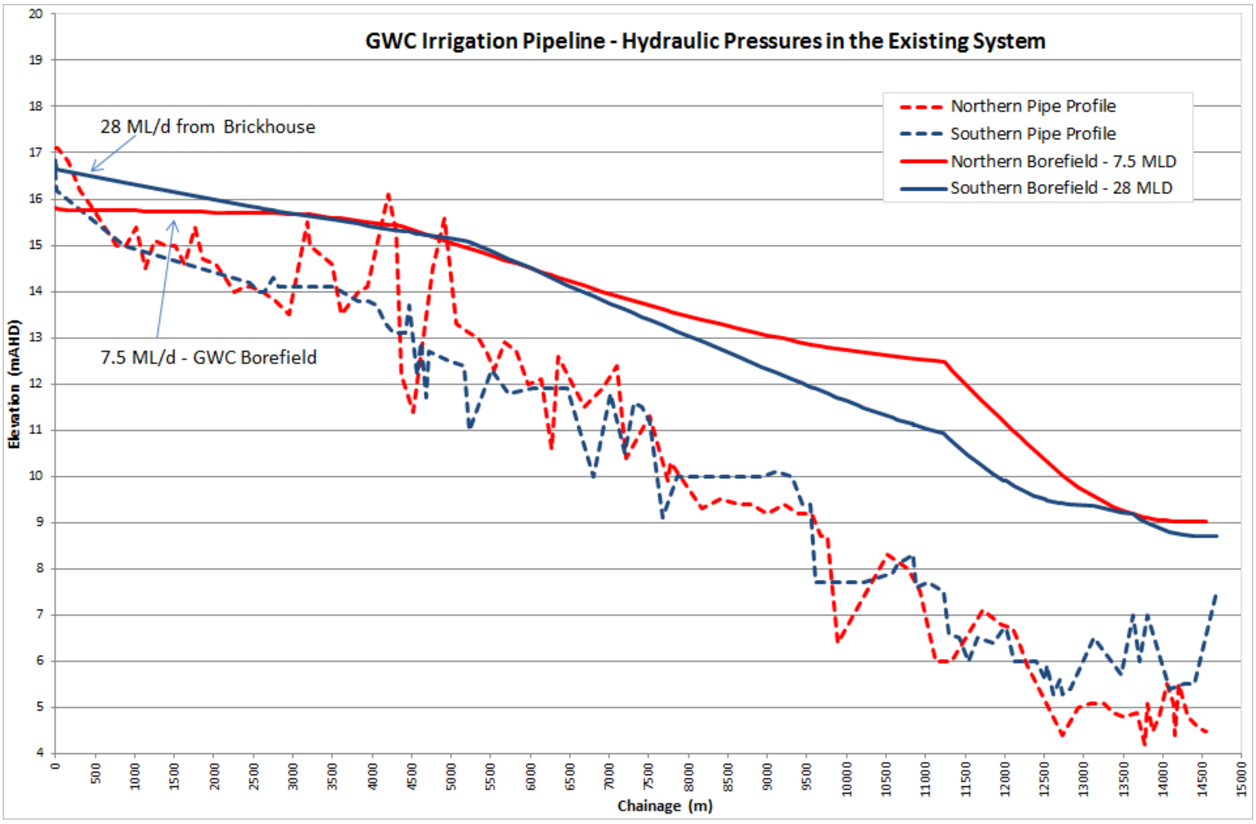


Figure 3: Hydraulic Grade Line - Existing irrigation system

The design report prepared by the Pipe Fusions Australia for the GWC irrigation supply pipeline upgrade project states that the system was planned and designed to maintain a minimum 7 metres residual pressure for the following flow rates:

- Current = Gravity supply of 800 L/s (70 ML/d)
- Ultimate = Pump supply of 1400 L/s (120 ML/d)

As mentioned previously, the combined supply rate from Northern and Southern Borefields are currently:

- Non-drought period - 29.6 ML/d (22 ML/d from Southern and 7.6 ML/d from Northern)
- Drought period - 35.6 ML/d (28 ML/d from Southern and 7.6 ML/d from Northern)

This shows that even though the system was designed for a flow rate of 70 ML/d (800 L/s), the two borefields can supply only half of it (i.e. 35.6 ML/d (412 L/s)) even during the drought periods. Due to this reduced flow rate, the residual pressure in the irrigators' distribution system would be lower than the pressure that would have been created by a flow rate of 70 ML/d, hence the possible reason why the system was experiencing low pressures and was unable to provide flow to some irrigators.

This is also the likely reason why the flow control devices were not operating the way they were supposed to when first installed. These flow valves need a higher pressure to operate properly.

6 Potential Solutions

The only way to increase the pressure in the Irrigators' Supply Pipeline is via a pump station.

One option is to install a new pump station and collector tank at the end of the Northern borefield collector main. The northern bores would pump water into the collector tank. The pump station would pump this water from the collector tank into the Irrigators' Supply Pipeline at a higher pressure. This pressure needs to be high enough to supply all the irrigators' storage tanks under a peak demand scenario. It is estimated that an additional 5-7 metres would be sufficient.

The second option is to divert the Northern Borefield across the river (or Nine-Mile bridge) to join the Southern Borefield collector main prior to the Brickhouse complex. The Brickhouse tanks could be utilised as the collector tanks for both borefields and then the existing pump station could be used to pump into the Irrigators' Supply Pipeline. The existing pump sets and possibly electrical gear would need to be upgraded. The old pump station building, currently constructed in asbestos, will also need to be replaced.

In both cases the individual irrigators control valves need to be re-established to restrict the flows into the tanks.

6.1 Option 1 – Build New Northern Borefield Pump Station & Collector Tank

The analysis used the following scenarios:

- Southern Borefield – Supply of 28 ML/d (324 L/s)
- The Southern Borefield supplies water via the Brickhouse pump station
- Northern Borefield – Supply of 7.5 ML/d (87 L/s)
- The Northern Borefield supplies water via the new pump station
- All the individual offtake flow control devices (FCV's) were reinstated and set at half the original flow rate (Refer to Column E in Appendix B)

The hydraulic grade line for this option is shown in Figure 4 below. It shows a residual pressure of between 4 to 8 metres, which should be sufficient to fill all the irrigators' storage tanks. It is also not an excessive pressure, thereby incurring less operational costs.

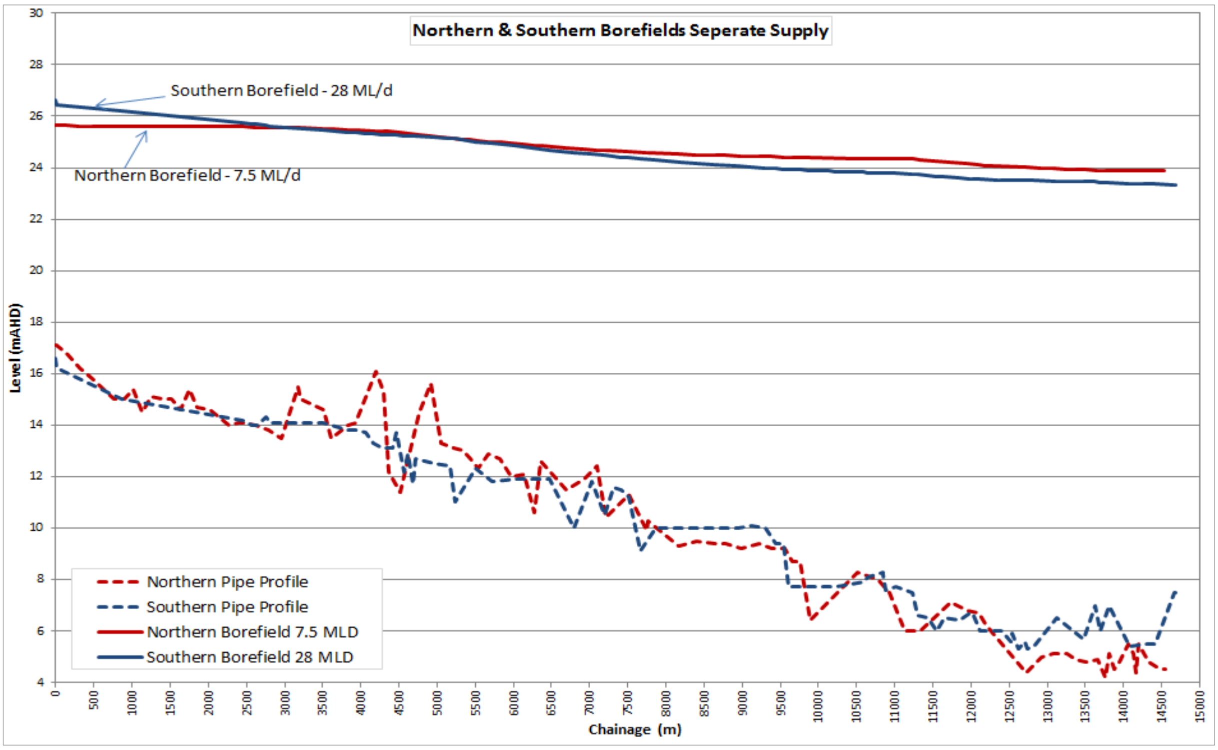


Figure 4: Option 1 - Hydraulic Grade Line

6.2 Option 2 – Divert Northern Borefield to Brickhouse Complex

This option assumes that the Northern Borefield collector main is diverted across/under the Gascoyne River and connected to the Brickhouse Tanks (Figure 5 below). Groundwater from both sources is stored in the Brickhouse storage tanks and the Brickhouse pump station used to pressurise the entire system.

The analysis used the following scenarios:

- Northern Borefield – Supply of 7.5 ML/d into the Brickhouse Tanks
- Southern Borefield – Supply of 28 ML/d into the Brickhouse Tanks
- Brickhouse Tanks and pumps – Supply of 35 ML/d to the entire irrigation system
- All the individual offtake flow control devices (FCVs) were reinstated and set at half the original flow rate (Refer to Column E in Appendix B)

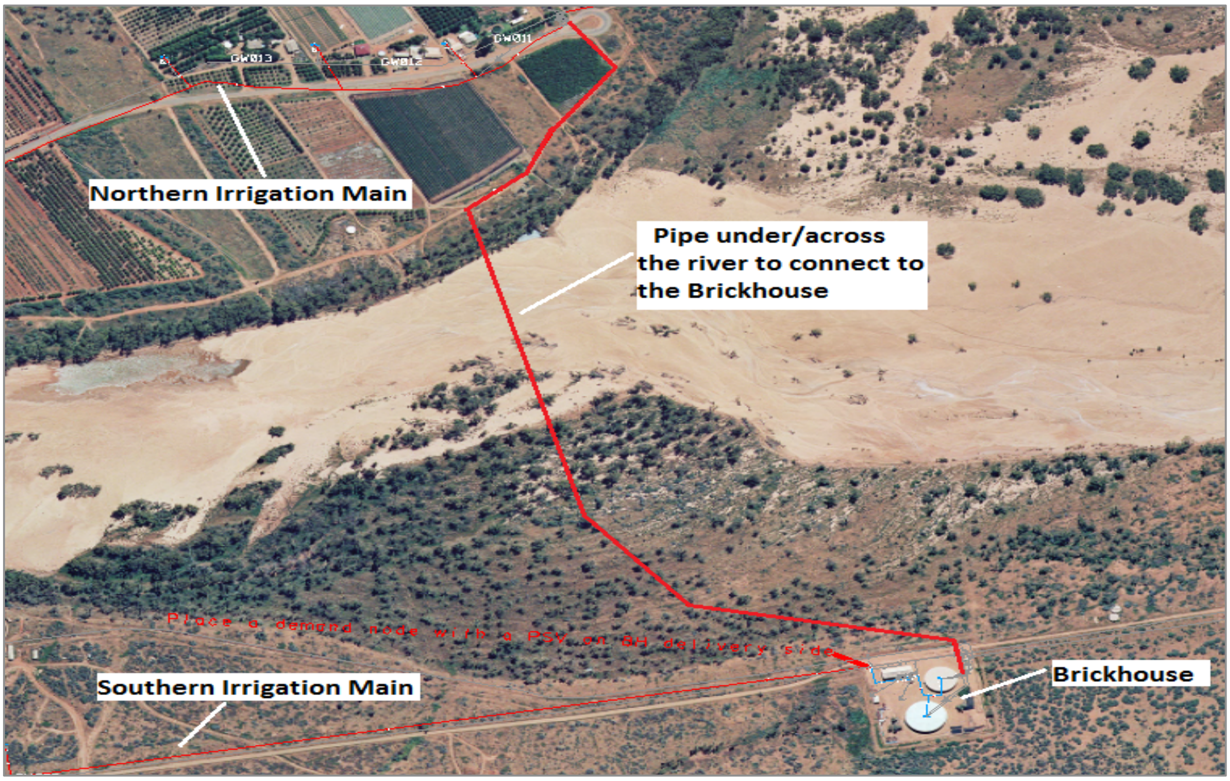


Figure 5: Proposed pipeline from Northern Borefield across Gascoyne River to Brickhouse Complex

The hydraulic grade line for this option is shown in Figure 6 below. It shows a residual pressure of between 6 to 10 metres, which should be sufficient to fill all the irrigators' storage tanks. It is also not an excessive pressure, thereby incurring less operational costs.

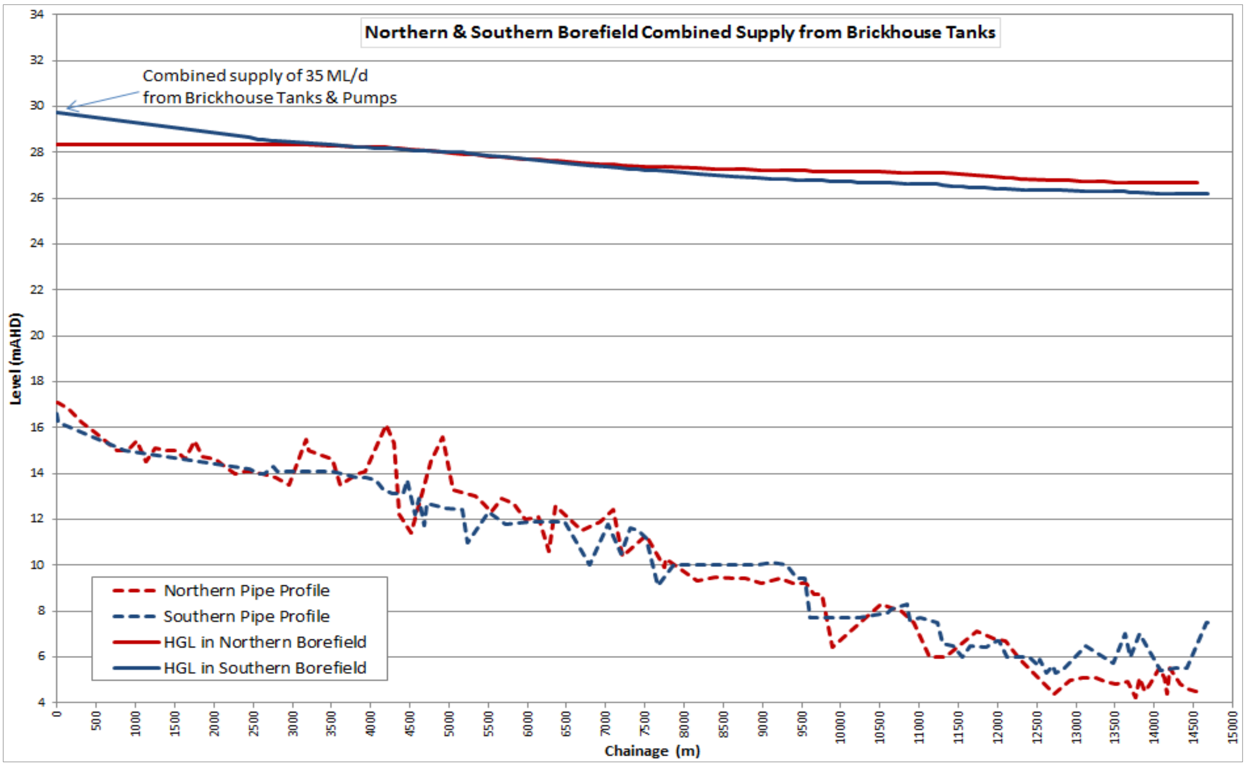


Figure 6: Option 2 – Hydraulic Grade Line

Figure 7 below shows the water distribution plan under both the supply modes and it indicates that every irrigator receives water during the peak demand period.

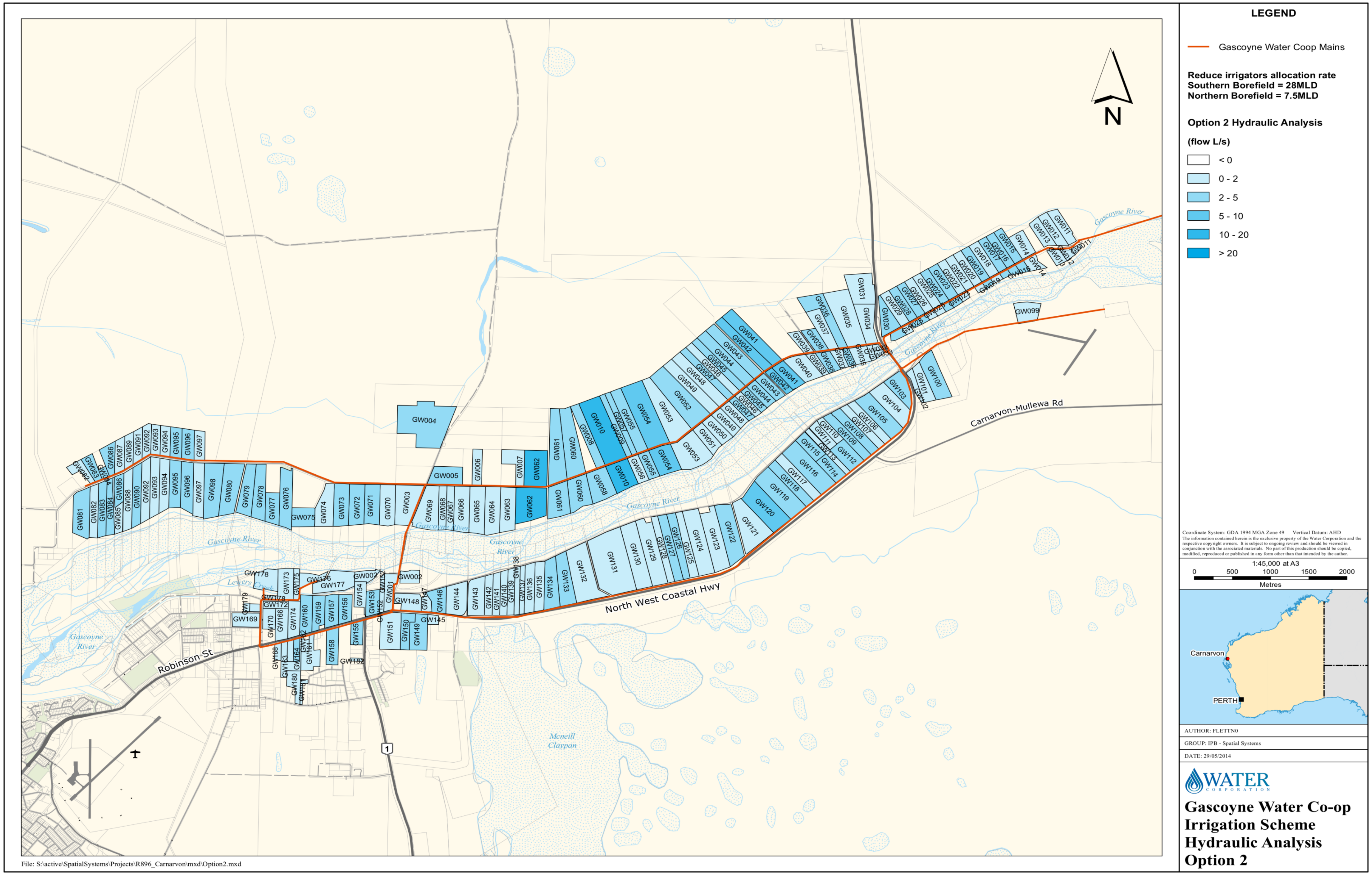


Figure 7: Water flows with enhanced pressures in ISP

7 Cost Comparison

A high level cost analysis was carried out with the infrastructure required for each supply option being:

Option 1 – Build New Northern Borefield Pump Station and Collector Tank

- Refurbishment of the Brickhouse pumps, electrics and building
- New northern pump station and collector tank
- Reinstating all the flow control valves in the irrigation distribution system
- Annual operating and maintenance costs

Option 2 – Divert Northern Borefield to Brickhouse Complex

- 1.4 km DN400 pipe to bring Northern Borefield water to the Brickhouse Tanks (assuming traversing the Gascoyne River)
- Refurbishment of the Brickhouse pumps, electrics and building
- Reinstating all the flow control devices
- Annual operating and maintenance costs

The following assumptions were used while conducting the cost estimation.

- Regional factor of 1.4 for Carnarvon (above 26th Parallel) *Note: This is a multiplying factor for building assets in remote areas, derived from past experience.*
- The costs of electrifying the Northern Borefield and bringing up to the standard was not taken into the estimation

The upfront capital and operation and maintenance costs are provided in the following table:

Note that he costs are conceptual and should be considered as indicative only.

Option	Capital Costs	Annual Operation & Maintenance Costs
1	$9.4 Million	$120,000
2	$8.3 Million	$80,000

8 Conclusions

- The residual pressures within the Irrigators' Supply Pipeline (ISP) are too low during peak demand periods and the irrigators' storage tanks are having difficulty being refilled. This is impacting their ability to water their crops. The main reason for this is that the ISP is too large for the current flows and the bore pumps that are pressurising the entire system cannot generate enough residual pressure. The only solution is to use a pump station(s) to increase the pressure in the ISP. Both options considered are feasible. The costing is high level and further detailed conceptual design and detailed costing needs to be completed prior to deciding on which option with which to proceed.

- To optimise the Carnarvon irrigation system, the following actions need to be undertaken.

    - Increase the pressure in the ISP as per above.
    - The Carnarvon irrigation scheme should be operated as an integrated scheme.
    - All bores should be electrified and automated.
    - All irrigators should have appropriately sized storage tanks on their properties to supply their peak demands from crop watering.
    - All irrigators should have their flow control valves reinstated and/or made operational to ensure that average daily flows are supplied to their storage tanks over a 24 hour basis to even out the peak demands on the scheme.

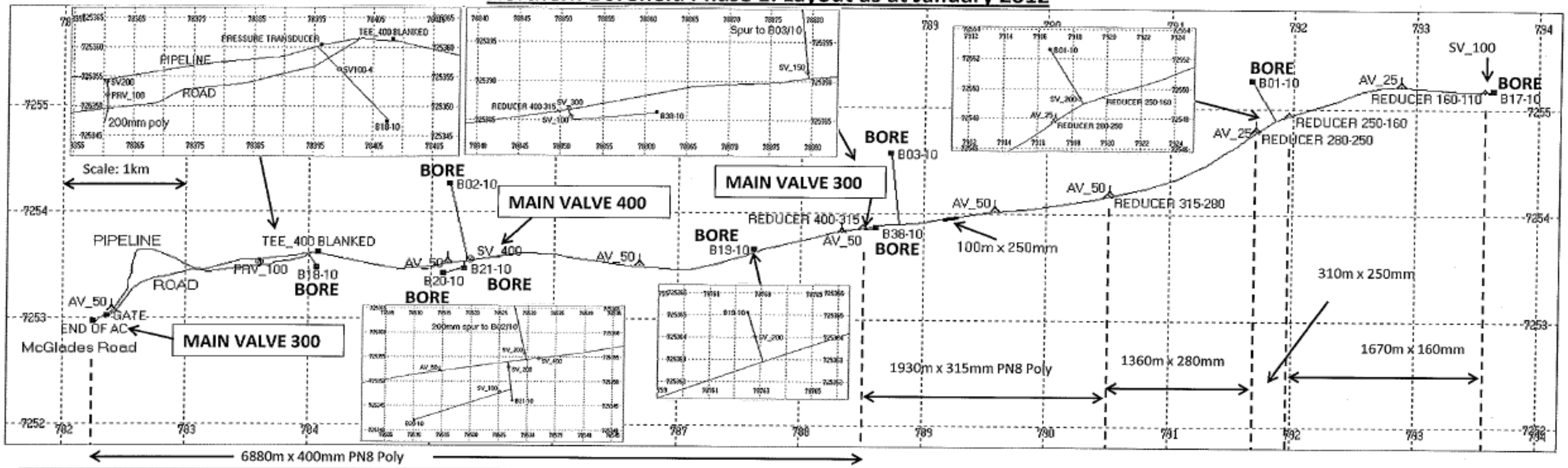
9 Appendices

Appendix 1 – Northern Borefield bores and collector main layout

Appendix 2 – Irrigators' Allocations

Appendix 1 – Northern Borefield bores and collector main layout

Northern Borefield Phase 1: Layout as at January 2012



Flow and Pump Specifications												
	Flow Rate					Distance	Pipe	Spur		Grundfos Pump Specs		
	Individual Bore			Mainline		to next	Size	Size	Length		Motor	Date
Point or tee-off	KL/day	L/s	m3/hr	L/s	m3/hr	Point - m	mm	mm	m	Model	Size - KW	Installed
End of 300mm A/C				87	315	130						
Gate end of McGlades Rd				87	315	1,730	400					
PR valve 100mm				87	315	350	400	200	80			
Bore B18/10	717	8.3	30	87	315	1,330	400	110	140	SP46-7	11	18-Nov-10
Bore B20/10	432	5.0	18	79	285	-	400	110	180	SP30-7	7.5	27-Nov-10
Bore B21/10	294	3.4	12	74	267	30	400	110	90	SP30-6	5.5	26-Nov-10
Bore B02/10	1,547	17.9	64	71	255	-	400	200	750	SP95-5	22	12-Nov-10
Mainline valve 400mm				53	190	2,400	400					
Bore B19/10	2,419	28.0	101	53	190	910	400	110	30	SP95-5	22	9-Dec-10
Bore B38/10	276	3.2	12	25	89	-	400	110	30	SP30-7	7.5	13-Dec-10
Reducer, 400x315mm				22	78	-	315					
Mainline valve 300mm				22	78	290	315					
Bore B03/10	916	10.6	38	22	78	740	315	160	680	SP60-8-B	13	30-Dec-10
Reducer 315x250	Location of 100m x 250mm not certain			11	40	100	250					
Reducer 250-315 (*est*)				11	40	900	315					
Reducer, 315x280mm				11	40	1,360	280					
Reducer, 280x250mm				11	40	190	250					
Bore B01/10	691	8.0	29	11	40	120	250	200	420	SP60-8-B	13	30-Dec-10
Reducer, 250x160mm				3	11	1,670	160					
Reducer, 160x110mm				3	11	-						
Bore B17/10 - end of line	259	3.0	11	3	11	n/a		110	30	SP30-7	7.5	31-Dec-10
TOTALS	**7,551**	**87.4**	**315**			**12,250**			**2430**			

GPS Co-ordinates					
Description	Easting	Northing	Description	Easting	Northing
Airvalve 1 - 50mm	782410	7253060	Pressure Transducer	783964	7253604
Airvalve 2 - 50mm	785147	7253519	REDUCER 160-110	793576	7255163
Airvalve 3 - 50mm	786698	7253498	REDUCER 250-160	791978	7254936
Airvalve 4 - 50mm	788338	7253814	REDUCER 280-250	791697	7254773
Airvalve 5 - 50mm	789584	7254025	REDUCER 315-280	790499	7254166
Airvalve 6 - 50mm	790523	7254172	REDUCER 400-315	788497	7253860
Airvalve 7 - 25mm	791712	7254789	SV100-	783994	7253562
Airvalve 8 - 25mm	792884	7255215	SV100-	785252	7253477
Bore B01-10	791671	7255260	SV100-	788513	7253854
Bore B02-10	785153	7254265	SV100-	793604	7255179
Bore B03-10	788730	7254570	SV150	788795	7253911
Bore B17-10	793638	7255173	SV200	783606	7253540
Bore B18-10	784074	7253473	SV200-	785268	7253529
Bore B19-10	787625	7253651	SV200-	785296	7253556
Bore B20-10	785103	7253419	SV200-	791846	7254932
Bore B21-10	785275	7253460	SV200-	787628	7253640
Bore B38-10	788615	7253860	SV300	788511	7253864
Main Gate	782379	7253015	SV400	785321	7253547
Master Meter	782365	7253030	TEE_400 BLANKED	784083	7253613
Pressure Relief Valve	783607	7253518			

Appendix 2 – Irrigator's Allocation Rate information provided by GWC

A	B	C	D	E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**	**50% Allocation rate (L/s)**	**No. of days**
GW001	35,000	3.4	119	1.7	238
GW002	5,000	2	29	1	58
GW003	40,000	3.9	119	1.95	237
GW004	47,000	4.5	121	2.25	242
GW005	72,000	6.9	121	3.45	242
GW006	5,000	2	29	1	58
GW007	35,000	3.4	119	1.7	238
GW008	100,000	7.9	147	3.95	293
GW009	52,000	5	120	2.5	241
GW010	280,000	27	120	13.5	240
GW011	5,000	2	29	1	58
GW012	5,000	2	29	1	58
GW013	29,000	2.8	120	1.4	240
GW014	37,000	3.6	119	1.8	238
GW015	55,000	4.3	148	2.15	296
GW016	48,000	4.4	126	2.2	253
GW017	70,000	5.2	156	2.6	312
GW018	37,000	3.6	119	1.8	238
GW019	50,000	4.8	121	2.4	241
GW020	10,000	2	58	1	116
GW021	7,000	2	41	1	81
GW022	15,000	2	87	1	174
GW023	70,000	5.2	156	2.6	312
GW024	50,000	4.8	121	2.4	241
GW025	25,000	2.4	121	1.2	241
GW026	10,000	2	58	1	116
GW027	56,000	5.3	122	2.65	245
GW028	47,000	4.5	121	2.25	242
GW029	35,000	3.4	119	1.7	238
GW030	46,000	4.4	121	2.2	242
GW031	29,000	2.8	120	1.4	240
GW032	5,000	2	29	1	58
GW033	5,000	2	29	1	58
GW034	30,000	2.9	120	1.45	239
GW035	15,000	2	87	1	174
GW036	55,000	5.3	120	2.65	240
GW037	11,000	2	64	1	127

A	B	C	D	E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**	**50% Allocation rate (L/s)**	**No. of days**
GW097	15,000	2	87	1	174
GW098	50,000	4.8	121	2.4	241
GW099	5,000	2	29	1	58
GW100	67,000	6.5	119	3.25	239
GW101	26,000	2.5	120	1.25	241
GW102	15,000	2	87	1	174
GW103	44,000	4.2	121	2.1	243
GW104	42,000	4.1	119	2.05	237
GW105	75,000	7.2	121	3.6	241
GW106	20,000	2	116	1	231
GW107	58,000	5.6	120	2.8	240
GW108	70,000	6.8	119	3.4	238
GW109	50,000	4.8	121	2.4	241
GW110	30,000	2.9	120	1.45	239
GW111	34,000	3.3	119	1.65	238
GW112	74,000	7.1	121	3.55	241
GW113	23,000	2.2	121	1.1	242
GW114	57,000	5.1	129	2.55	259
GW115	50,000	4.8	121	2.4	241
GW116	70,000	6.8	119	3.4	238
GW117	9,000	2	52	1	104
GW118	44,000	4.2	121	2.1	243
GW119	86,000	8.3	120	4.15	240
GW120	200,000	14.2	163	7.1	326
GW121	27,000	2.6	120	1.3	240
GW122	60,000	5.8	120	2.9	239
GW123	5,000	2	29	1	58
GW124	35,000	3.4	119	1.7	238
GW125	38,000	3.7	119	1.85	238
GW126	45,000	4.3	121	2.15	242
GW127	60,000	5.8	120	2.9	239
GW128	40,000	3.9	119	1.95	237
GW129	40,000	3.9	119	1.95	237
GW130	30,000	2.9	120	1.45	239
GW131	26,000	2.5	120	1.25	241
GW132	30,000	2.9	120	1.45	239
GW133	12,000	9.5	15	4.75	29

A	B	C	D		E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**		**50% Allocation rate (L/s)**	**No. of days**
GW038	55,000	5.3	120		2.65	240
GW039	25,000	2.4	121		1.2	241
GW040	27,000	2.6	120		1.3	240
GW041	110,000	10.6	120		5.3	240
GW042	129,000	11.7	128		5.85	255
GW043	76,000	7.3	120		3.65	241
GW044	52,000	5	120		2.5	241
GW045	55,000	5.3	120		2.65	240
GW046	39,000	3.8	119		1.9	238
GW047	44,000	4.2	121		2.1	243
GW048	33,000	3.2	119		1.6	239
GW049	5,000	2	29		1	58
GW050	30,000	2.9	120		1.45	239
GW051	18,000	2	104		1	208
GW052	100,000	9.6	121		4.8	241
GW053	35,000	3.4	119		1.7	238
GW054	245,000	23.6	120		11.8	240
GW055	62,000	6	120		3	239
GW056	35,000	2	203		1	405
GW057	73,000	7	121		3.5	241
GW058	71,000	6.8	121		3.4	242
GW059	5,000	2	29		1	58
GW060	75,000	7.2	121		3.6	241
GW061	45,000	4.3	121		2.15	242
GW062	277,000	26.6	121		13.3	241
GW063	5,000	2	29		1	58
GW064	19,000	2	110		1	220
GW065	20,000	2	116		1	231
GW066	29,000	2.8	120		1.4	240
GW067	30,000	2.9	120		1.45	239
GW068	40,000	3.9	119		1.95	237
GW069	40,000	3.9	119		1.95	237
GW070	10,000	2	58		1	116
GW071	47,000	4.5	121		2.25	242
GW072	48,000	4.6	121		2.3	242
GW073	50,000	4.8	121		2.4	241
GW074	40,000	3.9	119		1.95	237
GW075	70,000	5.7	142		2.85	284

A	B	C	D		E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**		**50% Allocation rate (L/s)**	**No. of days**
GW134	111,000	8.9	144		4.45	289
GW135	14,000	2	81		1	162
GW136	37,000	3.6	119		1.8	238
GW137	43,000	3.2	156		1.6	311
GW138	40,000	3.2	145		1.6	289
GW139	17,000	2	98		1	197
GW140	35,000	3.4	119		1.7	238
GW141	38,000	3.7	119		1.85	238
GW142	25,000	2.4	121		1.2	241
GW143	16,000	2	93		1	185
GW144	30,000	2.9	120		1.45	239
GW145	20,000	2	116		1	231
GW146	55,000	5.3	120		2.65	240
GW147	5,000	2	29		1	58
GW148	15,000	2	87		1	174
GW149	66,000	6.4	119		3.2	239
GW150	100,000	4.3	269		2.15	538
GW151	30,000	2.9	120		1.45	239
GW152	5,000	2	29		1	58
GW153	51,000	4.9	120		2.45	241
GW154	70,000	4.1	198		2.05	395
GW155	35,000	3.4	119		1.7	238
GW156	48,000	4.6	121		2.3	242
GW157	50,000	4.8	121		2.4	241
GW158	72,000	5.7	146		2.85	292
GW159	50,000	4.8	121		2.4	241
GW160	54,000	5.2	120		2.6	240
GW161	36,000	3.5	119		1.75	238
GW162	30,000	2	174		1	347
GW163	60,000	3.4	204		1.7	408
GW164	80,000	4.2	220		2.1	441
GW165	42,000	2	243		1	486
GW166	30,000	2.9	120		1.45	239
GW167	13,000	2	75		1	150
GW168	47,000	2	272		1	544
GW169	61,000	3.5	202		1.75	403
GW170	30,000	2.9	120		1.45	239
GW171	8,000	2	46		1	93

A	B	C	D		E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**		**50% Allocation rate (L/s)**	**No. of days**
GW076	55,000	5.3	120		2.65	240
GW077	50,000	4.8	121		2.4	241
GW078	47,000	4.5	121		2.25	242
GW079	60,000	5.8	120		2.9	239
GW080	50,000	4.8	121		2.4	241
GW081	83,000	8	120		4	240
GW082	40,000	3.3	140		1.65	281
GW083	46,000	4.4	121		2.2	242
GW084	58,000	5.6	120		2.8	240
GW085	40,000	3.9	119		1.95	237
GW086	67,000	6.5	119		3.25	239
GW087	50,000	4.1	141		2.05	282
GW088	8,000	2	46		1	93
GW089	5,000	2	29		1	58
GW090	45,000	4.3	121		2.15	242
GW091	17,000	2	98		1	197
GW092	20,000	2	116		1	231
GW093	5,000	2	29		1	58
GW094	19,000	2	110		1	220
GW095	50,000	4.8	121		2.4	241
GW096	100,000	9.6	121		4.8	241

A	B	C	D		E	F
Meter	**Allocation kL/yr**	**Allocation rate (L/s)**	**No. of days**		**50% Allocation rate (L/s)**	**No. of days**
GW172	48,000	3.4	163		1.7	327
GW173	12,000	2	69		1	139
GW174	36,000	3.5	119		1.75	238
GW175	8,000	2	46		1	93
GW176	15,000	2	87		1	174
GW177	5,000	2	29		1	58
GW178	5,000	2	29		1	58
GW179	5,000	2	29		1	58
GW180	73,000	4.1	206		2.05	412
GW181	8,000	2	46		1	93
GW182	5,000	2	29		1	58
	8,063,000					

	C	D		E	F
Total instantaneous flow (L/s)	**786.9**			**393.5**	
Average watering days		**111**			**223**
% Watering per year		**30.50%**			**61.01%**