

JBS Townsville

Environmental Evaluation Of Wastewater Irrigation

Response to A Request

DES CA4544; 101/0008424

Part 2 - **Groundwater** - Interim Report



Prepared for

JBS Australia

By

Bio-Track Pty Ltd

June 29, 2018

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1 INTRODUCTION

Bio-Track Pty Ltd has been commissioned by JBS Australia Pty Ltd to prepare a response to a request from the Department of Environment and Science (Notice to conduct or commission an environmental evaluation, CA4544; 101/0008424, dated 19 April 2018). This report is an interim report as part of an ongoing study.

It is assumed the reader is familiar with the Department of Environment and Science notice details.

2 INVESTIGATION

Temporary shallow groundwater monitoring bores have been installed at six locations on March 9, 2018. The locations were selected to sample water that may pass beyond the property boundary and potentially transport nutrient.

Three permanent monitoring bores are also located on the site. These are used for annual groundwater monitoring.

One production bore exists on the site.

The location of the bores is shown on Figure 1.

Bore log descriptions for the six temporary monitoring bores are provided in Table 1.

The groundwater level measurements taken on March 10, 2018 from the six temporary monitoring bores are provided in Table 2. The location of the monitoring bores has been surveyed. The survey report is provided as Appendix 1. The water surface level has been plotted and the levels are shown in Figure 2. The hydraulic gradient is in the range of 0.002 to 0.0025 m/m.

Analysis results of samples taken on March 10, 2018 from the six temporary monitoring bores are provided in Table 3. The bore recovery is very slow after purging due to the fine textured soil. The existing monitoring bores (Piezo 1-3) will be added to future monthly measurements.

Bore Locations

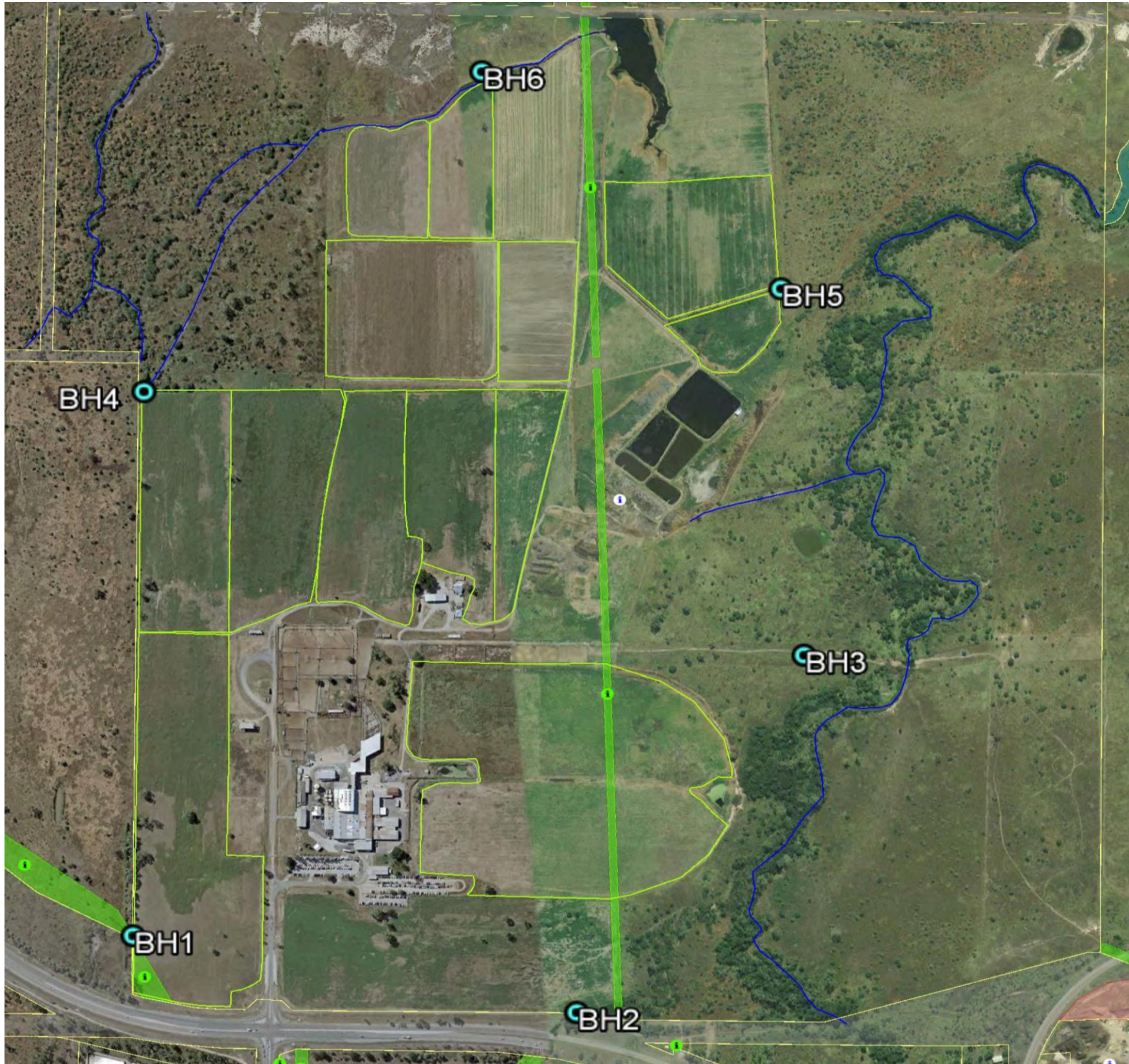
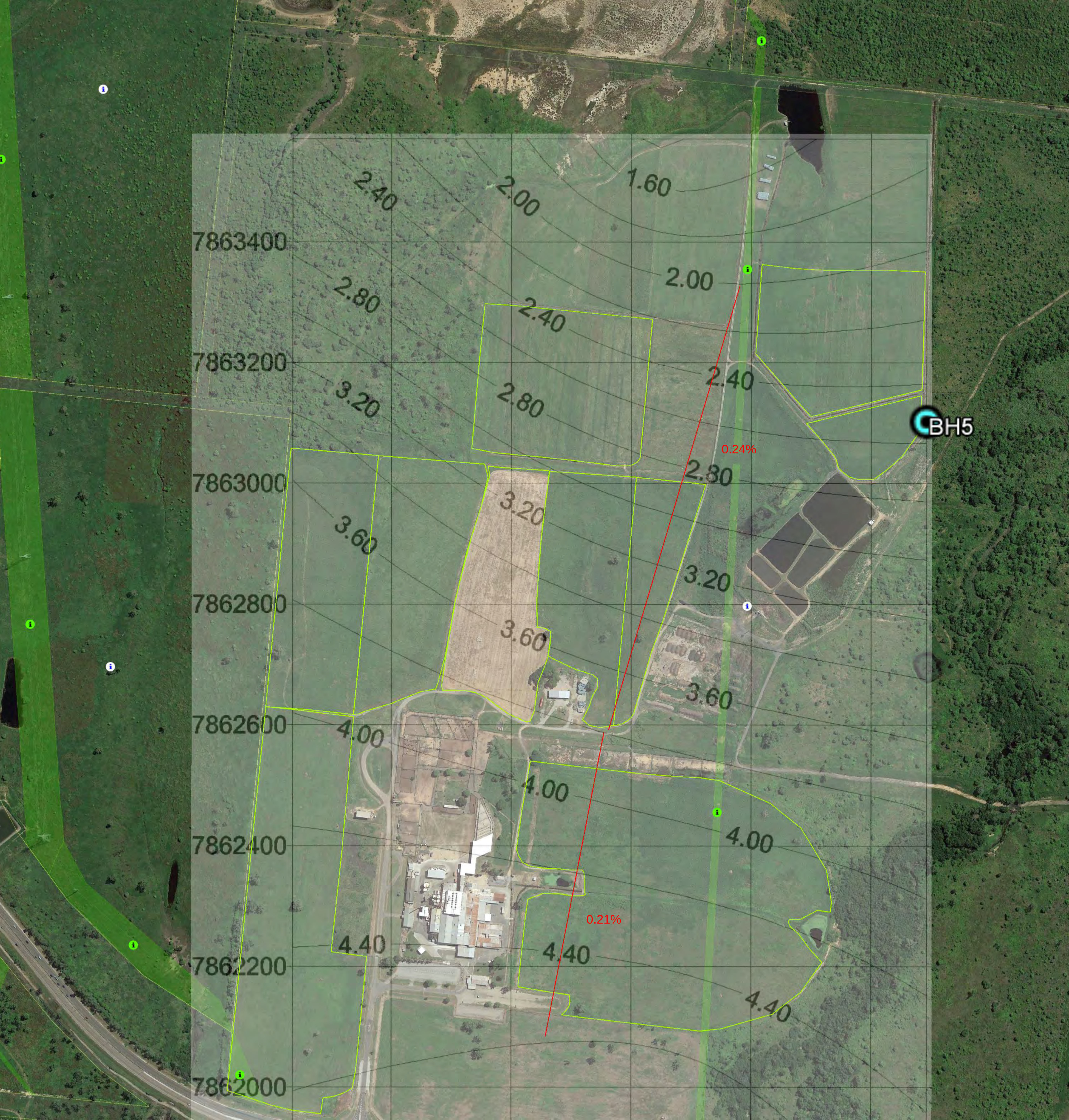
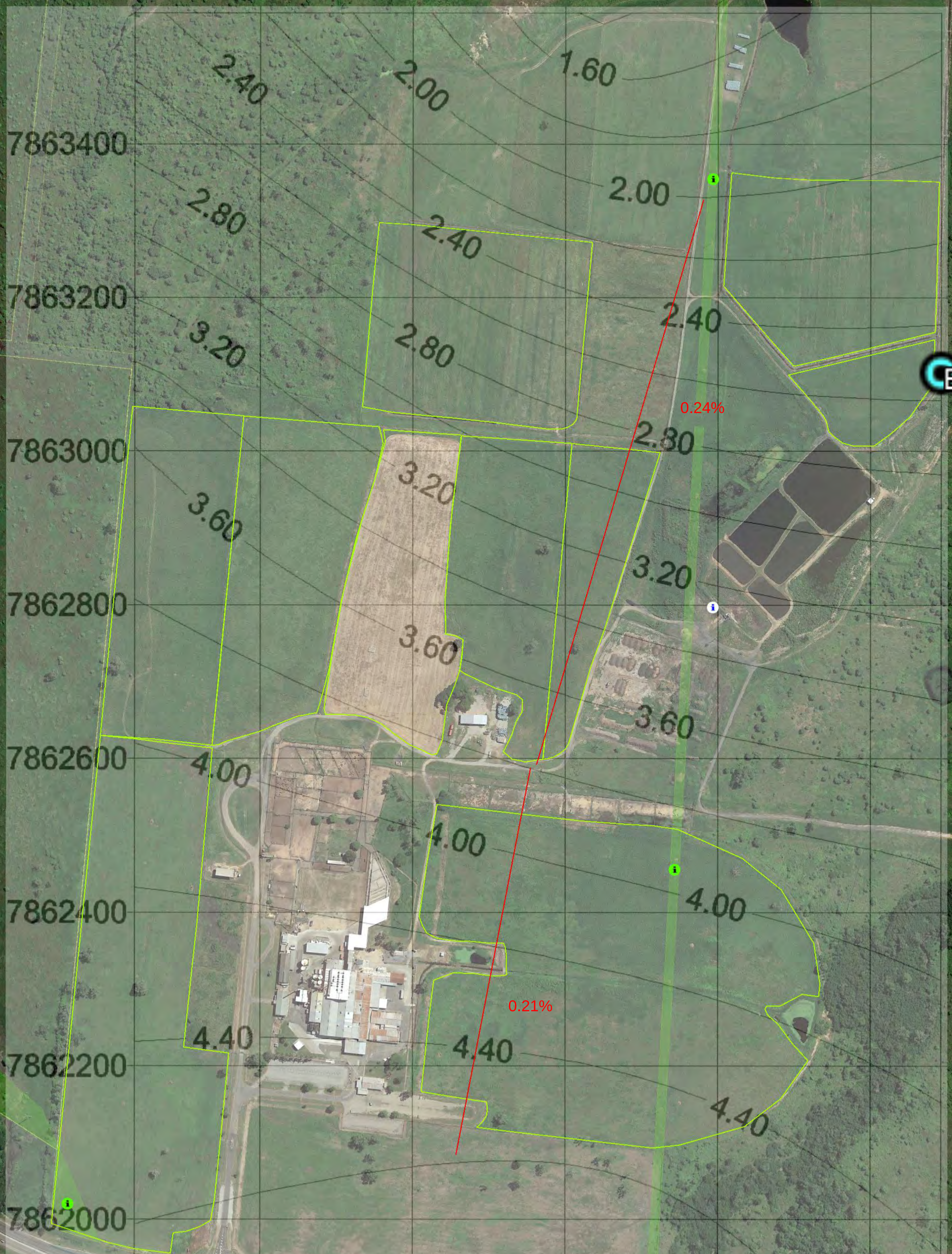


TABLE 1: Soil Profile Description																																																													
Date of Field Work		9/5/2018		Sampling Method	90 mm power auger																																																								
Field Staff		Peter Edmiston																																																											
Name	BH1	BH2	BH3	BH4	BH5	BH6																																																							
Relief/ Slope	Level plain	Level plain	Level plain	Level plain	Level plain	Level plain																																																							
Landform Pattern	Delta	Delta	Delta	Delta	Delta	Delta																																																							
Lf. Morphology	Simple-slope	Simple-slope	Simple-slope	Simple-slope	Simple-slope	Simple-slope																																																							
Lf. Elements	Plain	Plain	Plain	Plain	Plain	Plain																																																							
Drainage Class	Imperfectly drained	Imperfectly drained	Imperfectly drained	Imperfectly drained	Imperfectly drained	Imperfectly drained																																																							
Microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief	No microrelief																																																							
Soil Order	Sodosol	Sodosol	Sodosol	Sodosol	Sodosol	Sodosol																																																							
Sub Order	Natric	Natric	Natric	Natric	Natric	Natric																																																							
Profile Placement	depositional	depositional	depositional	depositional	depositional	depositional																																																							
Lat (WGS84)	-19.335022°	-19.336815°	-19.331401°	-19.326486°	-19.325505°	-19.321642°																																																							
Long.	146.850899°	146.857647°	146.861692°	146.851889°	146.861878°	146.857568°																																																							
m																																																													
Surface	firm	firm	firm	firm	firm	firm																																																							
0.0	grey brown silty clay	grey brown sandy clay, disturbed	dark grey silty clay	dark grey silty clay	dark grey silty clay	brown sandy clay loam																																																							
0.2	yellow brown sandy clay			dark grey silty clay		grey, medium clay	dark grey silty clay	dark brown clay, moist																																																					
0.4		yellow brown sandy clay							dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																																																	
0.6													yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																																												
0.8																		yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																																							
1.0																							yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																																		
1.2																												yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																													
1.4																																	yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																								
1.6																																						yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist																			
1.8																																											yellow brown sandy clay	dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist														
2.0			yellow brown sandy clay																																													dark grey silty clay	grey, medium clay	dark grey silty clay	dark brown clay, moist										
2.2				yellow brown sandy clay		dark grey silty clay	grey, medium clay																																													dark grey silty clay	dark brown clay, moist								
2.4									yellow brown sandy clay	dark grey silty clay	grey, medium clay																																											dark grey silty clay	dark brown clay, moist						
2.6														yellow brown sandy clay	dark grey silty clay	grey, medium clay																																								dark grey silty clay	dark brown clay, moist				
2.8																			yellow brown sandy clay	dark grey silty clay	grey, medium clay																																					dark grey silty clay	dark brown clay, moist		
3.0																								yellow brown sandy clay	dark grey silty clay	grey, medium clay																																		dark grey silty clay	dark brown clay, moist
3.2																													yellow brown sandy clay	dark grey silty clay	grey, medium clay																														
3.4	yellow brown sandy clay																																	dark grey silty clay	grey, medium clay	dark grey silty clay																									
3.6		yellow brown sandy clay																																					dark grey silty clay	grey, medium clay	dark grey silty clay																				
3.8													sandy clay, increasing sand																															----Terminated ----	----Terminated ----	----Terminated ----															
4.0					moist, yellow brown sandy clay			----Terminated ----					----Terminated ----					----Terminated ----																														----Terminated ----													
4.2						moist, yellow brown sandy clay	----Terminated ----					----Terminated ----											----Terminated ----																										----Terminated ----												
4.4										moist, yellow brown sandy clay	----Terminated ----						----Terminated ----											----Terminated ----																						----Terminated ----											
4.5					----Terminated ----										----Terminated ----	----Terminated ----						----Terminated ----											----Terminated ----																												
4.8						----Terminated ----		----Terminated ----					----Terminated ----					----Terminated ----																																											
5.0							----Terminated ----			----Terminated ----		----Terminated ----								----Terminated ----																																									

TABLE 2

Temporary Shallow Groundwater Observation Bore Name				TMB 1			TMB 2			TMB 3			TMB 4			TMB 5			TMB 6			
Location	Latitude			-19.335022°			-19.336815°			-19.331401°			-19.326486°			-19.325505°			-19.321642°			
	Longitude			146.850899°			146.857647°			146.861692°			146.851889°			146.861878°			146.857568°			
Easting MGA 94				484338.3			485040.2			485471.3			484434.6			485492.2			485038.4			
Northing				7862095.8			7861902.9			7862496.6			7863055.4			7863152.2			7863573.4			
		Casing Top Elevation (AHD)	m	10.174			9.315			7.091			6.894			6.215			5.136			
		Ground Surface Elevation (AHD)	m	9.49			8.48			6.64			6.09			5.83			4.63			
DIMENSIONS 9/5/2018		Casing Top To Base	m	4.753			5.05			5.1			5.303			4.99			4.903			
		Casing Base Elevation (AHD)	m	5.42			4.27			1.99			1.59			1.23			0.23			
		Casing Diameter	m	0.05			0.05			0.05			0.05			0.05			0.05			
		Case Slot Range	m	4.5-4.7			4.75-5			4.8-5.05			5.05-5.3			4.75-4.94			4.65-4.85			
		Casing Top To Ground Level	m	0.68			0.83			0.45			0.80			0.39			0.51			
Date	Time	OBSERVATIONS			D.B.G.L	G.W.L AHD	Sampled	D.B.G.L	G.W.L AHD	Sampled	D.B.G.L	G.W.L AHD	Sampled	D.B.G.L	G.W.L AHD	Sampled	D.B.G.L	G.W.L AHD	Sampled	D.B.G.L	G.W.L AHD	Sampled
10/05/18	9.15	D.B.G.L. (distance below ground level to water surface)		m	dry	<5.42	no	3.647	4.833	yes	2.889	3.751	yes	2.536	3.554	yes	2.425	3.405	yes	3.284	1.346	yes



BH5

0.24%

0.21%

Certificate of Analysis

Client Details

Client Name: JBS Swift
Postal Address: PO Box 1160
 AITKENVALE QLD 4810
Attention: Trevor Govindsamy
Telephone: 07 4720 8029
Email: Trevor.Govindsamy@jbssa.com.au

Laboratory Contact

Michelle Tink
 (MRACI C.Chem.)
 Laboratory Manager
 Phone: 07 4781 5214
 Fax: 07 4781 5589
 Email: michelle.tink@jcu.edu.au

Analysis Results:

Analysis	Unit	Bore 6 10/05/2018 J18-0144/1	Bore 2 10/05/2018 J18-0144/2	Bore 3 10/05/2018 J18-0144/3	Bore 4 10/05/2018 J18-0144/4
Total Nitrogen	µg N/L	312	943	206	232
Ammonia	µg N/L	18	40	8	4
Nitrite	µg N/L	<1	20	<1	1
Nitrate	µg N/L	46	429	18	39
Total Phosphorus	µg P/L	112	168	33	125
Filterable Reactive Phosphorus	µg P/L	105	135	26	112

Analysis	Unit	Bore 5 10/05/2018 J18-0144/5
Total Nitrogen	µg N/L	1,498
Ammonia	µg N/L	25
Nitrite	µg N/L	2
Nitrate	µg N/L	667
Total Phosphorus	µg P/L	181
Filterable Reactive Phosphorus	µg P/L	41

Comment:



Patrick Cunningham
 Laboratory Technician
 TropWATER



Michelle Tink MRACI C.Chem
 Laboratory Manager
 TropWATER



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Certificate of Analysis

Bio-Track Pty Ltd ABN 91 056 237 275

Phone: +617 3289 7179

Signatory:

Test Code/Name		[101] Water Test Suite #1	
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
Report Date	28/06/2018	Client Contact	Peter Edmiston
Sample Received Date	10/05/2018	Project Name	Wastewater Irrigation
Sample Disposal Date	10/07/2018	Job Number	
Sampling Date	10/07/2018	Order Number	
Sample Packaging	Plastic Bottle	Chain of Custody	
Temperature	Ambient	Client Email	
Report Summary		Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Elements																											
Ag	Al	As	B	Ca	Cd	Cl	Co	Cr	Cu	Fe	Hg	K	Li	Mg	Mn	Na	Ni	P	Pb	S	Se	Si	Sr	Ti	V	Zn	
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
<0.01	0.06	<0.05	0.25	47	<0.01	1100	0.01	0.02	<0.01	0.28	<0.01	9.4	<0.01	81	0.03	957	0.03		<0.1	21	<0.1	32	1.2	<0.01	<0.01	0.17	
<0.01	<0.05	<0.05	0.24	281	<0.01	2400	<0.01	<0.01	<0.01	0.24	<0.01	4.5	<0.01	294	<0.01	1500	0.01		<0.1	42	0.17	30	6.3	<0.01	<0.01	0.1	
<0.01	<0.05	<0.05	0.49	487	<0.01	2900	0.02	<0.01	<0.01	0.23	<0.01	20	<0.01	366	0.2	1890	0.02		<0.1	31	<0.1	19	10	<0.01	<0.01	0.11	
<0.01	<0.05	<0.05	0.45	624	<0.01	3100	0.04	<0.01	<0.01	0.26	<0.01	23	<0.01	494	0.39	2270	0.04		<0.1	51	<0.1	23	11	<0.01	<0.01	0.14	
<0.01	<0.05	<0.05	0.28	242	<0.01	2800	0.02	<0.01	<0.01	0.22	<0.01	30	<0.01	217	0.17	3050	0.01		<0.1	178	<0.1	15	3.2	<0.01	<0.01	0.12	



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Signatory:

Phone: +617 3289 7179 Bio-Track Pty Ltd ABN 91 056 237 275

Test Code/Name	[101] Water Test Suite #1		
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
SampleID	BH2	Client Contact	Peter Edmiston
		Project Name	Wastewater Irrigation
Report Date	28/06/2018	Job Number	
Sample Received Date	10/05/2018	Order Number	
Sample Disposal Date	10/07/2018	Chain of Custody	
Sample Packaging	Plastic Bottle	Client Email	
Temperature	Ambient	Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Element	Symbol	Reported Results	Units
Silver	Ag	<0.01	mg/L
Aluminium	Al	0.06	mg/L
Arsenic	As	<0.05	mg/L
Boron	B	0.25	mg/L
Calcium	Ca	47	mg/L
Cadmium	Cd	<0.01	mg/L
Chloride	Cl	1100	mg/L
Cobalt	Co	0.01	mg/L
Chromium	Cr	0.02	mg/L
Copper	Cu	<0.01	mg/L
Iron	Fe	0.28	mg/L
Mercury	Hg	<0.01	mg/L
Potassium	K	9.4	mg/L
Lithium	Li	<0.01	mg/L
Magnesium	Mg	81	mg/L
Manganese	Mn	0.03	mg/L
Sodium	Na	957	mg/L
Nickel	Ni	0.03	mg/L
Phosphorus	P		mg/L
Lead	Pb	<0.1	mg/L
Sulphur	S	21	mg/L
Selenium	Se	<0.1	mg/L
Silicon	Si	32	mg/L
Strontium	Sr	1.2	mg/L
Titanium	Ti	<0.01	mg/L
Vanadium	V	<0.01	mg/L
Zinc	Zn	0.17	mg/L
pH	pH	7.1	
Electrical Conductivity	E.C.	4.79	dS/m



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Test Code/Name	[101] Water Test Suite #1		
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
SampleID	BH3	Client Contact	Peter Edmiston
		Project Name	Wastewater Irrigation
Report Date	28/06/2018	Job Number	
Sample Received Date	10/05/2018	Order Number	
Sample Disposal Date	10/07/2018	Chain of Custody	
Sample Packaging	Plastic Bottle	Client Email	
Temperature	Ambient	Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Element	Symbol	Reported Results	Units
Silver	Ag	<0.01	mg/L
Aluminium	Al	<0.05	mg/L
Arsenic	As	<0.05	mg/L
Boron	B	0.24	mg/L
Calcium	Ca	281	mg/L
Cadmium	Cd	<0.01	mg/L
Chloride	Cl	2400	mg/L
Cobalt	Co	<0.01	mg/L
Chromium	Cr	<0.01	mg/L
Copper	Cu	<0.01	mg/L
Iron	Fe	0.24	mg/L
Mercury	Hg	<0.01	mg/L
Potassium	K	4.5	mg/L
Lithium	Li	<0.01	mg/L
Magnesium	Mg	294	mg/L
Manganese	Mn	<0.01	mg/L
Sodium	Na	1500	mg/L
Nickel	Ni	0.01	mg/L
Phosphorus	P		mg/L
Lead	Pb	<0.1	mg/L
Sulphur	S	42	mg/L
Selenium	Se	0.17	mg/L
Silicon	Si	30	mg/L
Strontium	Sr	6.3	mg/L
Titanium	Ti	<0.01	mg/L
Vanadium	V	<0.01	mg/L
Zinc	Zn	0.1	mg/L
pH	pH	7.3	
Electrical Conductivity	E.C.	9.52	dS/m



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Phone: +617 3289 7179 Bio-Track Pty Ltd ABN 91 056 237 275

Test Code/Name	[101] Water Test Suite #1		
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
SampleID	BH4	Client Contact	Peter Edmiston
		Project Name	Wastewater Irrigation
Report Date	28/06/2018	Job Number	
Sample Received Date	10/05/2018	Order Number	
Sample Disposal Date	10/07/2018	Chain of Custody	
Sample Packaging	Plastic Bottle	Client Email	
Temperature	Ambient	Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Element	Symbol	Reported Results	Units
Silver	Ag	<0.01	mg/L
Aluminium	Al	<0.05	mg/L
Arsenic	As	<0.05	mg/L
Boron	B	0.49	mg/L
Calcium	Ca	487	mg/L
Cadmium	Cd	<0.01	mg/L
Chloride	Cl	2900	mg/L
Cobalt	Co	0.02	mg/L
Chromium	Cr	<0.01	mg/L
Copper	Cu	<0.01	mg/L
Iron	Fe	0.23	mg/L
Mercury	Hg	<0.01	mg/L
Potassium	K	20	mg/L
Lithium	Li	<0.01	mg/L
Magnesium	Mg	366	mg/L
Manganese	Mn	0.2	mg/L
Sodium	Na	1890	mg/L
Nickel	Ni	0.02	mg/L
Phosphorus	P		mg/L
Lead	Pb	<0.1	mg/L
Sulphur	S	31	mg/L
Selenium	Se	<0.1	mg/L
Silicon	Si	19	mg/L
Strontium	Sr	10	mg/L
Titanium	Ti	<0.01	mg/L
Vanadium	V	<0.01	mg/L
Zinc	Zn	0.11	mg/L
pH	pH	7.2	
Electrical Conductivity	E.C.	12.30	dS/m



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Test Code/Name	[101] Water Test Suite #1		
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
SampleID	BH5	Client Contact	Peter Edmiston
		Project Name	Wastewater Irrigation
Report Date	28/06/2018	Job Number	
Sample Received Date	10/05/2018	Order Number	
Sample Disposal Date	10/07/2018	Chain of Custody	
Sample Packaging	Plastic Bottle	Client Email	
Temperature	Ambient	Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Element	Symbol	Reported Results	Units
Silver	Ag	<0.01	mg/L
Aluminium	Al	<0.05	mg/L
Arsenic	As	<0.05	mg/L
Boron	B	0.45	mg/L
Calcium	Ca	624	mg/L
Cadmium	Cd	<0.01	mg/L
Chloride	Cl	3100	mg/L
Cobalt	Co	0.04	mg/L
Chromium	Cr	<0.01	mg/L
Copper	Cu	<0.01	mg/L
Iron	Fe	0.26	mg/L
Mercury	Hg	<0.01	mg/L
Potassium	K	23	mg/L
Lithium	Li	<0.01	mg/L
Magnesium	Mg	494	mg/L
Manganese	Mn	0.39	mg/L
Sodium	Na	2270	mg/L
Nickel	Ni	0.04	mg/L
Phosphorus	P		mg/L
Lead	Pb	<0.1	mg/L
Sulphur	S	51	mg/L
Selenium	Se	<0.1	mg/L
Silicon	Si	23	mg/L
Strontium	Sr	11	mg/L
Titanium	Ti	<0.01	mg/L
Vanadium	V	<0.01	mg/L
Zinc	Zn	0.14	mg/L
pH	pH	7.0	
Electrical Conductivity	E.C.	15.11	dS/m



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Test Code/Name	[101] Water Test Suite #1		
Lab Reference (LR)	110518.441	Client Name	BIO-TRACK PTY LTD
SampleID	BH6	Client Contact	Peter Edmiston
		Project Name	Wastewater Irrigation
Report Date	28/06/2018	Job Number	
Sample Received Date	10/05/2018	Order Number	
Sample Disposal Date	10/07/2018	Chain of Custody	
Sample Packaging	Plastic Bottle	Client Email	
Temperature	Ambient	Client Address	781 Mount Glorious Road Highvale Brisbane Queensland

Element	Symbol	Reported Results	Units
Silver	Ag	<0.01	mg/L
Aluminium	Al	<0.05	mg/L
Arsenic	As	<0.05	mg/L
Boron	B	0.28	mg/L
Calcium	Ca	242	mg/L
Cadmium	Cd	<0.01	mg/L
Chloride	Cl	2800	mg/L
Cobalt	Co	0.02	mg/L
Chromium	Cr	<0.01	mg/L
Copper	Cu	<0.01	mg/L
Iron	Fe	0.22	mg/L
Mercury	Hg	<0.01	mg/L
Potassium	K	30	mg/L
Lithium	Li	<0.01	mg/L
Magnesium	Mg	217	mg/L
Manganese	Mn	0.17	mg/L
Sodium	Na	3050	mg/L
Nickel	Ni	0.01	mg/L
Phosphorus	P		mg/L
Lead	Pb	<0.1	mg/L
Sulphur	S	178	mg/L
Selenium	Se	<0.1	mg/L
Silicon	Si	15	mg/L
Strontium	Sr	3.2	mg/L
Titanium	Ti	<0.01	mg/L
Vanadium	V	<0.01	mg/L
Zinc	Zn	0.12	mg/L
pH	pH	7.4	
Electrical Conductivity	E.C.	14.72	dS/m

3 ASSESSMENT

The data collected from the six temporary monitoring bores on March 10, 2018 is consistent with data previously gathered during annual monitoring events. The level below the land surface is similar and the nutrient concentration are also similar. The hydraulic gradient observed during the March 10 measurements approximately matches the surface gradient.

The soil texture is a silty clay overlying clay. The in-situ hydraulic conductivity has not been measured but will be in the range of 10^{-2} to 10^{-5} /m/d. In-situ measurement of low permeability strata is time consuming.

Sampling and groundwater level measurement will be continued at monthly intervals from July 2018. This information will be used to assess the groundwater conditions during the second half of 2018.

The information gathered to date (annual monitoring and March 2018) does not reveal the presence of high levels of soluble nutrient.

BH	PO4	TP	% PO4	NH4	NOx	TN	Organic N	% NOx	E.C.
	mg/L			mg/L					d S/m
2	0.135	0.168	80%	0.04	0.449	0.943	0.454	48%	4.79
3	0.026	0.033	79%	0.008	0.18	0.206	0.018	87%	9.52
4	0.112	0.125	90%	0.004	0.04	0.232	0.188	17%	12.3
5	0.041	0.181	23%	0.025	0.669	1.498	0.804	45%	15.11
6	0.1	0.112	89%	0.018	0.046	0.312	0.248	15%	14.72
mean	0.08	0.12	72%	0.02	0.28	0.64	0.34	0.42	11.29

Table 4: Colour shaded presentation of measured groundwater values

Phosphorus levels fall within a narrow range and will be elevated by sediment, fine enough to pass through a 0.45 um filter, especially when subsequently acidified.

Ammonium N levels are all low.

Nitrate N and total levels are elevated for BH2 and BH5. Further tests are required to confirm if this is consistent.

Temporary Groundwater Observation Bore Number	Comments on March 10 Observations
1	dry, close to spray irrigated land
2	margin of irrigated area, expected flow from outside the site (disturbed but not irrigated land). Nutrient above averages
3	not irrigated, little or no expected flow from irrigated land, low nutrient
4	close to spray irrigated land, low nutrient
5	close to flood irrigated land, within flow path from irrigated land, above averages nutrient
6	close to flood irrigated, low nutrient, within flow path from flood irrigated land

Table 5: Groundwater Comments

Deep Drainage Rates

The elevation is expected to be linked to influence from marine salt held within the soil. The salinity trend observed is lowest on the most elevated sample point and highest on the lower point.

The use of chloride to estimate the long term average recharge rate is compromised by the presence of marine chloride. This can be associated with falling sea levels (as occurred 3000-5000 years ago) and cyclonic deposition of seawater. The recharge model assumes atmospheric chloride deposition is solely responsible for groundwater chloride. The atmospheric depositional rate for Townsville coastal areas is approximately 51 kg/ha/year. Using this model a groundwater chloride concentration of 1000 mg/L would predict a deep drainage rate of 51 mm/y. The chloride measurements for the most elevated bore (BH2) are close to 1000 mg/L. This predicted deep drainage rate based on 1000 mg/L chloride is similar to those predicted by the MEDLI water balance model.

If the period of groundwater transport has been long enough to develop an equilibrium, then one would expect the marine chloride would have been transported from the groundwater. If this condition is accepted then the deep drainage rates of the lower lying points are approximately half that of the elevated location.

Further complications are associated with changes in water use by plants. Higher rates of transpiration will lead to higher groundwater salinity. For example, a forested area that is cleared will subsequently have higher deep drainage rates. The groundwater chemistry is slow to change and the site may not be in equilibrium when assessed.

It is concluded the use of a chloride equilibrium model to estimate deep drainage (recharge) is questionable for much of this location. The most likely rate is approximately 50 mm/year but may be lower.

Transport Rate of Nutrient

The flow of water into the ground (groundwater recharge) is equivalent to the deep drainage rate. If a nutrient concentration is applied, it is then possible to estimate the rate at which the nutrient enters the groundwater.

Table 3 uses a worst case nitrogen concentration to predict the nitrogen transport to groundwater. This table refers to a groundwater chloride concentration with a predicted recharge rate of 51 mm/y. This is similar to water balance predictions generated by the MEDLI program for this location.

Input			Groundwater	Ratio	Recharge	
Cl deposition	Rainfall	Cl conc	Cl conc	Input/G.W.		
kg/ha/y	ML/ha/y	mg/L	mg/L		ML/ha/y	mm/y
51	1.09	46.8	1000	0.047	0.051	51
Land Area	Groundwater Recharge	Nitrogen Conc	Nitrogen Flux			
ha	ML/y	mg/L	kg/y	kg/ha/y		
90	45.9	1.3	59.7	0.66		

Table 3: Estimated load of nitrogen to groundwater

Grazing land is estimated to export approximately 3 kg/ha/y of total nitrogen in runoff and urban areas 12 kg/ha/y. The worst case groundwater case is approximately 22% of the runoff load for grazing land and 5.5% that for urban runoff.

Relative to the catchment and surrounding land use of Cleveland Bay, the contribution of irrigated nutrient entering the receiving environment is negligible both in mass load and as a relative contribution.

4 CONCLUSIONS

- * Data collected to date from bores established in 2018 is regarded as preliminary.
- * This data is consistent with groundwater levels and nutrient concentrations collected by routine monitoring under the existing license conditions
- * The flow path of groundwater is approximately in the direction of the land surface
- * The deep drainage rate is approximately 50 mm/year or less
- * The worst case measured soil nitrogen concentration is 1.5 mg N/L
- * The worst case groundwater nutrient export rate is 0.66 kg N/ha/y
- * The export of nitrogen from this site in groundwater provide a negligible contribution to the catchment mass exported into Cleveland Bay.

APPENDIX 1: SURVEY OF BORES JBS TOWNSVILLE

Monitoring Bore	MGA94 Easting	MGA94 Northing	AHD RL	Notes
P1	485512.2	7863642.4	5.599 5.11	Top of Internal Pipe Ground level
P2	484542.6	7862648.0	8.050 7.550	Top of Internal Pipe Ground level
P3	485154.9	7862319.3	7.931 7.55	Top of Internal Pipe Ground level
TMB 1	484338.3	7862095.8	10.174 9.49	Top of Internal Pipe Ground level
TMB 2	485040.2	7861902.9	9.315 8.48	Top of Internal Pipe Ground level
TMB 3	485471.3	7862496.6	7.091 6.64	Top of Internal Pipe Ground level
TMB 4	484434.6	7863055.4	6.894 6.09	Top of Internal Pipe Ground level
TMB 5	485492.2	7863152.2	6.215 5.83	Top of Internal Pipe Ground level
TMB 6	485038.4	7863573.4	5.136 4.63	Top of Internal Pipe Ground level
Water Bore	485054.0	7861945.8	8.835	Screw in Concrete base slab

Coordinate and Level Origin				
PM 163739	484335.025	7862089.526	9.458	Brass Plaque

Site Base Station for Survey				
PM 29519	484581.179	7862398.260	8.789	Brass Plaque

- Survey conducted by RTK GNSS (15/06/2018)
- Coordinates are MGA94
- Levels are AHD

Monitoring Bore – P1



Monitoring Bore – P2

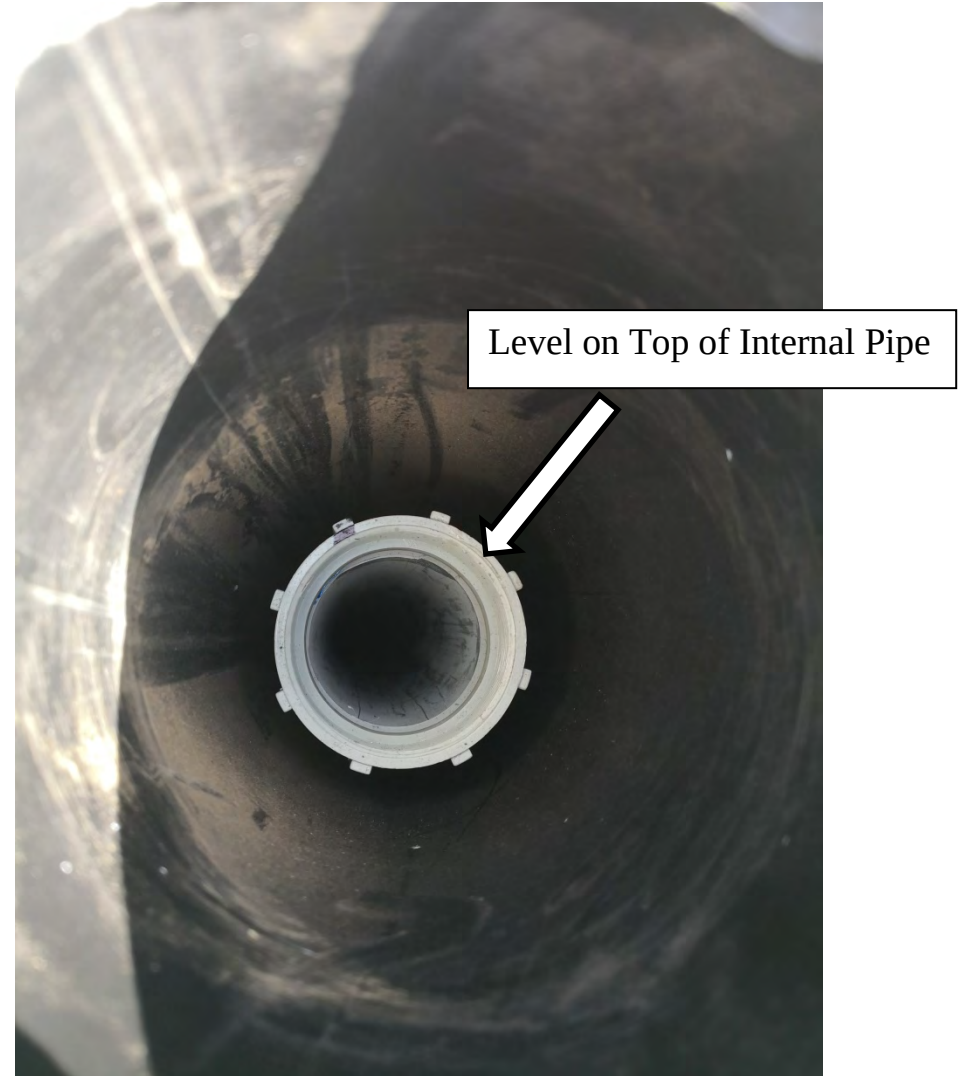


Level on Top of Internal Pipe

Monitoring Bore – P3



Monitoring Bore – TMB 1



Monitoring Bore – TMB 2



Level on Top of Internal Pipe

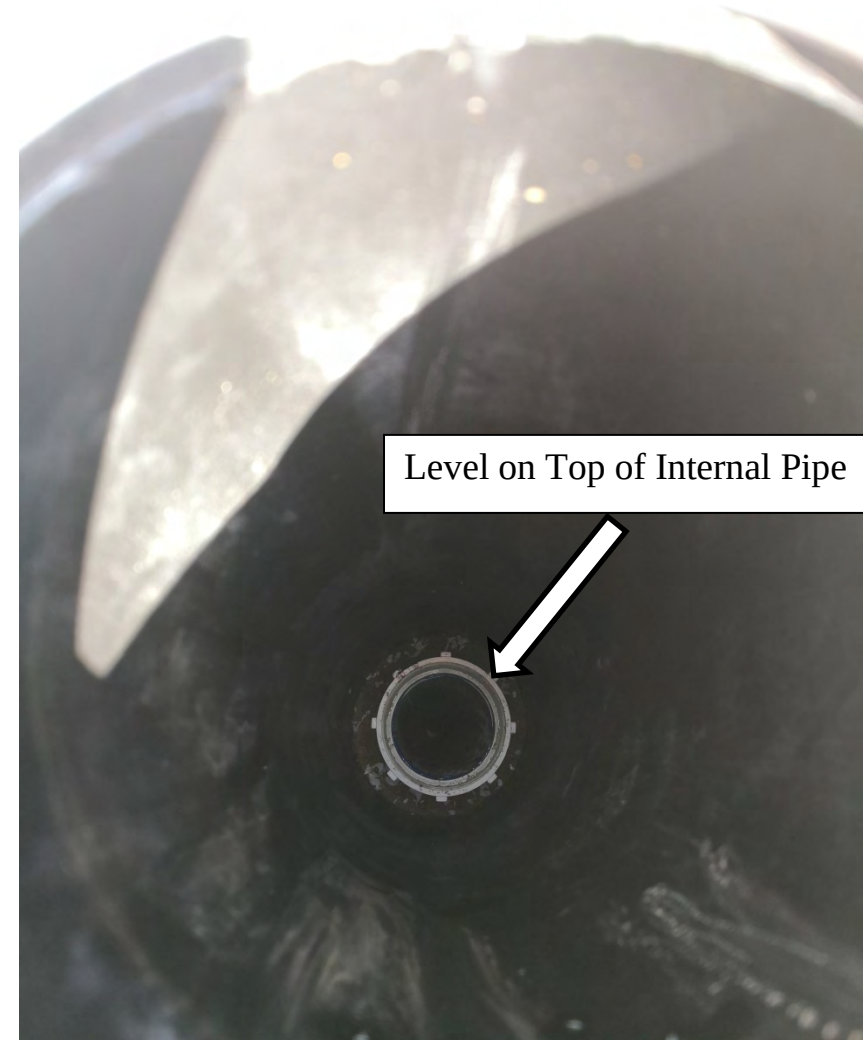
Monitoring Bore – TMB 3



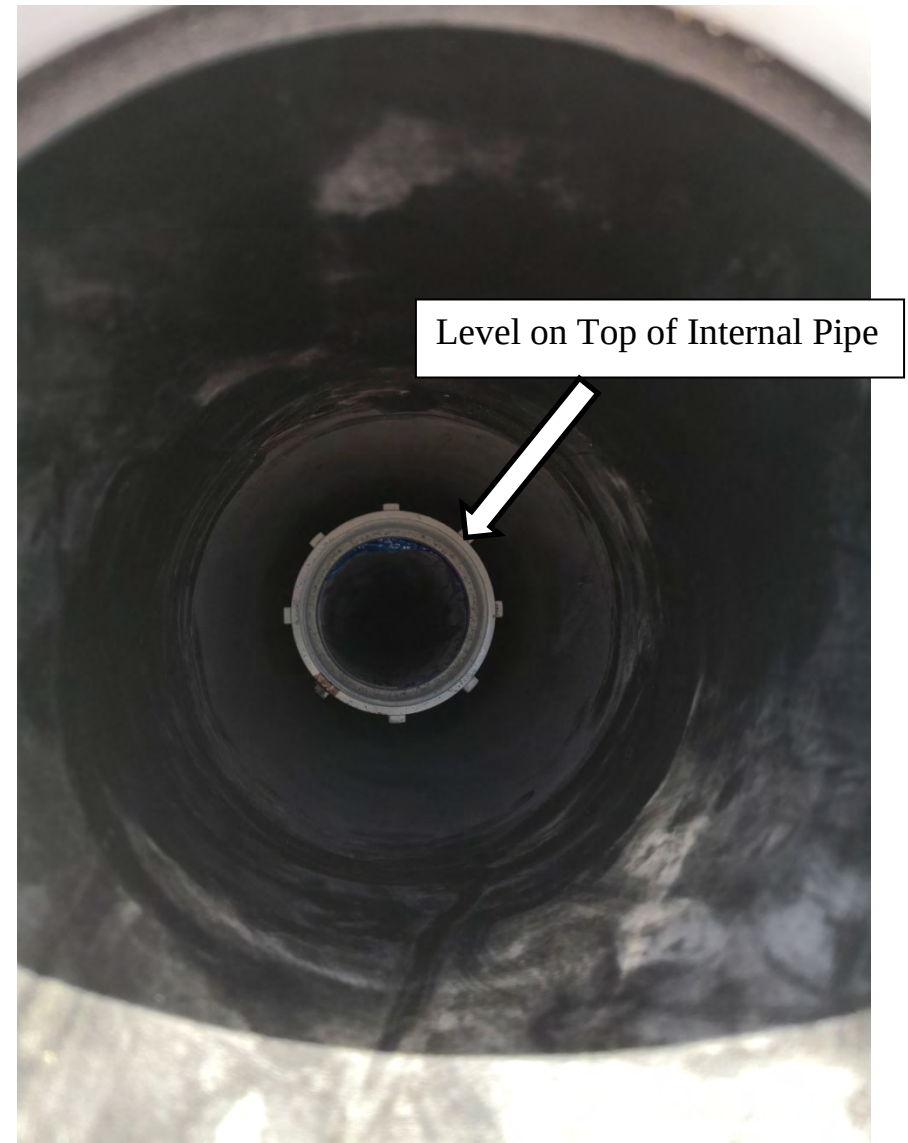
Monitoring Bore – TMB 4



Monitoring Bore – TMB 5



Monitoring Bore – TMB 6



Water Bore

