4 Conclusions and recommendations

The site slope, terrain, soil and vegetation characteristics were used to help identify the location of groundwater seepage zones at the proposed Pacific Pines Estate development site. One seepage zone of 4.74 hectares was identified towards the south of the site, north of the stage 1a residential development and south of the stage 1b retirement community.

To maintain the natural hydrological regime of the freshwater wetland EEC it is recommended that runoff be captured from within the development, stored and treated in bio-retention basins. This water should then be discharged to the nominated target seepage area, via the infiltration trenches associated with the bio-retention systems.

At the completion of the Pacific Pines Estate development, the volume of water captured in the bio-retention basins (229.06ML/yr) will exceed the estimated deep drainage loss caused by the hardstand of the development (211.76ML/yr). Both volumes are in surplus of the estimated average yearly recharge requirement for the seepage zone and freshwater wetland (27.68ML/yr) thus ensuring that the water requirements of these areas can be met.

Seepage that is excess to the water requirements of the wetlands will continue to discharge off site (as it currently does). That is, the near surface hydraulic boundary (the drain) for the groundwater in the hydrosols will not change in its elevation and no impediment to discharge will be created. The pre-development and post-development invert level for discharge of water associated with the wetland areas are both 1.5m AHD (refer to drawings numbered 10734.04 and 10734.05). Given that the seepage component of the landscape is maintained from the predevelopment to post development there will be no change within the wetland.

The bio-retention and infiltration system (for Stage 1A only) as described in Appendix 4 and detailed on SMEC Urban Consulting Drawings contained in Appendix 5 would provide an acceptable solution in that the stormwater inflow would be appropriately treated before it flows into the infiltration trenches.

The volume of water captured within the bio-retention basins will be sufficient to replace the deep drainage loss caused by the development and to maintain wetland conditions within the seepage zone and freshwater wetland EEC. Any surplus water in excess of the irrigation or seepage replacement requirements will have no deleterious impacts on the ecosystem. Excess flows will discharge westwards towards North Creek and the Ballina Nature Reserve.

This assessment demonstrates that the stormwater management and seepage devices can be appropriately configured to maintain the surface and groundwater relationships within the existing (pre-developed) range of natural variation.

5 Limitations of reporting

Gilbert & Sutherland Pty Ltd has made every effort to ensure that the information provided in this report is accurate. The interpretation of scientific data, however, involves professional judgement and as such is open to error.

In recognising the potential for errors in scientific interpretation, Gilbert & Sutherland Pty Ltd does not guarantee that the information is totally accurate or complete and clients are advised not to rely solely on this information when making commercial decisions. Any representation, statement, opinion or advice, expressed or implied is made in good faith and on the basis that the authors, Gilbert & Sutherland Pty Ltd, their agents or employees are not liable (whether by reason of lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to above.

Furthermore, this information should not be relied upon by any persons other than the client for whom it has been compiled. This information reflects the specific brief and the budget of the client concerned, who enjoys an individual tolerance of risk.

6 Appendix 1 – Borelogs

Borehole: **BH1**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557016
Depth (m):	0.60	**Northing:**	6812616
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark brown (7.5yr3/3), weak to moderate polyhedral (5-10mm) structure, earthy fabric, weak to firm consistence, common fine to medium roots, moist;
		CLAY LOAM, Dark brown (7.5yr3/4), moderate polyhedral (5-10mm) structure, rough ped fabric, weak to firm consistence, moist;
		CLAY LOAM, Very dark brown (7.5yr2.5/3), very few small pebbles, weak polyhedral (5-10mm) structure, earthy fabric, weak to firm consistence, common very fine to fine roots, moist;
.5		LIGHT CLAY, Dark reddish brown (5yr3/4), very few small pebbles, moderate subangular blocky (5-10mm) structure, rough ped fabric, weak to firm consistence, moist, borehole refusal at 2m below NSL (only 0.00-0.60m sample depth available).
1.0		
1.5		
2.0		
2.5		

Borehole: **BH2**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557052
Depth (m):	1.20	**Northing:**	6812727
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Very dark greyish brown (10yr3/2), common medium pebbles, weak to moderate polyhedral (5-10mm) structure, earthy fabric, weak consistence, few very fine to fine roots, moist;
.5		CLAY LOAM, Dark greyish brown (10yr4/2), common medium pebbles, weak polyhedral (5-10mm) structure, earthy fabric, weak consistence, very few very fine to fine roots, moist;
		CLAY LOAM, Dark brown (7.5yr3/4), watertable at 0.85m, moderate polyhedral (5-10mm) structure, rough ped fabric, weak consistence, moist;
1.0		LIGHT CLAY, Dark red (2.5yr3/6), few small pebbles, weak to moderate subangular blocky (5-10mm) structure, rough ped fabric, weak consistence, moist, borehole terminated at 1.20m.
1.5		
2.0		
2.5		

Borehole: **BH3**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557052
Depth (m):	2.00	**Northing:**	6812770
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark greyish brown (10yr4/2), few small to medium pebbles, weak subangular blocky (2-5mm) structure, earthy fabric, weak consistence, many fine to medium roots, moist, gradual change to;
.5		LIGHT CLAY, Brown (10yr4/3), watertable at 0.56m, few small pebbles, weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence, few very fine roots, moist;
1.0		LIGHT CLAY, Dark greyish brown (2.5y4/2), few to common small to medium pebbles, weak subangular blocky (5-10mm) structure, rough ped fabric, weak to firm consistence, few fine roots, moist;
1.5		MEDIUM HEAVY CLAY, Light olive brown (2.5y5/6), common medium pebbles, massive, rough ped fabric, weak consistence, moist, borehole terminated at 2.00m.
2.0		
2.5		

Borehole: **BH4**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557189
Depth (m):	1.50	**Northing:**	6812664
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LOAM, Brown (10yr4/3), few small pebbles, weak polyhedral (2-5mm) structure, earthy fabric, firm consistence, common fine roots, moist;
.5		CLAY LOAM, Dark greyish brown (2.5y4/2), massive, rough ped fabric, weak consistence, few fine roots, moist;
1.0		LIGHT MEDIUM CLAY, Red (2.5yr5/8), weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence, moist;
1.5		LIGHT CLAY, Red (10r4/8), weak polyhedral (2-5mm) structure, rough ped fabric, weak consistence, moist, borehole terminated at 1.50m.
2.0		
2.5		

Borehole: **BH5**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557134
Depth (m):	2.00	**Northing:**	6813254
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Brown (7.5yr4/4), massive, earthy fabric, weak consistence, common very fine to fine roots, moist;
.5		
1.0		LIGHT CLAY, Strong brown (7.5yr5/8), weak polyhedral (2-5mm) structure, rough ped fabric, weak consistence, moist, borehole terminated at 2.00.
1.5		
2.0		
2.5		

Borehole: **BH6**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557113
Depth (m):	2.50	**Northing:**	6813165
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LOAM, Dark yellowish brown (10yr3/4), massive, earthy fabric, very weak consistence, very fine to fine roots, moist;
.5		CLAY LOAM, Dark yellowish brown (10yr3/6), weak subangular blocky (2-5mm) structure, rough ped fabric, very weak consistence, moist.
1.0		SILTY LIGHT CLAY, Yellowish brown (10yr5/6), weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence, moist;
1.5		SILTY LIGHT CLAY, Red (2.5yr5/8), weak polyhedral (2-5mm) structure, rough ped fabric, weak consistence, moist, borehole terminated at 2.50m.
2.0		
2.5		

Borehole: **BH7**

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557085
Depth (m):	2.50	**Northing:**	6813030
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark brown (10yr3/3), trace of coarse sand (KS), massive, earthy fabric, weak consistence, few fine and medium roots, moist;
.5		CLAY LOAM, Dark yellowish brown (10yr4/4), watertable at 0.90m, few small pebbles, massive, rough ped fabric, weak consistence, moist;
1.0		CLAY LOAM, Dark olive grey (5y3/2), common small pebbles, weak subangular blocky (5-10mm) structure, rough ped fabric, weak consistence, moist;
1.5		HEAVY CLAY, Dark bluish grey (10B4/1), massive, smooth ped fabric, firm consistence, moist;
2.0		SILTY MEDIUM CLAY, Dark bluish grey (10B4/1), common small pebbles, weak subangular blocky (5-10mm) structure, rough ped fabric, weak to firm consistence, moist;
2.5		SILTY LIGHT CLAY, Greenish grey (5BG5/1), common small to medium pebbles, weak subangular blocky (5-10mm) structure, rough ped fabric, weak to firm consistence, moist, borehole terminated at 2.50m.

Borehole: Obs2

Project:	10734	**Drill Method:**	Solid Flight Auger
Client:	Lend Lease	**Easting:**	557047
Depth (m):	1.50	**Northing:**	6812621
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	07.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LOAM, Dark brown (7.5yr3/4), few small pebbles, massive, earthy fabric, weak consistence, many fine to medium roots, moist, sample taken from an open cut;
		CLAY LOAM, Strong brown (7.5yr5/8), very few small to large pebbles, massive, rough ped fabric, weak consistence, moist;
.5		CLAY LOAM, Dark brown (7.5yr3/3), very few cobbles to large pebbles, weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence, moist, sample taken from an open cut;
1.0		CLAY LOAM, Red (2.5yr5/8), very few medium pebbles, weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence,moist, sample taken from an open cut, observation terminated at 1.50m.
1.5		
2.0		
2.5		

Borehole: **BH8**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557093
Depth (m):	0.60	**Northing:**	6813019
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Olive grey (5y4/2), very few small pebbles, moderate sunangular blocky (2-5mm) structure, earthy fabric, weak consistence, common very fine and fine roots, moist;
		CLAY LOAM, Dark grey (10yr4/1), watertable at 0.22m, moderate subangular blocky (2-5mm) structure, earthy fabric, weak consistence, moist;
.5		LIGHT CLAY, Dark grey (5y4/1), strong subangular blocky (5-10mm) structure, rough ped fabric, very weak consistence, moist, borehole terminated at 0.50m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH9**

Project:	10734	**Drill Method:**	Hand Auger (D8cm)
Client:	Lend Lease	**Easting:**	557153
Depth (m):	1.00	**Northing:**	6812971
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT CLAY, Black (5y2.5/1), massive, earthy fabric, weak consistence, many fine to medium roots, moist;
.5		MEDIUM HEAVY CLAY, Bluish grey (5PB5/1), watertable at 0.58m, massive, earthy fabric, weak consistence;
		HEAVY CLAY, Bluish grey (5PB5/1), massive, weak consistence;
1.0		HEAVY CLAY, Dark bluish grey (5PB4/1), massive, weak consistence, borehole terminated at 1.00m.
1.5		
2.0		
2.5		

Borehole: BH10

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557109
Depth (m):	1.00	**Northing:**	6812983
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT MEDIUM CLAY, Black (10yr2/1), strong subangular blocky (2-5mm) structure, earthy fabric, firm consistence, common fine to medium roots, moist;
		MEDIUM HEAVY CLAY, Dark bluish grey (10B4/1), watertable at 0.33m, massive, firm consistence, few fine roots, moist;
.5		MEDIUM CLAY, Bluish grey (5PB5/1), massive, firm consistence, borehole terminated at 1.00m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH11**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557045
Depth (m):	1.00	**Northing:**	6812965
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT CLAY, Dark grey (10yr4/1), very weak subangular blocky (2-5mm) structure, rough ped fabric, weak consistence, few fine roots, moist;
.5		MEDIUM CLAY, Bluish grey (5PB6/1), watertable at 0.32m, weak polyhedral (5-10mm) structure, rough ped fabric, weak consistence, very few fine roots, moist;
		MEDIUM HEAVY CLAY, Very dark bluish grey (5PB3/1), massive, weak consistence, moist;
1.0		MEDIUM HEAVY CLAY, Bluish black (5PB2.5/1), massive, firm consistence, moist, borehole terminated at 1.00m.
1.5		
2.0		
2.5		

Borehole: **BH12**

Project:	10734	**Drill Method:**	Hand Auger (D8cm)
Client:	Lend Lease	**Easting:**	556993
Depth (m):	1.00	**Northing:**	6812914
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark grey (10yr4/1), massive, earthy fabric, weak consistence, many fine to medium roots, moist;
.5		MEDIUM HEAVY CLAY, Dark greyish brown (10yr4/2), watertable at 0.18m, moderate subangular blocky (10-20mm) structure, rough ped fabric, firm consistence, very few fine roots, moist;
1.0		LIGHT CLAY, Dark bluish grey (5PB4/1), massive, earthy fabric, weak consistence, moist;
1.5		LIGHT CLAY, Bluish grey (5PB6/1), massive, firm consistence, moist, borehole terminated at 1.00m.
2.0		
2.5		

Borehole: **BH13**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557028
Depth (m):	0.80	**Northing:**	6813065
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Strong brown (7.5yr5/8), massive, earthy fabric, very weak consistence, many fine to medium roots, moist;
.5		CLAY LOAM, Reddish yellow (7.5yr6/8), moderate angular blocky (5-10mm) structure, rough ped fabric, weak consistence, very few fine roots, moist, borehole terminated at 0.80m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH14**

Project:	10734	**Drill Method:**	Hand Auger (D8cm)
Client:	Lend Lease	**Easting:**	557033
Depth (m):	1.00	**Northing:**	6812832
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark grey (2.5y4/1), few large pebbles and small cobbles, moderate subangular blocky (2-5mm) structure, earthy fabric, weak consistence, common fine to medium roots, moist;
.5		HEAVY CLAY, Black (5y2.5/2), watertable at 0.35m, too disturbed to establish ped structure, weak consistence, moist;
		MEDIUM HEAVY CLAY, Dark bluish grey (5PB4/1), massive, weak consistence, moist;
1.0		MEDIUM HEAVY CLAY, Dark bluish grey (5PB4/1), massive, weak consistence, moist, borehole terminated at 1.00m.
1.5		
2.0		
2.5		

Borehole: **BH15**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557254
Depth (m):	0.70	**Northing:**	6812979
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT CLAY, Dark yellowish brown (10yr4/4), moderate subangular blocky (2-5mm) structure, earthy fabric, weak consistence, many fine to few medium roots, moist;
.5		HEAVY CLAY, Yellowish brown (10yr5/4), watertable at 0.4m, few small pebbles, moderate polyhedral (2-5mm) structure, earthy fabric, weak consistence, saturated, borehole terminated at 0.70m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH16**

Project:	10734	**Drill Method:**	Hand Auger (D8cm)
Client:	Lend Lease	**Easting:**	557080
Depth (m):	1.00	**Northing:**	6812896
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT CLAY, Very dark greyish brown (2.5y3/2), weak polyhedral (5-10mm) structure, earthy fabric, weak consistence, common fine roots, moist;
.5		MEDIUM CLAY, Very dark bluish grey (5PB3/1), watertable at 0.2m, massive, firm consistence, few fine roots, moist;
1.0		HEAVY CLAY, Bluish grey (10B6/1), massive, weak consistence, moist, borehole terminated at 1.00m.
1.5		
2.0		
2.5		

Borehole: **BH17**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	556965
Depth (m):	1.00	**Northing:**	6812841
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		HEAVY CLAY, Black (5y2.5/1), too disturbed to establish ped structure, earthy fabric, firm consistence, few fine to medium roots, moist;
		HEAVY CLAY, Bluish grey (10B5/1), massive, firm consistence, moist;
.5		HEAVY CLAY, Dark bluish grey (5PB4/1), massive, firm consistence, moist;
		HEAVY CLAY, Bluish grey (10B5/1), massive, firm consistence, moist;
1.0		HEAVY CLAY, Bluish grey (10B6/1), massive, firm consistence, moist, borehole terminated at 1.00m.
1.5		
2.0		
2.5		

Borehole: **BH18**

Project:	10734	**Drill Method:**	Hand Auger (D8cm)
Client:	Lend Lease	**Easting:**	557179
Depth (m):	1.00	**Northing:**	6812888
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Grey (10yr5/1), strong polyhedral (2-5mm) structure, earthy fabric, weak consistence, common fine roots, moist;
.5		LIGHT CLAY, Dark bluish grey (10B4/1), watertable at 0.25m, moderate subangular blocky (2-5mm) structure, earthy fabric, firm consistence, very few fine roots, moist, borehole terminated at 1.00m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH19**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557288
Depth (m):	0.60	**Northing:**	6812946
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Dark grey (5y4/1), very few small pebbles, moderate subangular blocky (2-5mm) structure, earthy fabric, weak consistence, common fine roots, moist;
.5		CLAY LOAM, Olive (5y4/4), watertable at 0.4m, many small pebbles to small cobbles, massive, weak consistence, few fine roots, saturated, borehole terminated at 0.60m due to collapse.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH20**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557346
Depth (m):	0.80	**Northing:**	6812800
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		CLAY LOAM, Yellowish brown (10yr5/4), few small pebbles, moderate subangular blocky (2-5mm) structure, earthy fabric, weak consistence, common fine roots, moist;
.5		SILTY CLAY LOAM, Yellowish brown (10yr5/6), very few small pebbles, weak polyhedral (5-10mm) structure, earthy fabric, weak consistence, moist, borehole terminated at 0.80m.
1.0		
1.5		
2.0		
2.5		

Borehole: **BH21**

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557359
Depth (m):	0.60	**Northing:**	6813123
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		LIGHT CLAY, Yellowish brown (10yr5/4), moderate polyhedral (2-5mm) structure, earthy fabric, weak consistence, common fine roots, moist;
.5		LIGHT MEDIUM CLAY, Yellowish brown (10yr5/6), few charcoal fragments and grey to white rounded (5-25mm) concretions increasing with depth, moderate subangular blocky (2-5mm) structure, earthy fabric, firm consistence, very few fine roots, moist, borehole terminated at 0.60m.
1.0		
1.5		
2.0		
2.5		

Borehole: BH22

Project:	10734	**Drill Method:**	Hand Auger (D10cm)
Client:	Lend Lease	**Easting:**	557304
Depth (m):	0.30	**Northing:**	6812811
Logged by:	DJY		
Drilled by:	G&S		
Drill date:	13.12.11		

GILBERT SUTHERLAND

Depth NSL(m)	Drilling: Graphic log	Drilling: Comments
		SILTY CLAY LOAM, Black (5y2.5/1), very few small pebbles, weak to moderate subangular blocky (5-10mm) structure, rough ped fabric, weak consistence, few fine roots, moist;
		MEDIUM CLAY, Olive (5y4/3), few small to medium pebbles, moderate subangular blocky (2-5mm) structure, rough ped fabric, firm consistence, few fine roots, moist, borehole terminated at 0.30m.
.5		
1.0		
1.5		
2.0		
2.5		

7 Appendix 2 – Permeability test results

Permeability Results

Constant head permeameter

Project 10734 **Location** BH5 (WP72)

Site description Stormwater Advice, Lennox Head, NSW

Tested by DJY **Date** 30-Nov-11

Test hole geometry

	Test 1	Test 2
Hole depth (m)	2	
Depth (m) of water in hole	1.7	
Hole diameter (mm)	90	
Depth (m) to imperm. layer		

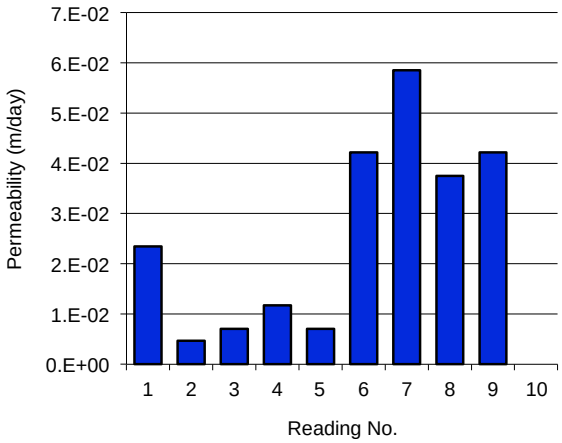
	Test 1	Test 2
Source of test water	tap	
Est. salinity (mg/L) of test water		
Est. SAR of test water		

TEST 1

Depth interval (m) tested 0.3 to 2 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.10	2.00	5.0E-02	2.3E-02
2	0.02	2.00	1.0E-02	4.7E-03
3	0.03	2.00	1.5E-02	7.0E-03
4	0.05	2.00	2.5E-02	1.2E-02
5	0.03	2.00	1.5E-02	7.0E-03
6	0.18	2.00	9.0E-02	4.2E-02
7	0.25	2.00	1.3E-01	5.9E-02
8	0.16	2.00	8.0E-02	3.7E-02
9	0.18	2.00	9.0E-02	4.2E-02
			Average:	2.6E-02

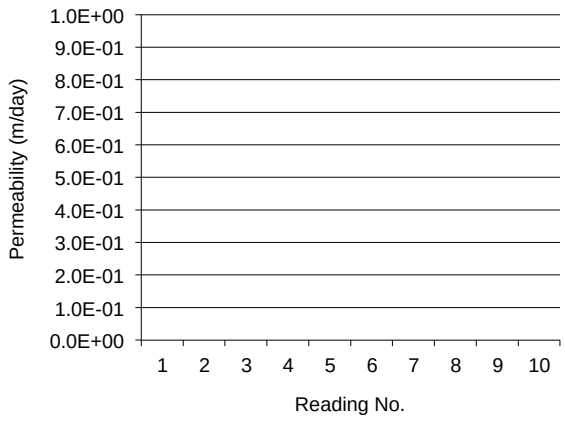


TEST 2

Depth interval (m) tested to Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
			Average:	



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use $K = 3Q\ln[H/r]/piH(2H+3S)$.

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project 10734 **Location** BH7 (WP74)

Site description Stormwater Advice, Lennox Head, NSW

Tested by DJY **Date** 30-Nov-11

Test hole geometry

	Test 1	Test 2
Hole depth (m)	1.05	
Depth (m) of water in hole	1	
Hole diameter (mm)	100	
Depth (m) to imperm. layer		

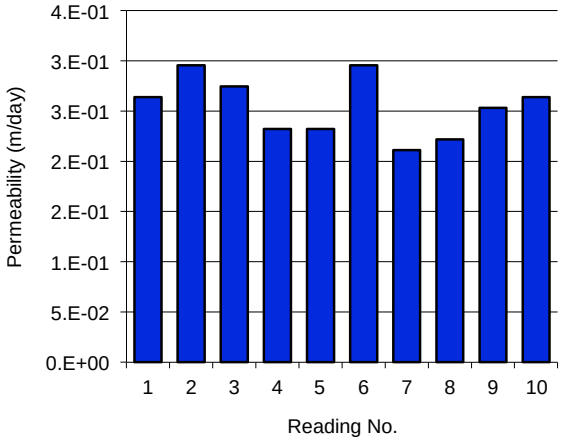
	Test 1	Test 2
Source of test water	tap	
Est. salinity (mg/L) of test water		
Est. SAR of test water		

TEST 1

Depth interval (m) tested 0.05 to 1.05 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.25	1.00	2.5E-01	2.6E-01
2	0.28	1.00	2.8E-01	3.0E-01
3	0.26	1.00	2.6E-01	2.7E-01
4	0.22	1.00	2.2E-01	2.3E-01
5	0.22	1.00	2.2E-01	2.3E-01
6	0.28	1.00	2.8E-01	3.0E-01
7	0.20	1.00	2.0E-01	2.1E-01
8	0.21	1.00	2.1E-01	2.2E-01
9	0.24	1.00	2.4E-01	2.5E-01
10	0.25	1.00	2.5E-01	2.6E-01
		Average:		2.5E-01

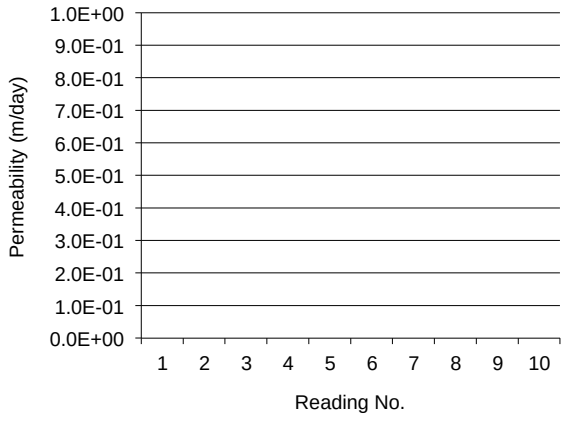


TEST 2

Depth interval (m) tested to Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
		Average:		



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use $K = 3Q\ln[H/r]/piH(2H+3S)$.

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project 10734 **Location** BH13

Site description Stormwater Advice, Lennox Head, NSW

Tested by DJY **Date** 14-Dec-11

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.8	0.8
Depth (m) of water in hole	0.72	0.72
Hole diameter (mm)	115	115
Depth (m) to imperm. layer		

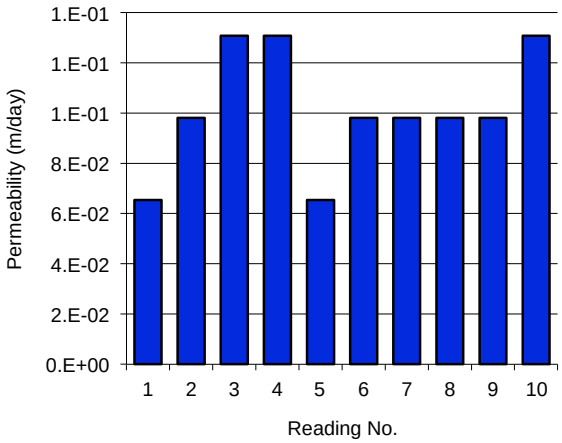
	Test 1	Test 2
Source of test water	tap	tap
Est. salinity (mg/L) of test water		
Est. SAR of test water		

TEST 1

Depth interval (m) tested 0.08 to 0.8 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.02	0.50	4.0E-02	6.5E-02
2	0.03	0.50	6.0E-02	9.8E-02
3	0.04	0.50	8.0E-02	1.3E-01
4	0.04	0.50	8.0E-02	1.3E-01
5	0.02	0.50	4.0E-02	6.5E-02
6	0.03	0.50	6.0E-02	9.8E-02
7	0.03	0.50	6.0E-02	9.8E-02
8	0.03	0.50	6.0E-02	9.8E-02
9	0.03	0.50	6.0E-02	9.8E-02
10	0.04	0.50	8.0E-02	1.3E-01
			Average:	1.0E-01

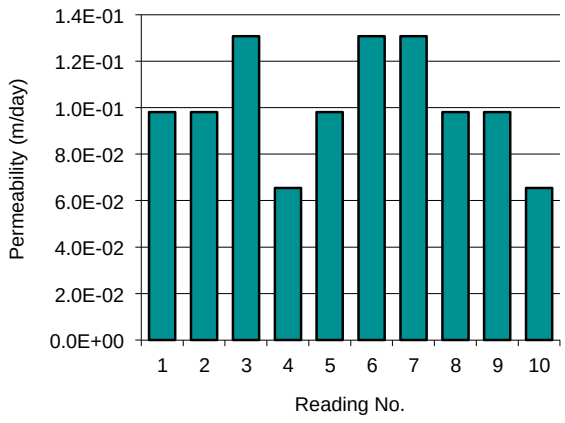


TEST 2

Depth interval (m) tested 0.08 to 0.8 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.03	0.50	6.0E-02	9.8E-02
2	0.03	0.50	6.0E-02	9.8E-02
3	0.04	0.50	8.0E-02	1.3E-01
4	0.02	0.50	4.0E-02	6.5E-02
5	0.03	0.50	6.0E-02	9.8E-02
6	0.04	0.50	8.0E-02	1.3E-01
7	0.04	0.50	8.0E-02	1.3E-01
8	0.03	0.50	6.0E-02	9.8E-02
9	0.03	0.50	6.0E-02	9.8E-02
10	0.02	0.50	4.0E-02	6.5E-02
			Average:	1.0E-01



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use $K = 3Q\ln[H/r]/piH(2H+3S)$.

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project 10734 **Location** BH20

Site description Stormwater Advice, Lennox Head, NSW

Tested by DJY **Date** 14-Dec-11

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.8	0.8
Depth (m) of water in hole	0.72	0.72
Hole diameter (mm)	115	115
Depth (m) to imperm. layer		

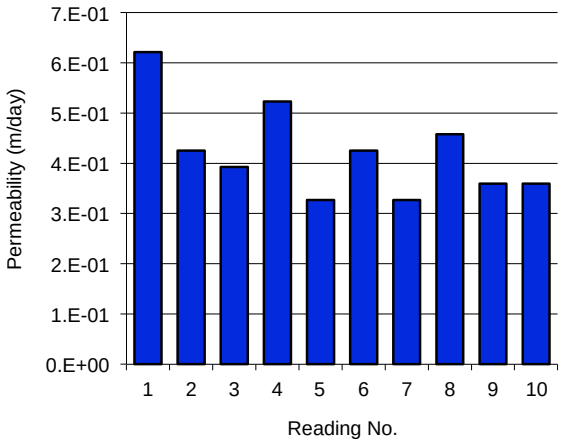
	Test 1	Test 2
Source of test water	tap	tap
Est. salinity (mg/L) of test water		
Est. SAR of test water		

TEST 1

Depth interval (m) tested 0.08 to 0.8 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.19	0.50	3.8E-01	6.2E-01
2	0.13	0.50	2.6E-01	4.3E-01
3	0.12	0.50	2.4E-01	3.9E-01
4	0.16	0.50	3.2E-01	5.2E-01
5	0.10	0.50	2.0E-01	3.3E-01
6	0.13	0.50	2.6E-01	4.3E-01
7	0.10	0.50	2.0E-01	3.3E-01
8	0.14	0.50	2.8E-01	4.6E-01
9	0.11	0.50	2.2E-01	3.6E-01
10	0.11	0.50	2.2E-01	3.6E-01
			Average:	4.2E-01

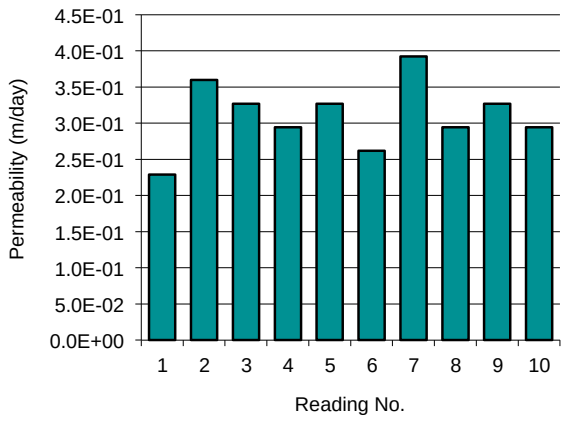


TEST 2

Depth interval (m) tested 0.08 to 0.8 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.07	0.50	1.4E-01	2.3E-01
2	0.11	0.50	2.2E-01	3.6E-01
3	0.10	0.50	2.0E-01	3.3E-01
4	0.09	0.50	1.8E-01	2.9E-01
5	0.10	0.50	2.0E-01	3.3E-01
6	0.08	0.50	1.6E-01	2.6E-01
7	0.12	0.50	2.4E-01	3.9E-01
8	0.09	0.50	1.8E-01	2.9E-01
9	0.10	0.50	2.0E-01	3.3E-01
10	0.09	0.50	1.8E-01	2.9E-01
			Average:	3.1E-01



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use $K = 3Q\ln[H/r]/piH(2H+3S)$.

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project 10734 **Location** BH21

Site description Stormwater Advice, Lennox Head, NSW

Tested by DJY **Date** 14-Dec-11

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.6	0.6
Depth (m) of water in hole	0.52	0.52
Hole diameter (mm)	115	115
Depth (m) to imperm. layer		

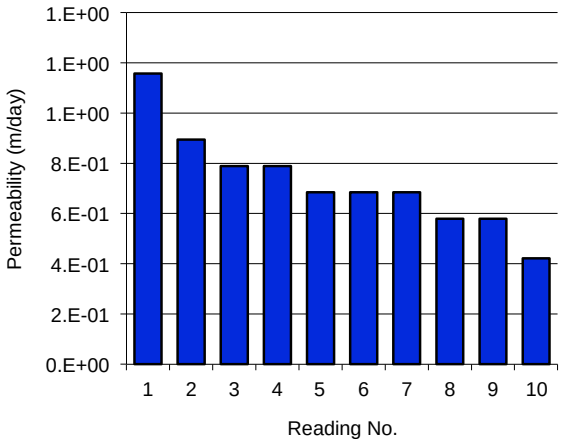
	Test 1	Test 2
Source of test water	tap	tap
Est. salinity (mg/L) of test water		
Est. SAR of test water		

TEST 1

Depth interval (m) tested 0.08 to 0.6 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.22	0.50	4.4E-01	1.2E+00
2	0.17	0.50	3.4E-01	8.9E-01
3	0.15	0.50	3.0E-01	7.9E-01
4	0.15	0.50	3.0E-01	7.9E-01
5	0.13	0.50	2.6E-01	6.8E-01
6	0.13	0.50	2.6E-01	6.8E-01
7	0.13	0.50	2.6E-01	6.8E-01
8	0.11	0.50	2.2E-01	5.8E-01
9	0.11	0.50	2.2E-01	5.8E-01
10	0.08	0.50	1.6E-01	4.2E-01
			Average:	7.3E-01

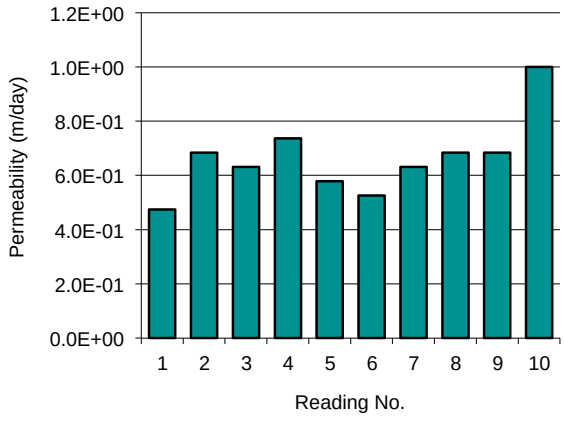


TEST 2

Depth interval (m) tested 0.08 to 0.6 Soil type tested

Test duration (mins)

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.09	0.50	1.8E-01	4.7E-01
2	0.13	0.50	2.6E-01	6.8E-01
3	0.12	0.50	2.4E-01	6.3E-01
4	0.14	0.50	2.8E-01	7.4E-01
5	0.11	0.50	2.2E-01	5.8E-01
6	0.10	0.50	2.0E-01	5.3E-01
7	0.12	0.50	2.4E-01	6.3E-01
8	0.13	0.50	2.6E-01	6.8E-01
9	0.13	0.50	2.6E-01	6.8E-01
10	0.19	0.50	3.8E-01	1.0E+00
			Average:	6.6E-01



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use $K = 3Q\ln[H/r]/piH(2H+3S)$.

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

8 Appendix 3 – MEDLI modelling results

```
****************************************
         SUMMARY OUTPUT
       MEDLI  Version 1.30

Data Set:   10734_Lennox zero irrigation
Run Date: 06/03/12   Time:14:08:27.47
****************************************

GENERAL INFORMATION
*******************
Title:    Pacific Pines, Lennox Head
Subject:  Water balance assessment
Client:   Lendlease
User:     Nick Gifford
Time:     Tue Mar 06 14:05:11 2012
Comments: [no entry]


RUN PERIOD
**********

Starting Date  1/ 1/1893
Ending Date   31/12/1995
Run Length    103 years   0 days
_____________________________________________________________________________
______

CLIMATE INFORMATION
*******************

Enterprise site: Lennox Head                        -28.8 deg S  153.6 deg E
Weather station: Ballina_____________________

  ANNUAL TOTALS    10 Percentile  50 percentile  90 Percentile
Rainfall mm/year         1228.         1704.         2433.
Pan Evap mm/year         1540.         1603.         1688.

      MONTHLY      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
Year
Rainfall     (mm)  181  200  215  181  197  165  134  100   72   92  103  142
1782
Pan Evap     (mm)  186  146  139  115   84   75   88  112  139  163  170  194
1610
Ave Max Temp DegC   27   28   26   24   22   20   19   20   22   23   25   26
23
Ave Min Temp DegC   21   21   20   17   15   13   12   12   14   16   18   20
16
Rad   (MJ/m2/day)   24   20   17   13   11   10   11   15   19   21   23   24
17
-------------------------------------------------------------------------------
------
MONTHLY IRRIGATION
******************

Irrigation   (mm)    0    0    0    0    0    0    0    0    0    0    0    0
0
_____________________________________________________________________________
______


SOIL PROPERTIES
***************
```

Soil type: Grey Clay

SOIL WATER PROPERTIES

		Layer 1	Layer 2	Layer 3	Layer 4
Bulk Density	(g/cm3)	1.4	1.4	1.4	1.4
Porosity	(mm/layer)	47.5	245.3	287.5	146.0
Saturated Water Content	(mm/layer)	47.0	243.0	284.4	144.6
Drained Upper Limit	(mm/layer)	42.0	218.0	254.4	128.1
Lower Storage Limit	(mm/layer)	26.7	137.5	184.2	98.4
Air Dry Moisture Content	(mm/layer)	4.2			
Layer Thickness	(mm)	100.0	500.0	600.0	300.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	719.0	290.0
Total Drained Upper Limit	(mm)	642.5	260.0
Total Lower Storage Limit	(mm)	446.8	164.2
Total Air Dry Moisture Content	(mm)	5.6	4.7
Total Depth	(mm)	1500.0	600.0

Maximum Plant Available Water Capacity		95.8
Saturated Hydraulic Conductivity		
At Surface	(mm/hr)	10.0
Limiting	(mm/hr)	0.1

RUNOFF

Runoff curve No II		75.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	3.5
URITCH	(mm)	6.0

AVERAGE WASTE STREAM
****

Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume	(ML/year)	36.52
Nitrogen	(tonne/year)	0.00
Phosphorus	(tonne/year)	0.00
Salinity	(tonne/year)	0.00
Nitrogen Concentration	(mg/L)	0.00
Phosphorus Concentration	(mg/L)	0.00
Salinity	(mg/L)	0.00
Salinity	(dS/m)	0.00

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	0.00

Phosphorus Concentration	(mg/L)	0.00
TDS Concentration	(mg/L)	0.00
Salinity	(dS/m)	0.00

IRRIGATION WATER

Irrigation triggered every 1 days
Irrigating 0 % of amount to reach upper storage limit

AREA

Total Irrigation Area	(ha)	1.00

VOLUMES

Total Irrigation	(ML/year)	0.00
Minimum Volume Irrigated by Pump	(ML/ha/day)	0.00
Maximum Volume Irrigated by Pump	(ML/ha/day)	0.00
Maximum Vol. Available For Shandying	(ML/yr)	0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.00
Average salinity of Irrigation	(mg/L)	0.00
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	0.00
After ammonia loss	(mg/L)	0.00
Average Phosphorus Conc of Irrigation	(mg/L)	0.00

FRESH WATER USAGE

Irrigation (shandying) water	(ML/yr)	0.00
Avg volume of fresh water used	(ML/yr)	0.00
Annual allocation	(ML/yr)	N/A

POND INFORMATION

POND GEOMETRY

		Pond 1
Final pond volume	(ML)	1.00
Final liquid volume	(ML)	1.00
Final sludge volume	(ML)	0.00
Average pond volume	(ML)	1.00
Average active volume	(ML)	1.00
Maximum pond volume	(ML)	1.00
Minimum allowable pond volume	(ML)	0.06
Average pond depth	(m)	4.00
Pond depth at outlet	(m)	4.00
Maximum water surface area	(m2 x1000)	0.39
Pond catchment area	(m2 x1000)	0.47

Pond footprint length	(m)	21.64
Pond footprint width	(m)	21.64

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	36.52
Recycle Volume from pond system	(ML/yr)	0.00
Rain water added to pond system	(ML/yr)	0.83
Evaporation loss from pond system	(ML/yr)	0.43
Seepage loss from pond system	(ML/yr)	0.01
Irrigation from last pond	(ML/yr)	0.00
Volume of overtopping	(ML/yr)	36.90
Sludge accumulated	(ML/yr)	0.00
Sludge accumulated	(t DM/yr)	0.00
Sludge removed	(ML/yr)	0.00
No of desludging events every 10 years		0.00
Increase in pond water volume	(ML/yr)	0.01

OVERTOPPING EVENTS

Volume of overtopping	(ML/yr)	36.90
No. of days pond overtops per 10 years		3651.53
Average Length of overtopping events	(days)	37609.00
% Reuse		0.00

No. of overtopping events every 10 years

> 0.000 ML	0.10
> 0.000 ML*	0.00
> 1.000 ML	0.00
> 2.000 ML	0.00
> 5.000 ML	0.00
> 10.000 ML	0.00
> 20.000 ML	0.00
> 50.000 ML	0.00

* Volume equivalent to 1 mm depth of water

No. periods/year without irrigable effluent		0.00
Average Length of such periods	(days)	0.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	0.00	Irrig. from pond (ML/yr) 0.0
Nitrogen removed by Irrigation	(tonne/yr)	0.00	
Nitrogen removed by Volatilisation	(tonne/yr)	0.00	
Nitrogen removed by Seepage	(tonne/yr)	0.00	
Nitrogen accumulated in Sludge	(tonne/yr)	0.00	
Nitrogen lost by Overtopping	(tonne/yr)	0.00	
Nitrogen involved in Recycling	(tonne/yr)	0.00	
Increase in pond Nitrogen	(tonne/yr)	0.00	

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent	(tonne/yr)	0.00	Irrig. from pond (ML/yr) 0.0
Phosphorus removed by Irrigation	(tonne/yr)	0.00	
Phosphorus removed by Seepage	(tonne/yr)	0.00	
Phosphorus accumulated in Sludge	(tonne/yr)	0.00	
Phosphorus lost by Overtopping	(tonne/yr)	0.00	
Phosphorus involved in Recycling	(tonne/yr)	0.00	
Increase in pond Phosphorus	(tonne/yr)	0.00	

POND SALINITY BALANCE

Salinity Added by Effluent	(tonne/yr)	0.00

Salinity removed by Irrigation (tonne/yr) 0.00
Salinity removed by Seepage (tonne/yr) 0.00
Salinity lost by Overtopping (tonne/yr) 0.00
Salinity involved in Recycling (tonne/yr) 0.00
Increase in pond Salinity (tonne/yr) 0.00

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	0.0
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.0
Average TDS Conc of Pond Liquid	(mg/L)	0.0
Average Salinity of Pond Liquid	(dS/m)	0.0
Average Potassium Conc of Pond Liquid	(mg/L)	0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	0.0
Phosphorus Conc of Pond Liquid	(mg/L)	0.0
TDS Conc of Pond Liquid	(mg/L)	0.0
EC of Pond Liquid	(dS/m)	0.0
Potassium Conc of Pond Liquid	(mg/L)	0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)	(kg/tonne)	0.00
Phosphorus in removed Sludge (db)	(kg/tonne)	0.00
Salt in removed Sludge (db)	(kg/tonne)	0.00
Potassium in removed Sludge (db)	(kg/tonne)	0.00

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge	(tonne/yr)	0.00
Phosphorus in removed Sludge	(tonne/yr)	0.00
Salt in removed Sludge (mass bal.)	(tonne/yr)	0.00
Salt in removed Sludge	(tonne/yr)	0.00
Potm. in removed Sludge (mass bal.)	(tonne/yr	0.00
Potassium in removed Sludge	(tonne/yr)	0.00

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 0.00% of field capacity)

Rainfall	(mm/year)	1782.2	Irrigation Area	(ha) 1.0
Irrigation	(mm/year)	0.0		
Soil Evaporation	(mm/year)	363.9		
Transpiration	(mm/year)	581.9		
Runoff	(mm/year)	571.1		
Drainage	(mm/year)	265.2		
Change in soil moisture	(mm/year)	0.1		

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1893	2657.0	0.0	211.4	779.0	1330.2	367.0	-30.6

1894	2191.0	0.0	46.2	787.4	834.8	420.1	102.5
1895	1555.0	0.0	45.1	739.5	584.0	251.7	-65.3
1896	1668.0	0.0	48.3	824.3	427.1	356.6	11.6
1897	1849.0	0.0	49.6	775.0	650.9	319.4	54.1
1898	2035.0	0.0	82.0	701.5	982.6	389.0	-120.1
1899	2499.0	0.0	180.8	744.3	1138.4	341.2	94.3
1900	1348.0	0.0	124.7	654.1	491.0	210.2	-132.1
1901	1560.0	0.0	283.3	504.4	511.3	279.2	-18.2
1902	1189.0	0.0	192.8	591.9	194.7	200.3	9.2
1903	1360.0	0.0	330.7	490.0	236.3	219.7	83.3
1904	1301.0	0.0	99.6	652.0	447.7	192.6	-90.9
1905	1108.0	0.0	395.5	271.4	277.6	120.1	43.4
1906	1432.0	0.0	210.2	716.2	191.4	207.7	106.4
1907	1938.0	0.0	52.7	752.2	856.6	291.8	-15.3
1908	1541.0	0.0	149.1	651.3	528.1	309.3	-96.8
1909	1391.0	0.0	219.9	717.9	156.1	259.7	37.5
1910	1610.0	0.0	47.8	801.0	508.7	262.7	-10.2
1911	1032.0	0.0	46.8	714.5	85.9	245.5	-60.8
1912	1472.0	0.0	237.4	550.2	488.4	195.0	1.0
1913	1771.0	0.0	285.7	634.3	648.0	201.7	1.3
1914	1861.0	0.0	363.1	621.2	530.9	288.3	57.5
1915	714.0	0.0	275.4	425.4	31.3	57.0	-75.0
1916	1702.0	0.0	258.5	674.6	308.4	331.2	129.3
1917	1598.0	0.0	50.6	826.2	487.9	285.3	-52.0
1918	1280.0	0.0	77.5	696.8	246.1	318.2	-58.6
1919	1549.0	0.0	451.9	432.2	466.2	183.0	15.7
1920	1691.0	0.0	253.6	760.2	295.6	359.1	22.4
1921	2296.0	0.0	47.2	716.3	1068.4	349.3	114.8
1922	1472.0	0.0	101.9	687.6	520.1	294.9	-132.5
1923	1196.0	0.0	410.1	356.4	283.5	144.1	1.9
1924	1706.0	0.0	300.1	729.3	524.0	159.0	-6.4
1925	2477.0	0.0	52.3	862.9	1051.4	381.7	128.7
1926	1300.0	0.0	111.5	640.1	336.1	267.4	-55.0
1927	2267.0	0.0	306.7	689.7	885.2	311.1	74.3
1928	1556.0	0.0	82.9	724.8	515.5	329.5	-96.8
1929	2269.0	0.0	405.2	616.3	1025.3	256.8	-34.4
1930	2344.0	0.0	450.5	485.4	1163.8	277.2	-32.8
1931	2025.0	0.0	543.6	460.1	649.7	294.9	76.6
1932	1155.0	0.0	433.1	480.7	128.0	199.2	-86.0
1933	2331.0	0.0	439.2	675.4	722.9	328.4	165.0
1934	2301.0	0.0	45.3	765.1	1131.3	377.3	-18.1
1935	1976.0	0.0	48.0	755.6	923.8	384.6	-136.0
1936	1622.0	0.0	96.4	628.6	524.1	227.7	145.1
1937	2666.0	0.0	487.0	726.2	1113.2	406.2	-66.6
1938	2109.0	0.0	81.1	736.0	1029.6	344.2	-81.9
1939	1787.0	0.0	479.8	481.1	564.5	271.1	-9.5
1940	1579.0	0.0	502.4	603.8	235.2	227.1	10.4
1941	1294.0	0.0	148.6	557.9	324.6	259.0	3.9
1942	1473.0	0.0	460.1	547.3	173.8	207.5	84.3
1943	2011.0	0.0	120.5	788.4	756.4	265.9	79.8
1944	1836.0	0.0	366.3	570.3	803.6	253.0	-157.1
1945	2053.0	0.0	490.9	478.8	832.9	209.2	41.2
1946	1241.0	0.0	435.5	446.5	249.1	126.5	-16.7
1947	1798.0	0.0	498.8	557.5	498.3	215.1	28.2
1948	1990.0	0.0	482.4	553.0	792.8	213.0	-51.2
1949	1739.0	0.0	501.1	595.9	439.9	228.4	-26.3
1950	2768.0	0.0	578.1	531.5	1224.7	373.1	60.6
1951	1215.0	0.0	338.2	501.8	230.8	197.7	-53.6
1952	1682.0	0.0	482.4	450.1	496.4	265.8	-12.7
1953	1937.0	0.0	459.5	418.8	859.1	158.7	40.9
1954	2315.0	0.0	542.1	576.3	886.6	343.9	-33.9
1955	2026.0	0.0	586.9	384.8	639.5	260.9	153.9
1956	1718.0	0.0	532.2	428.0	568.1	258.6	-68.8

1957	1250.0	0.0	454.6	500.0	177.8	186.9	-69.3
1958	2302.0	0.0	515.8	534.2	984.2	252.4	15.4
1959	2848.0	0.0	575.6	705.2	1063.1	423.9	80.2
1960	1201.0	0.0	402.1	598.1	91.0	179.7	-69.9
1961	1979.0	0.0	549.4	672.8	400.0	344.3	12.6
1962	2650.0	0.0	402.9	572.2	1242.2	317.7	115.1
1963	2569.0	0.0	545.9	613.8	1175.9	312.9	-79.6
1964	1694.0	0.0	475.9	546.8	429.0	244.9	-2.6
1965	1587.0	0.0	496.6	468.1	364.0	209.2	49.1
1966	1377.0	0.0	467.8	524.3	324.4	183.1	-122.6
1967	2138.0	0.0	417.1	718.5	691.7	298.7	12.0
1968	1119.0	0.0	316.6	607.9	85.6	106.1	2.8
1969	1640.0	0.0	552.4	509.6	259.8	277.7	40.5
1970	1661.0	0.0	576.4	529.2	276.5	169.2	109.7
1971	1280.0	0.0	502.1	447.7	209.9	287.5	-167.2
1972	2627.0	0.0	561.8	495.7	1208.1	318.1	43.3
1973	1678.0	0.0	468.6	566.2	301.9	325.3	15.9
1974	2389.0	0.0	553.2	402.6	1230.7	227.8	-25.3
1975	2331.0	0.0	568.6	486.0	813.9	365.0	97.5
1976	2054.0	0.0	491.0	552.2	797.6	305.6	-92.4
1977	1418.0	0.0	521.7	394.0	319.3	222.7	-39.7
1978	1729.0	0.0	577.0	449.8	365.4	218.8	118.0
1979	1567.0	0.0	524.3	410.9	461.3	286.9	-116.5
1980	1503.0	0.0	541.8	394.6	321.9	163.7	81.0
1981	1554.0	0.0	519.7	562.8	326.0	209.9	-64.4
1982	2015.0	0.0	483.7	595.6	606.3	331.6	-2.3
1983	2322.0	0.0	577.9	538.4	745.2	308.7	151.8
1984	2016.0	0.0	490.0	624.3	614.2	350.2	-62.7
1985	1831.0	0.0	473.9	658.9	545.8	238.7	-86.3
1986	1086.0	0.0	515.1	335.8	64.6	147.1	23.5
1987	2006.0	0.0	552.1	549.3	601.4	263.3	40.0
1988	2568.0	0.0	529.0	528.3	1122.3	345.7	42.7
1989	1677.0	0.0	619.5	426.5	395.7	300.0	-64.7
1990	1861.0	0.0	516.8	491.4	670.3	247.0	-64.4
1991	1650.0	0.0	500.3	414.6	416.0	204.2	114.8
1992	1128.0	0.0	552.3	435.2	34.1	211.1	-104.7
1993	1397.0	0.0	541.2	412.1	174.1	241.3	28.3
1994	1946.0	0.0	489.4	465.7	615.7	317.7	57.5
1995	1491.0	0.0	541.6	501.4	192.2	240.9	14.8

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	0.0	% of Total as ammonium 80.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.0	Deep Drainage (mm/year) 265.2
Nitrogen added in irrigation	(kg/ha/year)	0.0	
Nitrogen added in seed	(kg/ha/year)	1.1	
Nitrogen removed by crop	(kg/ha/year)	32.9	
Denitrification	(kg/ha/year)	0.3	
Leached NO3-N	(kg/ha/year)	0.0	
Change in soil organic-N	(kg/ha/year)	-31.7	
Change in soil solution NH4-N	(kg/ha/year)	0.0	
Change in soil solution NO3-N	(kg/ha/year)	-0.5	
Change in adsorbed NH4-N	(kg/ha/year)	0.0	
Initial soil organic-N	(kg/ha)	3272.0	
Final soil organic-N	(kg/ha)	8.6	
Initial soil inorganic-N	(kg/ha)	51.3	

Final soil inorganic-N (kg/ha) 0.0
Average N03-N conc in the root zone (mg/L) 0.0
Average N03-N conc below root zone (mg/L) 0.0
Average N03-N conc of deep drainage (mg/L) 0.0

PHOSPHORUS

Phosphorus added in irrigatn (kg/ha/year) 0.0 % of Total as phosphate 100.0
Phosphorus added in seed (kg/ha/year) 0.1
Phosphorus removed by crop (kg/ha/year) 0.1
Leached PO4-P (kg/ha/year) 0.0
Change in dissolved PO4-P (kg/ha/year) 0.0
Change in adsorbed PO4-P (kg/ha/year) 0.0
Average P04-P conc in the root zone (mg/L) 0.0
Average P04-P conc below root zone (mg/L) 0.0

SOIL P STORAGE LIFE

Year	YearNo.	Tot P stored kg/ha	P leached in year kg/ha
1893	1	248.2	0.0
1894	2	248.2	0.0
1895	3	248.1	0.0
1896	4	248.8	0.0
1897	5	248.1	0.0
1898	6	248.0	0.0
1899	7	248.0	0.0
1900	8	247.9	0.0
1901	9	247.9	0.0
1902	10	247.9	0.0
1903	11	247.8	0.0
1904	12	248.5	0.0
1905	13	247.8	0.0
1906	14	247.8	0.0
1907	15	247.7	0.0
1908	16	248.4	0.0
1909	17	247.7	0.0
1910	18	247.6	0.0
1911	19	247.6	0.0
1912	20	248.2	0.0
1913	21	247.5	0.0
1914	22	247.5	0.0
1915	23	247.5	0.0
1916	24	248.1	0.0
1917	25	247.4	0.0
1918	26	247.4	0.0
1919	27	247.3	0.0
1920	28	248.0	0.0
1921	29	247.2	0.0
1922	30	247.2	0.0
1923	31	247.2	0.0
1924	32	247.8	0.0
1925	33	247.1	0.0
1926	34	247.1	0.0
1927	35	247.1	0.0
1928	36	247.7	0.0
1929	37	247.0	0.0
1930	38	247.0	0.0
1931	39	246.9	0.0
1932	40	247.6	0.0
1933	41	246.9	0.0

1934	42	246.8	0.0
1935	43	246.8	0.0
1936	44	247.5	0.0
1937	45	246.7	0.0
1938	46	246.7	0.0
1939	47	246.7	0.0
1940	48	247.3	0.0
1941	49	246.6	0.0
1942	50	246.6	0.0
1943	51	246.6	0.0
1944	52	247.2	0.0
1945	53	246.5	0.0
1946	54	246.5	0.0
1947	55	246.5	0.0
1948	56	247.2	0.0
1949	57	246.5	0.0
1950	58	246.4	0.0
1951	59	246.4	0.0
1952	60	247.0	0.0
1953	61	246.4	0.0
1954	62	246.3	0.0
1955	63	246.3	0.0
1956	64	246.9	0.0
1957	65	246.2	0.0
1958	66	246.2	0.0
1959	67	246.2	0.0
1960	68	246.8	0.0
1961	69	246.1	0.0
1962	70	246.1	0.0
1963	71	246.1	0.0
1964	72	246.7	0.0
1965	73	246.0	0.0
1966	74	246.0	0.0
1967	75	246.0	0.0
1968	76	246.6	0.0
1969	77	245.9	0.0
1970	78	245.9	0.0
1971	79	245.9	0.0
1972	80	246.5	0.0
1973	81	245.8	0.0
1974	82	245.8	0.0
1975	83	245.8	0.0
1976	84	246.4	0.0
1977	85	245.7	0.0
1978	86	245.7	0.0
1979	87	245.7	0.0
1980	88	246.3	0.0
1981	89	245.6	0.0
1982	90	245.6	0.0
1983	91	245.6	0.0
1984	92	246.2	0.0
1985	93	245.5	0.0
1986	94	245.5	0.0
1987	95	245.5	0.0
1988	96	246.1	0.0
1989	97	245.4	0.0
1990	98	245.4	0.0
1991	99	245.4	0.0
1992	100	246.0	0.0
1993	101	245.3	0.0
1994	102	245.3	0.0
1995	103	245.3	0.0

PLANT

Plant species: Temperate pasture

PLANT WATER USE

Irrigation	(mm/year)	0.	Totl Irrigation Area(ha)	1.0
Pan coefficient	(%)	1.0		
Maximum crop coefficient	(%)	0.8		
Average Plant Cover	(%)	55.		
Average Plant Total Cover	(%)	67.		
Average Plant Rootdepth	(mm)	418.		
Average Plant Available Water Capacity	(mm)	96.		
Average Plant Available Water	(mm)	69.		
Yield produced per unit transp.	(kg/ha/mm)	6.		

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	3731.		
Net nitrogen removed by plant	(kg/ha/yr)	32.	Shoot Concn (%DM)	0.85
Net phosphorus removed by plant	(kg/ha/yr)	0.	Shoot Concn (%DM)	0.00

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	373.	0.6	0.4	0.2	0.0
2	327.	0.7	0.4	0.1	0.1
3	364.	0.8	0.3	0.1	0.1
4	281.	0.8	0.2	0.1	0.1
5	231.	0.8	0.1	0.1	0.1
6	219.	0.8	0.0	0.0	0.1
7	251.	0.8	0.0	0.1	0.1
8	309.	0.8	0.0	0.1	0.0
9	364.	0.8	0.1	0.2	0.0
10	345.	0.8	0.1	0.3	0.0
11	329.	0.7	0.2	0.3	0.0
12	338.	0.6	0.3	0.3	0.0

>>> NO-PLANT EVENTS <<<

%Days due to water stress	4.7
%Days due to nitrogen stress	0.0
No. of forced harvests per year	0.8
No. of normal harvests per year	0.6

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water (dS/m) 0.0 Irrigation (mm/year) 0.0
Average EC of Rainwater (dS/m x10) 0.3 Rainfall (mm/year) 1782.2

>>>No salinity calculations<<<
No. of years chosen for running averages 10

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 7.3
Average Nitrate-N Conc of Recharge (mg/L) 0.0

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

Concentration of NITRATE-N in Groundwater (mg/L)

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1897	0.0	0.0	0.0
	1902	0.0	0.0	0.0
	1907	0.0	0.0	0.0
	1912	0.0	0.0	0.0
	1917	0.0	0.0	0.0
	1922	0.0	0.0	0.0
	1927	0.0	0.0	0.0
	1932	0.0	0.0	0.0
	1937	0.0	0.0	0.0
	1942	0.0	0.0	0.0
	1947	0.0	0.0	0.0
	1952	0.0	0.0	0.0
	1957	0.0	0.0	0.0
	1962	0.0	0.0	0.0
	1967	0.0	0.0	0.0
	1972	0.0	0.0	0.0
	1977	0.0	0.0	0.0
	1982	0.0	0.0	0.0
	1987	0.0	0.0	0.0
	1992	0.0	0.0	0.0
Last	1995	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

MEDLIEXE.EXE : 1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE : 1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE : 439296 bytes Fri Dec 11 12:28:08 1998

OTHER INDUSTRY INPUT PARAMETERS - DATA SUMMARY

Nature of Industry: other

>>> Dryland run! <<< 1 file(s) copied

UNCONDITIONAL FINISH

9 Appendix 4 – Freshwater wetland EEC analyses

9.1 Bioretention details

The bioretention basins would be designed generally in accordance with QUDM and the Healthy Waterways Technical Design Guidelines. It is envisaged that the basins would be used to manage water quality alone and would generally be dry. However during (and for a short period after) wet weather, the basin may contain water to a depth of up to 300mm.

Where possible, a high flow bypass for flows in excess of $Q_{3months}$ would be installed. Otherwise, a combination of weir and pipe outlets would be provided.

The filter surface should be level while the floor of the basin should have a minimum grade of 0.5% towards a low point that would be additionally drained by a system of subsurface perforated drains at 1.5m maximum spacings. The subsurface drainage pipes are to be 100mm diameter class 400 perforated corrugated PVC pipe Type 1 with 6 rows of perforations 1.25mm wide by 7.4mm long. A non-perforated riser with a sealed removable screw cap is to be provided at the end of each perforated pipe for maintenance flushing.

Filter media
The bioretention filter's upper layer provides the majority of the pollutant removal function and is intended to support healthy vegetation growth to enhance the treatment process. It is to consist of at least 400mm depth of sandy loam with a nominal particle size of 0.45 to 0.50mm and a saturated hydraulic conductivity of 145 to 220 mm/hour. The organic content (measured in accordance with AS 1289.4.1.1-1997) should be 5% to 10%. The filter media must meet the requirements of FAWB 2009.[8]

Sieve size	%passing
3.4mm	100%
2.0mm	97 – 100%
1.0mm	89 – 92%
0.25mm	30 – 50%
0.15mm	10 – 30%
0.05mm	0 – 3%

Transition layer
The transition layer underlies the filter medium and is intended to prevent the filter medium flowing into the drainage layer and the pipe drains. This layer is be 150mm thick and is to consist of coarse sand having a particle size distribution as shown below.

Sieve size	%passing
1.4mm	100%
1.0mm	80%
0.7mm	44%
0.5mm	8.4%

[8] Estimate of irrigation requirement per hectare based on 5.84 ML/ha multiplied by the area of 4.74 ha = 27.68 ML/yr. The figure

Drainage layer
The lowest layer in the system is to consist of 150mm depth of granular backfill (2mm to 5mm gravel) bedding medium surrounding the perforated pipes. It provides for the free flow of filtered water to the pipe drainage system.

Details of the bioretention basin are presented within the SMEC civil drawings (Appendix 5). The basin characteristics are detailed in Table 4.2.1.

Table 4.2.1 Bioretention basin details

Basin No.	3	4
Inlet Properties		
Low Flow Bypass (m^3/s)	0.0	0.0
High Flow Bypass (m^3/s)	100	100
Storage Properties		
Extended Detention Depth (m)	0.3	0.3
Surface Area (m^2)	270	90
Seepage loss (mm/hr)	0.0	0.0
Infiltration Properties		
Filter area (m^2)	200	90
Filter depth (m)	0.6	0.6
Filter particle effective diameter (mm)	0.45	0.45
Saturated hydraulic conductivity (mm/hr)	180	180
Outlet properties		
Overflow weir width (m)	5.0	5.0

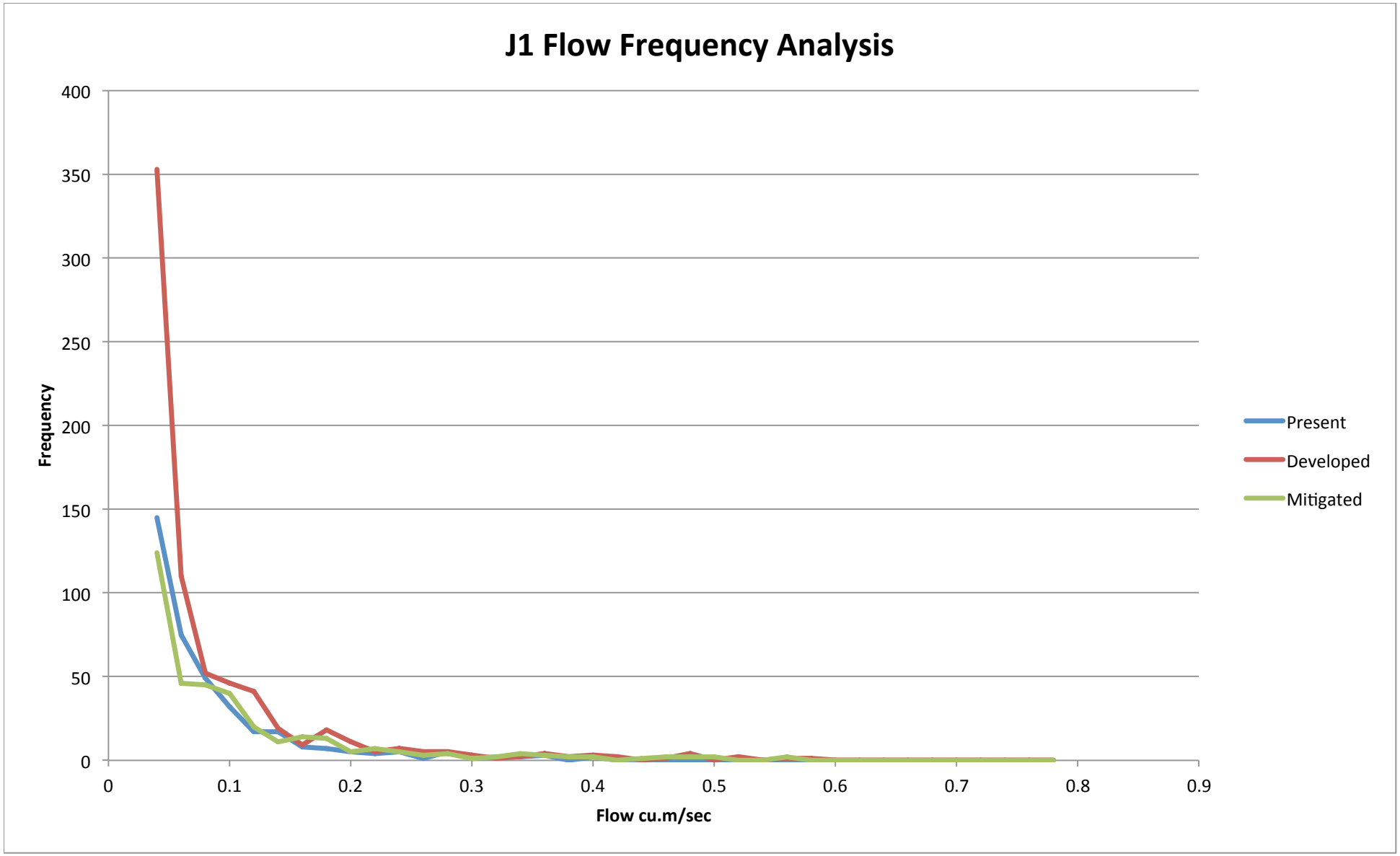
It is intended that the bioretention basin would be landscaped and planted out as a ‘rain garden’, rather than simply topsoiled and turfed. Species used would be selected from the list of approved species included in Appendix A of the Healthy Waterways Technical Design Guidelines. Details of the plant species selection, size and spacing would be provided by the landscape architects in a landscape plan to be submitted as part of an application for approval to operational works (landscaping).

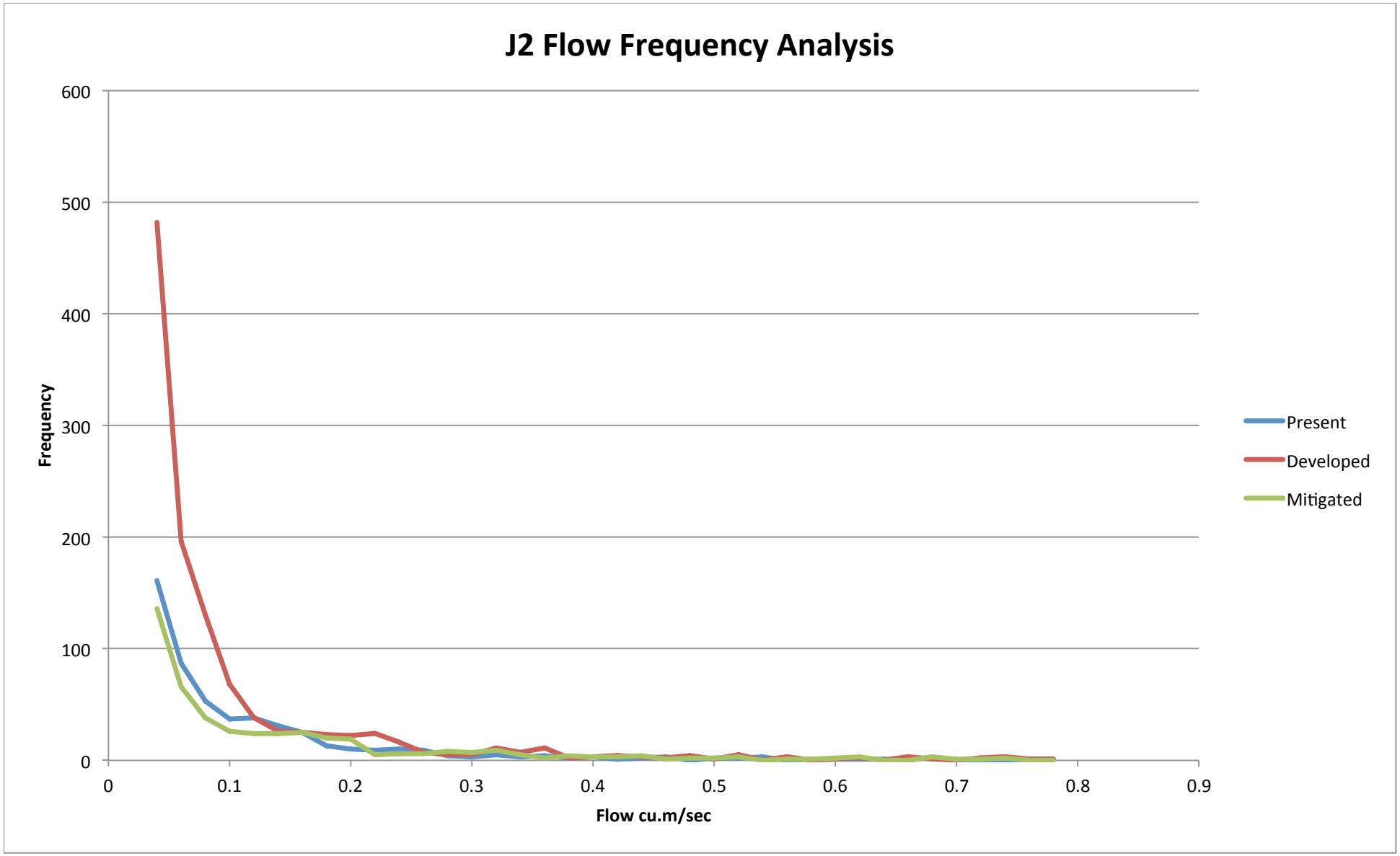
9.2 Average daily flows

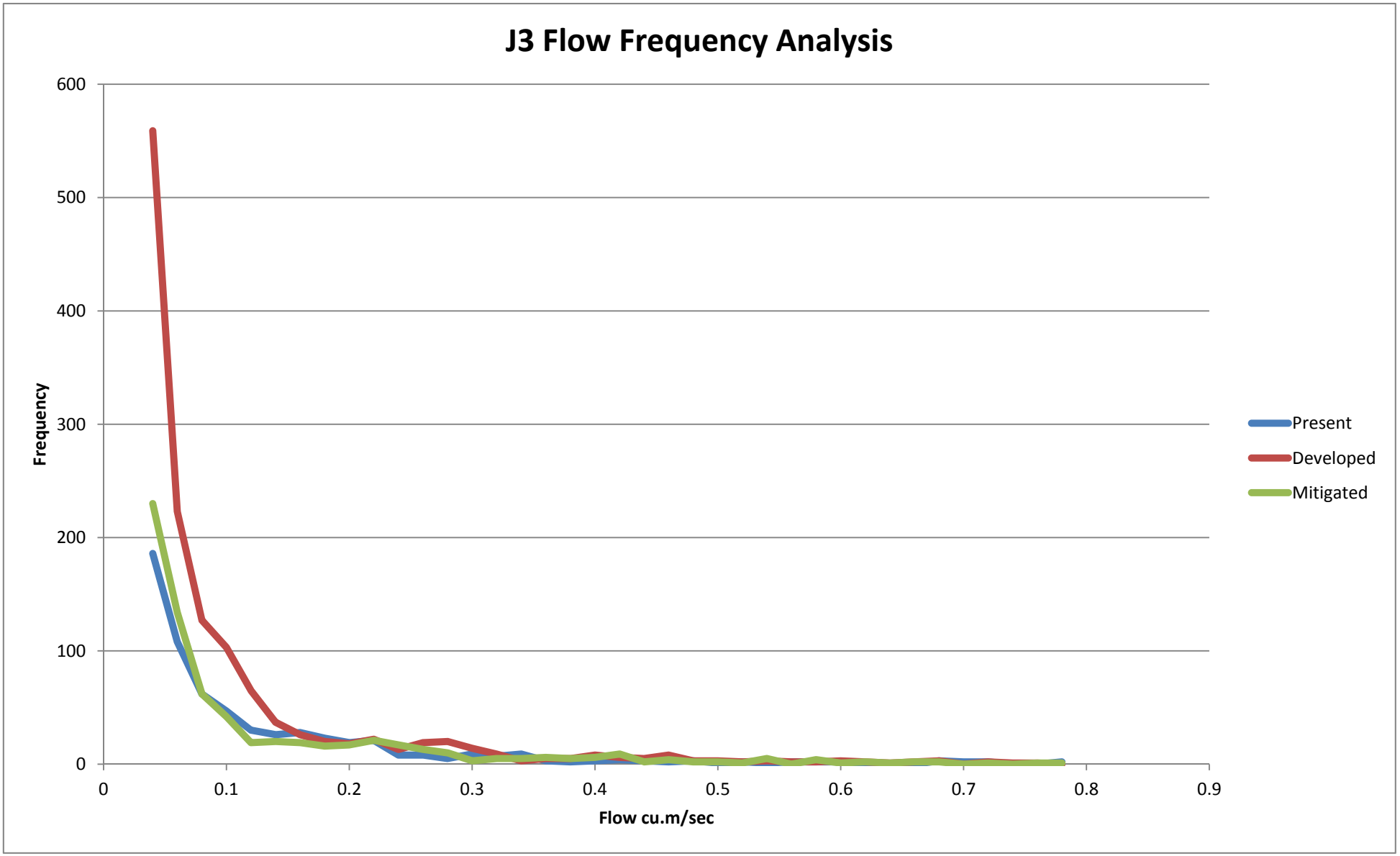
Job No 10734
Client Lend Lease
Project Pacific Pines NSW
Date 21/09/2012

	J1	J2	J3	J1 Flow frequency analysis				J2 Flow frequency analysis				J3 Flow frequency analysis			
Base Case															
	Outflow cu.m/sec	Outflow cu.m/sec	Outflow cu.m/sec	Flow cu.m/sec	Bas_Count	Dev_Count	Mit_Count	Flow cu.m/sec	Bas_Count	Dev_Count	Mit_Count	Flow cu.m/sec	Bas_Count	Dev_Count	Mit_Count
10%ile	0.00000	0.00000	0.00000	0	1726	1663	4568	0	1682	1622	4490	0	1441	1442	1307
Median	0.00017	0.00032	0.00045	0.02	4810	4546	1988	0.02	4705	4148	1955	0.02	4832	4107	4899
StdDev	0.02309	0.04428	0.05908	0.04	145	353	124	0.04	161	482	136	0.04	186	559	230
Mean	0.00529	0.01008	0.01393	0.06	75	110	46	0.06	87	196	66	0.06	108	223	134
90%ile	0.00623	0.01166	0.01756	0.08	49	52	45	0.08	53	130	38	0.08	62	127	62
				0.1	32	46	40	0.1	37	68	26	0.1	47	103	42
Developed Case				0.12	17	41	20	0.12	38	38	24	0.12	30	65	19
				0.14	17	19	11	0.14	31	26	24	0.14	26	37	20
10%ile	0.00000	0.00000	0.00000	0.16	8	9	14	0.16	25	25	25	0.16	28	26	19
Median	0.00048	0.00081	0.00101	0.18	7	18	13	0.18	13	23	20	0.18	23	20	16
StdDev	0.03434	0.06509	0.08395	0.2	5	11	5	0.2	10	22	19	0.2	19	18	17
Mean	0.00983	0.01842	0.02370	0.22	4	5	7	0.22	9	24	5	0.22	21	22	21
90%ile	0.02057	0.03809	0.04892	0.24	5	7	5	0.24	10	16	6	0.24	8	13	17
				0.26	1	5	3	0.26	9	7	6	0.26	8	19	13
				0.28	5	5	4	0.28	4	5	8	0.28	5	20	10
Change from Base Case				0.3	1	3	1	0.3	3	5	7	0.3	9	14	3
				0.32	2	1	2	0.32	5	11	9	0.32	7	9	5
10%ile	0	0	0	0.34	2	2	4	0.34	3	7	5	0.34	9	3	5
Median	175.9	148.6	121.6	0.36	3	4	3	0.36	4	11	2	0.36	3	5	6
StdDev	48.7	47.0	42.1	0.38	0	2	2	0.38	2	2	4	0.38	2	5	5
Mean	85.8	82.7	70.2	0.4	2	3	2	0.4	3	3	3	0.4	3	8	6
90%ile	230.1	226.8	178.6	0.42	0	2	0	0.42	1	4	3	0.42	4	6	9
				0.44	0	0	1	0.44	2	3	4	0.44	3	5	2
Mitigated Case				0.46	0	1	2	0.46	3	2	1	0.46	2	8	4
				0.48	0	4	2	0.48	0	4	2	0.48	3	3	2
10%ile	0.00000	0.00000	0.00000	0.5	0	0	2	0.5	2	1	2	0.5	1	3	2
Median	0.00000	0.00000	0.00000	0.52	0	2	0	0.52	2	5	3	0.52	2	2	1
StdDev	0.03101	0.00000	0.00027	0.54	0	0	0	0.54	3	0	0	0.54	1	3	5
Mean	0.00551	0.05824	0.07665	0.56	0	1	2	0.56	0	3	1	0.56	2	2	0
90%ile	0.00186	0.01026	0.01589	0.58	0	1	0	0.58	1	0	1	0.58	2	2	4
				0.6	0	0	0	0.6	1	1	2	0.6	2	3	1
				0.62	0	0	0	0.62	1	2	3	0.62	1	2	2
Change from Base Case				0.64	0	0	0	0.64	1	0	0	0.64	0	1	1
				0.66	0	0	0	0.66	0	3	0	0.66	0	2	2
10%ile	0	0	0	0.68	0	0	0	0.68	3	1	3	0.68	3	3	2
Median	-100.0	-100.0	-100.0	0.7	0	0	0	0.7	0	0	1	0.7	2	0	0
StdDev	34.3	-100.0	-99.5	0.72	0	0	0	0.72	0	2	1	0.72	2	2	1
Mean	4.0	477.6	450.4	0.74	0	0	0	0.74	0	3	2	0.74	0	1	0
90%ile	-70.2	-11.9	-9.5	0.76	0	0	0	0.76	1	1	0	0.76	0	1	1
				0.78	0	0	0	0.78	1	1	0	0.78	2	0	1

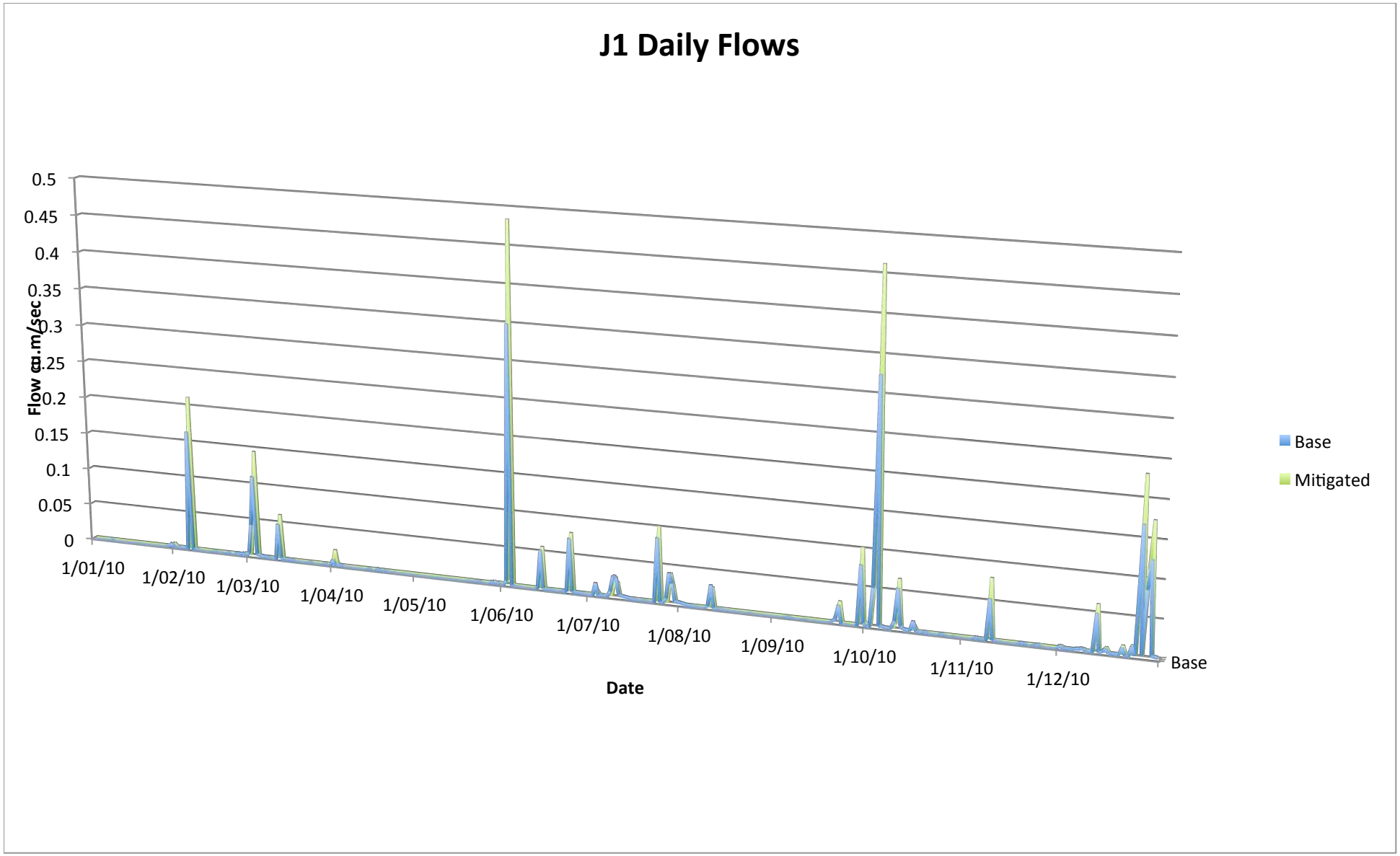
9.3 Freshwater wetland flow frequency graphs

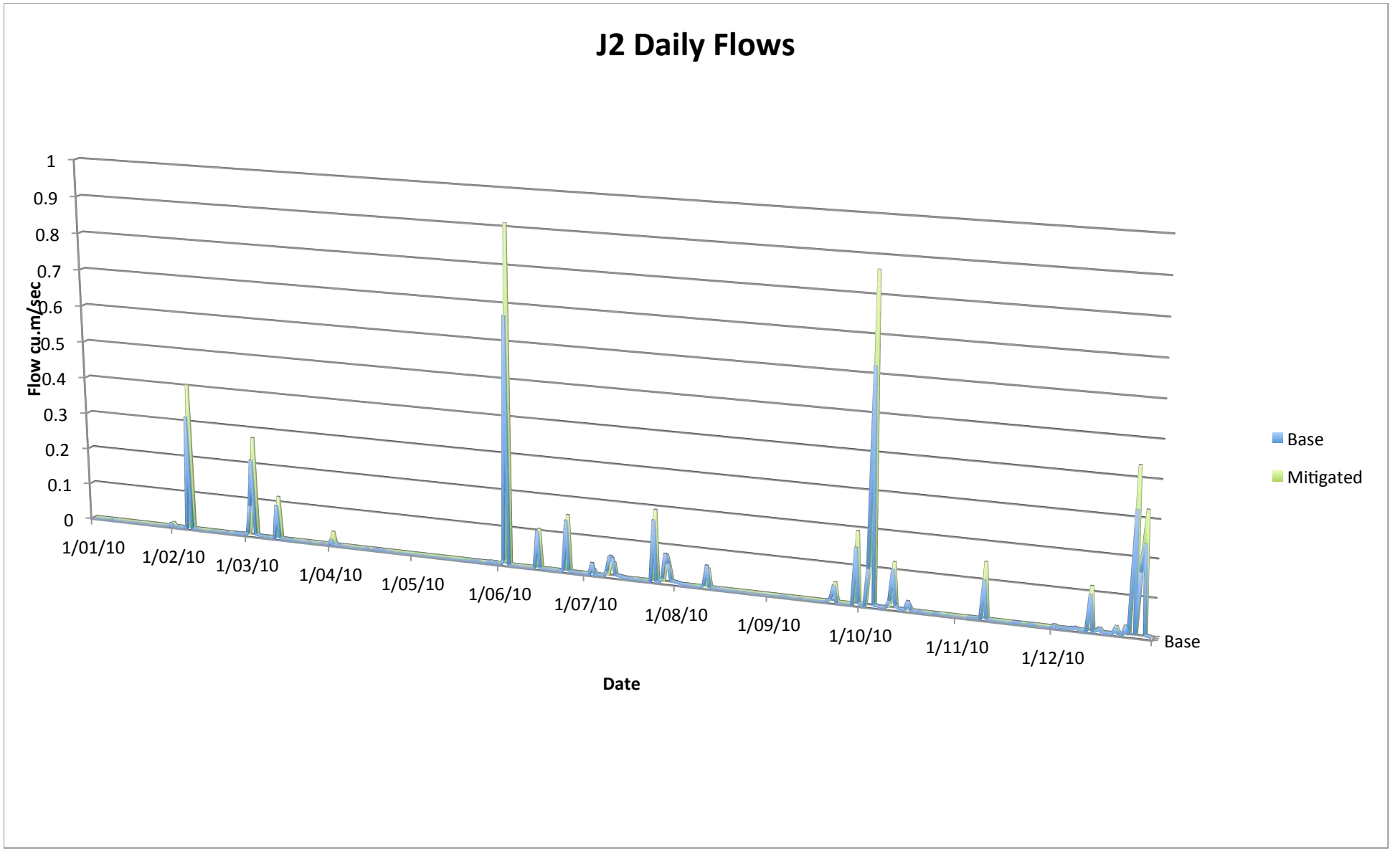

J1 Flow Frequency Analysis
Frequency
400
350
300
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Flow cu.m/sec
Present
Developed
Mitigated


J2 Flow Frequency Analysis
600
500
400
300
200
100
0
Frequency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Flow cu.m/sec
Present
Developed
Mitigated

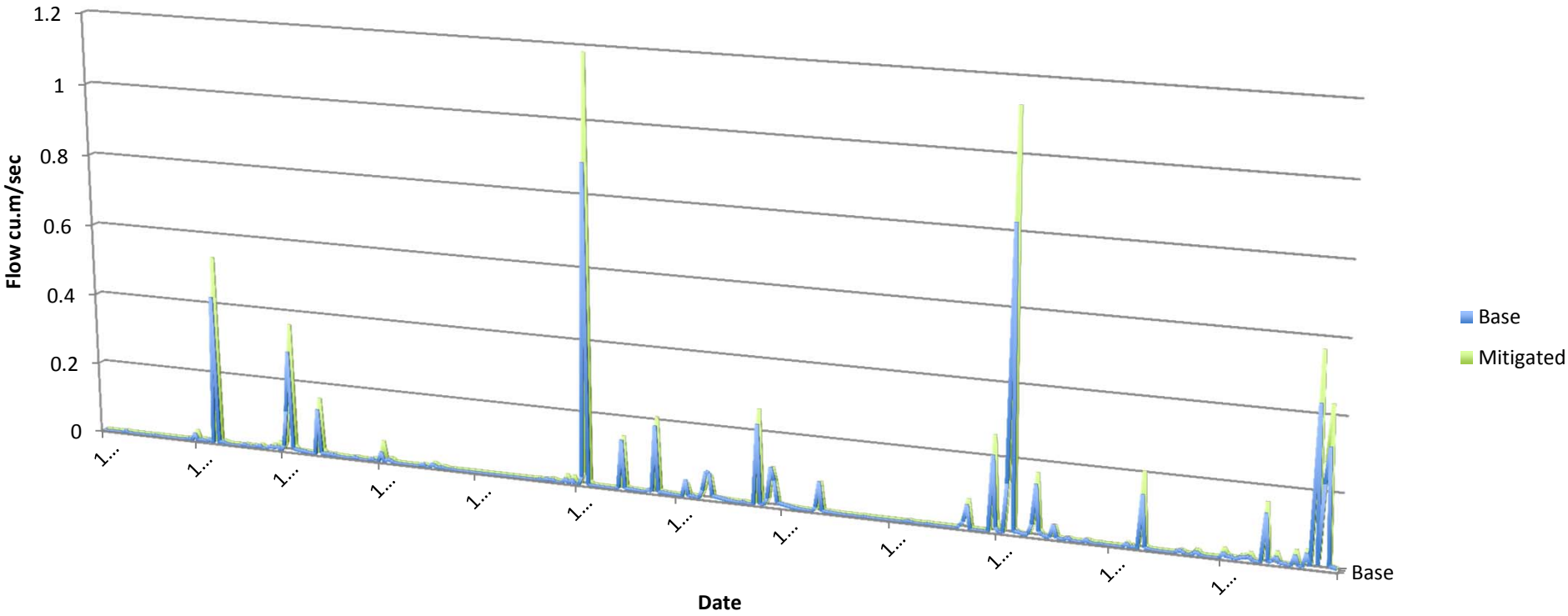

J3 Flow Frequency Analysis
600
500
400
300
200
100
0
Frequency
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Flow cu.m/sec
Present
Developed
Mitigated

9.4 Freshwater wetland EEC daily flows

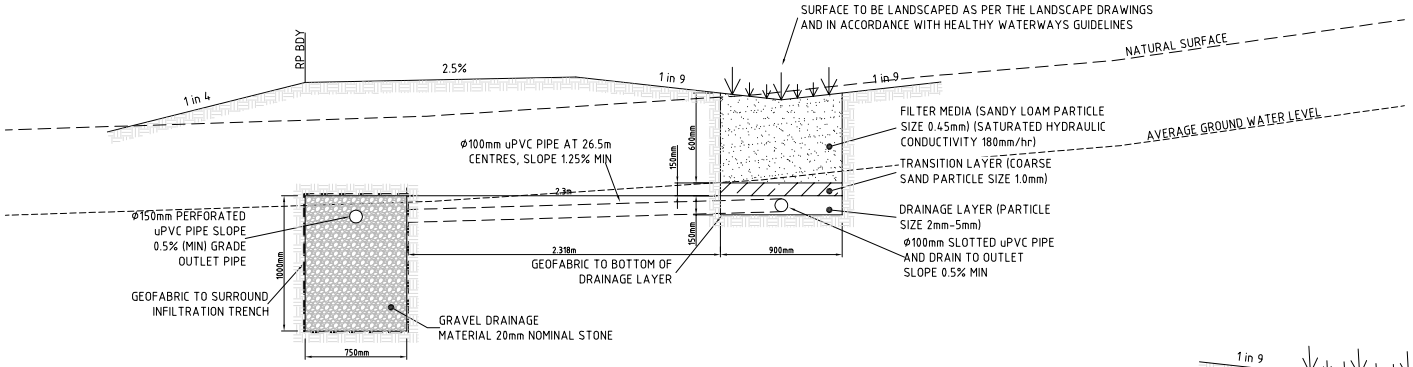

J1 Daily Flows
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Flow cu.m/sec
1/01/10
1/02/10
1/03/10
1/04/10
1/05/10
1/06/10
1/07/10
1/08/10
1/09/10
1/10/10
1/11/10
1/12/10
Base
Date
Base
Mitigated


J2 Daily Flows
Flow cu.m/sec
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/01/10
1/02/10
1/03/10
1/04/10
1/05/10
1/06/10
1/07/10
1/08/10
1/09/10
1/10/10
1/11/10
1/12/10
Base
Date
Base
Mitigated

J3 Daily Flows

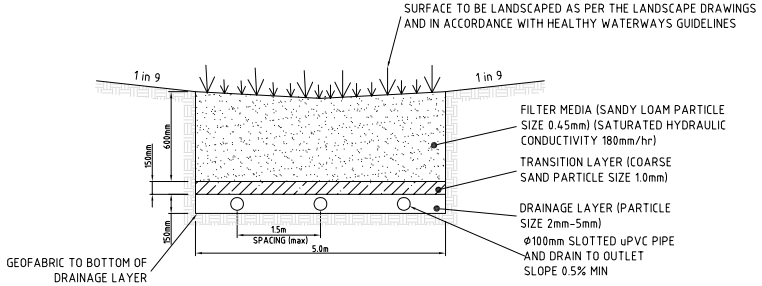


10 Appendix 5 – Reference drawings by SMEC civil engineering

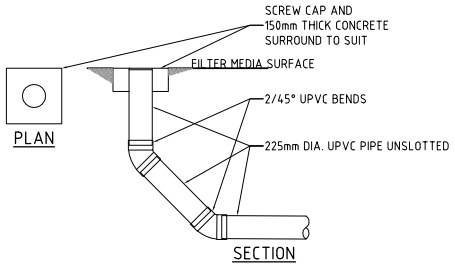


TYPICAL DETAIL A
BIO-RETENTION SWALE AND INFILTRATION TRENCH
NTS

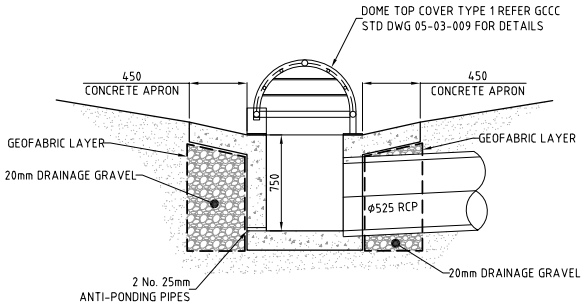
NOTE
1. THE BIO-RETENTION FILTER MEDIA IS NOT TO BE INSTALLED UNTIL ALL OTHER WORKS ON THE SUBDIVISION IS COMPLETED. REFER TO GILBERT AND SUTHERLAND APPROVED STORMWATER MANAGEMENT REPORT FOR FURTHER DETAILS.
2. THE BIO-RETENTION AREA IS TO BE COVERED IN GEOTEXTILE FABRIC, 2.5mm COURSE SAND AND TURFED DURING THE ON MAINTENANCE PERIOD.



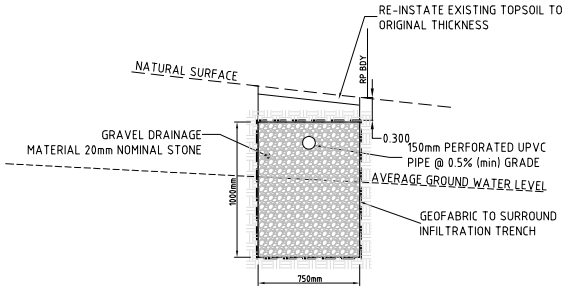
TYPICAL DETAIL B
BIO-RETENTION SWALE
NTS



INSPECTION OPENING (ISO) DETAILS - END OF LINE
SCALE 1:25



TYPICAL DETAIL D
SLOTTED 900x600 SURCHARGE PIT
1:20



TYPICAL DETAIL C
INFILTRATION TRENCH
NTS

REVISION		DATE	DES/DFT	APP'D
E	Details Amended	25.09.12	SH/JF	
D	Response to IR	15.08.12	SA/JF	
C	Response to IR	07.08.12	SH/JF	
B	Response to IR	25.07.12	SH/DS	
A	Issued For Approval	18.01.12	SH/JF	

Lend Lease

Principal
Lend Lease
235 Varsity Parade
Varsity Lakes QLD 4227

Project Leader
S.Sandford
Designed
S.Hartley
Drawn
J.Flynn
Checked

Authorised

Date
October 2011

Scale @ A1

0 0.2 0.4 0.8
Scale 1:20

smec urban consulting group
Smec Urban
Prana Centre, PO Box 953, Nerang, QLD, 4211
p +61 7 5578 0222 | f +61 7 5578 0202 | www.smecurban.com.au
Adelaide +61 8 8223 6455 Melbourne +61 3 9869 0800
Brisbane +61 7 3831 8988 Perth +61 8 9323 5900
Geelong +61 3 5228 3100 Traralgon +61 3 5173 0100

PACIFIC PINES ESTATE
Stage 1A
Ballina Shire Council
Stormwater
Stormwater Infiltration Trench and Bio-Retention Swale
Drawing No. 3310069E-01A-67 **Rev E**
Dev. App. No.
Sheet No. 1 of 1

Subject to Approval
Not to be used for construction