6.5.2 Sediment quality

Ten sediment samples were collected and analysed for total nitrogen, total phosphorus, and heavy metals. Figure 48 above shows locations of these samples. The samples were collected from the top of the sediment layer. Results from laboratory analysis are in the Table 35.

Table 35. Sediment samples analysis, Isabella Pond

Analyte	Units	Sample ID										Average across site
		IS_01	IS_02	IS_03	IS_04	IS_05	IS_06	IS_07	IS_08	IS_09	IS_10	
TP	mg/kg	400	570	460	660	580	540	470	280	340	380	476
TN	mg/kg	300	2200	2600	2600	1300	1500	2200	4000	2100	1100	2178
Heavy Metals												
Arsenic	mg/kg	2.6	3.5	3.9	4	4	4	3.4	< 2	2.4	2.7	3
Cadmium	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	<0.4
Chromium	mg/kg	13	15	17	19	13	15	16	6.4	12	11	14
Copper	mg/kg	20	22	33	26	16	20	25	8.6	24	17	21
Lead	mg/kg	37	52	64	57	38	55	47	16	42	39	46
Mercury	mg/kg	-	-	-	-	-	-	-	< 0.05	0.05	0.05	0.05
Nickel	mg/kg	6.9	6.5	7.6	7.6	5.5	6.7	6.4	< 5	5.1	< 5	6
Zinc	mg/kg	280	300	310	350	200	250	320	120	230	210	254

Averages were calculated for each parameter based on nine of the ten samples. Sample IS_01 was not deemed representative of the pond (note the relatively low total nitrogen) and was thus excluded. It was collected in a shallow section near an inlet, from a thin layer of sediment (less than 0.2 m). Averages for parameters were applied to the total site sediment mass, producing the following results:

- Total nitrogen accumulated in the pond = 2425 kg/year
- Total phosphate (as P) accumulated in the pond = 530 kg/year
- Total Suspended Solids accumulated in the pond = 33,400 tonne/year

There were no heavy metal readings that exceeded the NEPM HIL (National Environment Protection Measure - Health Investigation Level). This indicates that any spoil removed from the pond would be likely to be suitable for landscaping soil within the site.

If the spoil was to be disposed of to a landfill, according to the ACT Waste Standard (2000), the heavy metal concentrations in the sediment from this pond are below "CT2" values, and therefore it is likely that the material would be classified as "Solid Waste" which incurs a disposal charge of $135.15/tonne (ACT Government 2014b). Levels of lead and zinc were higher at Isabella Pond than site averages. Lead was 10% higher than the average, and zinc 25%- though both metals were still below investigation levels. See Figure 28. Average sediment heavy metal concentrations per site for a comparison of sites. There were no levels of cadmium detected at Isabella Pond (limit of reporting is 0.4 mg/kg).

6.5.3 MUSIC modelling

Pollutant loads generated from the Isabella Pond catchment were estimated for total suspended sediments (TSS), total phosphorus (TP) and total nitrogen (TN) using MUSIC. The model set up and input parameters are detailed in Appendix A. It is noted two scenarios were modelled, one with a pond as the treatment node and one with a sedimentation basin as the treatment node.

The mean annual pollutant load removal for TSS, TP and TN are presented in Table 36. Table 36 also compares MUSIC pollutant load results to the sediment analysis. When modelled as a pond, the pollutant load removal is significantly less in comparison to the sedimentation basin scenario.

Table 36. MUSIC pollutant load results for Isabella pond, and comparison to sediment analysis

	MUSIC results - Pond		MUSIC results – Sedimentation Basin		Sediment analysis results
	% load reduction	Load removed (kg/year)	% load reduction	Load removed (kg/year)	Load accumulated (kg/year)
TSS	30.6	900,000	54.7	1,570,000	1,113,000
TP	25.7	1,340	41.6	2,190	530
TN	9.9	3,800	18.8	7,300	2,420

The rate of sediment accumulation determined through the sediment depth survey (refer to Section 6.5.1) correlates well with the rate of sediment accumulation determined by the MUSIC model for the pond node. MUSIC predicts higher rates of TN and TP accumulation than suggested by sediment sampling.

6.6 Point Hut

Point Hut Pond is a large pond located online on a tributary of the Murrumbidgee, south of Lake Tuggeranong. Available construction drawings for the weir are dated 1986 which we have taken as the year of construction for purposes of analysis (Scott & Furphy Engineers 1986). The catchment includes the suburbs of Conder, Banks and Gordon. The main inlets are pre-treated in GPTs.

Key features of the pond are:

- Pond surface area: 15.8 ha
- Pond water volume: 399,043 m^3 or 399 ML
- Normal water level: 573 m AHD
- Catchment area: 1496 ha
- Pond area as % of catchment: 1.05%
- Land use in the catchment is primarily natural / bushland areas and low density residential as indicated in Table 37 below.

Table 37: Point Hut Pond catchment land use.

Land Use	Area (ha)	Area (%)	Total Impervious Area (ha)
Residential – Lower density	551.48	36.97%	330.89
Commercial	8.29	0.56%	7.46
Urban Open Space	121.35	8.13%	7.28
Rural Areas	16.13	1.08%	0.81
Natural / Bushland	732.14	49.08%	0.00
Roads / Transport	62.37	4.18%	37.42
TOTAL	1491.75	100	**383.86**

6.6.1 Sediment accumulation

A physical survey of the pond was undertaken in April 2015 in order to gauge sediment depth and thickness. A qualitative description of the sediment (or base surface of pond) was also noted. The survey covered the area of the pond with measurements taken at a spacing of approximately 30 m. Survey points are shown in Figure 52.

Measurements from the physical survey were analysed to quantify sediment collected in Point Hut Pond. With a total volume of 436,562 m^3, sediment accounted for 37,549 m^3 (8.6%). Water volume was 39,903 m^3. Figure 53 shows the sediment thickness of Point Hut Pond, and Figure 54 shows the water depth.

The bulk density of the sediment is estimated at 1.5 tonnes/m^3, resulting in

- A mass of 56,300 tonnes of sediment capture

- Over the twenty-nine year period since construction, this means that the pond has collected 1942 tonnes of sediment per year from the catchment.

Note that the bulk density estimate is based on a dry density of sediment, assuming that the volume would not change substantially if the sediment was in a dry state. TSS quantities in MUSIC are based on the dry weight of suspended solids.

This also assumes no sediment removal over the life of the pond.

Figure 52. Gauging and sampling locations, Point Hut Pond

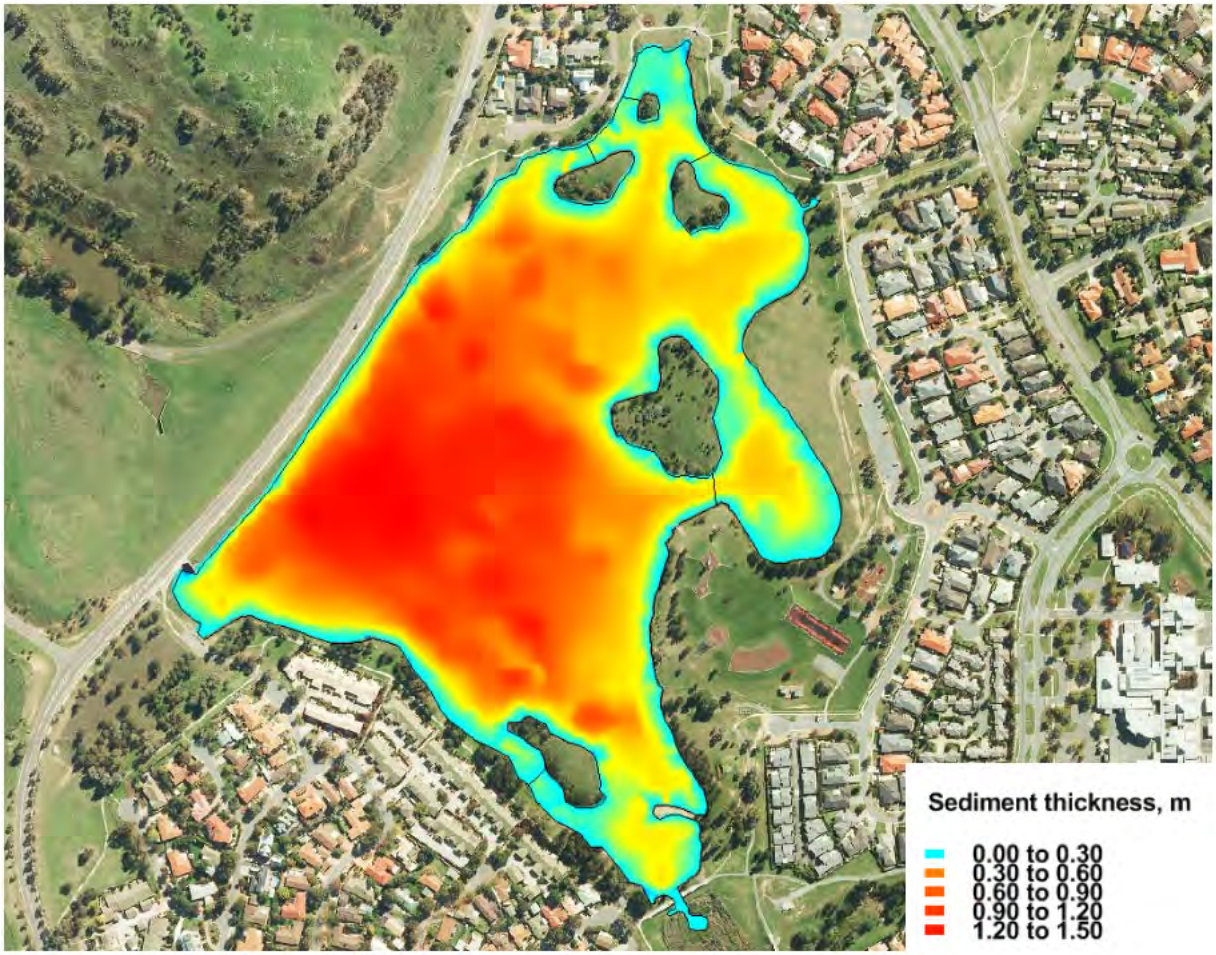

Figure 53. Sediment thickness, Point Hut Pond

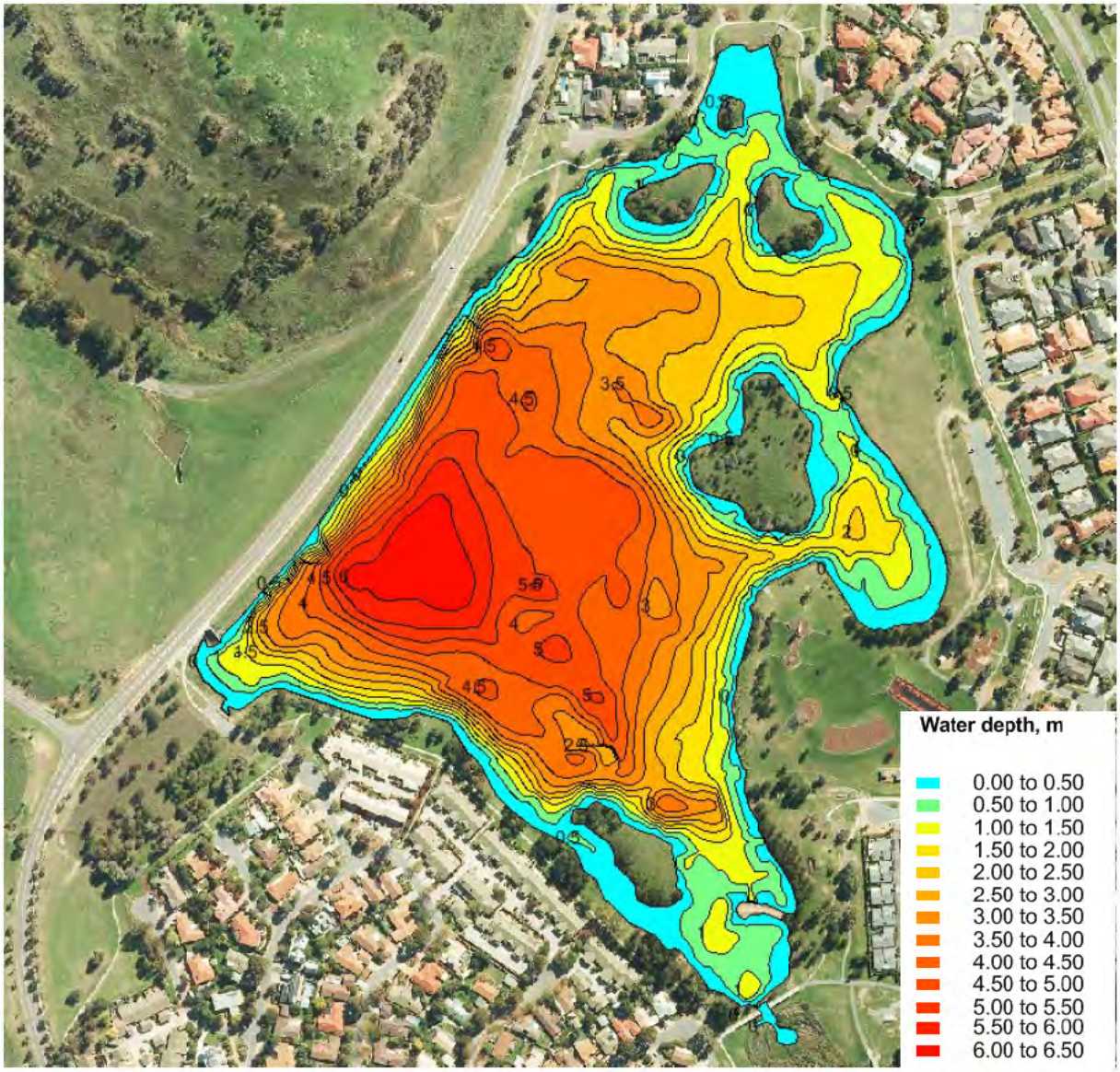

Figure 54. Water depth contours, Point Hut Pond

Sediment in Point Hut pond was brown to grey-brown silt, with various degrees of clay or sand. In deeper sections of the pond samples were thicker and included streaks of black (likely from underlying layers of clay).

Validation

Figure 55 below is a plot of the Point Hut Pond silt surface contours taken from Ecowise Environmental's report (2009b). This contour plot is very similar to Figure 54. Therefore the Ecowise (2009b) data helps to support the calculations for sediment volume in Point Hut Pond.

Figure 55. Bathymetric silt survey, Point Hut Pond (Ecowise Environmental 2009b)

6.6.2 Sediment quality

Ten sediment samples were collected and analysed for total nitrogen, total phosphorus, and heavy metals. Figure 52 above shows locations of these samples. The samples were collected from the top of the sediment layer, which represents the most recently deposited material. Results from laboratory analysis are in Table 38.

Table 38. Sediment sample results, Point Hut Pond

Analyte	Units	Sample ID										Average across site
		PH_01	PH_02	PH_03	PH_04	PH_05	PH_06	PH_07	PH_08	PH_09	PH_10	
TP	mg/kg	340	320	460	450	250	270	310	310	280	300	329
TN	mg/kg	2200	1300	2000	1600	1700	940	1601	2000	1800	2500	1764
Heavy Metals												
Arsenic	mg/kg	2.2	2.1	2.7	2.7	2.1	2	< 2	< 2	25	2.1	5
Cadmium	mg/kg	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	<0.4
Chromium	mg/kg	10	9.5	15	15	11	13	11	10	27	9.7	13
Copper	mg/kg	10	8.7	14	13	8.8	10	10	11	17	9.5	11
Lead	mg/kg	20	18	30	28	22	22	17	17	37	20	23
Mercury	mg/kg	< 0.05	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	<0.05
Nickel	mg/kg	< 5	< 5	6.3	6.1	< 5	6.9	< 5	< 5	9.7	< 5	7
Zinc	mg/kg	72	68	110	98	62	31	75	140	10000*	67	80

*This result is considered to be an outlier and has not been used in the calculation of average values.

Site averages were calculated for each parameter based on all ten samples. These averages were applied to the total site sediment mass, producing the following results:

- Total nitrogen accumulated in the pond = 3,400 kg/year
- Total phosphate (as P) accumulated in the pond = 640 kg/year
- Total Suspended Solids accumulated in the pond = 1,942 tonne/year

There were no heavy metal readings that exceeded the NEPM HIL (National Environment Protection Measure - Health Investigation Level). This indicates that any spoil removed from the pond would be likely to be suitable for landscaping soil within the site.

If the spoil was to be disposed of to a landfill, according to the ACT Waste Standard (2000), the heavy metal concentrations in the sediment from this pond are below "CT2" values, and therefore it is likely that the material would be classified as "Solid Waste" which incurs a disposal charge of $135.15/tonne (ACT Government 2014b). All site averages for heavy metal concentrations for Point Hut were comparable with other sites. See Figure 28 for a comparison of sites. There were no levels of cadmium detected at Point Hut (limit of reporting is 0.4 mg/kg).

6.6.3 MUSIC modelling

Pollutant loads generated from the Point Hut Pond catchment were estimated for total suspended sediments (TSS), total phosphorus (TP) and total nitrogen (TN) using MUSIC. The model set up and input parameters are detailed in Appendix A. It is noted two scenarios were modelled, one with a pond as the treatment node and one with a sedimentation basin as the treatment node.

The mean annual pollutant load removal for TSS, TP and TN are presented in Table 39. Table 39 also compares MUSIC pollutant load results to the sediment analysis. When modelled as a pond, the pollutant load removal is significantly less in comparison to the sedimentation basin scenario.

Table 39. MUSIC pollutant load results for Point Hut Pond, and comparison to sediment analysis.

	MUSIC results - pond		MUSIC results – sedimentation basin		Sediment analysis results Load accumulated (kg/year)
	% load reduction	Load removed (kg/year)	% load reduction	Load removed (kg/year)	
TSS	54.9	377,000	69.4	464,000	1,942,000
TP	41.2	539	51.4	657	640
TN	11.2	1,200	31.5	3,240	3,400

In comparison to the sediment analysis (refer to Sections 6.7.1 and 6.7.2), the rate of TSS accumulation is significantly underestimated by the MUSIC model for both the pond and sedimentation basin scenarios. The sediment depth survey suggests that 1,942 tonnes of sediment has accumulated per year in Point Hut pond, while MUSIC estimates only 377 tonnes/year for the pond scenario and 464 for the sedimentation basin scenario. However it is possible that a significant proportion of the accumulated sediment actually represents construction-stage sediment, which is not represented in MUSIC.

In terms of TP, there is better agreement between the MUSIC model and the sediment analysis results for both pond and sedimentation basin scenarios. The MUSIC model significantly underestimates TN accumulation for the pond scenario, however the estimate correlates well with the sediment analysis results for the sedimentation basin scenario.

6.7 Giralang Pond

Giralang Pond is an online pond on Ginninderra Creek. Giralang Pond is downstream of Gungahlin Pond and upstream of Lake Ginninderra. Giralang Pond is fed by a large upstream catchment.

The pond has two main inlets, including flows from Ginninderra Creek entering the north of the pond and a second inlet enters from the east from Gungaderra Creek which drains a large area to the east of the pond. The pond contains a small island and is surrounded by soft landscaped edges. The only available construction drawings are for the GPT upgrade which are dated 1989. However, it is assumed the age of the original construction of the pond is forty years, situating its construction mid-1970s – the same time as the suburb development.

Key features of the pond are:

- Pond surface area: 1.3 ha

- Pond water volume: 6,425 m^3 or 6.43 ML
- Normal water level: 581 m AHD
- Catchment area: 7,965 ha
- Pond area as % of catchment area: 0.017%
- Land use in the catchment is primarily natural / bushland areas and low density residential as indicated in Table 40 below.

Table 40: Giralang Pond catchment land use.

Land Use	Area (ha)	Area (%)	Total Impervious Area (ha)
Residential – Higher density	100.09	1.26%	75.07
Residential – Lower density	2695.25	33.82%	1617.15
Commercial	181.68	2.28%	163.51
Industrial	12.56	0.16%	11.93
Urban Open Space	1043.03	13.09%	62.58
Rural Areas	36.69	0.46%	1.83
Natural / Bushland	3304.77	41.47%	0.00
Roads / Transport	594.54	7.46%	356.72
TOTAL	**7968.62**	**100**	**2288.81**

6.7.1 Sediment accumulation

A physical survey of the pond was undertaken in April 2015 in order to gauge sediment depth and thickness. A qualitative description of the sediment (or base surface of pond) was also noted. The survey covered the area of the pond with measurements taken at a spacing of approximately 15 m. Survey data points are shown in Figure 56.

Measurements from the physical survey were analysed to quantify sediment collected in Giralang Pond. With a total volume of 9,577 m^3, sediment accounted for 3,152 m^3 (33%). Water volume was 6,425 m^3. Figure 57 shows the sediment thickness in Giralang Pond, and Figure 58 shows the water depth.

The bulk density of the sediment is estimated at 1.5 tonnes/m^3, resulting in

- A mass of 4,700 tonnes of sediment capture
- Over a forty year* period since construction, this means that the pond has collected 118 tonnes of sediment per year from the catchment.

*The age of Giralang Pond has been assumed as forty years, similar to the suburb of Giralang.

Note that the bulk density estimate is based on a *dry* density of sediment, assuming that the volume would not change substantially if the sediment was in a dry state. TSS quantities in MUSIC are based on the dry weight of suspended solids.

This also assumes no sediment removal over the life of the pond.

Figure 56. Gauging and sampling locations, Giralang Pond

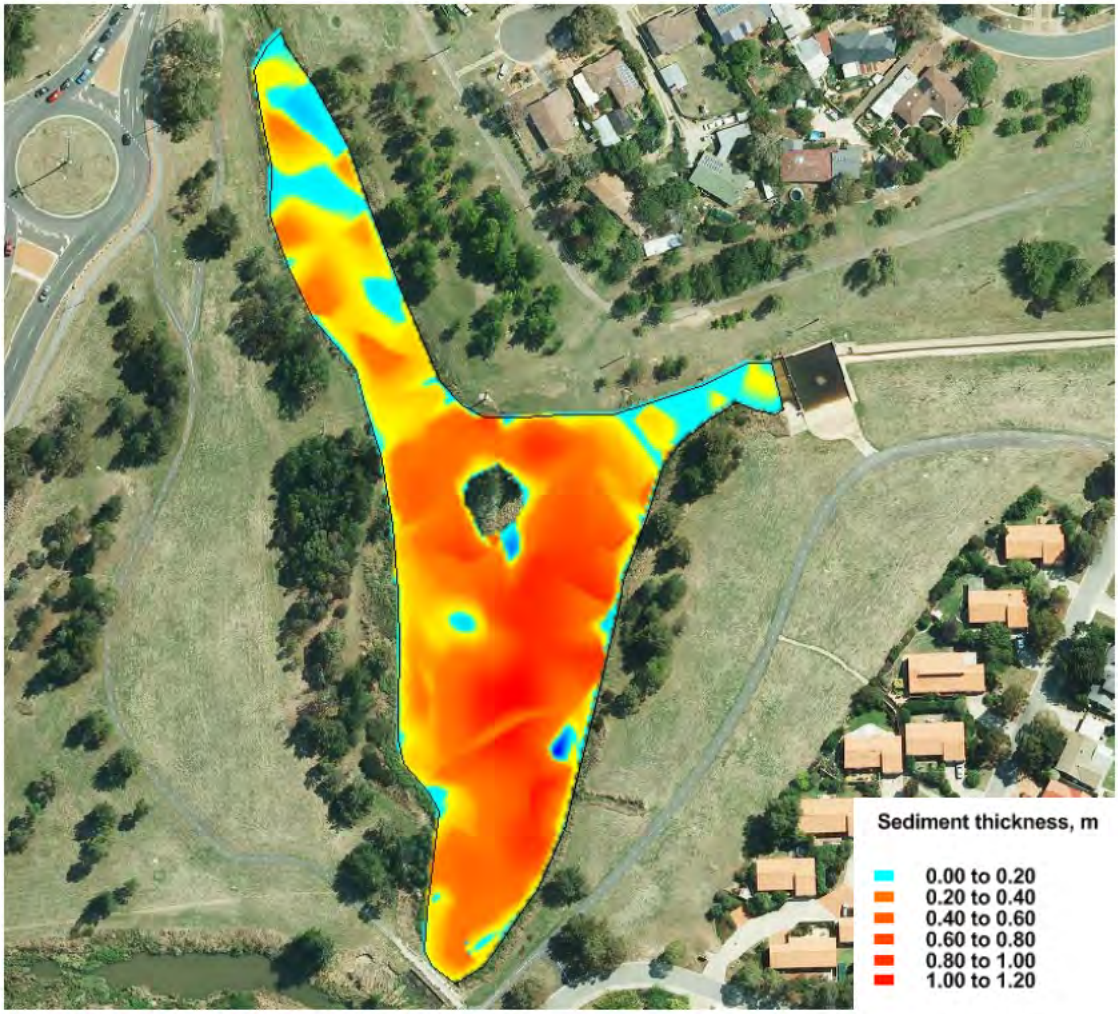

Figure 57. Sediment thickness, Giralang Pond