Hydrosphere Consulting

Ballina Shire Council

North Creek Dredging
Sediment Investigation Report

May 2018

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Cover Photo: North Creek looking downstream from Prospect Bridge through 'Area C'

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15-021 – NORTH CREEK DREDGING

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CONTENTS

APPENDICES

1. INTRODUCTION

Ballina Shire Council is investigating the feasibility of dredging in North Creek for the purposes of:

1. Providing a sand resource for fill on Council landholdings and possibly for other purposes;
2. Improving the navigability of North Creek to ensure safe boating and recreational activities; and
3. Increasing tidal flushing and hence improve water quality within North Creek.

Hydrosphere Consulting (2016) prepared a scoping study for the dredging of North creek which discusses the approval pathway for the project and identifies a range of investigations that are required to provide additional certainty to the project. One of the key investigations needed was to determine characteristics of the sediments to be dredged and any likely restrictions on the use of this material. A preliminary dredging plan was developed at that time (Hydrosphere Consulting, 2017) based on available information to estimate the sediment footprint and quantities to be dredged. This dredging plan identified four key areas (A, B, C and D) for further investigation for dredging Figure 1.

This report documents the outcomes of this sampling, with particular reference to:

- Sediment grain size distribution;
- Contamination status; and
- Acid sulfate soil risk.

Although the dredging plan will change in response the outcomes of the current and other investigations, these four broad reference areas are still used to delineate the discussion in this report and are shown in Figure 1.

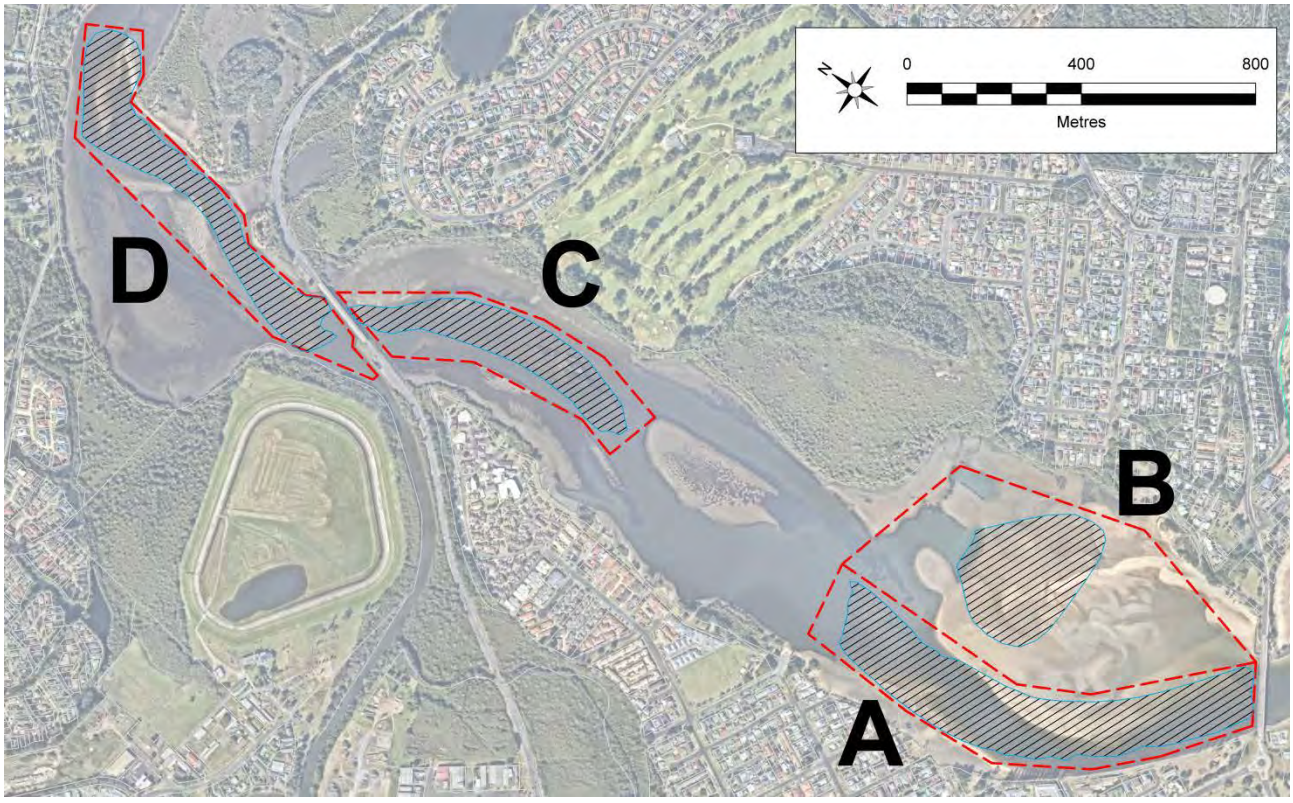


Figure 1: North Creek dredging investigation areas and initial proposed dredging footprint (hatched)

2. METHODOLOGY

Planning for the sediment investigations included a 'Dial Before You Dig' query which determined that an active telecommunications cable was present in the vicinity of the dredging and sampling area, necessitating minor readjustment of the original sediment sampling plan to maintain appropriate standoff distances. A separate cable location and mapping exercise was conducted concurrent to the sediment investigations with the cable location detected electromagnetically (but not sighted) as shown in Appendix 1. Also concurrent to the sediment coring was a hydrographic survey which was undertaken for entire study area as shown in Appendix 2.

Sediment coring was undertaken within the target dredging areas in order to characterise the sediments in these locations. Forty coring locations were pre-selected based on the intended dredging footprint, proposed depth of cut and with reference to the geomorphological features of the waterway. During sediment coring, refusal of the corer at a number of locations due to the presence of indurated sands ('coffee rock') necessitated a number of additional cores, resulting in a total of 43 cores for the study. Coring was performed utilising a 60mm vibracoring system deployed from Hydrosphere's work vessel 'Mudskipper'. With this method, an aluminium tube is vibrated mechanically and driven vertically downwards, typically around 3.5m, into the sediment. A food-grade plastic liner and core catcher/cone assembly is utilised to retain the sediment within the tube. The tube is extracted from the sediment using an on-board crane, and once aboard, the plastic lining and sediment core are extracted and the core is then available for further processing. Although the vibration of the tube leads to some minor disturbance of the core periphery, this method generally yields an excellent representation of the sub-surface strata allowing photography, logging and sub-sampling of specific depths/strata from the sediment core.

Cores were logged and sub-sampled at Hydrosphere's workshop, with multiple samples taken per core for analysis of sediment particle size distribution, acid sulfate soil and chemical contaminants. Sub-sample depths are shown in core logs presented in Appendix 3. Sub-samples were placed on ice and submitted to Southern Cross University's Environmental Analysis Laboratory (EAL) for analysis. The EAL is NATA accredited for all the analyses undertaken. Samples were taken for four suites of analysis as follows. The abbreviations correspond with the codes of the core logs presented in Appendix 3.

- PSD – Particle dry sieving classification in accordance with the Wentworth grain size classification (>2mm – gravel and organic matter, 1-2mm – very coarse sand, 500µm-1mm – coarse sand, 250-500µm – medium sand, 125-250µm – fine sand, 63-125µm – very fine sand, <63µ - silt and clay);
- ASS – Testing for Acid Sulphate Soils (ASS) which involved a full analysis of chromium reducible sulphur, actual and potential acidity, neutralising capacity and theoretical liming rate;
- ENM – Corresponding the EAL's analysis suite for excavated natural material (ENM; see EPA 2014) which included testing for pH, moisture content, electrical conductivity, foreign material (rubber, plastic, bitumen, paper, cloth, painted wood etc.), metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (C10-C40) and BTEX (C6-C10); and
- PEST – Corresponding to EAL's analysis suite for pesticides which included testing for Organo-chlorines (OC), Organo-phosphates (OP) and Polychlorinated Biphenyls (PCB).

These four suites were selected as they are commonly utilised for the classification of excavated material and cover all common urban, industrial and agricultural contaminants potentially present in the North Creek sediments.

3. RESULTS AND DISCUSSION

Final locations for the 43 cores taken for the study are shown in Figure 2 and Figure 3. Core logs for all sample locations are presented in Appendix 3. These provide a summary of the appearance of sediments encountered, the depths and analyses applied to sub-samples and physical/aesthetic characteristics. Full laboratory analytical results are presented in Appendix 4.

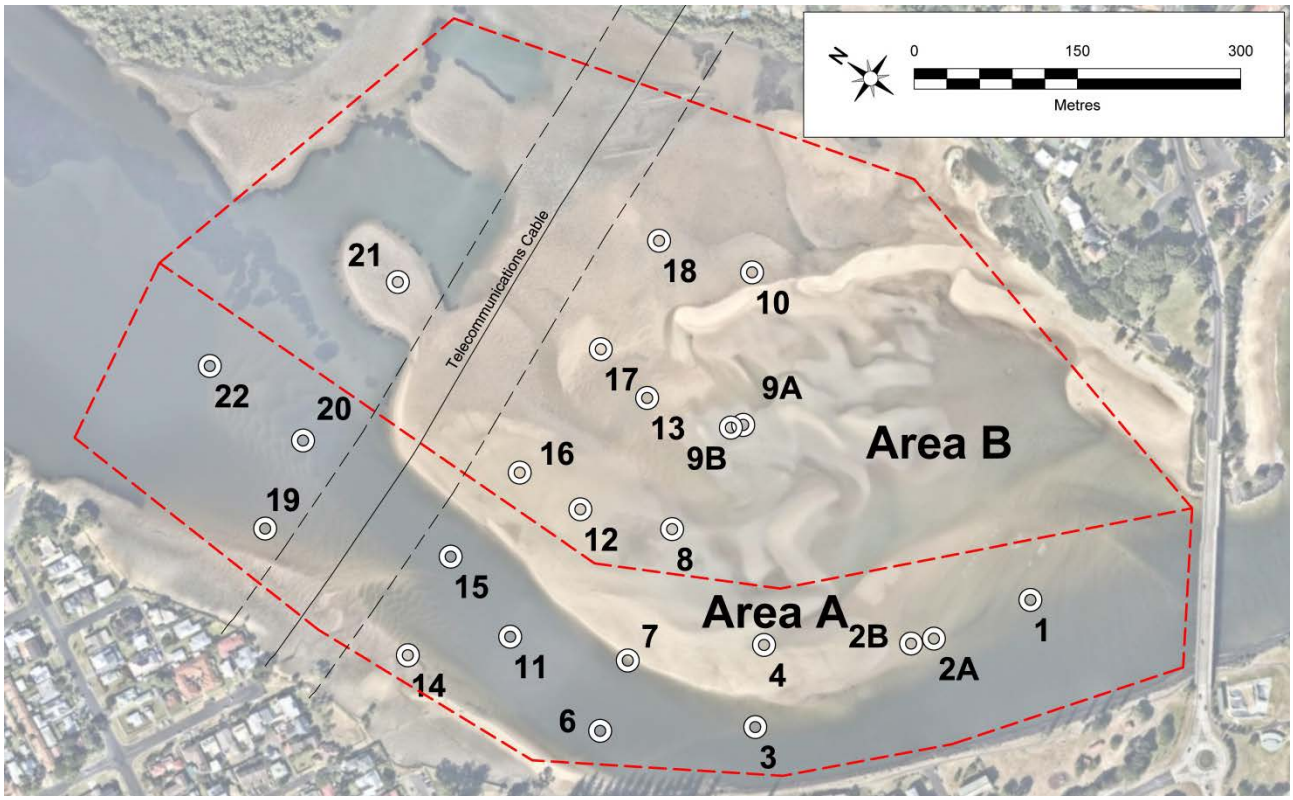


Figure 2. Sediment coring locations – Areas A and B

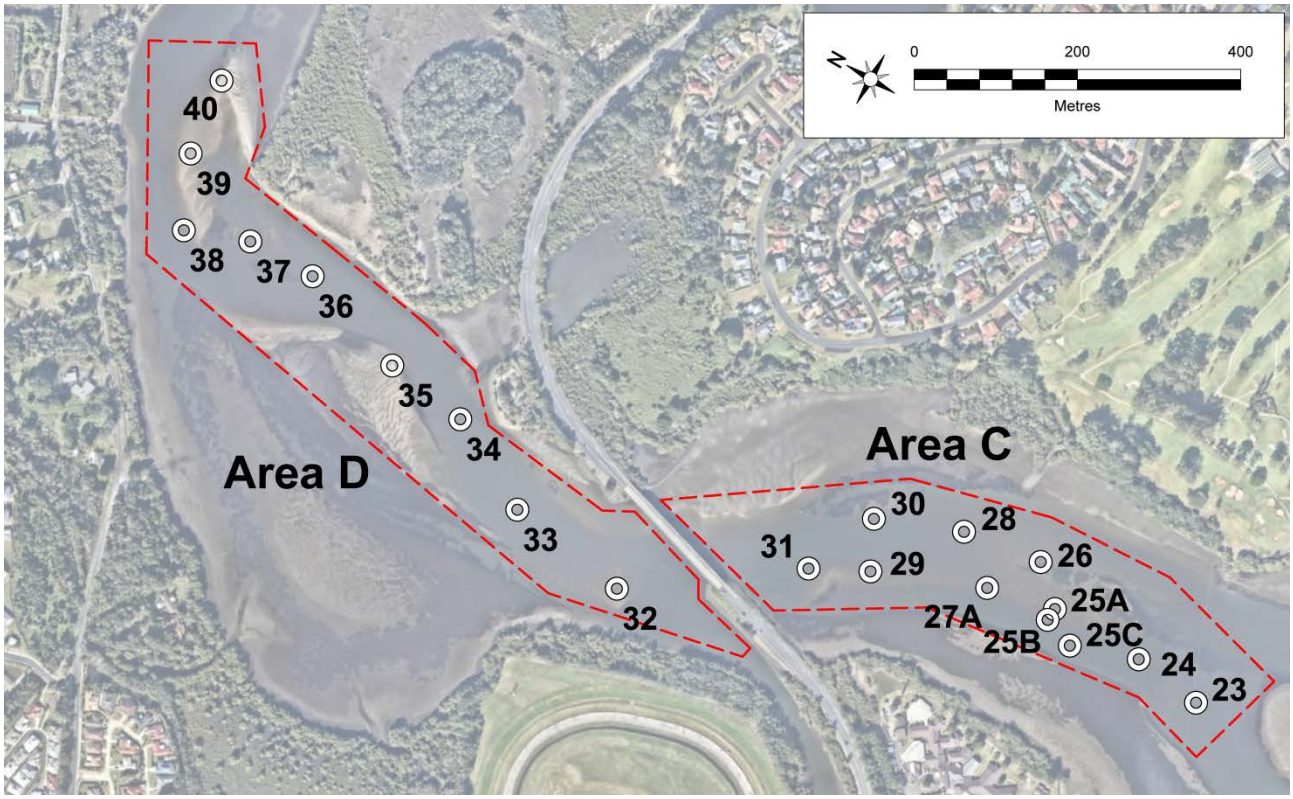


Figure 3. Sediment coring locations – Areas C and D

3.1 Grain Size

Particle size distribution (PSD) results show that sediment grain size varies throughout the project area however is generally dominated by sand-sized fractions. The grain size characteristics and distribution within each of the broad dredge investigation areas are discussed below.

Area A

This area is geomorphologically active, with shifting sand shoals and encompasses the most downstream section of the main North Creek channel. This area is subject to strong tidal currents and is subjected to ocean waves which propagate into the waterway from the Richmond River mouth.

Key points in relation to grain size for samples in this area are discussed below.

- At the most downstream cores (BH01, BH02A, BH02B) sediments were generally consistent throughout the cores however contained a higher proportion of fine sands (33-57%). These samples contained virtually no shell material and it was noted during sampling that the sediments in this area were very dense and compacted.
- Cores BH03, BH04, BH06, BH07, BH11 and BH15 were dominated by medium sand (60-90%) and contained virtually no material >2mm and no silt/clay.
- Core BH14 which is located at the western periphery of the investigation area contained less medium sand and higher proportions of other sand sizes than the downstream sites. A layer of oyster shells of around ~5-10 cm was present at around -2.8m AHD and some silty sand between -0.85 and -1.59m AHD.
- Cores BH19 and BH20 contained a surface stratum of approximately 50/50 medium-fine sand with medium sand dominating deeper strata. Some minor shell material was present in the middle and deep strata.
- Core BH22 - dominated by medium sands (~70%) throughout with large shell fragments present in the sand below -4.85m AHD.

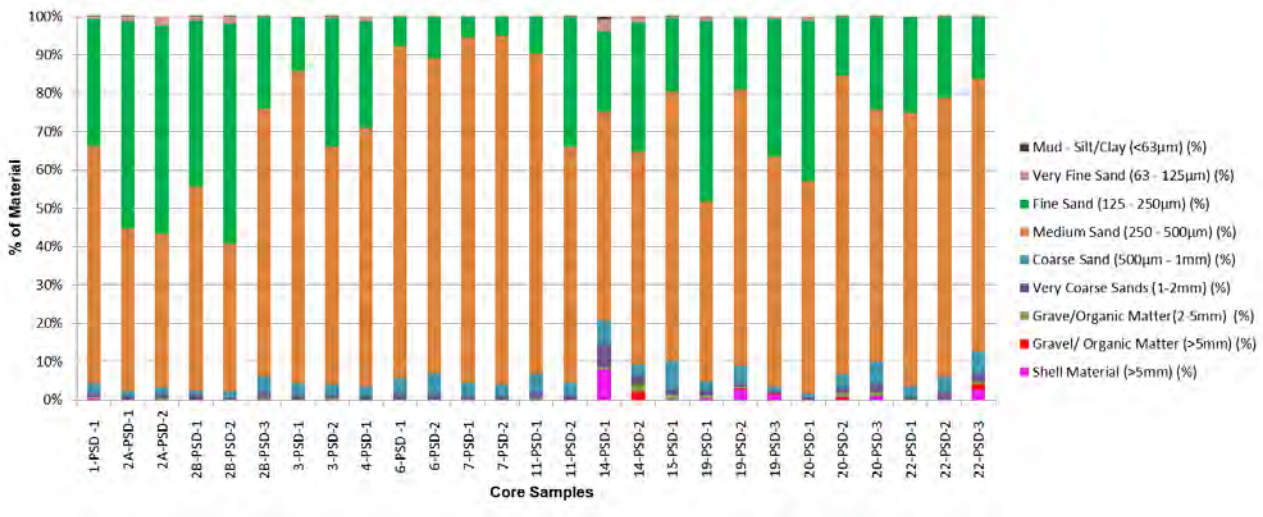


Figure 4: Particle size distribution of Area A sediment samples (Wentworth grain size classification)

Overall, the sediments sampled throughout Area A were generally dominated by clean marine medium-sized sands. Wave action towards the downstream margin has resulted in very dense packing of the sand in this area, however the quality of the material is excellent. Towards the western margin (i.e. BH14 and BH19) some lower quality material was encountered, with both shell and/or silt being found in greater proportions. Similarly, sediments at depth towards the upstream end of Area A (i.e. BH22) and the neighbouring core from Area B (BH21) also had increased levels of shell at depth.

Area B

This area encompasses the main extent of the exposed North Creek shoals and transitions from the wave influenced shallows at the downstream end through to relatively sheltered flats towards the north. The sands in this area shift considerably as evidenced by the continued growth and migration of the Serpentine Beach which forms the eastern border of this area. Key points of note are as follows:

- Cores BH08, BH09A, BH09B, BH10, BH12 and BH16 all exhibit similar sediment characteristics. Surface strata are dominated by medium sands (72-89%) which is then underlain by material that is lower in medium sand (46-61%) and higher in fine sands. Cores where deeper material was sampled showed a return to a higher medium sand content material at depth.
- A small amount of shell and silt/clay was encountered in the deeper stratum (below -2.38m AHD) in BH10 near the north-eastern end of this Area B and it has also been observed that silty material has accumulated within the small seagrass patches which lie further east of this core. It is considered that sediments are likely to become progressively more silty in this direction. This trend would be consistent with sheltered nature of this area as it is protected from wave action and strong tidal currents by the continued propagation of the Serpentine Beach.
- BH17 and BH18 generally contained higher fine sand portions with scattered shell fragments throughout. BH17 contained a layer of large shell (-2.32 to -2.56m AHD) and scattered shell fragments below this similar to BH18.
- BH021 generally contained a higher proportion of fine sand but also had a higher presence (2.7-5.5%) of coarse and very coarse sand fractions. The middle stratum (-1.90 to -2.57m AHD) contained a high proportion of both silt/clay (~1.8%) and shell material (~10%). This site is located close to an existing dredge hole which was formed when sand was dredged for the Prospect Bridge construction project. Some material was placed at the site of BH21 during that project to form a bird roost, however it is unlikely that this material would have been placed at the depth of silt/clay and shell and therefore is considered a natural deposit.

Overall, Area B contains significant reserves of high quality sand, however areas upstream and to the north east, which are sheltered from wave and tidal currents contain siltier material and are more likely to contain large shell material.

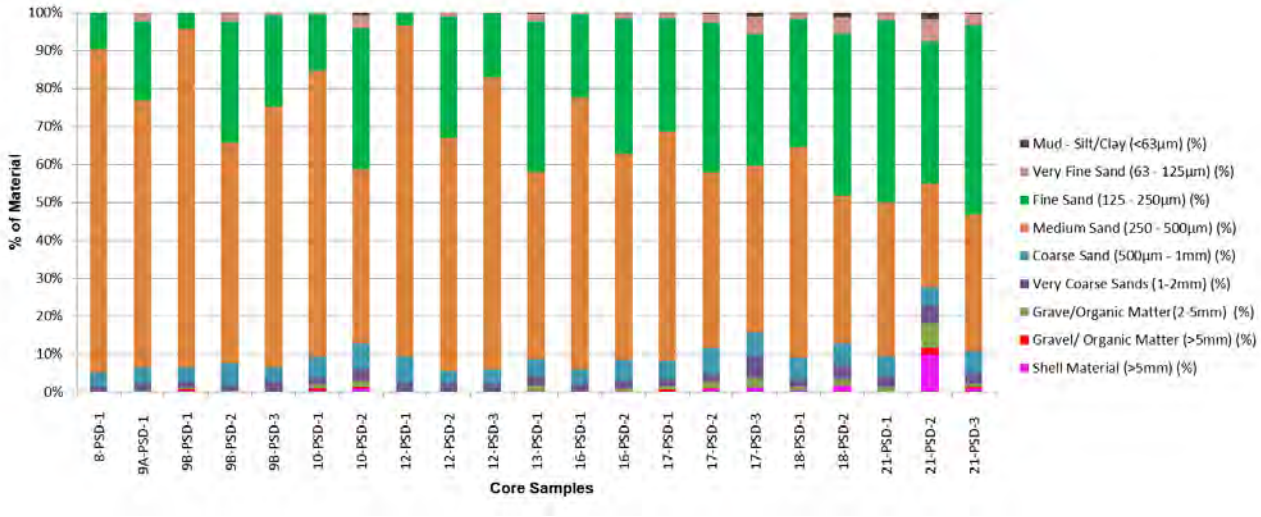


Figure 5: Particle size distribution of Area B sediment samples (Wentworth grain size classification)

Area C

Compared to the relatively homogenous nature of the majority of the material encountered in the downstream Areas A and B, sediment strata throughout Area C are relatively complex. Coffee rock was encountered at varying levels, necessitating repeat coring in an attempt to locate deeper surface sediments. The shallowest coffee rock was encountered at around -0.7m AHD (BH25A and BH25B) but also close to the sediment surface even in deeper water for many of the sites. It is concluded that the majority of the eastern side of the Area C is underlain by a thick layer of coffee rock, which has been cut down to deeper elevations in the central channel by natural processes, but is likely to be widespread at shallow elevations throughout the eastern side of this area.

In addition to the coffee rock, there were significant deposits of heavy shell in some areas, no doubt associated with the large natural oyster bank that exists on the eastern side of North Creek, downstream of Prospect Bridge. Shell was located at depth, as well as being observed to completely cover the shallow channel bed downstream of the bridge.

Some deep sand was still evident in one area (represented by BH29 and BH30), which was underlain at around -4.4m AHD by silty sand with heavy shell content.

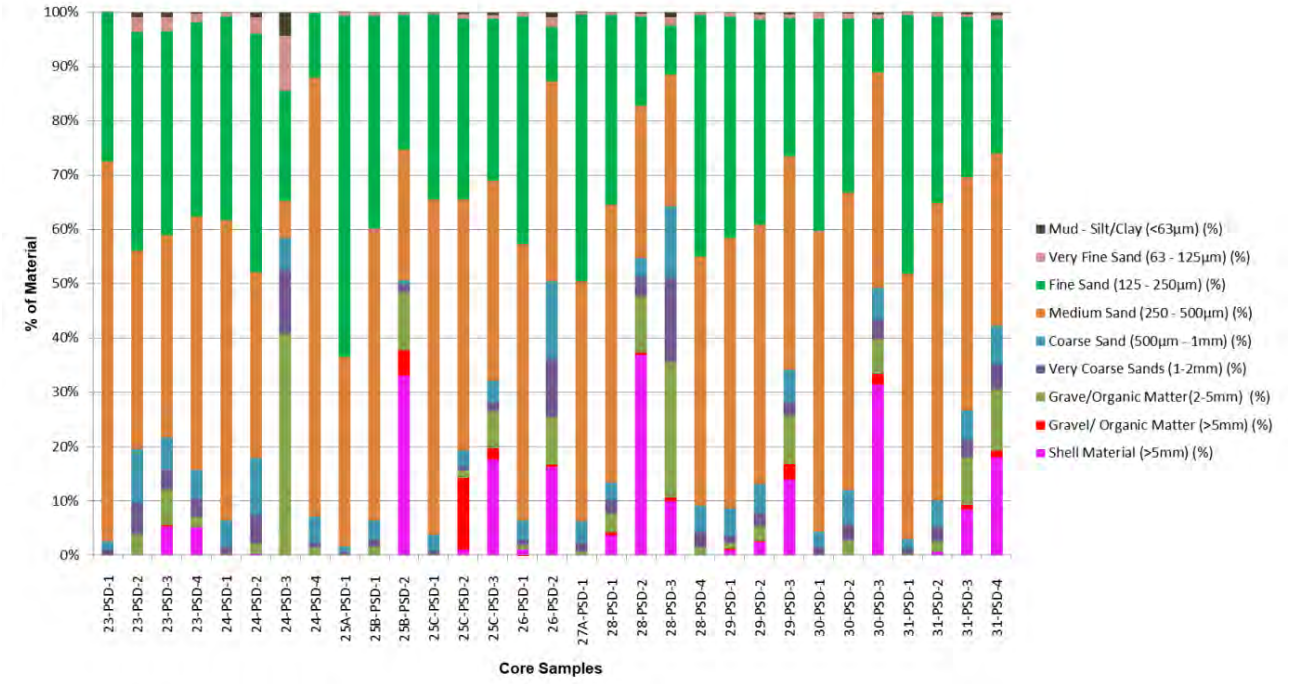


Figure 6: Particle size distribution of Area C sediment samples (Wentworth grain size classification)

Overall, the sediment quality in Area C is highly variable. The depth of sand is often constrained by the shallow coffee rock, and there is significant potential to encounter very shelly or silty strata throughout this area. There are also more areas of seagrass in this reach, which tends to accumulate silt within the surface layers.

Area D

This area upstream of Prospect Bridge was less variable than Area C and did not produce any evidence of coffee rock to the depth sampled. Some strata with heavy shell content were still encountered however the overall density of shell and the extent of sediments containing shell were significantly less than Area C.

It was notable that one section of Area D, represented by BH35, BH36 and also separately BH40 contained deep sands, albeit with slightly elevated silt/clay content. BH37 also had good quality sand but had one layer of shelly material between -1.59 and -2.1m AHD. Other areas (BH38 and BH40) had 1.6 to 2.3m of surface sand of relatively good quality before transitioning to strata with higher fines content.

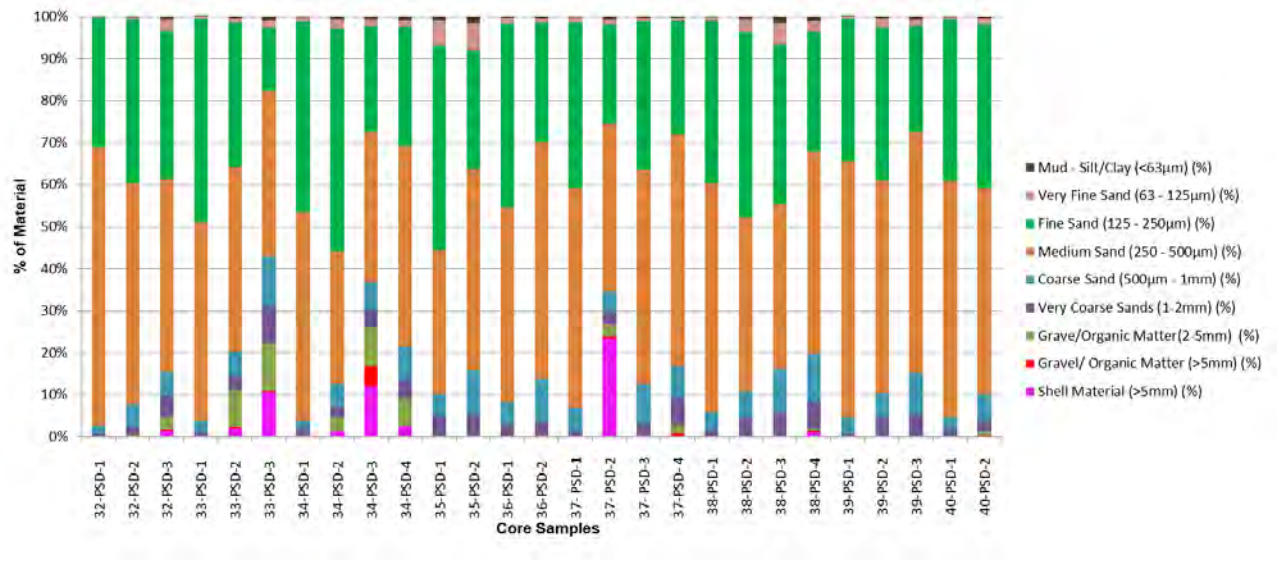


Figure 7: Particle size distribution of Area D sediment samples (Wentworth grain size classification)

3.2 Acid Sulphate Soil

Acid sulfate soils (ASS) are sediments or soils which contain iron sulphides which, when exposed to oxygen form sulphuric acid (Ahern, 1998). Actual ASS (AASS) are soils or sediments that are highly acidic (generally <pH4) due to the oxidation of sulphides in the material. Potential ASS (PASS) is soil or sediment containing sulfidic material that has not been oxidised, however, if oxidised will have a high acid generating potential. Disturbance of such soils that fall under these classifications pose a risk in the form of the release or generation of sulphuric acid and deoxygenation of waters which could result in fish kills and other environmental impacts.

Samples from 39 of the cores and various strata within those cores were analysed using the detailed laboratory chromium suite analysis to identify the level of PASS and evaluate any risk associated with PASS. Chromium Reducible Sulfur (Scr) analysis measures actual acidity (AASS), reducible inorganic sulfur (PASS) and acid neutralising capacity from which the net acidity is calculated. For coarse materials such as sand, an action threshold of 0.03% Scr is considered to indicate the presence of PASS. Under the NSW *ASSMAC Acid Sulfate Soils Assessment Guidelines (1998)* an ASS Management Plan should be prepared (for works disturbing >1000 tonnes of soil) if the oxidisable sulfur content of the material is >0.03%.

Table 1 provides a summary of ASS results for the North Creek sediments and indicates that the majority of cores contained appreciable, although not consistent, levels of oxidisable sulphur. Overall, sulphidic material and resultant PASS was present throughout the material analysed within the proposed dredge areas. With the exception of a few locations, results indicated that PASS was generally not present within surface strata. In the majority of samples where sulphidic material exceeded the 0.03% Scr threshold results indicated that there was sufficient native shell material to provide excess 'self-neutralising' capacity, although this would not remove the requirement to develop an acid sulphate soil management plan to be implemented during dredging works.

Area A

Sulphidic material was clearly less prevalent in Area A compared to the other target areas with only eight samples returning values higher than the 0.03% Scr threshold (0.033-0.356% Scr). The highest value was recorded at BH21 and the second highest (0.297Scr) at BH14 which were both noted to have higher silt contents than the rest of Area 1. Sulphidic material was encountered at depths ranging from 0.32 m to 1.82 m below sediment surface and was not found in any of the surface layer samples (note 14-ASS-1 and 4-ASS-1 do not represent just the surface stratum). In all cases (with exception of BH14), the analysis detected that there was sufficient carbonate to provide excess acid neutralising capacity (ANC) resulting in a negative net acidity.

Area B

Sulphidic material was detected in every core except BH08 in Area B. Values exceeding the 0.03% Scr threshold ranged from 0.032 to 0.224% Scr with the higher values occurring in cores BH10, BH17 and BH18 at depth towards the north-eastern sheltered portion of this site. The sulphidic material once again appears to not occur in surface strata. Sulphidic material was encountered at depths ranging from 0.73 to 2.55 m below sediment surface. Samples 9A-ASS-1 and 13-ASS-1 were homogenised samples collected from across the full depth of each core and therefore it is difficult to pinpoint the actual depth at which the sulphidic material actually occurs at those sites. But given the results from the other cores and description of material present, it is likely the sulphidic material at BH09 and BH13 is also not present in the surface strata. In all samples exceeding the threshold, results indicate that sufficient ANC is present to result in negative net acidity.

Area C

Sulphidic material was present in samples throughout Area C. Values exceeded the 0.03%Scr threshold in 13 samples ranging from 0.042 to 0.938%Scr. As observed in Areas A and B, sulphidic material was absent from all surface strata sampled. BH28 was exceptional in having almost 1%Scr, which is common for indurated sands, but oddly, the deep "apparently clean sand" from BH24 also had exceptionally high Scr. In many cases the very high shell content of the Area C sediments was sufficient to provide a negative liming rate calculation.

Area D

Sulphidic material is prevalent throughout Area D with 77% of samples exceeding the 0.03% Scr threshold ranging from 0.03% to 0.340% Scr. Although more samples exceeded the threshold the average exceedance value (0.117% Scr) was lower than that of Areas A and C. Once again, sulphidic material tended not to be present in the sampled surface strata (with the exception of BH35 and BH36). Excess ANC tended to be lower within this area.

Table 1: Summary of ASS analysis

Sample Identification	Potential Sulfidic Acidity		Actual Acidity		Acid Neutralising Capacity		Net Acidity	Lime Calculation
	(% S_{cr})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg CaCO3/t DW)
Area A								
1-ASS-1	0.029	18	9.56	0	1.06	212	-124	-6.2
2A-ASS-1	0.019	12	9.48	0	0.80	160	-95	-4.8
2A-ASS-2	0.053	33	9.55	0	1.30	260	-140	-7.0
2B-ASS-1	0.023	14	9.66	0	1.04	208	-124	-6.2
2B-ASS-2	0.055	34	9.65	0	1.05	210	-106	-5.3
2B-ASS-3	0.011	7	9.63	0	0.42	83	-48	-2.4
3-ASS-1	0.021	13	9.67	0	0.68	135	-77	-3.9
3-ASS-2	0.033	20	9.68	0	0.45	89	-39	-2.0
4-ASS-1	0.059	37	9.65	0	1.32	264	-139	-7.0
6-ASS-1	0.018	11	9.51	0	0.33	67	-33	-1.7
6-ASS-2	0.017	11	7.49	0	0.02	4	8	0.6
7-ASS-1	0.024	15	9.47	0	0.50	101	-52	-2.6
7 -ASS2	0.029	18	9.37	0	0.40	80	-35	-1.8
11-ASS-1	0.012	7	9.60	0	0.45	90	-52	-2.6
11-ASS-2	0.027	17	9.10	0	0.20	41	-10	-0.5
14-ASS-1	0.297	185	9.17	0	1.39	279	0	0.0
14-ASS-2	0.060	38	9.06	0	0.26	52	3	0.2
15-ASS-1	0.012	7	9.66	0	0.68	135	-83	-4.1
19-ASS-1	0.003	2	9.00	0	0.17	34	-21	-1.0
19-ASS-2	0.014	9	9.40	0	0.58	116	-69	-3.4
19-ASS-3	0.008	5	9.58	0	1.23	245	-158	-7.9
20-ASS-1	0.012	7	9.52	0	0.89	179	-112	-5.6
20-ASS-2	0.014	9	9.39	0	0.37	75	-41	-2.1
20-ASS-3	0.010	6	9.58	0	0.80	159	-100	-5.0
21-ASS-1	0.008	5	9.45	0	0.55	111	-69	-3.4
21-ASS-2	0.356	222	9.10	0	2.43	485	-101	-5.1
21-ASS-3	0.135	84	9.37	0	0.91	182	-37	-1.9
22-ASS-1	0.015	9	9.46	0	0.47	95	-54	-2.7
22-ASS-2	0.013	8	9.46	0	0.44	89	-51	-2.5
22-ASS-3	0.014	9	9.56	0	0.69	138	-83	-4.2
Area B								
8-ASS-1	0.023	14	9.56	0	0.50	101	-53	-2.7
8-ASS-2	0.010	6	9.67	0	0.54	107	-66	-3.3
9A-ASS-1	0.041	26	9.51	0	0.86	172	-89	-4.4
9B-ASS-1	0.012	7	9.58	0	0.54	107	-64	-3.2
9B -ASS-2	0.046	29	9.58	0	1.23	246	-135	-6.8
9B-ASS-3	0.018	11	9.70	0	0.93	185	-113	-5.6
10-ASS-1	0.013	8	9.60	0	1.15	230	-145	-7.3
10-ASS-2	0.122	76	9.49	0	3.00	599	-323	-16.2
12-ASS-1	<0.005	0	9.61	0	0.39	78	-52	-2.6
12-ASS-2	0.033	21	9.61	0	0.96	192	-107	-5.4
12-ASS-3	0.012	8	9.61	0	0.62	125	-76	-3.8
13-ASS-1	0.035	22	9.55	0	1.55	309	-184	-9.2
16-ASS-1	<0.005	0	9.65	0	0.63	126	-84	-4.2
16-ASS-2	0.032	20	9.55	0	0.99	198	-112	-5.6
17-ASS-1	0.007	4	9.62	0	1.05	210	-136	-6.8
17-ASS-2	0.022	14	9.61	0	1.96	392	-248	-12.4
17-ASS-3	0.224	140	9.35	0	2.82	563	-236	-11.8
18-ASS-1	0.012	8	9.61	0	1.18	237	-150	-7.5
18-ASS-2	0.143	89	9.44	0	3.08	616	-322	-16.1

Sample Identification	Potential Sulfidic Acidity		Actual Acidity		Acid Neutralising Capacity		Net Acidity	Lime Calculation
	(% S_{cr})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg CaCO3/t DW)
Area C								
23-ASS- 1	0.011	7	8.52	0	0.25	50	-26	-1.3
23-ASS-2	0.271	169	8.73	0	0.80	160	62	4.7
23-ASS-3	0.148	92	9.16	0	1.37	273	-90	-4.5
23-ASS-4	0.055	34	9.41	0	1.17	233	-121	-6.1
24-ASS-1	0.005	3	9.20	0	0.16	31	-18	-0.9
24-ASS-2	0.283	177	8.53	0	0.61	122	95	7.1
24-ASS-3	0.879	548	8.40	0	2.76	551	181	13.5
24-ASS-4	0.015	9	9.58	0	1.18	236	-148	-7.4
25A-ASS-1	0.011	7	8.77	0	0.14	28	-12	-0.6
25B-ASS-1	0.005	3	9.38	0	1.58	315	-207	-10.4
25B-ASS-2	<0.005	0	9.33	0	2.06	412	-275	-13.7
25C-ASS-1	0.019	12	9.10	0	0.24	47	-20	-1.0
25C-ASS-2	0.065	41	9.08	0	0.66	133	-48	-2.4
25C-ASS-3	0.168	105	9.02	0	2.23	445	-192	-9.6
26-ASS-1	0.007	4	9.28	0	0.39	78	-48	-2.4
26-ASS-2	0.270	168	9.33	0	16.55	3307	-2036	-101.8
27A-ASS-1	0.006	3	9.27	0	0.33	66	-41	-2.0
28-ASS-1	<0.005	0	9.53	0	0.81	163	-108	-5.4
28-ASS-2	0.036	22	9.56	0	9.36	1869	-1224	-61.2
28-ASS-3	0.938	585	8.82	0	10.76	2150	-848	-42.4
28-ASS-4	0.120	75	8.95	0	1.13	227	-76	-3.8
29-ASS-1	0.008	5	8.80	0	0.27	53	-31	-1.5
29-ASS-2	0.012	7	9.22	0	0.45	89	-52	-2.6
29-ASS-3	0.025	16	9.39	0	2.97	593	-380	-19.0
30-ASS-1	0.010	6	9.38	0	0.59	118	-73	-3.6
30-ASS-2	0.045	28	9.35	0	2.43	486	-296	-14.8
31-ASS-1	0.003	2	8.81	0	0.18	36	-22	-1.1
31-ASS-2	0.026	16	9.22	0	0.61	122	-65	-3.2
31-ASS-3	0.042	26	9.34	0	2.26	452	-275	-13.8
31-ASS-4	0.007	4	9.50	0	5.41	1081	-716	-35.8
Area D								
32-ASS-1	0.006	4	8.78	0	0.18	36	-20	-1.0
32-ASS-2	0.019	12	8.61	0	0.23	46	-18	-0.9
32-ASS-3	0.060	37	9.18	0	0.99	198	-94	-4.7
33-ASS-1	0.006	4	8.46	0	0.12	23	-12	-0.6
33-ASS-2	0.039	24	9.07	0	0.62	123	-58	-2.9
33-ASS-3	0.225	140	9.23	0	7.76	1551	-894	-44.7
34-ASS-1	0.012	8	8.70	0	0.14	28	-11	-0.6
34-ASS-2	0.057	36	9.11	0	0.45	90	-24	-1.2
34-ASS-3	0.153	95	9.28	0	4.66	932	-526	-26.3
34-ASS-4	0.104	65	9.25	0	2.10	420	-215	-10.8
35-ASS-1	0.066	41	8.58	0	0.28	56	4	0.3
35-ASS-2	0.340	212	8.74	0	0.90	180	92	6.9
36-ASS-1	0.036	23	7.88	0	0.21	42	-5	-0.3
36-ASS-2	0.110	69	7.57	0	0.18	36	45	3.3
37-ASS-1	0.012	7	8.71	0	0.12	24	-8	-0.4
37-ASS-2	0.126	79	9.22	0	1.87	374	-170	-8.5
37-ASS-3	0.072	45	8.10	0	0.21	42	17	1.3
37-ASS-4	0.032	20	7.40	0	0.10	20	7	0.5
38-ASS-1	0.020	12	7.40	0	0.05	10	6	0.4
38-ASS-2	0.094	59	7.61	0	0.24	48	27	2.0
38-ASS-3	0.317	198	8.09	0	0.59	118	119	8.9
38-ASS-4	0.185	115	9.02	0	1.24	248	-50	-2.5
39-ASS-1	<0.005	0	7.90	0	0.15	30	-20	-1.0
39-ASS-2	0.101	63	8.71	0	0.36	72	15	1.1
39-ASS-3	0.131	82	8.10	0	0.53	106	11	0.8
40-ASS-1	0.030	19	7.80	0	0.18	36	-5	-0.3
40-ASS-2	0.071	44	7.90	0	0.33	66	0	0.0

3.3 Chemical Contaminants

The sediments were tested for a large suite of chemical contaminants in order to cover the potential urban, industrial and agricultural contaminants that could impact the beneficial use of dredged material. A summary of the results of the ENM suite of analyses, pesticide screening and tributyltin (TBT) are presented in Table 2.

The results indicate that majority of metals analysed for, including arsenic, lead, chromium, copper, nickel, and zinc were detected at low levels in a number of samples, although well below relevant guideline values (DEWHA, 2009; ANZECC/ARMCANZ, 2000). Hydrocarbon and physical contaminant levels were all below limit of reporting. All samples analysed for pesticides and TBT returned values below the limit of reporting. All material sampled is considered to be uncontaminated with all chemical contaminant test results being either undetectable or significantly below relevant guideline values.

Table 2: Chemical contamination results

Samples	28-ENM-1	29-ENM-1	32-ENM-1	33-ENM-1	35-ENM-1	2B-1	3-1	7-1	9B-1	10-1	12-1	14-1	16-1	18-1	20-1	22-1	23-1	25C-1	37-1	39-1
Metals																				
Arsenic (mg/kg)	7	4	4	5	3	2	2	2	2	2	2	2	2	3	3	3	4	5	4	4
Lead (mg/kg)	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1
Cadmium (mg/kg)	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	9	4	5	4	3	2	1	1	1	2	1	5	1	3	2	3	8	4	4	4
Copper (mg/kg)	4	1	2	1	1	<1	<1	<1	<1	1	<1	2	<1	1	1	1	4	2	1	1
Nickel (mg/kg)	6	3	4	3	2	1	1	1	1	1	1	3	1	2	2	2	6	4	3	3
Zinc (mg/kg)	24	13	13	16	12	3	2	2	3	5	4	8	3	6	6	8	28	14	9	11
Mercury (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hydrocarbons																				
Polycyclic Aromatic Hydrocarbons (PAH) BTEX Total Recoverable Hydrocarbons	Below limit of reporting for all samples																			
Other																				
(Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	Below limit of reporting for all samples																			
Pesticides PCB's TBT	Below limit of reporting for all samples																			

4. SUMMARY AND CONCLUSIONS

All sediment samples analysed from throughout the target dredge areas are considered to be free of contamination from metals, hydrocarbons, organochlorines, organotins and physical contaminants. Several metals, likely to be of natural origin, were detected at low concentrations, but well below guideline limits.

ASS results indicate that the majority of cores contained appreciable, although not consistent, levels of oxidisable sulphur. Sulphidic content was most prolific at sites upstream of Prospect Bridge within Area D with the majority of samples exceeding the 0.03% Scr threshold. It appears that the presence of PASS is highly variable with depth as, interestingly, Scr was generally not recorded within any of the surface strata analysed. In the majority of samples where sulphidic material exceeded the 0.03% Scr threshold results indicated that there was sufficient carbonate material to provide excess 'self-neutralising' capacity, although this would not remove the requirement to develop an acid sulphate soil management plan to be implemented during dredging works. It is considered that appropriate methods to address ASS risks are available and that this is not likely to be a limiting factor in utilising the material as development fill where it can be treated and monitored *in situ*. Such material would need to treated and verified as PASS-free before use in other potential applications such as beach nourishment.

Grain size composition varies across the investigation area, although the majority of the material analysed is dominated by medium-fine sand fractions. Grain size distribution, consistency of the material and the presence of excess shell are considered to be the key factors controlling the use of the material.

Areas A and B, particularly where exposed to strong tidal currents and wave energy, were highly consistent 'clean' marine sands with minimal silt or shell material. In areas with less water movement, the proportion of silt gradually increases and the risk of encountering discrete lenses of silt or shell deposits increase. Overall, both Areas A and B represent a significant sand resource ideally suited for fill. Apart from the presence of the telecommunications cable, no physical impediments such as bedrock were encountered, although a remnant rock wall, approximately aligned with the boundary between Areas A and B does exist and will need to be avoided.

Area C is regarded as the most problematic for dredging. There is substantially higher risk of encountering silty material and/or excessive shell content. The volume of free sand is reduced by the presence of shallow coffee rock and there is also a natural oyster bank as well as rock walls and extensive seagrass beds in the vicinity which reduce the attractiveness of this area for gaining fill. Conversely, this reach is also the most problematic for navigation (as evidenced by numerous propeller scars through the seagrass) and is also likely to be a key restriction for tidal flows upstream of Prospect Bridge.

Area D contains less desirable sediments than Areas A or B, but is significantly more promising than Area C. Good quality sand is present at the site, and the proximity to the Southern Cross Industrial Estate development area is a significant advantage. Additional coring and grain size testing in this area may be require to better understand this resource, although testing for chemical contaminants is not considered to be warranted.

Overall, it is concluded that selective dredging in Areas A, B and D will yield excellent material for development fill. Higher value uses for the material in Areas A and B, particularly, is possible, however treatment (e.g. for PASS) would be required and potentially other processing or quality control (e.g. hydrocyclone separation of silt, screening of coarse shell) or freshwater washing (e.g. for concrete production) could be involved. These factors will need to be considered in the overall benefit/cost evaluation of the project.

5. REFERENCES

Ahern C R, Stone, Y, and Blunden B (1998). Acid Sulfate Soils Assessment Guidelines Published by the Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia.

ANZECC/ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines.

DEWHA (2009). National Assessment Guidelines for Dredging. Commonwealth of Australia, Canberra, 2009.

EPA (2014) Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014. The excavated natural material order 2014. NSW Environmental Protection Authority.

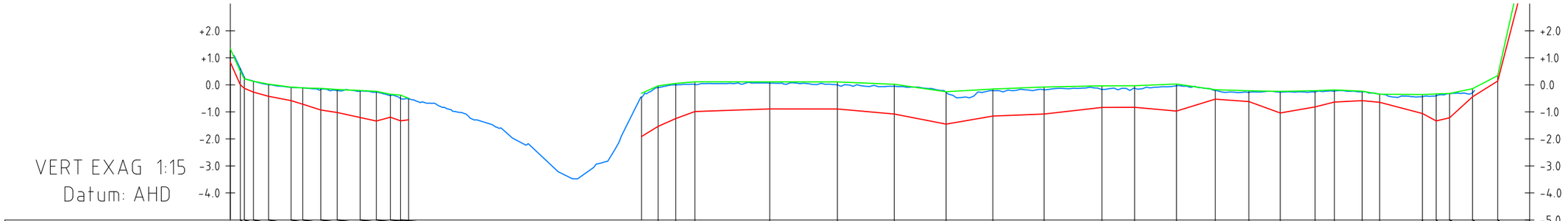
Hydrosphere Consulting (2016). North Creek Dredging Scoping Study. Prepared for Ballina Shire Council.

Hydrosphere Consulting (2017) North Creek Dredging Project – Sediment Investigation Sampling & Analysis Plan. Report for Ballina Shire Council, March 2017.

Appendix 1: Telecommunications Cable Location

Notes:

1. Cable location undertaken by Johns Cable Location, 31 January 2018.
2. Cable depths and location inferred from electromagnetic detection only - cable not physically sighted.
3. Cable location points surveyed by Hydrosphere Consulting 31 January 2018 by RTK GPS.
4. Hydrographic survey undertaken by Hydrosphere Consulting between 28 December 2017 and 4 January 2018.



CHAINAGE	HYDROSURVEY	CABLE DEPTH	SURVEY	CABLE
0	+0.188	-1.60	-0.313	-1.913
10	+0.021	-0.50	0.501	0.001
20	-0.063	-0.35	0.224	-0.126
30	-0.112	-0.40	0.130	-0.270
40	-0.177	-0.45	0.027	-0.423
50	-0.215	-0.50	-0.084	-0.584
60	-0.233	-0.60	-0.115	-0.715
70	-0.272	-0.80	-0.131	-0.931
80	-0.381	-0.85	-0.172	-1.022
90	-0.539	-1.00	-0.208	-1.208
100	-0.677	-1.10	-0.239	-1.339
110	-0.883	-0.85	-0.347	-1.197
120	-1.067	-0.95	-0.381	-1.331
130	-1.365			
140	-1.593			
150	-2.097			
160	-2.484			
170	-3.109			
180	-3.477			
190	-3.120			
200	-2.732			
210	-1.455			
220	-0.314			
230	-0.058	-1.50	-0.036	-1.536
240	+0.008	-1.30	0.053	-1.247
250	+0.030	-1.10	0.112	-0.988
260	+0.046			
270	+0.055	-1.00	0.110	-0.890
280	+0.065			
290	+0.060			
300	+0.065			
310	+0.044	-1.00	0.108	-0.892
320	+0.019			
330	-0.005			
340	-0.035			
350	-0.068	-1.10	0.021	-1.079
360	-0.065			
370	-0.081			
380	-0.160	-1.20	-0.253	-1.453
390	-0.379			
400	-0.470	-1.00	-0.155	-1.155
410	-0.229			
420	-0.216			
430	-0.179	-1.00	-0.079	-1.079
440	-0.172			
450	-0.128			
460	-0.130			
470	-0.117	-0.80	-0.036	-0.836
480	-0.128			
490	-0.147			
500	-0.110	-0.80	-0.031	-0.831
510	-0.069			
520	-0.048	-1.00	0.031	-0.969
530	-0.129			
540	-0.268	-0.35	-0.179	-0.529
550	-0.279			
560	-0.266	-0.40	-0.218	-0.618
570	-0.265			
580	-0.270	-0.80	-0.241	-1.041
590	-0.261			
600	-0.224	-0.60	-0.217	-0.817
610	-0.238	-0.45	-0.186	-0.636
620	-0.278			
630	-0.362	-0.35	-0.235	-0.585
640	-0.415	-0.30	-0.346	-0.646
650	-0.442			
660	-0.371	-0.70	-0.359	-1.059
670	-0.307	-1.00	-0.334	-1.334
680		-0.90	-0.319	-1.219
690		-0.30	-0.143	-0.443
700		-0.20	0.341	0.141
710		-0.92	5.611	4.695
720				

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0 100 200

Metres

CLIENT

BALLINA SHIRE COUNCIL

JOB NUMBER

15-021

NORTH CREEK DREDGING
TELECOMMUNICATIONS CABLE

REVISION	DATE	DESCRIPTION	DRAWN
	2018-01-31	REV 0	MH

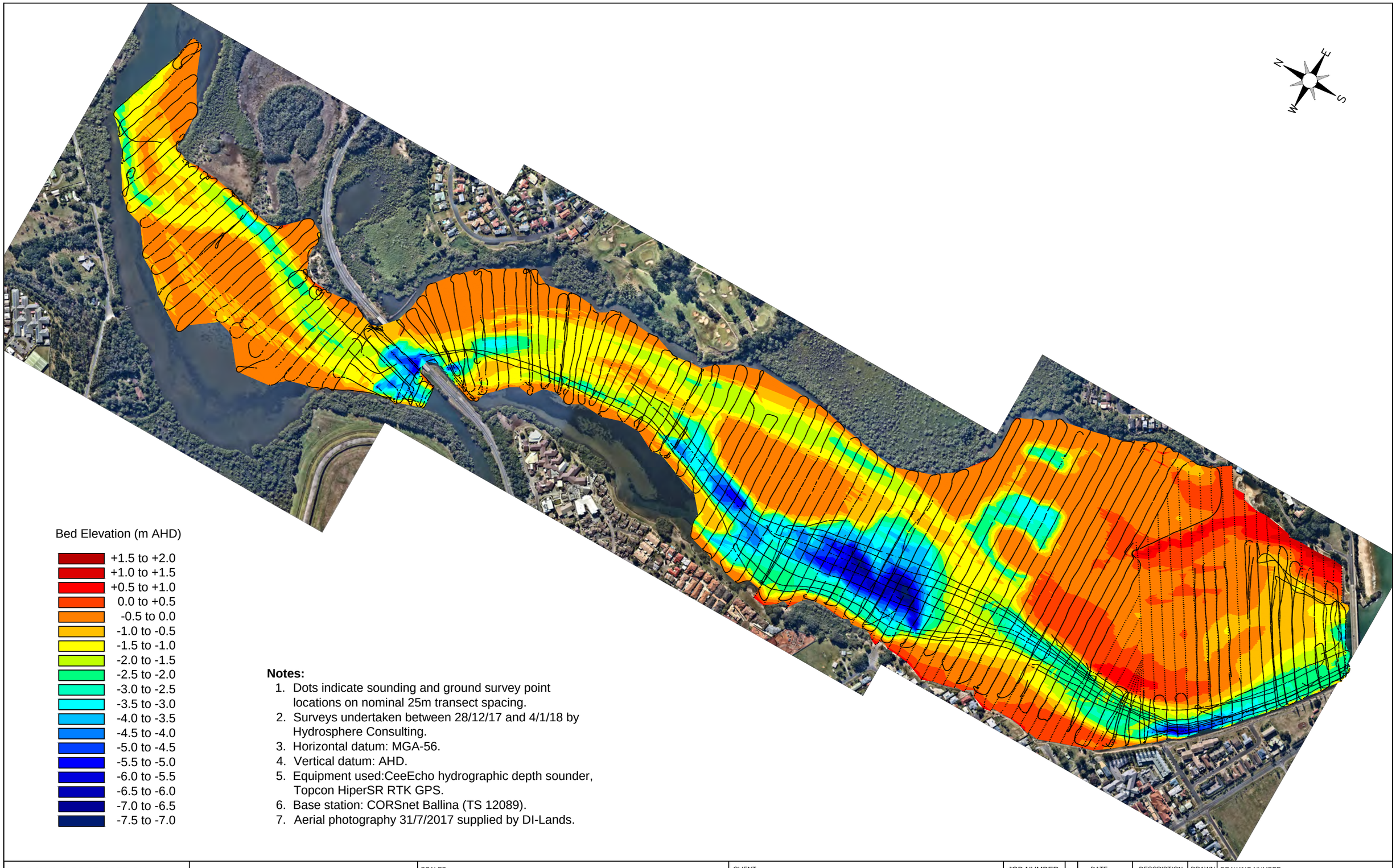
DRAWING NUMBER

FIGURE 1

SHEET 1 OF 1

Y:\15-021 North Creek Dredging\Drawings\North Creek Cable.dwg

Appendix 2: Hydrographic Survey



Bed Elevation (m AHD)

- +1.5 to +2.0
- +1.0 to +1.5
- +0.5 to +1.0
- 0.0 to +0.5
- -0.5 to 0.0
- -1.0 to -0.5
- -1.5 to -1.0
- -2.0 to -1.5
- -2.5 to -2.0
- -3.0 to -2.5
- -3.5 to -3.0
- -4.0 to -3.5
- -4.5 to -4.0
- -5.0 to -4.5
- -5.5 to -5.0
- -6.0 to -5.5
- -6.5 to -6.0
- -7.0 to -6.5
- -7.5 to -7.0

Notes:

1. Dots indicate sounding and ground survey point locations on nominal 25m transect spacing.
2. Surveys undertaken between 28/12/17 and 4/1/18 by Hydrosphere Consulting.
3. Horizontal datum: MGA-56.
4. Vertical datum: AHD.
5. Equipment used:CeeEcho hydrographic depth sounder, Topcon HiperSR RTK GPS.
6. Base station: CORSnet Ballina (TS 12089).
7. Aerial photography 31/7/2017 supplied by DI-Lands.

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Metres

CLIENT: BALLINA SHIRE COUNCIL

JOB NUMBER: 15-021

NORTH CREEK DREDGING
HYDROGRAPHIC SURVEY JANUARY 2018

REVISION	DATE	DESCRIPTION	DRAWN
	2018-01-04	REV 0	MH

DRAWING NUMBER

FIGURE 1

SHEET 1 OF 1

Y:\15-021 North Creek Dredging\Drawings\North Creek Hydrosurvey Points Jan 2018.dwg

Appendix 3: Sediment Core Logs

Borehole Log

BH01

Project Number:	15-021	Core identifier:	BH01
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556094 6806556
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.22
Vertical Datum:	Australian Height Datum	Core length:	1.05
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
1-PSD-1 1-ASS-1					-1.3 to -1.4	0.0 to 0.1		Sand	Yellow	No odour. No shell
					-1.4 to -1.8	0.2 to 0.6		Sand	Medium Grey	No odour. No shell
					-1.9 to -2.2	0.7 to 1.0		Sand	White Grey	No odour. No shell
					-2.3 to -4.8	1.1 to 3.6	Core terminated in dense sand			

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Y:\15-021 North Creek Dredging\Core logs\Core BH01.dwg

Borehole Log

BH02A

Project Number:	15-021	Core identifier:	BH02A
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556015 6806608
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.74
Vertical Datum:	Australian Height Datum	Core length:	1.50

Notes:

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
2A-PSD-1 2A-ASS-1	■	■			-0.8 to -1.00 / 0.0 to 0.3		Sand	Yellow-Light Grey	No odour. No shell
2A-PSD-2 2A-ASS-2	■	■			-1.1 to -2.00 / 0.4 to 1.3		Sand	Medium Grey	No odour. No shell
					-2.1 to -2.2 / 1.4 to 1.5		Sand	Light Grey	No odour. No shell
					-2.3 to -4.3 / 1.6 to 3.6		Core terminated in dense sand		

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Borehole Log

BH02B

Project Number:	15-021	Core identifier:	BH02B
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555999 6806623
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.58
Vertical Datum:	Australian Height Datum	Core length:	2.20
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
2B-ASS-1 2B-PSD-1					-0.6 / 0.0 to -0.9 / 0.3		Sand	Yellow	No odour. No shell
2B-ENM-1 2B-PEST-1 2B-ASS-2 2B-PSD-2					-1.00 / 0.4 to -2.00 / 1.6		Sand	Medium Grey	No odour. No shell
2B-ASS-3 2B-PSD-3					-2.3 / 1.7 to -2.7 / 2.2		Sand	White Grey	No odour. No shell
					-2.8 / 2.2 to -4.2 / 3.6		Core terminated in dense sand		

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Borehole Log

BH03

Project Number:	15-021	Core identifier:	BH03
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555855 6806697
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.51
Vertical Datum:	Australian Height Datum	Core length:	3.30
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
3-ASS-1 3-PSD-1 3-ENM-1 3-PEST-1					-1.6 to -3.4	0.0 to 1.9		Sand	Yellow - Medium Grey	No odour. No shell
3-ASS-2 3-PSD-2					-3.5 to -4.8	2.0 to 3.3		Sand	Light Grey	No odour. No shell
					-4.9 to -5.1	3.4 to 3.6		Core terminated in dense sand		

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Borehole Log

BH04

Project Number:	15-021	Core identifier:	BH04
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555921 6806733
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.05
Vertical Datum:	Australian Height Datum	Core length:	2.95
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
4-ASS-1 4-PSD-1					0.0 to -1.00		Sand	Yellow	No odour. No shell. Apparently very consistent material. Colours grade.
					-1.00 to -2.00			Light Grey	
					-2.00 to -3.00			Medium Grey	
					-3.00		Core terminated in dense sand		

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Borehole Log

BH06

Project Number:	15-021	Core identifier:	BH06
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555771 6806812
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.84
Vertical Datum:	Australian Height Datum	Core length:	2.95
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
6-ASS-1 6-PSD-1					-2.9 to -3.2	0.0 to 0.4		Sand	Light Grey	No odour. No shell
					-3.3 to -3.5	0.5 to 0.7		Sand	Medium Grey	No odour. No shell
6-ASS-2 6-PSD-2					-3.6 to -5.7	0.8 to 2.9		Sand	White Grey	No odour. No shell
					-5.8 to -6.00	3.0 to 3.6	Core terminated in dense sand			

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Borehole Log

BH07

Project Number:	15-021	Core identifier:	BH07
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555838 6806828
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.97
Vertical Datum:	Australian Height Datum	Core length:	2.31
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
7-ASS-1 7-PSD-1 7-ENM-1 7-PEST-1					-1.00 / 0.0 to -2.00 / 1.0		Sand	Yellow	No odour. No shell
					-2.00 / 1.0 to -2.5 / 1.5		Sand	Light Grey with Medium Grey patches	No odour. No shell
7-ASS-2 7-PSD-2					-2.6 / 1.6 to -3.00 / 2.0 to -3.2 / 2.3		Sand	Medium Grey	No odour. No shell
					-3.3 / 2.4 to -4.00 / 3.0 to -4.6 / 3.6	Core terminated in dense sand			

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Borehole Log

BH08

Project Number:	15-021	Core identifier:	BH08
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555960 6806863
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.15
Vertical Datum:	Australian Height Datum	Core length:	3.34
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
8-ASS-1 8-PSD-1					-0.2 to -2.5 / 0.0 to 2.4		Sand	Yellow - Medium Grey	No shell
8-ASS-2					-2.6 to -3.4 / 2.5 to 3.3		Sand	Yellow	No shell
					-3.5 to -3.7 / 3.4 to 3.6		Core terminated in dense sand		

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Borehole Log

BH09A

Project Number:	15-021	Core identifier:	BH09A
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556076 6806864
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.13
Vertical Datum:	Australian Height Datum	Core length:	2.11
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
9A-ASS-1 9A-PSD-1					-1.00 / 1.0 -2.00 / 2.0		Sand	Light Grey Medium Grey	Colour grades from light grey at surface to medium grey at depth. Appears to be consistent material throughout.
					-3.00 / 3.0		Core terminated in dense sand		

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Borehole Log

BH09B

Project Number:	15-021	Core identifier:	BH09B
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556068 6806872
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.09
Vertical Datum:	Australian Height Datum	Core length:	3.25
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
9B-ASS-1 9B-PSD-1					-0.1 to -0.8 / 0.0 to 0.7		Sand	Yellow - Light Grey	No shell.
9B-ASS-2 9B-PSD-2 9B-ENM-1 9B-PEST-1					-0.9 to -2.3 / 0.8 to 2.2		Sand	Medium Grey	No shell.
9B-ASS-3 9B-PSD-3					-2.4 to -3.3 / 2.3 to 3.2		Sand	Light Grey - Yellow	Scattered fine shell. Colours grade.
					-3.4 to -3.7 / 3.3 to 3.6		Core terminated in dense sand		

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Borehole Log

BH10

Project Number:	15-021	Core identifier:	BH10
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556196 6806937
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.13
Vertical Datum:	Australian Height Datum	Core length:	3.40
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
10-ASS-1 10-PSD-1 10-ENM-1 10-PEST-1					-0.2 to -3.7 / 0.0 to 3.6		Sand	Yellow - Light Grey	No shell.
10-ASS-2 10-PSD-2					-2.4 to -3.5 / 2.3 to 3.4		Sand	Light Grey	Scattered large shell. Slightly silty.
					-3.6 to -3.7 / 3.5 to 3.6		Core terminated in dense sand		

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BH11

Project Number:	15-021	Core identifier:	BH11
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555794 6806929
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.43
Vertical Datum:	Australian Height Datum	Core length:	3.15
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
11-ASS-1 11-PSD-1					-2.5 to -3.2	0.0 to 0.8		Sand	Yellow - Medium Grey	No odour. No shell
11-ASS-2 11-PSD-2					-3.3 to -4.3	0.9 to 1.9		Sand	White Grey	No odour. No shell
					-4.4 to -4.5	2.0 to 2.1		Sand	Light Brown - Light Grey	No odour. No shell
					-4.6 to -5.5	2.2 to 3.1		Sand	White Grey	No odour. No shell
					-5.6 to -6.00	3.2 to 3.6	Core terminated in dense sand			

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Borehole Log

BH12

Project Number:	15-021	Core identifier:	BH12
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556927 6806943
Horiztontal Datum:	MGA-56	Bed Elevation:	+0.14
Vertical Datum:	Australian Height Datum	Core length:	3.15
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
12-ASS-1 12-PSD-1					+0.1 to -0.5 / 0.0 to 0.7		Sand	Yellow	No shell.
12-ASS-2 12-PSD-2 12-ENM-1 12-PEST-1					-0.6 to -1.7 / 0.8 to 1.9		Sand	Medium Grey	No shell. Slightly silty
12-ASS-3 12-PSD-3					-1.8 to -3.00 / 2.0 to 3.1		Sand	Light Grey-Yellow	No shell..
					-3.1 to -3.4 / 3.2 to 3.6		Core terminated in dense sand		

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BH13

Project Number:	15-021	Core identifier:	BH13
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556046 6806951
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.49
Vertical Datum:	Australian Height Datum	Core length:	3.40
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
13-ASS-1 13-PSD-1					-1.00 -2.00 -3.00	1.0 2.0 3.0		Sand	Yellow - Light Grey	Slightly yellow at surface. Very consisted throughout. Scattered shell.
					-4.00	3.5		Core terminated in dense sand		

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Borehole Log

BH14

Project Number:	15-021	Core identifier:	BH14
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555727 6806997
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.43
Vertical Datum:	Australian Height Datum	Core length:	3.25
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
					-0.5 to -0.9	0.0 to 0.4		Sand	Yellow	No odour. No shell
					-0.8 to -0.9	0.4 to 0.5		Silty Sand	Medium Grey	No odour. No shell
14-ASS-1 14-PSD-1					-1.00 to -1.5	0.5 to 1.1		Silty Sand	Medium - Dark Grey	No odour. No shell
					-1.6 to -2.7	1.2 to 2.3		Sand	Light Grey	No odour. No shell
14-ASS-2 14-PSD-2 14-ENM-1 14-PEST-1					-2.8	2.3 to 2.4		Sand	Light Grey	Oyster shells
					-2.9 to -3.4	2.5 to 3.0		Sand	Light Grey	No odour. No shell
					-3.5	3.1		Organic	Dark Grey	Leaf/organics
					-3.6	3.2		Sand	Light Grey	No odour. No shell
					-3.7 to -4.00	3.3 to 3.6	Core terminated in dense sand			

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BH15

Project Number:	15-021	Core identifier:	BH15
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555824 6807016
Horiztontal Datum:	MGA-56	Bed Elevation:	-3.23
Vertical Datum:	Australian Height Datum	Core length:	3.30
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
					-3.3 to -3.4 / 0.0 to 0.2		Sand	Light Grey	No odour. No shell
					-3.5 to -3.7 / 0.3 to 0.5		Sand	Yellow	No odour. No shell
15-ASS-1 15-PSD-1					-3.8 to -6.00 / 0.6 to 3.0		Sand	White Grey	No odour. No shell
					-6.00 / 3.0 to 3.6		Core terminated in dense sand		

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BH16

Project Number:	15-021	Core identifier:	BH16
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555923 6807008
Horiztontal Datum:	MGA-56	Bed Elevation:	+0.12
Vertical Datum:	Australian Height Datum	Core length:	3.30
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
16-ASS-1 16-PSD-1					+0.1 to -1.00 / 0.0 to 1.1		Sand	Yellow	No shell. Apparent clean sand
16-ENM-1 16-PEST-1 16-ASS-2 16-PSD-2					-1.1 to -3.00 / 1.2 to 3.1		Sand	Light Grey - Medium Grey	Various bands of Light - Medium Grey
					-3.2 to -3.5 / 3.3 to 3.6		Core terminated in dense sand		

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BH17

Project Number:	15-021	Core identifier:	BH17
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556059 6807011
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.03
Vertical Datum:	Australian Height Datum	Core length:	3.30
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
17-ASS-1 17-PSD-1					0.0 to -1.00		Sand	Yellow - Light Grey	Scattered fine shell.
17-ASS-2 17-PSD-2					-1.00 to -2.00		Sand	Medium Grey	Slightly silty. Scattered fine shell.
					-2.00 to -2.50		Sand	Medium Grey	Slightly silty. Scattered large shell fragments.
17-ASS-3 17-PSD-3					-2.50 to -3.00		Sand	Medium Grey	Slightly silty. Scattered fine shell.
					-3.00 to -3.60		Core terminated in dense sand		

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Borehole Log

BH18

Project Number:	15-021	Core identifier:	BH18
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556171 6807024
Horiztontal Datum:	MGA-56	Bed Elevation:	0.00
Vertical Datum:	Australian Height Datum	Core length:	3.40
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
18-ASS-1 18-PSD-1 18-ENM-1 18-PEST-1	■	■	■	■	0.0 to -2.5		Sand	Yellow Light Grey	Colours grading. Scattered fine shell fragments.
18-ASS-2 18-PSD-2	■	■	■	■	-2.6 to -3.4		Sand	Medium Grey	Scattered fine shell.
					-3.5 to -3.6		Core terminated in dense sand		

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Borehole Log

BH19

Project Number:	15-021	Core identifier:	BH19
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555748 6807171
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.18
Vertical Datum:	Australian Height Datum	Core length:	3.66
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
19-ASS-1 19-PSD-1					-1.2 to -2.3 / 0.0 to 1.1		Sand	Yellow	No odour.Scattered shell
19-ASS-2 19-PSD-2					-2.4 to -4.2 / 1.2 to 3.0		Sand	Light Grey	No odour. Minor silt and shell patches
19-ASS-3 19-PSD-3					-4.3 to -4.8 / 3.1 to 3.6		Sand	Yellow - Light Grey	No odour. Some pebbles and shell fragments
							Core terminated in dense sand		

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BH20

Project Number:	15-021	Core identifier:	BH20
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555834 6807188
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.00
Vertical Datum:	Australian Height Datum	Core length:	3.16
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
20-ASS-1 20-PSD-1					-2.00 to -2.3	0.0 to 0.3		Sand	Yellow	No odour.Scattered shell
20-ASS-2 20-PSD-2 20-ENM-1 20-PEST-1					-2.4 to -3.5	0.4 to 1.5		Sand	Medium Grey	No odour. Slightly silty. Some fine shell
20-ASS-3 20-PSD-3					-3.6 to -5.1	1.6 to 3.1		Sand	Yellow - Light Grey	Scattered coarse shell
					-5.2 to -5.6	3.2 to 3.6	Core terminated in dense sand			

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Borehole Log

BH21

Project Number:	15-021	Core identifier:	BH21
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	556003 6807200
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.08
Vertical Datum:	Australian Height Datum	Core length:	3.35
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
21-ASS-1 21-PSD-1	■	■			-0.1 to -1.8 / 0.0 to 1.8		Sand	Light Brown - Light Grey	Scattered fine shell
21-ASS-2 21-PSD-2	■	■			-1.9 to -2.5 / 1.9 to 2.4		Silty Sand	Medium Grey	Heavy shell content
21-ASS-3 21-PSD-3	■	■			-2.6 to -3.4 / 2.5 to 3.3		Sand	Light - Medium Grey	No shell
					-3.5 to -3.7 / 3.4 to 3.6		Core terminated in dense sand		

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BH22

Project Number:	15-021	Core identifier:	BH22
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555841 6807298
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.20
Vertical Datum:	Australian Height Datum	Core length:	3.61
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
22-ASS-1 22-PSD-1	■	■	■	■	-2.3 to -2.5	0.0 to 0.3		Sand	Yellow - Medium Grey	
22-ASS-2 22-PSD-2 22-ENM-1 22-PEST-1	■	■	■	■	-2.6 to -4.8	0.4 to 2.6		Sand	Medium Grey	Some silt present. Fine shell present
22-ASS-3 22-PSD-3	■	■	■	■	-4.9 to -5.8	2.7 to 3.6		Sand	Yellow	Shell fragments
								Core terminated in dense sand		

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Borehole Log

BH23

Project Number:	15-021	Core identifier:	BH23
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555853 6808005
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.69
Vertical Datum:	Australian Height Datum	Core length:	3.50
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
23-ASS-1 23-PSD-1	■	■	■	■	-1.7 to -2.00	0.0 to 0.3		Sand	Light Brown	
23-ASS-2 23-PSD-2 23-ENM-1 23-PEST-1	■	■	■	■	-2.1 to -2.8	0.4 to 1.1		Silty Sand	Dark Grey	
	■	■	■	■	-2.9 to -3.6	1.2 to 1.9		Silty Sand	Dark Grey	
23-ASS-3 23-PSD-3	■	■	■	■	-3.7 to -4.00	2.0 to 2.3		Sand	Medium Grey	Some shell
	■	■	■	■	-4.1 to -4.6	2.4 to 2.9		Sand	Medium Grey	High shell content with concentrated layer at -2.94m.
23-ASS-4 23-PSD-4	■	■	■	■	-4.7 to -5.00	3.0 to 3.4		Sand	Light Grey	Scattered large shell.
					-5.2 to -5.3	3.5 to 3.6		Core terminated in dense sand		

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Borehole Log

BH24

Project Number:	15-021	Core identifier:	BH24
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555864 6808092
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.03
Vertical Datum:	Australian Height Datum	Core length:	3.55
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
24-ASS-1 24-PSD-1	■	■			-2.1 to -2.7	0.0 to 0.6		Sand	Light Brown	
24-ASS-2 24-PSD-2	■	■			-2.8 to -4.1	0.7 to 2.0		Sand	Light Grey	Slightly silty. Scattered fine shell.
					-4.2 to -4.7	2.1 to 2.7		Silty Sand	Medium - Dark Grey	Sludgy consistency. Apparent high silt content. No shell evident
24-ASS-3 24-PSD-3	■	■			-4.8 to -4.9	2.8 to 2.9		Sandy silt/clay	Medium Grey	Sludgy consistency. High silt content. No shell evident.
					-5.00 to -5.3	3.0 to 3.3		Sand	Light Grey	High shell content.
24-ASS-4 24-PSD-4	■	■			-5.4 to -5.5	3.4 to 3.5		Sand	Yellow	Apparent clean sand.
					-5.6	3.6		Core terminated in dense sand		

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Borehole Log

BH25A

Project Number:	15-021	Core identifier:	BH25A
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555867 6808212
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.19
Vertical Datum:	Australian Height Datum	Core length:	0.62
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
25A-ASS-1 25A-PSD-1	■	■			-0.2 to -3.8 / 0.0 to 3.6		Sand	Light Brown	
							Rock	Dark Brown	
							Core terminated in coffee rock		

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Borehole Log

BH25B

Project Number:	15-021	Core identifier:	BH25B
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555851 6808213
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.91
Vertical Datum:	Australian Height Datum	Core length:	0.75
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
25B-ASS-1 25B-PSD-1	■	■			-2.00	0.0–0.3		Sand	Light Brown	Scattered fine shell
25B-ASS-2 25B-PSD-2	■	■			-2.3	0.4–0.6		Sand	Medium Brown	Heavy shell. Slightly silty.
					-2.6	0.7		Rock	Dark Brown	Coffee rock
					-3.00	1.0	Core terminated in coffee rock			
					-4.00	2.0				
					-5.00	3.0				

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Borehole Log

BH25C

Project Number:	15-021	Core identifier:	BH25C
Client:	Ballina Shire Council	Date:	18/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555837 6808173
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.44
Vertical Datum:	Australian Height Datum	Core length:	1.03
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
25C-ASS-1 25C-PSD-1	■	■	■	■	-2.5 to -2.6	0.0 to 0.1		Sand	Light Brown	
25C-ASS-2 25C-PSD-2 25C-ENM-1 25C-PEST-1	■	■	■	■	-2.7 to -3.00	0.2 to 0.6		Silty Sand	Medium Grey	Scattered small shell.
25C-ASS-3 25C-PSD-3	■	■	■	■	-3.1 to -3.3	0.7 to 0.9		Silty Sand	Medium Brown - Medium Grey	High shell content
					-3.4	1.0		Rock	Dark Brown	Coffee Rock
					-3.5 to -6.00	1.1 to 3.6	Core terminated in coffee rock			

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Borehole Log

BH26

Project Number:	15-021	Core identifier:	BH26
Client:	Ballina Shire Council	Date:	11/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555908 6808255
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.05
Vertical Datum:	Australian Height Datum	Core length:	2.40
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
26-ASS-1 26-PSD-1					-1.1 to -1.7 / 0.0 to 0.6		Sand	Light Brown	Scattered fine shell.
					-1.7 to -2.00 / 0.6 to 1.0		Sand	Medium Grey	Scattered fine shell.
26-ASS-2 26-PSD-2					-2.00 to -3.4 / 1.0 to 2.4		Silty Sand	Medium Grey	High shell content
					-3.4		Coffee Rock	Dark Brown	
					-3.5 to -4.6 / 2.5 to 3.6				Core terminated in coffee rock

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BH27A

Project Number:	15-021	Core identifier:	BH27A
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555848 6808296
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.40
Vertical Datum:	Australian Height Datum	Core length:	1.05
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
27A-ASS-1 27A-PSD-1	■	■			-1.4 to -2.00 / 0.0 to 0.6		Sand	Light Brown	No shell.
					-2.00 to -2.1 / 0.6 to 0.7		Sand	Light Brown	Dense medium shell. Slightly silty.
					-2.1 to -2.4 / 0.7 to 1.0		Coffee Rock	Dark Brown	
					-2.5 to -5.00 / 1.1 to 3.6	Core terminated in coffee rock			

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BH28

Project Number:	15-021	Core identifier:	BH28
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555894 6808355
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.82
Vertical Datum:	Australian Height Datum	Core length:	1.65
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
28-ASS-1 28-PSD-1	■	■	■	■	-1.9	0.0 – 0.1		Sand	Light Brown	Scattered fine shell.
28-ASS-2 28-PSD-2	■	■			-2.00	0.2		Shell	Light Brown	Almost entirely shell.
28-ASS-3 28-PSD-3 28-ENM-1 28-PEST-1	■	■	■	■	-2.1 – -3.00	0.3 – 1.2		Silty Sand	Medium Grey	Apparent very high silt/clay content. Scattered heavy large shell.
28-ASS-4 28-PSD-4	■	■	■	■	-3.1 – -3.3	1.3 – 1.5		Sand	Dark Brown	Semi-indurated sand.
					-3.4	1.6		Rock	Dark Brown	Coffee rock.
					-3.5 – -5.4	1.7 – 3.6	Core terminated in coffee rock			

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Borehole Log

BH29

Project Number:	15-021	Core identifier:	BH29
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555795 6808431
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.26
Vertical Datum:	Australian Height Datum	Core length:	3.50
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
29-ASS-1 29-PSD-1	■	■	■	■	-1.3 to -2.1	0.0 to 0.8		Sand	Medium Brown	
29-ASS-2 29-PSD-2 29-ENM-1 29-PEST-1	■	■	■	■	-2.2 to -4.3	0.9 to 3.1		Sand	Medium Brown - Medium Grey	Scattered medium to fine shell. Some patches of silt.
29-ASS-3 29-PSD-3	■	■			-4.4 to -4.7	3.2 to 3.4		Sand	Medium Grey	Slightly silty. Heavy shell
					-4.8	3.5 to 3.6		Core terminated in dense sand and heavy shell		

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BH30

Project Number:	15-021	Core identifier:	BH30
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555853 6808459
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.62
Vertical Datum:	Australian Height Datum	Core length:	3.00
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
30-ASS-1 30-PSD-1					-1.7 to -2.2 / 0.0 to 0.6		Sand	Light Brown	Scattered fine shell
30-ASS-2 30-PSD-2					-2.3 to -4.3 / 0.7 to 2.7		Sand	Medium Grey	Scattered fine shell. Some patches of silt.
30-PSD-3					-4.4 to -4.6 / 2.8 to 3.0		Silty sand	Medium Grey	Heavy shell
					-4.7 to -5.2 / 3.1 to 3.6		Core terminated in dense sand and heavy shell		

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Borehole Log

BH31

Project Number:	15-021	Core identifier:	BH31
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555760 6808498
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.98
Vertical Datum:	Australian Height Datum	Core length:	1.90
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
31-ASS-1 31-PSD-1					-2.00	0.0		Sand	Light Brown	Slightly silty. Some scattered shell.
31-ASS-2 31-PSD-2					-2.6	0.6		Sand	Medium Grey	Slightly silty. Some scattered shell.
31-ASS-3 31-PSD-3					-3.00	1.0		Silty sand	Medium - Dark Grey	High shell content. Medium to coarse shell size.
31-ASS-4 31-PSD-4					-3.7	1.7		Clayey silty sand	Yellow - Brown	Heavy shell content. Very clayey appearance.
					-3.9	1.9		Coffee Rock	Dark Brown	Shell on surface.
					-4.00	2.0	Core terminated in coffee rock			
					-5.00	3.0				
					-5.6	3.6				

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Borehole Log

BH32

Project Number:	15-021	Core identifier:	BH32
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555622 6808690
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.08
Vertical Datum:	Australian Height Datum	Core length:	3.35
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
32-ASS-1 32-PSD-1					-1.1 to -1.9	0.0 to 0.8		Sand	Light Brown	No shell.
32-ASS-2 32-PSD-2 32-ENM-1 32-PEST-1					-2.00 to -3.1	0.9 to 2.1		Sand	Light Brown - Medium Grey	Scattered fine shell.
32-ASS-3 32-PSD-3					-3.2 to -4.4	2.2 to 3.3		Silty sand	Medium Grey	Scattered medium shell. Slightly brown.
					-4.5 to -4.7	3.4 to 3.6	Core terminated in dense sand			

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Borehole Log

BH33

Project Number:	15-021	Core identifier:	BH33
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555646 6808844
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.90
Vertical Datum:	Australian Height Datum	Core length:	3.50
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation	Depth	Graphic	Texture	Colour	Comments
33-ASS-1 33-PSD-1					-2.00 to -2.6	0.0 to 0.7		Sand	Light Brown	No shell.
33-ASS-2 33-PSD-2 33-ENM-1 33-PEST-1					-2.7 to -4.3	0.8 to 2.4		Sand	Light - Medium Grey	Scattered medium-fine shell. Some patches of silt.
33-ASS-3 33-PSD-3					-4.4 to -5.2	2.5 to 3.3		Silty sand	Medium Grey	Lots of large shell. Individual oyster shells.
					-5.3 to -5.4	3.4 to 3.5		Sand	Medium Grey	Scattered fine shell.
					-5.5	3.6		Core terminated in dense sand		

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Borehole Log

BH34

Project Number:	15-021	Core identifier:	BH34
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555707 6808959
Horiztontal Datum:	MGA-56	Bed Elevation:	-2.44
Vertical Datum:	Australian Height Datum	Core length:	3.10
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
34-ASS-1 34-PSD-1					-2.5 to -2.9 / 0.0 to 0.5		Sand	Light Brown	
34-ASS-2 34-PSD-2					-3.00 to -3.7 / 0.6 to 1.2		Slightly silty sand	Medium Grey	Some fine scattered shell.
34-ASS-3 34-PSD-3					-3.8 to -4.1 / 1.3 to 1.7		Silty sand	Medium Grey	Very high heavy shell content.
34-ASS-4 34-PSD-4					-4.2 to -5.1 / 1.8 to 2.6		Slightly silty sand	Medium Grey	Scattered large shell.
					-5.2 / 2.7 to 2.8		Silty sand	Medium Grey	Heavy shell. Similar to strata 3.
					-5.3 to -5.5 / 2.9 to 3.1		Sand	Light Grey	No shell.
					-5.6 to -6.00 / 3.2 to 3.6		Core terminated in dense sand		

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BH35

Project Number:	15-021	Core identifier:	BH35
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555723 6809064
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.22
Vertical Datum:	Australian Height Datum	Core length:	3.10
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
					0.0		Sand	Light Brown	No shell.
35-ASS-1 35-PSD-1					-1.00		Sand	Medium Grey	Scattered fine shell.
35-ASS-2 35-PSD-2 35-ENM-1 35-PEST-1					-2.00 -3.00		Sand	Medium Grey	Slightly clayey appearance. No shell.
						Core terminated in dense sand			

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Borehole Log

BH36

Project Number:	15-021	Core identifier:	BH36
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555769 6809203
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.53
Vertical Datum:	Australian Height Datum	Core length:	3.10
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
36-ASS-1 36-PSD-1					-1.6 to -2.4 / 0.0 to 0.9		Sand	Light Brown - Medium Grey Red tinge	Slightly silty
36-ASS-2 36-PSD-2					-2.5 to -4.6 / 1.0 to 3.1		Sand	Light Grey	Leaves buried at ~1.5 m. Very uniform. No shell.
					-4.7 to -5.1 / 3.2 to 3.6		Core terminated in dense sand		

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Borehole Log

BH37

Project Number:	15-021	Core identifier:	BH37
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555769 6809291
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.04
Vertical Datum:	Australian Height Datum	Core length:	3.55
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
37-ASS-1 37-PSD-1					-1.1 to -1.5 / 0.0 to 0.5		Sand	Light Brown	Coarse sand
37-ASS-2 37-PSD-2					-1.6 to -2.00 / 0.6 to 1.0		Sand	Medium Grey	Slightly silty. High shell content. Large shell fragments. Moist.
37-ASS-3 37-PSD-3 37-ENM-1 37-PEST-1					-2.1 to -3.00 / 1.1 to 2.0		Sand	Light Grey	Slightly silty. No shell. Moist.
37-ASS-4 37-PSD-4					-3.9 to -4.00 / 2.8 to 3.0		Sand	Yellow	Coarse sand. Dry. No shell
					-4.6 / 3.6		Core terminated in dense sand		

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BH38

Project Number:	15-021	Core identifier:	BH38
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555740 6809368
Horiztontal Datum:	MGA-56	Bed Elevation:	-1.11
Vertical Datum:	Australian Height Datum	Core length:	3.60
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
38-ASS-1 38-PSD-1					-1.2 to -2.2 / 0.0 to 1.1		Sand	Light Brown - Light Grey	No shell.
38-ASS-2 38-PSD-2					-2.3 to -2.7 / 1.2 to 1.6		Sand	Medium Grey	Slightly silty.
38-ASS-3 38-PSD-3					-2.8 to -3.8 / 1.7 to 2.7		Clayey silty sand	Medium Grey	
38-ASS-4 38-PSD-4					-3.9 to -4.7 / 2.8 to 3.6		Silty sand	Medium Grey	Some shell fragments.
							Core terminated in dense sand		

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BH39

Project Number:	15-021	Core identifier:	BH39
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555826 6809407
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.43
Vertical Datum:	Australian Height Datum	Core length:	3.35
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
39-ASS-1 39-PSD-1					-1.00 / 1.0		Sand	Light Brown - Light Grey	No shell.
39-ASS-2 39-PSD-2 39-ENM-1 39-PEST-1					-2.00 / 2.0		Sand	Light Grey	Some scattered shell. Some silt.
39-ASS-3 39-PSD-3					-3.00 / 3.0		Silty sand	Medium Grey	
					-4.00 / 3.6	Core terminated in dense sand			

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BH40

Project Number:	15-021	Core identifier:	BH40
Client:	Ballina Shire Council	Date:	13/12/17
Project Name	North Creek Dredging Investigation	Method:	Vibrocore 60mm
Location:	North Creek Ballina, NSW	Position:	555922 6809419
Horiztontal Datum:	MGA-56	Bed Elevation:	-0.29
Vertical Datum:	Australian Height Datum	Core length:	3.35
Notes:			

Sample	PSD	ASS	ENM	PEST	Datum Elevation / Depth	Graphic	Texture	Colour	Comments
40-ASS-1 40-PSD-1					-0.3 to -0.9 / 0.0 to 0.6		Sand	Yellow - Light Grey	Darker towards bottom of stratum. No shell.
40-ASS-2 40-PSD-2					-1.00 to -3.6 / 0.7 to 3.3		Sand	Medium Grey	Scattered shell towards top of stratum.
					-3.7 to -3.9 / 3.4 to 3.6	Core terminated in dense sand			

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Appendix 4: Laboratory Results

GRAIN SIZE ANALYSIS (sieving technique) (Page 1 of 1)

33 soil samples supplied by HydroSphere Consulting Pty Ltd on 20th December, 2017. Lab Job No. G6120
Analysis requested by Rod Conroy. **Your Reference: North Creek.**
PO Box 7059 BALLINA NSW 2478

SAMPLE ID	Lab Code	>5mm Shell Material (acid separation)	>5mm	>2mm Gravel/ Organic Matter	1 - 2mm Very Coarse Sand	500µm - 1mm Coarse Sand	250 - 500µm Medium Sand	125 - 250µm Fine Sand	63 - 125µm Very Fine Sand	<63µm Mud (Silt/Clay)
1 -1	G6120/1	0.43%	0.47%	0.38%	0.86%	2.57%	61.90%	33.33%	0.47%	0.01%
2B -1	G6120/2	0.00%	0.00%	0.13%	1.24%	1.27%	53.13%	43.19%	1.00%	0.03%
2B -2	G6120/3	0.00%	0.00%	0.00%	0.47%	1.92%	38.50%	57.25%	1.83%	0.03%
2B -3	G6120/4	0.00%	0.00%	0.52%	1.40%	4.21%	69.92%	23.76%	0.18%	0.01%
3 -1	G6120/5	0.07%	0.08%	0.14%	1.02%	3.35%	81.25%	13.90%	0.25%	0.00%
3 -1	G6120/6	0.09%	0.09%	0.30%	1.10%	2.44%	62.16%	33.63%	0.26%	0.01%
4 -1	G6120/7	0.00%	0.00%	0.10%	1.02%	2.38%	67.44%	27.99%	1.08%	0.00%
6 -1	G6120/8	0.00%	0.00%	0.20%	1.51%	3.98%	86.55%	7.70%	0.05%	0.00%
6 -2	G6120/9	0.00%	0.00%	0.00%	1.66%	5.50%	81.91%	10.91%	0.03%	0.00%
7 -1	G6120/10	0.00%	0.00%	0.23%	1.04%	3.19%	90.11%	5.42%	0.01%	0.00%
7 -2	G6120/11	0.00%	0.00%	0.00%	1.12%	2.88%	91.03%	4.90%	0.06%	0.00%
8 -1	G6120/12	0.00%	0.00%	0.13%	1.22%	3.66%	85.41%	9.52%	0.05%	0.00%
9B -1	G6120/13	0.34%	0.73%	0.47%	1.30%	3.88%	89.27%	4.34%	0.01%	0.00%
9B -2	G6120/14	0.00%	0.00%	0.47%	1.31%	5.80%	58.14%	31.95%	2.20%	0.13%
9B -3	G6120/15	0.00%	0.00%	0.08%	2.66%	3.78%	68.53%	24.27%	0.62%	0.06%
10 -1	G6120/16	0.35%	0.96%	0.98%	1.70%	5.60%	75.45%	14.99%	0.31%	0.01%
10 -2	G6120/17	1.00%	1.40%	1.62%	3.30%	6.52%	45.89%	37.11%	3.41%	0.74%
11 -1	G6120/18	0.00%	0.00%	0.38%	1.62%	4.86%	83.54%	9.58%	0.03%	0.00%
11 -2	G6120/19	0.00%	0.00%	0.16%	1.03%	3.40%	61.52%	33.63%	0.23%	0.01%
12 -1	G6120/20	0.00%	0.00%	0.13%	2.00%	7.34%	87.18%	3.31%	0.04%	0.00%
12 -2	G6120/21	0.00%	0.00%	0.13%	1.93%	3.51%	61.27%	32.26%	0.88%	0.01%
12 -3	G6120/22	0.00%	0.00%	0.13%	2.08%	3.64%	77.11%	16.94%	0.10%	0.00%
13 -1	G6120/23	0.10%	0.10%	1.58%	2.52%	4.47%	49.41%	39.67%	1.96%	0.29%
14 -1	G6120/24	8.09%	8.11%	0.47%	5.88%	6.40%	54.23%	21.15%	2.92%	0.84%
14 -2	G6120/25	0.00%	2.16%	1.76%	2.16%	3.19%	55.43%	33.84%	1.24%	0.22%
15 -1	G6120/26	0.22%	0.22%	1.29%	1.37%	7.27%	70.23%	19.18%	0.38%	0.06%
16 -1	G6120/27	0.00%	0.00%	0.15%	1.85%	3.83%	71.86%	21.98%	0.32%	0.00%
16 -2	G6120/28	0.00%	0.00%	0.88%	2.03%	5.51%	54.42%	35.62%	1.46%	0.08%
17 -1	G6120/29	0.21%	0.50%	1.15%	1.77%	4.78%	60.38%	29.96%	1.36%	0.10%
17 -2	G6120/30	0.77%	0.89%	1.92%	1.84%	6.98%	46.18%	39.56%	2.17%	0.46%
17 -3	G6120/31	1.20%	1.27%	2.49%	5.73%	6.19%	43.88%	34.75%	4.68%	1.01%
18 -1	G6120/32	0.38%	0.38%	0.98%	1.81%	5.81%	55.47%	33.80%	1.48%	0.27%
18 -2	G6120/33	1.81%	1.82%	1.42%	3.74%	5.75%	38.95%	42.77%	4.41%	1.14%

Note:
1: The Dry and Wet Sieving Analysis method was used for this grain size determination (Method of: Lewis and McConchie, 1994. Analytical Sedimentology. Chapman and Hall, USA.)

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Graham Lancaster
Laboratory Manager

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

GRAIN SIZE ANALYSIS (sieving technique) (Page 1 of 1)

35 soil samples supplied by HydroSphere Consulting Pty Ltd on 15th December, 2017. Lab Job No. G5990
Analysis requested by Rod Conroy. **Your Reference: PSD**
PO Box 7059 BALLINA NSW 2478

SAMPLE ID	Lab Code	>5mm Shell Material (acid separation)	>5mm	>2mm Gravel/ Organic Matter	1 - 2mm Very Coarse Sand	500µm - 1mm Coarse Sand	250 - 500µm Medium Sand	125 - 250µm Fine Sand	63 - 125µm Very Fine Sand	<63µm Mud (Silt/Clay)
2A-PDS-1	G5990/1	0.00%	0.00%	0.03%	1.00%	1.31%	42.46%	54.09%	1.08%	0.03%
2A-PSD-2	G5990/2	0.09%	0.09%	0.36%	1.05%	1.95%	39.91%	54.41%	2.21%	0.00%
9A-PSD-1	G5990/3	0.00%	0.00%	0.35%	1.89%	4.23%	70.47%	20.72%	2.28%	0.06%
21-PSD-1	G5990/4	0.18%	0.20%	1.24%	2.71%	5.18%	40.69%	47.81%	1.97%	0.21%
21-PSD-2	G5990/5	9.96%	11.48%	6.53%	4.86%	4.83%	27.23%	37.41%	5.86%	1.80%
21-PSD-3	G5990/6	0.91%	1.28%	0.89%	2.68%	5.96%	36.16%	49.69%	2.98%	0.36%
27A-PSD-1	G5990/7	0.00%	0.00%	0.63%	1.49%	4.08%	44.21%	49.13%	0.40%	0.05%
28-PSD-1	G5990/8	3.70%	4.19%	3.53%	2.32%	3.28%	51.31%	34.80%	0.51%	0.06%
28-PSD-2	G5990/9	36.98%	37.39%	10.36%	3.60%	3.35%	28.08%	16.35%	0.62%	0.25%
28-PSD-3	G5990/10	9.97%	10.65%	24.97%	15.38%	13.27%	24.21%	9.10%	1.55%	0.87%
28-PSD-4	G5990/11	0.00%	0.00%	1.49%	2.92%	4.79%	45.73%	44.53%	0.37%	0.17%
29-PSD-1	G5990/12	0.99%	1.15%	1.10%	1.25%	5.05%	49.84%	40.82%	0.63%	0.16%
29-PSD-2	G5990/13	2.40%	2.53%	2.82%	2.48%	5.27%	47.76%	37.85%	0.96%	0.34%
29-PSD-3	G5990/14	13.88%	16.85%	8.87%	2.47%	5.96%	39.27%	25.49%	0.71%	0.38%
30-PSD-1	G5990/15	0.00%	0.00%	0.16%	1.42%	2.77%	55.37%	39.07%	1.12%	0.10%
30-PSD-2	G5990/16	0.15%	0.15%	2.57%	2.83%	6.48%	54.70%	32.10%	0.92%	0.26%
30-PSD-3	G5990/17	31.44%	33.35%	6.50%	3.50%	5.92%	39.74%	9.78%	0.76%	0.46%
31-PSD-1	G5990/18	0.00%	0.00%	0.23%	1.01%	1.76%	48.84%	47.58%	0.53%	0.04%
31-PSD-2	G5990/19	0.67%	0.71%	1.90%	2.54%	4.91%	54.72%	34.43%	0.59%	0.18%
31-PSD-3	G5990/20	8.43%	9.33%	8.71%	3.19%	5.41%	42.99%	29.48%	0.57%	0.34%
31-PSD-4	G5990/21	17.99%	19.29%	11.22%	4.59%	7.18%	31.78%	24.53%	0.85%	0.57%
32-PSD-1	G5990/22	0.00%	0.00%	0.00%	0.74%	1.89%	66.28%	30.76%	0.27%	0.07%
32-PSD-2	G5990/23	0.04%	0.12%	0.33%	1.88%	5.48%	52.58%	38.85%	0.67%	0.08%
32-PSD-3	G5990/24	1.48%	1.71%	2.99%	5.20%	5.67%	45.73%	35.33%	2.64%	0.74%
33-PSD-1	G5990/25	0.00%	0.00%	0.05%	1.07%	2.70%	47.31%	48.42%	0.43%	0.01%
33-PSD-2	G5990/26	2.07%	2.33%	9.04%	3.27%	5.63%	43.94%	34.31%	1.02%	0.46%
33-PSD-3	G5990/27	10.69%	11.01%	11.24%	8.68%	11.99%	39.39%	15.10%	1.67%	0.92%
34-PSD-1	G5990/28	0.00%	0.00%	0.34%	1.47%	2.12%	49.65%	45.43%	0.86%	0.13%
34-PSD-2	G5990/29	1.35%	1.38%	3.27%	2.44%	5.62%	31.41%	52.97%	2.22%	0.68%
34-PSD-3	G5990/30	12.11%	16.69%	9.22%	4.42%	6.43%	35.85%	25.17%	1.57%	0.66%
34-PSD-4	G5990/31	2.44%	2.44%	6.49%	4.70%	7.88%	47.80%	28.17%	1.62%	0.89%
35-PSD-1	G5990/32	0.00%	0.00%	0.40%	4.55%	5.03%	34.35%	48.65%	6.16%	0.86%
35-PSD-2	G5990/33	0.00%	0.00%	0.30%	5.20%	10.42%	47.81%	28.23%	6.50%	1.55%
36-PSD-1	G5990/34	0.00%	0.00%	0.03%	2.80%	5.45%	46.34%	43.56%	1.55%	0.27%
36-PSD-2	G5990/35	0.00%	0.00%	0.32%	3.45%	9.95%	56.46%	28.50%	0.85%	0.47%

Note:
1: The Dry and Wet Sieving Analysis method was used for this grain size determination (Method of: Lewis and McConchie, 1994. Analytical Sedimentology. Chapman and Hall, USA.)

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Laboratory Manager

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GRAIN SIZE ANALYSIS (sieving technique) (Page 1 of 1)

38 soil samples supplied by HydroSphere Consulting Pty Ltd on 13th December, 2017. Lab Job No. G5852
Analysis requested by Rod Conroy. **Your Reference: North Creek - 1**
PO Box 7059 BALLINA NSW 2478

SAMPLE ID	Lab Code	>5mm Shell Material (acid separation)	>5mm Shell/ Gravel/ Organic Matter	2-5mm Gravel/ Organic Matter	1 - 2mm Very Coarse Sand	500µm - 1mm Coarse Sand	250 - 500µm Medium Sand	125 - 250µm Fine Sand	63 - 125µm Very Fine Sand	<63µm Mud (Silt/Clay)
19- 1	G5852/1	0.49%	0.49%	0.85%	1.20%	2.35%	46.74%	47.37%	0.92%	0.09%
19- 2	G5852/2	2.79%	3.01%	0.61%	0.76%	4.54%	72.07%	18.69%	0.32%	0.00%
19- 3	G5852/3	1.53%	1.54%	0.12%	0.63%	1.36%	59.82%	36.06%	0.48%	0.00%
20- 1	G5852/4	0.00%	0.00%	0.07%	0.68%	0.96%	55.33%	42.00%	0.96%	0.00%
20- 2	G5852/5	0.36%	0.79%	0.81%	1.41%	3.67%	77.92%	15.22%	0.16%	0.03%
20- 3	G5852/6	1.05%	1.05%	0.89%	2.39%	5.56%	65.80%	24.18%	0.12%	0.01%
22- 1	G5852/7	0.00%	0.00%	0.22%	0.54%	2.83%	71.46%	24.70%	0.26%	0.00%
22- 2	G5852/8	0.00%	0.00%	0.21%	1.88%	4.09%	72.68%	20.94%	0.17%	0.03%
22- 3	G5852/9	2.88%	4.09%	0.92%	1.97%	5.71%	71.00%	16.10%	0.19%	0.03%
23- 1	G5852/10	0.00%	0.00%	0.13%	0.90%	1.57%	69.97%	27.39%	0.05%	0.00%
23- 2	G5852/11	0.00%	0.00%	3.94%	5.78%	9.80%	36.57%	40.27%	2.69%	0.95%
23- 3	G5852/12	5.32%	5.53%	6.61%	3.82%	5.77%	37.27%	37.48%	2.61%	0.92%
23- 4	G5852/13	5.17%	5.24%	1.87%	3.40%	5.36%	46.53%	35.76%	1.54%	0.31%
24- 1	G5852/14	0.00%	0.00%	0.26%	1.35%	4.74%	55.32%	37.59%	0.59%	0.16%
24- 2	G5852/15	0.20%	0.27%	1.82%	5.21%	10.62%	34.25%	43.84%	3.01%	0.98%
24- 3	G5852/16	0.00%	0.00%	40.71%	11.77%	5.91%	6.85%	20.32%	10.13%	4.31%
24- 4	G5852/17	0.00%	0.00%	1.50%	0.86%	4.69%	80.90%	11.89%	0.15%	0.00%
25A- 1	G5852/18	0.00%	0.00%	0.22%	0.33%	1.04%	34.90%	62.88%	0.59%	0.04%
25B- 1	G5852/19	0.00%	0.00%	1.60%	1.25%	3.58%	53.80%	39.15%	0.44%	0.18%
25B- 2	G5852/20	33.05%	37.73%	10.65%	1.35%	0.84%	24.12%	24.79%	0.40%	0.12%
25C- 1	G5852/21	0.00%	0.00%	0.27%	0.37%	3.20%	61.68%	34.09%	0.28%	0.10%
25C- 2	G5852/22	1.06%	14.16%	1.53%	0.61%	2.92%	46.34%	33.22%	0.77%	0.45%
25C- 3	G5852/23	17.67%	19.67%	6.79%	1.71%	3.89%	36.92%	29.76%	0.74%	0.51%
26- 1	G5852/24	1.06%	1.06%	0.81%	0.90%	3.65%	50.90%	41.86%	0.67%	0.15%
26- 2	G5852/25	16.19%	16.66%	8.82%	10.68%	14.33%	36.86%	9.90%	1.80%	0.95%
37- 1	G5852/26	0.00%	0.00%	0.04%	1.41%	5.39%	52.38%	39.38%	1.29%	0.11%
37- 2	G5852/27	23.46%	24.06%	2.88%	2.64%	5.02%	39.98%	23.41%	1.26%	0.74%
37- 3	G5852/28	0.00%	0.00%	0.31%	3.01%	9.13%	51.16%	35.42%	0.64%	0.32%
37- 4	G5852/29	0.00%	0.84%	2.06%	6.28%	7.68%	54.99%	27.23%	0.60%	0.32%
38- 1	G5852/30	0.00%	0.00%	0.04%	1.53%	4.32%	54.46%	38.73%	0.84%	0.08%
38- 2	G5852/31	0.00%	0.00%	0.09%	4.46%	6.46%	41.24%	44.03%	2.96%	0.77%
38- 3	G5852/32	0.00%	0.00%	0.23%	5.71%	10.32%	39.10%	37.96%	5.16%	1.53%
38- 4	G5852/33	1.08%	1.38%	0.52%	6.26%	11.63%	48.14%	28.47%	2.55%	1.05%
39- 1	G5852/34	0.00%	0.00%	0.02%	0.92%	3.60%	60.99%	34.02%	0.42%	0.03%
39- 2	G5852/35	0.00%	0.00%	0.04%	4.58%	5.74%	50.67%	36.31%	2.08%	0.59%
39- 3	G5852/36	0.00%	0.00%	0.11%	5.17%	10.16%	57.16%	25.21%	1.53%	0.65%
40- 1	G5852/37	0.00%	0.00%	0.00%	1.83%	2.77%	56.17%	38.61%	0.53%	0.08%
40- 2	G5852/38	0.23%	0.25%	1.03%	2.85%	5.97%	49.13%	38.77%	1.42%	0.57%

Note:
1: The Dry and Wet Sieving Analysis method was used for this grain size determination (Method of: Lewis and McConchie, 1994. Analytical Sedimentology. Chapman and Hall, USA.)

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Graham Lancaster
Laboratory Manager

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

RESULTS OF ACID SULFATE SOIL ANALYSIS

34 samples supplied by HydroSphere Consulting Pty Ltd on 20/12/2017. Lab Job No.G6121
Analysis requested by Rod Conroy. Your Job: North Creek

PO Box 7059 BALLINA NSW 2478

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		Actual Acidity (Titratable Actual Acidity - TAA)		Retained Acidity (S_{KCl} – S_{KCl})		Acid Neutralising Capacity (ANC_{BT})		Net Acidity (based on S_{CR})	Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{CR})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(%S_{NAS})	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg CaCO3/t DW)
Method Info.		**	**		*(In-house method S21)*				*(In-house method S20)*		*(In-house method 16b)*		**		*(In-house method S14)*		**	**
1 -1	*G6121/1*	Coarse	17.2	0.21	8.38	6.28	-2.10	Low	0.029	18	9.56	0	..	..	1.06	212	-124	-6
2B -1	*G6121/2*	Coarse	18.3	0.22	8.79	6.49	-2.30	Low	0.023	14	9.66	0	..	..	1.04	208	-124	-6
2B -2	*G6121/3*	Coarse	17.8	0.22	8.90	6.48	-2.42	Low	0.055	34	9.65	0	..	..	1.05	210	-106	-5
2B -3	*G6121/4*	Coarse	16.6	0.20	8.86	6.29	-2.57	Low	0.011	7	9.63	0	..	..	0.42	83	-48	-2
3 -1	*G6121/5*	Coarse	17.8	0.22	8.93	6.50	-2.43	Low	0.021	13	9.67	0	..	..	0.68	135	-77	-4
3 -1	*G6121/6*	Coarse	18.3	0.22	8.88	6.35	-2.53	Low	0.033	20	9.68	0	..	..	0.45	89	-39	-2
4 -1	*G6121/7*	Coarse	18.2	0.22	8.89	6.54	-2.35	Low	0.059	37	9.65	0	..	..	1.32	264	-139	-7
6 -1	*G6121/8*	Coarse	17.3	0.21	8.84	6.21	-2.63	Low	0.018	11	9.51	0	..	..	0.33	67	-33	-2
6 -2	*G6121/9*	Coarse	16.4	0.20	6.90	2.26	-4.64	Low	0.017	11	7.49	0	..	..	0.02	4	8	1
7 -1	*G6121/10*	Coarse	18.0	0.22	8.84	6.34	-2.50	Low	0.024	15	9.47	0	..	..	0.50	101	-52	-3
7 -2	*G6121/11*	Coarse	17.9	0.22	8.82	6.28	-2.54	Low	0.029	18	9.37	0	..	..	0.40	80	-35	-2
8 -1	*G6121/12*	Coarse	18.2	0.22	8.86	6.41	-2.45	Low	0.023	14	9.56	0	..	..	0.50	101	-53	-3
8 -2	*G6121/13*	Coarse	16.9	0.20	8.93	6.46	-2.47	Low	0.010	6	9.67	0	..	..	0.54	107	-66	-3
9B -1	*G6121/14*	Coarse	17.5	0.21	8.93	6.34	-2.59	Low	0.012	7	9.58	0	..	..	0.54	107	-64	-3
9B -2	*G6121/15*	Coarse	19.6	0.24	8.82	6.52	-2.30	Low	0.046	29	9.58	0	..	..	1.23	246	-135	-7
9B -3	*G6121/16*	Coarse	18.2	0.22	8.88	6.45	-2.43	Low	0.018	11	9.70	0	..	..	0.93	185	-113	-6
10 -1	*G6121/17*	Coarse	18.2	0.22	8.86	6.47	-2.39	Low	0.013	8	9.60	0	..	..	1.15	230	-145	-7
10 -2	*G6121/18*	Coarse	20.4	0.26	8.74	6.90	-1.84	Very High	0.122	76	9.49	0	..	..	3.00	599	-323	-16
11 -1	*G6121/19*	Coarse	18.1	0.22	8.75	6.45	-2.30	Low	0.012	7	9.60	0	..	..	0.45	90	-52	-3
11 -2	*G6121/20*	Coarse	17.9	0.22	8.64	5.32	-3.32	Low	0.027	17	9.10	0	..	..	0.20	41	-10	-1
12 -1	*G6121/21*	Coarse	18.1	0.22	8.90	6.44	-2.46	Low	<0.005	0	9.61	0	..	..	0.39	78	-52	-3
12 -2	*G6121/22*	Coarse	19.1	0.24	8.80	6.48	-2.32	Low	0.033	21	9.61	0	..	..	0.96	192	-107	-5
12 -3	*G6121/23*	Coarse	17.7	0.22	8.81	6.47	-2.34	Low	0.012	8	9.61	0	..	..	0.62	125	-76	-4
13 -1	*G6121/24*	Coarse	19.0	0.23	8.70	6.64	-2.06	Low	0.035	22	9.55	0	..	..	1.55	309	-184	-9
14 -1	*G6121/25*	Medium	21.8	0.28	8.53	4.75	-3.78	Very High	0.297	185	9.17	0	..	..	1.39	279	0	0
14 -2	*G6121/26*	Coarse	18.6	0.23	8.56	2.96	-5.60	Low	0.060	38	9.06	0	..	..	0.26	52	3	0
15 -1	*G6121/27*	Coarse	17.2	0.21	8.81	6.57	-2.24	Low	0.012	7	9.66	0	..	..	0.68	135	-83	-4
16 -1	*G6121/28*	Coarse	17.9	0.22	8.84	6.52	-2.32	Low	<0.005	0	9.65	0	..	..	0.63	126	-84	-4
16 -2	*G6121/29*	Coarse	18.1	0.22	8.76	6.52	-2.24	Low	0.032	20	9.55	0	..	..	0.99	198	-112	-6
17 -1	*G6121/30*	Coarse	18.0	0.22	8.82	6.50	-2.32	Low	0.007	4	9.62	0	..	..	1.05	210	-136	-7
17 -2	*G6121/31*	Coarse	19.1	0.24	8.80	6.57	-2.23	Low	0.022	14	9.61	0	..	..	1.96	392	-248	-12
17 -3	*G6121/32*	Coarse	21.8	0.28	8.60	7.26	-1.34	Medium	0.224	140	9.35	0	..	..	2.82	563	-236	-12
18 -1	*G6121/33*	Coarse	18.7	0.23	8.77	6.63	-2.14	Low	0.012	8	9.61	0	..	..	1.18	237	-150	-8
18 -2	*G6121/34*	Coarse	19.8	0.25	8.64	6.95	-1.69	Very High	0.143	89	9.44	0	..	..	3.08	616	-322	-16

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Ahern CR, McElnea AE and Sullivan LA (2004). *Acid sulfate soil laboratory method guidelines*. Queensland Department of Natural Resources, Mines and Energy: Indooroopilly, Qld, Australia.
4. The Acid Base Accounting Equation is **Net Acidity = Actual Acidity + Retained Acidity + Potential Sulfidic Acidity (S_{cr} or S_{CR}) – Acid Neutralising Capacity/Fineness Factor** (Ahern et al. 2004 - full reference above).
5. Retained Acidity is required when the pH_{KCl} < 4.5 or where jarosite has been visually observed. Acid Neutralising Capacity is required when the Potential Sulfidic Acidity is greater than the texture dependent trigger and the pH_{KCl} is ≥ 6.5.
6. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 19 mol H^+/t; medium texture ≥ 0.06% S or 37 mol H^+/t; fine texture ≥ 0.1% S or 62 mol H^+/t)** (Ahern *et al.* 2004 - full reference above)
7. For projects that disturb > 1000 tonnes of soil, the coarse trigger of ≥ 0.03% S must be applied in accordance with Ahern CR, Stone Y and Blunden B (1998). *Acid sulfate soils assessment guidelines*. Acid Sulfate Soil Management Advisory Committee: Wollongbar, NSW, Australia.
8. Acid sulfate soil texture triggers can be related to standard soil textures: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays (Ahern et al. 1998 - full reference above).
9. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
10. **The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Ahern et al. 2004). This is only applied to positive values. An increased Safety Factor may be required in some cases.**
11. A negative Net Acidity result indicates an excess acid neutralising capacity.
12. '..' is reported where a test is either not requested or not required. Where pH_{KCl} is < 4.5 or > 6.5, zero is reported for S_{NAS} and ANC in Net Acidity calculations, respectively.
13. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
14. ** NATA accreditation does not cover the performance of this service.

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF ACID SULFATE SOIL ANALYSIS

38 samples supplied by HydroSphere Consulting Pty Ltd on 13/12/2017. Lab Job No.G5851
Analysis requested by Rod Conroy. Your Job: North Creek-1

PO Box 7059 BALLINA NSW 2478

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		Actual Acidity (Titratable Actual Acidity - TAA)		Retained Acidity (S_{KCl} − S_{CO})		Acid Neutralising Capacity (ANC_{BT})		Net Acidity (based on S_{CR})	Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{CR})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(%S_{NAS})	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg CaCO3/t DW)
Method Info.		**		**		*(In-house method S21)*			*(In-house method S20)*		*(In-house method 16b)*		**		*(In-house method S14)*		**	**
19- 1	*G5851/1*	Coarse	19.3	0.24	8.17	6.39	-1.78	High	0.003	2	9.00	0	..	..	0.17	34	-21	-1.0
19- 2	*G5851/2*	Coarse	19.2	0.24	8.49	6.51	-1.98	High	0.014	9	9.40	0	..	..	0.58	116	-69	-3.4
19- 3	*G5851/3*	Coarse	16.8	0.20	8.67	6.52	-2.15	High	0.008	5	9.58	0	..	..	1.23	245	-158	-7.9
20- 1	*G5851/4*	Coarse	20.1	0.25	8.66	6.69	-1.97	High	0.012	7	9.52	0	..	..	0.89	179	-112	-5.6
20- 2	*G5851/5*	Coarse	18.6	0.23	8.66	6.52	-2.14	High	0.014	9	9.39	0	..	..	0.37	75	-41	-2.1
20- 3	*G5851/6*	Coarse	18.5	0.23	8.80	6.66	-2.14	High	0.010	6	9.58	0	..	..	0.80	159	-100	-5.0
22- 1	*G5851/7*	Coarse	18.8	0.23	8.74	6.58	-2.16	High	0.015	9	9.46	0	..	..	0.47	95	-54	-2.7
22- 2	*G5851/8*	Coarse	19.0	0.24	8.69	6.58	-2.11	High	0.013	8	9.46	0	..	..	0.44	89	-51	-2.5
22- 3	*G5851/9*	Coarse	17.9	0.22	8.80	6.58	-2.22	High	0.014	9	9.56	0	..	..	0.69	138	-83	-4.2
23- 1	*G5851/10*	Coarse	18.7	0.23	8.47	5.39	-3.08	High	0.011	7	8.52	0	..	..	0.25	50	-26	-1.3
23- 2	*G5851/11*	Medium	29.2	0.41	8.21	3.38	-4.83	Very High	0.271	169	8.73	0	..	..	0.80	160	62	4.7
23- 3	*G5851/12*	Coarse	22.2	0.28	8.43	6.81	-1.62	Very High	0.148	92	9.16	0	..	..	1.37	273	-90	-4.5
23- 4	*G5851/13*	Coarse	18.5	0.23	8.63	6.97	-1.66	High	0.055	34	9.41	0	..	..	1.17	233	-121	-6.1
24- 1	*G5851/14*	Coarse	18.4	0.23	8.62	6.48	-2.14	High	0.005	3	9.20	0	..	..	0.16	31	-18	-0.9
24- 2	*G5851/15*	Medium	27.9	0.39	8.26	3.18	-5.08	Very High	0.283	177	8.53	0	..	..	0.61	122	95	7.1
24- 3	*G5851/16*	Fine	45.6	0.84	8.07	3.10	-4.97	Very High	0.879	548	8.40	0	..	..	2.76	551	181	13.5
24- 4	*G5851/17*	Coarse	17.7	0.22	8.93	6.61	-2.32	High	0.015	9	9.58	0	..	..	1.18	236	-148	-7.4
25A- 1	*G5851/18*	Coarse	19.6	0.24	8.43	5.48	-2.95	High	0.011	7	8.77	0	..	..	0.14	28	-12	-0.6
25B- 1	*G5851/19*	Coarse	20.3	0.25	8.57	6.77	-1.80	High	0.005	3	9.38	0	..	..	1.58	315	-207	-10.4
25B- 2	*G5851/20*	Coarse	19.0	0.23	8.54	6.54	-2.00	Very High	<0.005	0	9.33	0	..	..	2.06	412	-275	-13.7
25C- 1	*G5851/21*	Coarse	22.1	0.28	8.50	6.15	-2.35	High	0.019	12	9.10	0	..	..	0.24	47	-20	-1.0
25C- 2	*G5851/22*	Coarse	21.2	0.27	8.46	5.93	-2.53	Very High	0.065	41	9.08	0	..	..	0.66	133	-48	-2.4
25C- 3	*G5851/23*	Coarse	19.0	0.23	8.44	6.36	-2.08	High	0.168	105	9.02	0	..	..	2.23	445	-192	-9.6
26- 1	*G5851/24*	Coarse	19.5	0.24	8.56	6.55	-2.01	Medium	0.007	4	9.28	0	..	..	0.39	78	-48	-2.4
26- 2	*G5851/25*	Coarse	24.6	0.33	8.62	7.37	-1.25	High	0.270	168	9.33	0	..	..	16.55	3307	-2036	-101.8
37- 1	*G5851/26*	Coarse	17.6	0.21	8.55	5.58	-2.97	Very High	0.012	7	8.71	0	..	..	0.12	24	-8	-0.4
37- 2	*G5851/27*	Coarse	23.5	0.31	8.35	7.01	-1.34	Very High	0.126	79	9.22	0	..	..	1.87	374	-170	-8.5
37- 3	*G5851/28*	Coarse	22.1	0.28	8.23	2.53	-5.70	Very High	0.072	45	8.10	0	..	..	0.21	42	17	1.3
37- 4	*G5851/29*	Coarse	16.9	0.20	8.06	2.44	-5.62	High	0.032	20	7.40	0	..	..	0.10	20	7	0.5
38- 1	*G5851/30*	Coarse	20.9	0.26	8.06	3.80	-4.26	Medium	0.020	12	7.40	0	..	..	0.05	10	6	0.4
38- 2	*G5851/31*	Coarse	21.9	0.28	8.02	2.48	-5.54	High	0.094	59	7.61	0	..	..	0.24	48	27	2.0
38- 3	*G5851/32*	Medium	27.6	0.38	8.01	2.64	-5.37	High	0.317	198	8.09	0	..	..	0.59	118	119	8.9
38- 4	*G5851/33*	Medium	22.7	0.29	8.33	6.75	-1.58	High	0.185	115	9.02	0	..	..	1.24	248	-50	-2.5
39- 1	*G5851/34*	Coarse	19.3	0.24	8.16	5.11	-3.05	High	<0.005	0	7.90	0	..	..	0.15	30	-20	-1.0
39- 2	*G5851/35*	Coarse	20.2	0.25	8.26	2.60	-5.66	High	0.101	63	8.71	0	..	..	0.36	72	15	1.1
39- 3	*G5851/36*	Coarse	20.5	0.26	8.13	2.86	-5.27	High	0.131	82	8.10	0	..	..	0.53	106	11	0.8
40- 1	*G5851/37*	Coarse	19.5	0.24	8.12	3.00	-5.12	Medium	0.030	19	7.80	0	..	..	0.18	36	-5	-0.3
40- 2	*G5851/38*	Coarse	21.2	0.27	8.20	2.58	-5.62	Medium	0.071	44	7.90	0	..	..	0.33	66	0	0.0

NOTES:

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4. The Acid Base Accounting Equation is **Net Acidity = Actual Acidity + Retained Acidity + Potential Sulfidic Acidity (S_{Cr} or S_{CR}) − Acid Neutralising Capacity/Fineness Factor** (Ahern et al. 2004 - full reference above).
5. Retained Acidity is required when the pH_{KCl} < 4.5 or where jarosite has been visually observed. Acid Neutralising Capacity is required when the Potential Sulfidic Acidity is greater than the texture dependent trigger and the pH_{KCl} is ≥ 6.5.
6. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 19 mol H^+/t; medium texture ≥ 0.06% S or 37 mol H^+/t; fine texture ≥ 0.1% S or 62 mol H^+/t)** (Ahern *et al.* 2004 - full reference above)
7. For projects that disturb > 1000 tonnes of soil, the coarse trigger of ≥ 0.03% S must be applied in accordance with Ahern CR, Stone Y and Blunden B (1998). *Acid sulfate soils assessment guidelines*. Acid Sulfate Soil Management Advisory Committee: Wollongbar, NSW, Australia.
8. Acid sulfate soil texture triggers can be related to standard soil textures: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays (Ahern et al. 1998 - full reference above).
9. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
10. **The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Ahern et al. 2004). This is only applied to positive values. An increased Safety Factor may be required in some cases.**
11. A negative Net Acidity result indicates an excess acid neutralising capacity.
12. '..' is reported where a test is either not requested or not required. Where pH_{KCl} is < 4.5 or > 6.5, zero is reported for S_{NAS} and ANC in Net Acidity calculations, respectively.
13. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
14. ** NATA accreditation does not cover the performance of this service.

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF ACID SULFATE SOIL ANALYSIS

34 samples supplied by HydroSphere Consulting Pty Ltd on 15/12/17. Lab Job No.G5978
Analysis requested by Rod Conroy. Your Job: ASS

PO Box 7059 BALLINA NSW 2478

Sample Identification	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		Actual Acidity (Titratable Actual Acidity - TAA)		Retained Acidity (S_{KCl} – S_{KCl})		Acid Neutralising Capacity (ANC_{BT})		Net Acidity (based on S_{CR})	Lime Calculation
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{CR})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	(%S_{NAS})	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg CaCO3/t DW)
Method Info.		**	**		*(In-house method S21)*				*(In-house method S20)*		*(In-house method 16b)*		**		*(In-house method S14)*		**	**
2A-ASS-1	*G5978/1*	Coarse	18.2	0.22	8.58	7.09	-1.49	High	0.019	12	9.48	0	..	..	0.80	160	-95	-5
2A-ASS-2	*G5978/2*	Coarse	17.9	0.22	8.87	6.91	-1.96	High	0.053	33	9.55	0	..	..	1.30	260	-140	-7
9A-ASS-1	*G5978/3*	Coarse	18.1	0.22	8.87	6.64	-2.23	High	0.041	26	9.51	0	..	..	0.86	172	-89	-4
21-ASS-1	*G5978/4*	Coarse	18.9	0.23	8.76	6.63	-2.13	High	0.008	5	9.45	0	..	..	0.55	111	-69	-3
21-ASS-2	*G5978/5*	Coarse	20.8	0.26	8.54	6.70	-1.84	Very High	0.356	222	9.10	0	..	..	2.43	485	-101	-5
21-ASS-3	*G5978/6*	Coarse	19.9	0.25	8.74	6.53	-2.21	High	0.135	84	9.37	0	..	..	0.91	182	-37	-2
27A-ASS-1	*G5978/7*	Coarse	19.3	0.24	8.59	6.43	-2.16	High	0.006	3	9.27	0	..	..	0.33	66	-41	-2
28-ASS-1	*G5978/8*	Coarse	18.2	0.22	8.77	6.71	-2.06	High	<0.005	0	9.53	0	..	..	0.81	163	-108	-5
28-ASS-2	*G5978/9*	Coarse	19.0	0.23	8.90	8.19	-0.71	Very High	0.036	22	9.56	0	..	..	9.36	1869	-1224	-61
28-ASS-3	*G5978/10*	Fine	40.4	0.68	8.23	7.08	-1.15	Very High	0.938	585	8.82	0	..	..	10.76	2150	-848	-42
28-ASS-4	*G5978/11*	Coarse	21.1	0.27	8.34	5.84	-2.50	High	0.120	75	8.95	0	..	..	1.13	227	-76	-4
29-ASS-1	*G5978/12*	Coarse	19.7	0.25	8.50	5.89	-2.61	High	0.008	5	8.80	0	..	..	0.27	53	-31	-2
29-ASS-2	*G5978/13*	Coarse	19.6	0.24	8.53	6.51	-2.02	High	0.012	7	9.22	0	..	..	0.45	89	-52	-3
29-ASS-3	*G5978/14*	Coarse	19.3	0.24	8.65	6.89	-1.76	High	0.025	16	9.39	0	..	..	2.97	593	-380	-19
30-ASS-1	*G5978/15*	Coarse	20.0	0.25	8.61	6.65	-1.96	High	0.010	6	9.38	0	..	..	0.59	118	-73	-4
30-ASS-2	*G5978/16*	Coarse	20.0	0.25	8.67	6.76	-1.91	High	0.045	28	9.35	0	..	..	2.43	486	-296	-15
31-ASS-1	*G5978/17*	Coarse	20.2	0.25	8.56	6.53	-2.03	High	0.003	2	8.81	0	..	..	0.18	36	-22	-1
31-ASS-2	*G5978/18*	Coarse	19.8	0.25	8.47	6.59	-1.88	High	0.026	16	9.22	0	..	..	0.61	122	-65	-3
31-ASS-3	*G5978/19*	Medium	20.8	0.26	8.61	6.84	-1.77	High	0.042	26	9.34	0	..	..	2.26	452	-275	-14
31-ASS-4	*G5978/20*	Medium	27.5	0.38	8.76	7.02	-1.74	High	0.007	4	9.50	0	..	..	5.41	1081	-716	-36
32-ASS-1	*G5978/21*	Coarse	20.5	0.26	8.52	6.44	-2.08	High	0.006	4	8.78	0	..	..	0.18	36	-20	-1
32-ASS-2	*G5978/22*	Coarse	19.5	0.24	8.27	5.66	-2.61	High	0.019	12	8.61	0	..	..	0.23	46	-18	-1
32-ASS-3	*G5978/23*	Coarse	19.8	0.25	8.45	6.58	-1.87	High	0.060	37	9.18	0	..	..	0.99	198	-94	-5
33-ASS-1	*G5978/24*	Coarse	18.5	0.23	8.34	5.52	-2.82	High	0.006	4	8.46	0	..	..	0.12	23	-12	-1
33-ASS-2	*G5978/25*	Medium	20.3	0.26	8.43	6.07	-2.36	High	0.039	24	9.07	0	..	..	0.62	123	-58	-3
33-ASS-3	*G5978/26*	Medium	24.3	0.32	8.53	7.50	-1.03	High	0.225	140	9.23	0	..	..	7.76	1551	-894	-45
34-ASS-1	*G5978/27*	Coarse	19.7	0.25	8.48	5.43	-3.05	High	0.012	8	8.70	0	..	..	0.14	28	-11	-1
34-ASS-2	*G5978/28*	Coarse	20.5	0.26	8.39	5.92	-2.47	High	0.057	36	9.11	0	..	..	0.45	90	-24	-1
34-ASS-3	*G5978/29*	Medium	21.6	0.28	8.63	6.86	-1.77	High	0.153	95	9.28	0	..	..	4.66	932	-526	-26
34-ASS-4	*G5978/30*	Medium	21.5	0.27	8.52	6.82	-1.70	High	0.104	65	9.25	0	..	..	2.10	420	-215	-11
35-ASS-1	*G5978/31*	Coarse	19.2	0.24	8.49	2.98	-5.51	High	0.066	41	8.58	0	..	..	0.28	56	4	0
35-ASS-2	*G5978/32*	Medium	23.3	0.30	8.22	2.73	-5.49	Very High	0.340	212	8.74	0	..	..	0.90	180	92	7
36-ASS-1	*G5978/33*	Coarse	21.4	0.27	7.91	3.55	-4.36	High	0.036	23	7.88	0	..	..	0.21	42	-5	0
36-ASS-2	*G5978/34*	Coarse	20.6	0.26	7.88	2.10	-5.78	High	0.110	69	7.57	0	..	..	0.18	36	45	3

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Ahern CR, McElnea AE and Sullivan LA (2004). *Acid sulfate soil laboratory method guidelines*. Queensland Department of Natural Resources, Mines and Energy: Indooroopilly, Qld, Australia.
4. The Acid Base Accounting Equation is **Net Acidity = Actual Acidity + Retained Acidity + Potential Sulfidic Acidity (S_{cr} or S_{os}) – Acid Neutralising Capacity/Fineness Factor** (Ahern et al. 2004 - full reference above).
5. Retained Acidity is required when the pH_{KCl} < 4.5 or where jarosite has been visually observed. Acid Neutralising Capacity is required when the Potential Sulfidic Acidity is greater than the texture dependent trigger and the pH_{KCl} is ≥ 6.5.
6. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 19 mol H^+/t; medium texture ≥ 0.06% S or 37 mol H^+/t; fine texture ≥ 0.1% S or 62 mol H^+/t)** (Ahern *et al.* 2004 - full reference above)
7. For projects that disturb > 1000 tonnes of soil, the coarse trigger of ≥ 0.03% S must be applied in accordance with Ahern CR, Stone Y and Blunden B (1998). *Acid sulfate soils assessment guidelines*. Acid Sulfate Soil Management Advisory Committee: Wollongbar, NSW, Australia.
8. Acid sulfate soil texture triggers can be related to standard soil textures: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays (Ahern et al. 1998 - full reference above).
9. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
10. **The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Ahern et al. 2004). This is only applied to positive values. An increased Safety Factor may be required in some cases.**
11. A negative Net Acidity result indicates an excess acid neutralising capacity.
12. '..' is reported where a test is either not requested or not required. Where pH_{KCl} is < 4.5 or > 6.5, zero is reported for S_{NAS} and ANC in Net Acidity calculations, respectively.
13. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
14. ** NATA accreditation does not cover the performance of this service.

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS

6 samples supplied by HydroSphere Consulting Pty Ltd on 13th December, 2017 - Lab Job No. G5853
Analysis requested by Rod Conroy. **Your Project: North Creek-1**
PO Box 7059 BALLINA NSW 2478

	Method	Sample 1 20-1	Sample 2 22-1	Sample 3 23-1	Sample 4 25C-1	Sample 5 37-1	Sample 6 39-1
	Job No.	*G5853/1*	*G5853/2*	*G5853/3*	*G5853/4*	*G5853/5*	*G5853/6*
Moisture Content (% moisture)	Inhouse - 105˚C	18	18	24	19	18	16
PESTICIDE ANALYSIS SCREEN							
DDT+DDE+DDD (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin + Dieldrin (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlordane (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCB (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organochlorine Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyrifos (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organophosphate Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB's (mg/kg)	Subcontracted - Envirolab report no. 182072	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TBT							
Monobutyltin (ng/g)	Subcontracted - Envirolab report no. 182072	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibutyltin (ng/g)	Subcontracted - Envirolab report no. 182072	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tributyltin (ng/g)	Subcontracted - Envirolab report no. 182072	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3. ppm = mg/kg dried sample
4. Exchangeable sodium percentage (ESP) is calculated as sodium (cmol+/kg) divided by ECEC
5. All results as dry weight DW - samples were dried at 40ºC for 24-48hrs prior to crushing and analysis.
6. Aluminium detection limit is 0.05 cmol+/kg; Hydrogen detection limit is 0.1 cmol+/kg. However for calculation purposes a value of 0 is used.
7. For conductivity 1 dS/m = 1 mS/cm = 1000 μS/cm
8. 1 cmol+/kg = 1 meq/100g
9. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
10. Conversion of cmol+/kg to mg/kg multiply cmol+/kg by:
230 for Sodium; 391 for Potassium; 200 for Calcium; 122 for Magnesium; 90 for Aluminium
11. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry)

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Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS

5 samples supplied by HydroSphere Consulting Pty Ltd on 15th December, 2017 - Lab Job No. G5988
Analysis requested by Rod Conroy. **Your Project: PEST**
PO Box 7059 BALLINA NSW 2478

	Method	Sample 1 28-PEST-1	Sample 2 29-PEST-1	Sample 3 32-PEST-1	Sample 4 33-PEST-1	Sample 5 35-PEST-1
	Job No.	*G5988/1*	*G5988/2*	*G5988/3*	*G5988/4*	*G5988/5*
Moisture Content (% moisture)	Inhouse - 105˚C	21	15	17	14	18
PESTICIDE ANALYSIS SCREEN						
DDT+DDE+DDD (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin + Dieldrin (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Chlordane (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
HCB (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organochlorine Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyrifos (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organophosphate Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
PCB's (mg/kg)	Subcontracted - Envirolab report no. 182253	<0.1	<0.1	<0.1	<0.1	<0.1
TBT						
Monobutyltin (ng/g)	Subcontracted - NMI report no. RN1182910	<0.5	<0.5	<0.5	<0.5	<0.5
Dibutyltin (ng/g)	Subcontracted - NMI report no. RN1182910	<0.5	<0.5	<0.5	<0.5	<0.5
Tributyltin (ng/g)	Subcontracted - NMI report no. RN1182910	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3. ppm = mg/kg dried sample
4. Exchangeable sodium percentage (ESP) is calculated as sodium (cmol+/kg) divided by ECEC
5. All results as dry weight DW - samples were dried at 40ºC for 24-48hrs prior to crushing and analysis.
6. Aluminium detection limit is 0.05 cmol+/kg; Hydrogen detection limit is 0.1 cmol+/kg. However for calculation purposes a value of 0 is used.
7. For conductivity 1 dS/m = 1 mS/cm = 1000 μS/cm
8. 1 cmol+/kg = 1 meq/100g
9. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
10. Conversion of cmol+/kg to mg/kg multiply cmol+/kg by:
230 for Sodium; 391 for Potassium; 200 for Calcium; 122 for Magnesium; 90 for Aluminium
11. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry)

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Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF SOIL ANALYSIS

9 samples supplied by Hydrosphere Consulting Pty Ltd on 20th December, 2017 - Lab Job No. G6119
Analysis requested by Rod Conroy. **Your Project: North Creek**
PO Box 7059 BALLINA NSW 2478

	Method	Sample 1 2B- 1	Sample 2 3- 1	Sample 3 7- 1	Sample 4 9B- 1	Sample 5 10- 1	Sample 6 12- 1	Sample 7 14- 1	Sample 8 16- 1	Sample 9 18- 1
	Job No.	*G6119/1*	*G6119/2*	*G6119/3*	*G6119/4*	*G6119/5*	*G6119/6*	*G6119/7*	*G6119/8*	*G6119/9*
Moisture Content (% moisture)	Inhouse - 105˚C	21	22	22	21	21	22	22	23	22
PESTICIDE ANALYSIS SCREEN										
DDT+DDE+DDD (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin + Dieldrin (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlordane (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
HCB (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organochlorine Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyrifos (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other Organophosphate Pesticides (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
PCB's (mg/kg)	Subcontracted - Envirolab report no. 182838	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TBT										
Monobutyltin (ng/g)	Subcontracted - NMI report no. 1183172	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibutyltin (ng/g)	Subcontracted - NMI report no. 1183172	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tributyltin (ng/g)	Subcontracted - NMI report no. 1183172	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Notes:

1: ECEC = Effective Cation Exchange Capacity = sum of the exchangeable Mg, Ca, Na, K, H and Al
2: Exchangeable bases determined using standard Ammonium Acetate extract (Method 15D3) with no pretreatment for soluble salts. When Conductivity ≥0.25 dS/m soluble salts are removed (Method 15E2).
3. ppm = mg/kg dried sample
4. Exchangeable sodium percentage (ESP) is calculated as sodium (cmol+/kg) divided by ECEC
5. All results as dry weight DW - samples were dried at 40°C for 24-48hrs prior to crushing and analysis.
6. Aluminium detection limit is 0.05 cmol+/kg; Hydrogen detection limit is 0.1 cmol+/kg. However for calculation purposes a value of 0 is used.
7. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
8. 1 cmol+/kg = 1 meq/100g
9. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
10. Conversion of cmol+/kg to mg/kg multiply cmol+/kg by:
    230 for Sodium; 391 for Potassium; 200 for Calcium; 122 for Magnesium; 90 for Aluminium
11. Metals analysed by ICP-MS (Inductively Coupled Plasma - Mass Spectrometry)

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Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

6 samples supplied by HydroSphere Consulting Pty Ltd on 13/12/17. Lab Job No.G5854
Analysis requested by Rod Conroy. Your Job: North Creek-1
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	*EAL Detection Limits*	Sample 1 20-1	Sample 2 22-1	Sample 3 23-1	Sample 4 25C-1	Sample 5 37-1	Sample 6 39-1
		G5854/1		*G5854/1*	*G5854/2*	*G5854/3*	*G5854/4*	*G5854/5*	*G5854/6*
Moisture Content (% moisture)	..	Inhouse - 110˚C	*<0.1*	18	17	26	21	18	18
METALS									
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	3	3	4	5	4	4
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.5*	1	1	2	2	1	1
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	2	3	8	4	4	4
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	1	1	4	2	1	1
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	2	2	6	4	3	3
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	6	8	28	14	9	11
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.05*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	*<0.01*	2.98	2.80	5.29	3.29	3.05	3.08
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	..	8.85	8.87	8.53	8.62	8.61	8.46
Polycyclic Aromatic Hydrocarbons (PAH)									
Naphthalene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene (mg/kg)	..	*c*	*<0.05*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b)&(k)flouranthene (mg/kg)	..	*c*	*<0.2*	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a,h)anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,I)perylene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sum of reported PAHs (mg/kg)	11	*c*	..	..	..	..	..	..	..
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	*c*	*<0.5*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HYDROCARBON ANALYSIS RESULTS									
BTEX									
Benzene (mg/kg)	13	*c*	*<0.2*	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene (mg/kg)	14	*c*	*<0.5*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (mg/kg)	15	*c*	*<1*	<1	<1	<1	<1	<1	<1
m+p-Xylene (mg/kg)	16	*c*	*<2*	<2	<2	<2	<2	<2	<2
o-Xylene (mg/kg))		*c*	*<1*	<1	<1	<1	<1	<1	<1
Naphthalene (mg/kg)	..	*c*	*<1*	<1	<1	<1	<1	<1	<1
Total Recoverable Hydrocarbons									
C10-C14 Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50	<50	<50
C15-C28 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100	<100	<100
C29-C36 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100	<100	<100
Sum of C10-C36 (mg/kg)	17	*c*	..	..	..	..	..	..	..
C10-C16 Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50	<50	<50
C10-C16 less Naphthalene Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50	<50	<50
C16-C34 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100	<100	<100
C34-C40 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100	<100	<100
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	*** As per RTA T276*	*<0.01*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

METHODS REFERENCE

a. 1:3Nitric/HCl digest - APHA 3125 ICPMS
b. 1:3Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab report no. 182070

NATA
Accreditation No. 14960.
Accredited for compliance with ISO/IEC 17025.

NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014 (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)*
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

6 samples supplied by HydroSphere Consulting Pty Ltd on 13/12/17. Lab Job No.G5854
Analysis requested by Rod Conroy. Your Job: North Creek-1
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	MIN	MAX	AVERAGE	ENM - Col 2 AVERAGE	ENM - Col 3 MAX
		G5854/1				see note 2	see note 2
Moisture Content (% moisture)	..	Inhouse - 110˚C	17	26	20	..	..
METALS							
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	3	5	4	20	40
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	2	1	50	100
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.1	<0.1	<0.1	0.5	1.0
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	8	4	75	150
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	4	2	100	200
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	6	3	30	60
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	6	28	13	150	300
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.05	<0.05	<0.05	0.5	1.0
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	2.80	5.29	3.42	1.5	3.0
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	8.46	8.87	8.66	5 - 9	4.5 - 10
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluorene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Phenanthrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluoranthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benz(a)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Chrysene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(a)pyrene (mg/kg)	..	c	<0.05	<0.05	..	..	..
Benzo(b)&(k)flouranthene (mg/kg)	..	c	<0.2	<0.2	..	..	..
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Dibenz(a,h)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(g,h,i)perylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Sum of reported PAHs (mg/kg)	11	c	<0.1	..	<1.0	20	40
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	c	<0.5	<0.5	<0.5	0.5	1.0
HYDROCARBON ANALYSIS RESULTS							
BTEX							
Benzene (mg/kg)	13	c	<0.2	<0.2	..	..	0.5
Toluene (mg/kg)	14	c	<0.5	<0.5	..	..	65
Ethylbenzene (mg/kg)	15	c	<1	<1	..	..	25
m+p-Xylene (mg/kg)	16	c	<2	<2	..	..	15
o-Xylene (mg/kg))		c	<1	<1	..	..	
Naphthalene (mg/kg)	..	c	<1	<1	..	..	..
Total Recoverable Hydrocarbons							
C10-C14 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C15-C28 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C29-C36 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Sum of C10-C36 (mg/kg)	17	c	..	..	<250	250	500
C10-C16 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C10-C16 less Naphthalene Fraction (mg/kg)	..	c	<50	<50	..	..	..
C16-C34 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C34-C40 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	** As per RTA T276	<0.01	<0.01	<0.01	<0.05	<0.1

METHODS REFERENCE

a. $^{1:3}$Nitric/HCl digest - APHA 3125 ICPMS
b. $^{1:3}$Nitric/HCl digest - APHA 3120 ICPOES
c. *Analysis sub-contracted - Envirolab report no. 182070*

NATA
Accreditation No. 14960.
Accredited for compliance with ISO/IEC 17025.

NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014 (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)*
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

5 samples supplied by HydroSphere Consulting Pty Ltd on 15/12/17. Lab Job No.G5989
Analysis requested by Rod Conroy. Your Job: ENM
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	EAL Detection Limits	Sample 1 28-ENM-1	Sample 2 29-ENM-1	Sample 3 32-ENM-1	Sample 4 33-ENM-1	Sample 5 35-ENM-1
		G5989/1		G5989/1	G5989/2	G5989/3	G5989/4	G5989/5
Moisture Content (% moisture)	..	Inhouse - 110˚C	<0.1	16	19	18	21	14
METALS								
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	7	4	4	5	3
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.5	2	1	1	1	1
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	9	4	5	4	3
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	4	1	2	1	1
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	6	3	4	3	2
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	24	13	13	16	12
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	<0.01	6.37	3.07	2.94	2.91	2.59
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	..	8.48	8.68	8.58	8.65	8.59
Polycyclic Aromatic Hydrocarbons (PAH)								
Naphthalene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene (mg/kg)	..	c	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b)&(k)flouranthene (mg/kg)	..	c	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a,h)anthracene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,I)perylene (mg/kg)	..	c	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sum of reported PAHs (mg/kg)	11	c	..	..	..	..	..	..
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	c	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
HYDROCARBON ANALYSIS RESULTS								
BTEX								
Benzene (mg/kg)	13	c	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene (mg/kg)	14	c	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (mg/kg)	15	c	<1	<1	<1	<1	<1	<1
m+p-Xylene (mg/kg)	16	c	<2	<2	<2	<2	<2	<2
o-Xylene (mg/kg))		c	<1	<1	<1	<1	<1	<1
Naphthalene (mg/kg)	..	c	<1	<1	<1	<1	<1	<1
Total Recoverable Hydrocarbons								
C10-C14 Fraction (mg/kg)	..	c	<50	<50	<50	<50	<50	<50
C15-C28 Fraction (mg/kg)	..	c	<100	<100	<100	<100	<100	<100
C29-C36 Fraction (mg/kg)	..	c	<100	<100	<100	<100	<100	<100
Sum of C10-C36 (mg/kg)	17	c	..	..	..	..	..	..
C10-C16 Fraction (mg/kg)	..	c	<50	<50	<50	<50	<50	<50
C10-C16 less Naphthalene Fraction (mg/kg)	..	c	<50	<50	<50	<50	<50	<50
C16-C34 Fraction (mg/kg)	..	c	<100	<100	<100	<100	<100	<100
C34-C40 Fraction (mg/kg)	..	c	<100	<100	<100	<100	<100	<100
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	** As per RTA T276	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

METHODS REFERENCE

a. [1:3]Nitric/HCl digest - APHA 3125 ICPMS
b. [1:3]Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab report no. 182254

NATA
Accreditation No. 14960.
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NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014 (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)*
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

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checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

5 samples supplied by HydroSphere Consulting Pty Ltd on 15/12/17. Lab Job No.G5989
Analysis requested by Rod Conroy. Your Job: ENM
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	MIN	MAX	AVERAGE	ENM - Col 2 AVERAGE	ENM - Col 3 MAX
		G5989/1				see note 2	see note 2
Moisture Content (% moisture)	..	Inhouse - 110˚C	14	21	18	..	..
METALS							
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	3	7	5	20	40
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	2	1	50	100
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.1	0	<0.1	0.5	1.0
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	3	9	5	75	150
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	4	2	100	200
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	6	4	30	60
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	12	24	16	150	300
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.05	<0.05	<0.05	0.5	1.0
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	2.59	6.37	3.58	1.5	3.0
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	8.48	8.68	8.60	5 - 9	4.5 - 10
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluorene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Phenanthrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluoranthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benz(a)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Chrysene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(a)pyrene (mg/kg)	..	c	<0.05	<0.05	..	..	..
Benzo(b)&(k)flouranthene (mg/kg)	..	c	<0.2	<0.2	..	..	..
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Dibenz(a,h)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(g,h,I)perylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Sum of reported PAHs (mg/kg)	11	c	<0.1	..	<1.0	20	40
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	c	<0.5	<0.5	<0.5	0.5	1.0
HYDROCARBON ANALYSIS RESULTS							
BTEX							
Benzene (mg/kg)	13	c	<0.2	<0.2	..	..	0.5
Toluene (mg/kg)	14	c	<0.5	<0.5	..	..	65
Ethylbenzene (mg/kg)	15	c	<1	<1	..	..	25
m+p-Xylene (mg/kg)	16	c	<2	<2	..	..	15
o-Xylene (mg/kg))		c	<1	<1	..	..	
Naphthalene (mg/kg)	..	c	<1	<1	..	..	..
Total Recoverable Hydrocarbons							
C10-C14 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C15-C28 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C29-C36 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Sum of C10-C36 (mg/kg)	17	c	..	..	<250	250	500
C10-C16 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C10-C16 less Naphthalene Fraction (mg/kg)	..	c	<50	<50	..	..	..
C16-C34 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C34-C40 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	** As per RTA T276	<0.01	<0.01	<0.01	<0.05	<0.1

METHODS REFERENCE

a. [1:3]Nitric/HCl digest - APHA 3125 ICPMS
b. [1:3]Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab report no. 182254

NATA
Accreditation No. 14960.
Accredited for compliance with ISO/IEC 17025.

NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014 (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)*
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

9 samples supplied by Hydrosphere Consulting Pty Ltd on the 20th December, 2017. Job Number: G6118
Analysis requested by Rod Conroy. **Your Project: North Creek**
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	*EAL Detection Limits*	Sample 1 2B-1	Sample 2 3-1	Sample 3 7-1	Sample 4 9B-1
		Job No.		*G6118/1*	*G6118/2*	*G6118/3*	*G6118/4*
Moisture Content (% moisture)	..	Inhouse - 110˚C	*<0.1*	18	19	19	18
METALS							
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	2	2	2	2
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.5*	1	1	1	1
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.1*	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	2	1	1	1
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	<1	<1	<1	<1
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	1	1	1	1
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<1*	3	2	2	3
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	*<0.05*	0.06	<0.05	<0.05	<0.05
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	*<0.01*	2.25	2.86	2.32	2.53
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	..	9.22	9.13	9.25	9.19
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Acenaphthylene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Acenaphthene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Fluorene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Phenanthrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Fluoranthene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Pyrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Chrysene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene (mg/kg)	..	*c*	*<0.05*	<0.05	<0.05	<0.05	<0.05
Benzo(b)&(k)flouranthene (mg/kg)	..	*c*	*<0.2*	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Dibenz(a,h)anthracene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene (mg/kg)	..	*c*	*<0.1*	<0.1	<0.1	<0.1	<0.1
Sum of reported PAHs (mg/kg)	11	*c*	..	..	..	..	..
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	*c*	*<0.5*	<0.5	<0.5	<0.5	<0.5
HYDROCARBON ANALYSIS RESULTS							
BTEX							
Benzene (mg/kg)	13	*c*	*<0.2*	<0.2	<0.2	<0.2	<0.2
Toluene (mg/kg)	14	*c*	*<0.5*	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (mg/kg)	15	*c*	*<1*	<1	<1	<1	<1
m+p-Xylene (mg/kg)	16	*c*	*<2*	<2	<2	<2	<2
o-Xylene (mg/kg))		*c*	*<1*	<1	<1	<1	<1
Naphthalene (mg/kg)	..	*c*	*<1*	<1	<1	<1	<1
Total Recoverable Hydrocarbons							
C10-C14 Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50
C15-C28 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100
C29-C36 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100
Sum of C10-C36 (mg/kg)	17	*c*	..	..	..	..	..
C10-C16 Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50
C10-C16 less Naphthalene Fraction (mg/kg)	..	*c*	*<50*	<50	<50	<50	<50
C16-C34 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100
C34-C40 Fraction (mg/kg)	..	*c*	*<100*	<100	<100	<100	<100
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	*** As per RTA T276*	*<0.01*	<0.01	<0.01	<0.01	<0.01

METHODS REFERENCE

a. [1:3]Nitric/HCl digest - APHA 3125 ICPMS
b. [1:3]Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab Report No. 182839

NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014 (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)*
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

NATA
Accreditation No. 14960.
Accredited for compliance with ISO/IEC 17025.

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checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

9 samples supplied by Hydrosphere Consulting Pty Ltd on the 20th December, 2017. Job Number: G6118
Analysis requested by Rod Conroy. **Your Project: North Creek**
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	Sample 5 10-1	Sample 6 12-1	Sample 7 14-1	Sample 8 16-1	Sample 9 18-1
		Job No.	*G6118/5*	*G6118/6*	*G6118/7*	*G6118/8*	*G6118/9*
Moisture Content (% moisture)	..	Inhouse - 110˚C	20	20	24	18	20
METALS							
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	2	2	2	3
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	1	1	1	1
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	1	5	1	3
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	<1	2	<1	1
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	1	3	1	2
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	5	4	8	3	6
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.05	<0.05	<0.05	<0.05	<0.05
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	2.92	2.74	1.21	2.42	2.94
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	9.07	9.13	8.67	9.20	9.07
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene (mg/kg)	..	*c*	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b)&(k)flouranthene (mg/kg)	..	*c*	<0.2	<0.2	<0.2	<0.2	<0.2
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a,h)anthracene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,I)perylene (mg/kg)	..	*c*	<0.1	<0.1	<0.1	<0.1	<0.1
Sum of reported PAHs (mg/kg)	11	*c*	..	..	..	..	..
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	*c*	<0.5	<0.5	<0.5	<0.5	<0.5
HYDROCARBON ANALYSIS RESULTS							
BTEX							
Benzene (mg/kg)	13	*c*	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene (mg/kg)	14	*c*	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (mg/kg)	15	*c*	<1	<1	<1	<1	<1
m+p-Xylene (mg/kg)	16	*c*	<2	<2	<2	<2	<2
o-Xylene (mg/kg))		*c*	<1	<1	<1	<1	<1
Naphthalene (mg/kg)	..	*c*	<1	<1	<1	<1	<1
Total Recoverable Hydrocarbons							
C10-C14 Fraction (mg/kg)	..	*c*	<50	<50	<50	<50	<50
C15-C28 Fraction (mg/kg)	..	*c*	<100	<100	<100	<100	<100
C29-C36 Fraction (mg/kg)	..	*c*	<100	<100	<100	<100	<100
Sum of C10-C36 (mg/kg)	17	*c*	..	..	..	..	..
C10-C16 Fraction (mg/kg)	..	*c*	<50	<50	<50	<50	<50
C10-C16 less Naphthalene Fraction (mg/kg)	..	*c*	<50	<50	<50	<50	<50
C16-C34 Fraction (mg/kg)	..	*c*	<100	<100	<100	<100	<100
C34-C40 Fraction (mg/kg)	..	*c*	<100	<100	<100	<100	<100
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	*** As per RTA T276*	<0.01	<0.01	<0.01	<0.01	<0.01

METHODS REFERENCE

a. [1:3]Nitric/HCl digest - APHA 3125 ICPMS
b. [1:3]Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab Report No. 182839

NOTES

1. *DW = Dry Weight. na = no guidelines available*
2. *NSW EPA ENM Guidelines - Protection of the Environment Operations (Waste) Regulation 2014*
   (The Excavation Natural Material Order 2014 - Resource Recovery Order under Part 9, Clause 93)
3. *For statistical purposes, half detection limit replaced with samples NOT DETECTED*
4. ** denotes these test procedures are as yet not NATA accredited but quality control data is available

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Graham Lancaster (Nata signatory)
Laboratory Manager

RESULTS OF ENM SOIL ANALYSIS

9 samples supplied by Hydrosphere Consulting Pty Ltd on the 20th December, 2017. Job Number: G6118
Analysis requested by Rod Conroy. **Your Project: North Creek**
PO Box 7059 BALLINA NSW 2478

	ENM Number	Method	MIN	MAX	AVERAGE	ENM - Col 2 AVERAGE	ENM - Col 3 MAX
		Job No.				see note 2	see note 2
Moisture Content (% moisture)	..	Inhouse - 110˚C	18	24	20	..	..
METALS							
Arsenic (mg/kg)	4	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	3	2	20	40
Lead (mg/kg)	3	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	1	1	50	100
Cadmium (mg/kg)	2	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.1	<0.1	<0.1	0.5	1.0
Chromium (mg/kg)	5	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	5	2	75	150
Copper (mg/kg)	6	1:3Nitric/HCl digest - APHA 3125 ICPMS	<1	2	<1	100	200
Nickel (mg/kg)	7	1:3Nitric/HCl digest - APHA 3125 ICPMS	1	3	1	30	60
Zinc (mg/kg)	8	1:3Nitric/HCl digest - APHA 3125 ICPMS	2	8	4	150	300
Mercury (mg/kg)	1	1:3Nitric/HCl digest - APHA 3125 ICPMS	<0.05	0.06	<0.05	0.5	1.0
Soil Conductivity (1:5 water dS/m)	9	Rayment and Higginson 4B1	1.21	2.94	2.46	1.5	3.0
Soil pH (1:5 water)	10	Rayment and Higginson 4A1	8.67	9.25	9.10	5 - 9	4.5 - 10
Polycyclic Aromatic Hydrocarbons (PAH)							
Naphthalene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Acenaphthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluorene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Phenanthrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Fluoranthene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benz(a)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Chrysene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(a)pyrene (mg/kg)	..	c	<0.05	<0.05	..	..	..
Benzo(b)&(k)flouranthene (mg/kg)	..	c	<0.2	<0.2	..	..	..
Indeno(1,2,3-c,d)pyrene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Dibenz(a,h)anthracene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Benzo(g,h,I)perylene (mg/kg)	..	c	<0.1	<0.1	..	..	..
Sum of reported PAHs (mg/kg)	11	c	<0.1	..	<1.0	20	40
Benzo(a)pyrene TEQ calc (PQL) (mg/kg)	12	c	<0.5	<0.5	<0.5	0.5	1.0
HYDROCARBON ANALYSIS RESULTS							
BTEX							
Benzene (mg/kg)	13	c	<0.2	<0.2	..	..	0.5
Toluene (mg/kg)	14	c	<0.5	<0.5	..	..	65
Ethylbenzene (mg/kg)	15	c	<1	<1	..	..	25
m+p-Xylene (mg/kg)	16	c	<2	<2	..	..	15
o-Xylene (mg/kg))		c	<1	<1	..	..	
Naphthalene (mg/kg)	..	c	<1	<1	..	..	..
Total Recoverable Hydrocarbons							
C10-C14 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C15-C28 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C29-C36 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Sum of C10-C36 (mg/kg)	17	c	..	..	<250	250	500
C10-C16 Fraction (mg/kg)	..	c	<50	<50	..	..	..
C10-C16 less Naphthalene Fraction (mg/kg)	..	c	<50	<50	..	..	..
C16-C34 Fraction (mg/kg)	..	c	<100	<100	..	..	..
C34-C40 Fraction (mg/kg)	..	c	<100	<100	..	..	..
Contaminants (Physical - rubber, plastic, bitumen, paper, cloth, paint wood) (%)	18	** As per RTA T276	<0.01	<0.01	<0.01	<0.05	<0.1

METHODS REFERENCE

a. 1:3Nitric/HCl digest - APHA 3125 ICPMS
b. 1:3Nitric/HCl digest - APHA 3120 ICPOES
c. Analysis sub-contracted - Envirolab Report No. 182839

NOTES

1. *DW = Dry Weight. na = no guidelines available*
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