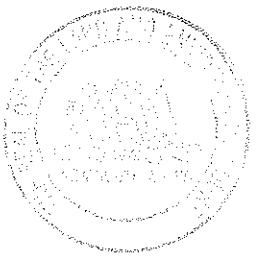

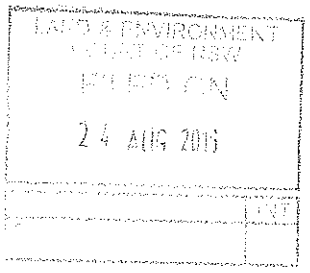

Form A (version 2)

INDIVIDUAL EXPERT REPORT OF DAVID BRISTOW

23 AUGUST 2016

COURT DETAILS

Court	Land and Environment Court of New South Wales
Class	1
Case number	2016/159652 (formerly 2015/10898) & 2016/157848 (formerly 2015/10951)

TITLE OF PROCEEDINGS

PROCEEDINGS 2016/159652

Applicant	**Liverpool City Council**
First respondent	**Moorebank Recyclers Pty Ltd**
Second respondent	**Minister for Planning**

PROCEEDINGS 2016/157848

First applicant	**Benedict Industries Pty Limited**
Second applicant	**Tanlane Pty Limited**
First respondent	**Minister for Planning**
Second respondent	**Moorebank Recyclers Pty Limited**

PREPARATION DETAILS

Prepared for	**Moorebank Recyclers Pty Ltd,** First respondent in proceedings 2016/159652 and Second respondent in proceedings 2016/157848
Legal representative	Mark Gerard McDonald, Mark McDonald & Associates Lawyers Pty Ltd
Legal representative reference	MGM 01/246
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Simmonds & Bristow Pty Ltd

The Regional and Remote Water Specialist

Moorebank Recyclers P/L

Leachate Treatment Plant

Statement of Evidence

August 2016

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Client:	Moorebank Recyclers P/L
Client Contact:	Brent Lawson

	Name	Signed	Date
Written by:	David Bristow		August 2016
Reviewed by:	David Bristow		August 2016
Authorised for release by:	David Bristow Managing Director		23/08/2016

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Moorebank Recyclers P/L
Landfill Leachate Treatment Plant

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EXECUTIVE SUMMARY

0.1 The project approval granted by the planning assessment commission in respect of the application by Moorebank Recyclers Pty Ltd for the construction and operation of a materials recycling facility has been appealed by the Liverpool City Council and Ors on various grounds, including issues associated with leachate management, extraction, treatment and disposal.

0.2 The disused landfill on Newbridge Road adjacent the Georges River has accumulated a significant volume of leachate since its closure in 1979.

0.3 The landfill requires dewatering to allow the site to be redeveloped and to protect the waters of the Georges River from leachate overflow from the landfill.

0.4 Up to approximately 120ML of leachate is required to be removed, treated and released/discharged.

0.5 The raw leachate is brackish and contaminated with significant concentrations of ammonia and organic carbon. It also contains trace concentrations of metals, notably Boron, and petroleum hydrocarbons, notably mid-range TRH C15-C28.

0.6 There are two likely discharge points for treated leachate namely:

i. The Georges River;

ii. The Sewer.

0.7 Water quality objectives for the each potential discharge location can be set based on ANZECC 2000 water quality guidelines for marine environments (the river) and Sydney Water Sewer acceptance guidelines (the sewer).

0.8 Approval for release to either of the identified release points is yet to be obtained, though a preliminary application has been made (August 2016) to Sydney Water for a sewer release. A sewer connection to a 375mm sewer is available at the entrance to the site on Newbridge Road.

0.9 The treatment of the leachate proposed is responsive to the raw leachate quality and each release point identified. Treatment processes include:

a) Blending;

b) pH correction;

c) Oily water separation (for river release only);

d) Biological oxidation and denitrification (for river release only);

e) Dissolved Air Floatation;

f) Filtration;

g) Activated carbon adsorption (for river release only);

h) Ion Exchange (for river release only);

i) Disinfection;

j) Site Reuse.

0.10 The proposed plant would need to be operated by a qualified and competent operator, supported by documented operation and maintenance schedules and procedures and monitoring program.

0.11 The proposed treatment plant will include odour control of selected plant and is expected to be quiet and have a low energy footprint.

0.12 Specific responses to the Liverpool City Council's Amended Statement of Facts and Contentions and the Statement of Evidence of Ms Rowena Salmon and Mr Andrew Kosciuszko as they refer to leachate treatment have been addressed.

0.13 The principal theme of the Council's contentions appears focused on the lack of detail on the management of leachate, information on the treatment of leachate and the water quality to be produced to allow conditioning and auditing/enforcement. Ms Salmon and Mr Kosciuszko echo similar concerns in their Statement of Evidence.

0.14 The positive commitment to use a leachate treatment plant to manage the dewatering of the landfill plus the provision of the concept design for the plant, setting water quality objectives for two nominated release points and provision of details of the operational intent for the plant in managing leachate in this report allows the proposed intent to be described, conditioned or enforced.

0.15 The provision of appropriate leachate extraction & treatment systems and disposal of treated leachate to an approved release point should address the points of contention with respect of leachate control/management.

1. INTRODUCTION

1.1 This report has been prepared on instructions from Mark McDonald & Associates Lawyers Pty Ltd, to consider and describe appropriate leachate treatment systems to treat leachate to be withdrawn from the disused landfill on Lot 6 in DP 1065574, being land at Newbridge Road, Moorebank.

1.2 The landfill ceased operation in 1979 and the land is currently subject to a project approval granted under the former Part 3A of the Environmental Planning and Assessment Act 1979 for a 500,000 tonne/annum materials recycling facility that is subject of an appeal by Liverpool City Council and Benedict Industries Pty Ltd & Tanlane Pty Ltd in the NSW Land & Environment Court (proceedings 2016/159652 and 2016/157848).

1.3 The grounds of appeal include amongst other things, that the former land fill is not being managed to prevent surface and groundwater contamination from stormwater and accumulated leachate.

1.4 This report details treatment systems that are considered appropriate for the treatment of leachate removed from the former landfill, to allow it to be dewatered, the site developed and the landfill leachate control re-established.

1.5 I have also been instructed by Mark McDonald & Associates Lawyers Pty Ltd (Appendix F) to consider how the leachate treatment system responds to the consolidated contentions of the Liverpool City Council in the matter as filed 24 June 2016 – specifically:

Part B Contentions:

- Stormwater - Paragraph 9(b), (d), (e) and (f);
- Contamination - Paragraph 11(c), (d), f(iii), (h), (i), (j), (n), (p),(r), (s) and (u); and
- Waste Management - Paragraph 12(f)(iii), (h), (k) and (l),

and the Statements of Evidence of Andrew Kosciuszko and Rowena Salmon, which have been filed on behalf of the Liverpool City Council in the proceedings.

2. STATEMENT TO THE COURT

2.1 This report has been prepared by me, David Bristow, Managing Director and Principal of Simmonds & Bristow Pty Ltd of 40 Reginald St, Rocklea, Qld.

2.2 I am a Chemical Engineer (University of Qld 1986), a Chartered Engineer (CPEng), Registered Professional Engineer (Qld) and Registered Engineer on the National Engineering Register (NER).

2.3 I am a specialist water and wastewater engineer, with 30 years' experience in the design, construction and operation/maintenance, of water, wastewater and trade waste treatment plants. My Curriculum Vitae is attached in Appendix A.

2.4 I have received and read a copy of Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 – (UCPR) and Schedule 7 of the UCPR – Expert Witness Code Of Conduct and agree to be bound by them.

2.5 I acknowledge that my duty is to the Court and not to any party that may have engaged me or who is responsible for my fees.

2.6 The opinions expressed in this report are mine and I have not received or accepted any instructions to adopt any point of view other than my own.

2.7 Whilst I have considered the matter of leachate treatment, I have not had sufficient time to fully determine at the time of writing, the following matters:

a) Obtain an approval for the release of treated leachate to either of the two most likely points of release namely: The Georges River or Sydney Water's Sewer.

2.8 And consequentially until an approval can be determined:

b) The treatment capacity (as opposed to the capability/duty) of the treatment plant;

2.9 I will update the court as further information becomes available regarding an approval for release and/or developed regarding the plant capacity and its associated size.

2.10 I have also not tested the recommended treatment regimens by way of laboratory or pilot plant testing, rather I have relied on literature review, industry design texts and my experience to establish the treatment trains recommended. I have had the opportunity of reviewing and considering some lab scale pilot work by Mr Eric Mangraviti of UWWS, undertaken for Moorebank Recyclers in mid July 2016, which I have included in Appendix G.

2.11 I inspected the site on the 27th July 2016.

3. REFERENCES

3.1 I have relied on the following material in preparing this report:

1. Environmental Site Assessment – Moorebank Recyclers Pty Ltd, Moorebank NSW – Dr S Wood, ERM 06 June 2016;
2. Expert Report - Moorebank Recyclers Pty Ltd, Moorebank NSW – Dr S Wood, ERM 06 June 2016;
3. Remedial Action Plan - Proposed Materials Recycling Facility Newbridge Road Moorebank, NSW – Dr Wood ERM - August 2016;
4. ANZECC 2000 - Australian and New Zealand Guidelines for Fresh and Marine Water Quality Oct 2000;
5. Sydney Water - Industrial customers - Acceptance standards and charging rates for 2016–17;
6. Wastewater Engineering: Treatment and Reuse – Metcalf and Eddy – McGraw Hill;
7. Rethinking Dissolved Air Flotation (DAF) Design For Industrial Pre-treatment – Ross, Smith, Valentine - 2000 WEF and Purdue University Industrial Wastes Technical Conference;
8. State-of-the-Art Report Food Manufacturing Coalition for Innovation and Technology Transfer -Removal and Management of Fats, Oils and Greases March 1997;
9. Wastewater Ammonia Removal by Ion Exchange – USEPA – Water Pollution Control Research Series 17010 ECZ 02/71;
10. Water Treatment Processes for Reducing Nitrate – World Health Organisation;
11. Various manufacturers specification and literature sources for ion exchange resins for ammonia, nitrate & boron removal;
12. Georges River Estuary Coastal Zone Management Plan- BMTWBM July 2013;
13. Georges River Estuary Data Compilation & Estuary Processes Study – SMEC 2010;
14. River Health George River Report card – 2014-2015 Georges River Combined Council's Committee Inc;
15. Water Quality Data – Georges River 2003 & 2005 – Georges River Environmental Education Centre;
16. Water Management and Pollution Control Assessment Moorebank Recyclers Materials Recycling Facility, Newbridge Road, Moorebank Evans & Peck - August 2013;
17. Statement Of Evidence - Andrew Kosciuszko in the matter of Liverpool City Council v Moorebank Recyclers Pty Ltd and Minister for Planning NSW LEC 2015/10898 18 July 2016;
18. Statement of Evidence – Rowena Salmon in the matter of Liverpool City Council v Moorebank Recyclers Pty Ltd and Minister for Planning NSW LEC 2015/10898 4 August 2016;
19. Amended Statement of Facts and Contentions – Liverpool City Council filed 24 June 2016;
20. Amended Statement of Facts and Contentions – Tanlane Pty Ltd & Benedict Industries filed 29 July 2016;
21. Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 (UCPR) - the Expert Witness Code of Conduct in Schedule 7 of the UCPR;
22. Expert Report on Sewage Management, Flooding and Stormwater, including Water Quality Data on the Georges River - Dr Steven Perrens August 2016.

4. THE SITE

4.1 Site description

4.1.1 The site is located off Newbridge Road Moorebank, on the western bank of the Georges River.

Figure 1: Site locality plan

4.2 Site inspection and observations

4.2.1 The site forms part of the Georges River flood plain and much of the land has been raised several metres as part of old landfill development.

4.2.2 The site currently appears flat, with an obvious clay cap and on the raised section clear of significant vegetation.

5. LEACHATE

5.1 The old landfill has accumulated considerable leachate and to redevelop the site for a material recycling facility the level of leachate needs to be reduced to allow for foundation development. Additionally the level of leachate needs to be reduced to regain positive control over the leachate volume and reduce and minimise the risk to leachate overflowing the landfill to the Georges River.

5.2 The leachate has been characterised by sampling and analysis. This work has been reported Dr Sophie Wood of ERM in June 2016.

5.3 The leachate could be described as brackish, with significant concentrations of ammonia and organic carbon. There are trace concentrations of heavy metals, notably Boron and hydrocarbons, notably mid factions (C15-C28).

5.4 Tabulated data from ERM's Environmental Site Assessment is presented in Appendix B.

5.5 It is estimated by JK Geotechnics that up to approximately 120ML of leachate needs to be drawn down from within the old landfill. They also estimate that the leachate can be extracted at 3.5-5.25ML/day, reducing exponentially as the leachate is drawn down.

5.6 The leachate is proposed to be extracted by a horizontal gallery well and pump within the new development area and by spears in the undeveloped area of the site (JK Geotechnics 10 August 2016).

6. DISPOSAL AND RELEASE POINTS

6.1 To determine treatment requirements, the release point or point of discharge needs to be considered.

6.2 Each will have differing water quality objectives or requirements.

6.3 Two release points are evident from inspection of the site:

a) The Georges River as an environmental release;

b) Sydney Water's sewer in Newbridge Road as a sewer trade waste discharge (Sewer Access Report - Appendix C).

6.4 There are currently no approvals in place for either of these release points.

6.5 It can be anticipated that the following water quality standards would need to be achieved to allow any of these release points to be considered:

a) The Georges River – ANZECC Water Quality Guidelines 2000 - 80% percentile Protection Limits – Marine Waters;

b) The Sewer – Sydney Water Sewer Acceptance Limits.

6.6 The treatment capacity of the leachate treatment plant will also dependant on the rate that the release point can accommodate the treated flow.

6.7 This is yet to be determined and tested for any of the likely release points and will be subject to application being made to:

a) NSW EPA for river release;
b) Sydney Water for a sewer discharge.

6.8 A comparison of the untreated leachate against the two release standards is provided in Appendix B.

6.9 I have made preliminary enquiries and application to Sydney Water (5-11 August 2016 – Application Number 109186) for a possible sewer discharge to their network. I have been informed by them that a suitable 375mm diameter sewer main at the entrance to the site on Newbridge Road would be the appropriate point of connection. Verbal information from them indicates to me that a sewer connection is likely to be practical and possible, based on the requested potential flow rate (1-6L/sec) and the size (and hence nominal capacity) of the 375mm sewer main. I have not received any formal or confirmatory communication that suggests that an approval for connect will be granted at the date of this report. I will update the court when further information becomes available.

7. LEACHATE QUALITY AND QUANTITY

7.1 Design influent quality

7.2.1 The design raw leachate quality is shown in the following table.

Table 1: Design Raw Leachate Quality

Parameter	Unit of measure	Mean Value	Maximum Value
pH (expected qualitative)		Near Neutral	
Total Dissolved Solids	mg/L	4000	20000
TOC	mg/L	90	300
Ammonia as N	mg/L	150	600
Metals (Principally Boron)	mg/L	2	5 (Outlier at 80mg/L)
Hydrocarbons (TRH C6-C36)	mg/L	5	15
Pesticides	ug/L	Nil Reported	
Herbicides	ug/L	Nil reported	

7.2 Treated Leachate Quality – Release to Georges River

7.2.1 The following water quality objective would be set to release to the Georges River.

Table 2: Proposed Release Limit - George River

Parameter	Unit of measure	Mean Value	Maximum Value
pH		7.0	6.5-8.0
Total Dissolved Solids	mg/L	4000	5000
TOC	mg/L	<5	<10
Ammonia as N	mg/L	<1	<2
Metals (Principally Boron)	mg/L	<0.1	<1
Total Hydrocarbons (TRH C6-C36)	mg/L	<0.05	<0.1
Pesticides	ug/L	<LOR (Limit of reporting)	
Herbicides	ug/L	<LOR	

7.3 Treated Leachate Quality – Release to Sewer

7.3.1 The following water quality objective would be set to release to the sewer.

Table 3: Proposed Release Limits - Sewer

Parameter	Unit of measure	Mean Value	Maximum Value
pH (expected qualitative)		7.0	6.5-8.0
Total Dissolved Solids	mg/L	4000	5000
TOC	mg/L	50	150
Ammonia as N	mg/L	100	100
Metals (Principally Boron)	mg/L	<2	<5
Hydrocarbons (TRH C6-C36)	mg/L	<1	<5
Pesticides	ug/L	<LOR	
Herbicides	ug/L	<LOR	

7.4 Volume of Leachate

7.4.1 The volume of leachate to be treated to allow the material recycling facility to commence construction is estimated at up to 66ML (JK Geotechnics August 2016).

7.4.2 The volume of leachate to be treated to regain control of the landfill leachate pool is estimated at up to an additional 52ML (JK Geotechnics August 2016).

7.4.3 The rate at which leachate can be withdrawn from the land fill has been reported to me as 3.5-5.25ML/day, reducing exponentially as the landfill dewaters (JK Geotechnics August 2016).

7.4.4 The rate at which the leachate will be withdrawn and treated has yet to be determined and as such the capacity of the proposed treatment plant is indeterminate.

8. TREATMENT OPTIONS

8.1 To achieve the water quality objectives for each of the release points the following treatment trains are likely.

Table 4: Treatment Processes Recommended For Each Release Point, Including Unit Process Duty

Unit Process	Duty	Georges River	Sewer
Feed Pumps – Well and Spears	Transfer of Raw Leachate to plant	✓	✓
Blending Tank with Aeration mixing and Transfer Pump	To blend and aerate leachate, diluting high contaminate concentrations with low concentrations to feed a consistent leachate quality to treatment plant and improve treatment robustness, provide primary oxidation reduce TOC and ammonia and some volatiles	✓	✓
Pre-treatment pH Correction	Adjust pH to control set point to optimise downstream processes	✓	✓
Oily Water Separator	Protective Barrier to Remove Petroleum Hydrocarbons from raw leachate if pockets of high oil contamination found	✓	✗
Aerobic RBC to oxidise TOC, ammonia and absorb metals	Biologically Oxidise and reduce TOC, Ammonia Biologically Absorb Metals and reduce soluble concentrations	✓	✗
Anoxic Biological Contactor	Biologically strip leachate of oxidised nitrogen (NOx) and Consume TOC under anoxic conditions	✓	✗
Coagulant Dosing	Chemically coagulate metals and phosphorus from solution, improve float formation and hydrocarbon attachment	✓	✓
Dissolved Air Floatation	Float coagulated solids, metals, hydrocarbons from leachate	✓	✓

Unit Process	Duty	Georges River	Sewer
Filtration (Disk or Media) to polish solids and metals from the DAF effluent	Barrier protection for removal of residual suspended solids, metals and attached hydrocarbons from DAF effluent. Protect ion exchange and Activated carbon process from solids fouling and disinfection process from loss of efficiency from shadowing	✓	✗
Post treatment pH Correction	Change pH to release limits	✓	✓
Activated Carbon Filtration	Barrier Process to remove residual metals and petroleum hydrocarbons to ANZECC limits	✓	✗
Ion Exchange (Mixed bed)	Barrier Process to remove residual boron, ammonia and NOx to ANZECC limits	✓	✗
Disinfection	Barrier Process to allow water to be reused for wash water and release a biologically benign treated leachate	✓	✓
Treated Water Storage Tank	For local water supply, and composite monitoring prior to release	✓	✓
Flow metering	To measure treatment plant and release flowrates	✓	✓
Reclaimed Wash Water Reuse	For sprays, chemical makeup and plant wash water to reduce demand on site water supply resource	✓	✓
V-Belt Press	To dewater DAF Float and Sludge by products prior to disposal to off-site landfill	✓	✓

8.2 All plant will need to be designed and supplied to be compliant with AS2430 Classification of Hazardous Areas and AS/NZS60079 Electrical Apparatus for Explosive Environments.

8.3 Process Flow diagrams for each treatment train are provided in Appendices D & E.

8.4 All treatment processes chosen are robust and proven.

8.5 Water quality objectives can be readily achieved, through blending of the leachate and subsequent treatment by the nominated treatment process train for the selected release point.

8.6 The treatment train proposed for riverine release is the more complex. This is simply a function of the tighter water quality objectives, particularly nitrogen. The ion exchange process is an important polishing step to this end.

8.7 The raw leachate is not heavily contaminated with metals or hydrocarbons.

8.8 In the main these contaminants are below the ANZECC limits for marine waters and it could be argued that further treatment steps for the removal of these contaminants are not needed, based on the impacted nature of the river catchment (River Health Report 2014-15 GRCCC).

8.9 Landfill leachate can be highly variable, and whilst leachate blending is recommended, it is considered prudent to provide additional treatment processes that can deliver dual purpose treatment, such as the DAF, as a safeguard against unexpected pockets of more highly contaminated leachate.

8.10 Salinity control is only exercised through blending the different leachate sources to achieve an aggregate result. Should lower salinity concentrations be required a desalination process would need to be employed, such as reverse osmosis or sub-atmospheric flash distillation. This additional process is not considered unusual and is used routinely by industry as well as the marine industry to desalinate and reclaim polluted waters.

8.11 Odour control will need to be provided (activated carbon and/or bio-filter) on process units that may generate some odour, such as the blending tank and DAF.

8.12 The processes chosen are generally quiet and have a relatively low energy footprint.

8.13 Following initial dewatering of the landfill and re-establishment of the cap, there should be a consequential significant reduction in leachate generation. The proposed plant can be operated either in a semi batch and/or reduced capacity mode to provide flexibility for on-going leachate management of these small volumes of leachate. Alternately tankering, to an offsite disposal facility, of the small volumes of leachate that may accumulate from time to time could be used for ongoing leachate management.

8.14 ***Pilot Bench Testing by UWWS***

Some laboratory bench scale pilot testing of aeration, coagulation, sedimentation and activated carbon filtration was undertaken by Mr Eric Mangraviti of UWWS for Moorebank Recyclers. I have viewed the results of this work with Mr Mangraviti and whilst the testing is not exhaustive, it is instructive.

8.15 The aeration alone causes a rise in pH and release of little of the pollutants. There was a small reduction in ammonia and odour control on the aerated blending tank will be mandatory.

8.16 The use of coagulants, sedimentation only, and carbon/filtration appears to deliver a 25% reduction in ammonia, and significant reduction in hydrocarbons. Chemical and activated carbon treatment alone was unsuitable for metals reduction as expected.

8.17 Alternate and supplementary treatments are needed to remove pollutants to target concentrations. I have recommended alternate treatments, including pH control, biological oxidation, DAF, filtration and ion exchange.

8.18 I support Mr Mangraviti in his view that better pH control and DAF treatment would produce improved results and that biological treatment for the removal of ammonia is appropriate. The use of high pH and aeration to reduce ammonia is also well understood and a reliable ammonia reduction technique. Because of the need for scrubbing the off-gas and the odour risk from this process, I would not prefer this treatment over biological oxidation for ammonia removal.

8.19 A copy of the UWWS report and test results are attached in Appendix G for completeness.

9. PLANT OPERATION

9.1 Irrespective of the release point finally approved and the associated treatment plant adopted, the treatment plant will need to be operated by a competent operator in accordance with a considered detailed operations and maintenance manual.

9.2 ***Operator Competence***

The operator should possess at least a Certificate III in Water Industry Treatment, with the following appropriate competencies:

Table 5: Recommended Treatment Plant Operator Competencies

Competency Unit	Descriptor
NWPGEN001	Apply the risk management principles of the water industry standards, guidelines and legislation
NWPGEN004	Assess, implement and report environmental procedures
BSBWHS303	Participate in WHS hazard identification, risk assessment and risk control
CPCCCM1015A	Carry out measurements and calculations
NWPGEN008	Sample and test wastewater
NWPTRT031	Operate and control sedimentation and clarification processes
NWPTRT015	Operate and control coagulation and flocculation processes
NWPTRT082	Operate and control nutrient removal processes
NWPTRT033	Operate and control DAF processes
NWPTRT035	Operate and control ion exchange and softening processes
TLID2003A	Handle dangerous goods/hazardous substances
NWPTRT091	Operate and control solids handling processes

9.3 Qualification can be readily obtained through NSW TAFE, Chisholm Institute, Enviro-Check Enterprises Pty Ltd & Simmonds & Bristow Pty Ltd (Source – Training.gov.au for NWP30315 - https://training.gov.au/Search/SearchOrganisation?nrtCodeTitle=NWP30315&scopeItem=Qualification&tabIndex=1&ImplicitNrtScope=True&orgSearchByScopeSubmit=Search&IncludeUnregisteredRtosForScopeSearch=False)

9.4 ***Documented Procedures - Operation and maintenance Manual***

The provision of a detailed operation and maintenance manual for review by the regulating authority is premature at this time and would normally be conditioned as part of any approval granted for the development.

9.5 The detailed O&M manual should contain the following information:

i. Title and Version Control;
ii. Hazard and Risk Identification and Management;
iii. General Description of the Plant;
iv. Theory of Operation;
v. Descriptions of each treatment process;
vi. Operating Instructions for the plant as a whole;
vii. Operating Instructions for each treatment process;
viii. Daily/Weekly/Monthly Operational Checklists;
ix. Control Set points and Critical Control Points;
x. Monitoring Program;
xi. Sampling and Site Testing Protocols;
xii. Instructions to adjust control set points;
xiii. Trouble Shooting Guide;
xiv. Maintenance Schedules;
xv. Start up and Shut down procedures;
xvi. General Arrangement as Constructed Drawings of the Plant and its treatment units;
xvii. Manufacturers Engineering Specifications and exploded sections;
xviii. Manufacturers Technical Literature on process units (Pumps, Blowers, Valves, etc);
xix. Spare Parts list;
xx. Chemical Listings and Safety Data Sheets.

9.6 The documented procedures for the plant operation should be used as part of the on-site training and handover of the plant to operational personnel following construction/installation & commissioning.

10. CONSIDERATION OF CONSOLIDATED CONTENTIONS

10.1 The following consolidated contentions of the Liverpool City Council as filed on 24 June 2016 have been considered in the development of the recommended leachate treatment systems.

10.2 ***Stormwater Collection***

10.3 *9. There is insufficient information with respect to stormwater collection and its management for a proper assessment of the impacts of the Development to be undertaken.*

10.4 *Particulars:*

10.5 *b. There is insufficient information to be able to assess the management and potential impact of nutrients, salts, hydrocarbons, heavy metals and other relevant contaminants that are likely to reach the groundwater system or the Georges River and associated riparian zone. Any discharge of contaminated water from the site to the receiving environment should be in accordance with current best practice which is to have a neutral or beneficial impact on the environment.*

10.6 *d. The water quality management system relies on the outcomes of the Site water balance assessment. There is insufficient material to assess the risks to the receiving environment, which includes the environment that receives either groundwater or surface water discharges from the Site, during periods where there is limited demand for Site water. Further information about water balance modelling assumptions and results, together with expected water quantity and quality released into the receiving environment is required.*

10.7 *e. There is insufficient material to assess the risk and likely consequences of the proposed stormwater collection sumps intercepting potentially contaminated groundwater and driving the generation of landfill leachate. The consequence of this risk on groundwater flow rates and quality has not been determined. There is insufficient information in relation to the construction and operation requirements of the stormwater sump system. Council notes that Dr Sophie Woods (the contamination expert for Moorebank Recyclers), in her Expert Contamination Report filed 6 June 2016, in section 4.1 in response to Council's contention 10(d), agreed that "the position of the sumps above the landfill cap, and the sealing to prevent water infiltration into the cap was not clearly presented" and she relied on verbal information regarding the proposed design in her assessment. Dr Woods has recommended particular details for the design of the sumps which are not reflected in the current design.*

10.8 *f. No Information has been provided to identify how oil and water are to be separated. There is no information to enable an assessment of measures required to ensure that any oil contamination trapped in a sump is removed when required.*

10.9 **Response:**

10.10 These contentions relate to Stormwater collection and Management. The leachate collection and treatment system is quite separate and isolated from the stormwater collection and treatment system. There is no proposed intermingling of these two water sources.

10.11 To the extent that leachate is mentioned in the wording of each contention and that the contention might relate to the proposed leachate treatment system, I respond as follows:

i. The leachate treatment processes outlined are responsive to each release point considered and the water quality objective appropriate for that release point.

ii. Additionally the treatment processes outlined have been chosen to provide an appropriate barrier response to potential contaminants such as metals and hydrocarbons.

iii. The water quality to be produced by the various recommended leachate treatment plants is detailed in Section 8. Water quality objectives have been chosen that are achievable and appropriate for the release points considered.

iv. The water quality objective for the Georges River is considered equivalent to better than the water quality reported to be present in the river and consequently the discharge if approved, is not expected to have any negative impact on the river.

v. The recommended leachate treatment systems can be operated to treat the leachate pumped from the disused landfill to dewater it initially and could be used subsequently to treat small maintenance volumes leachate removed to maintain approved standing water levels in the landfill, during and following remediation of its cap. The leachate treatment system is not intended nor configured to treat stormwater.

vi. Any oil present in the leachate is, based on the laboratory analysis, expected to be negligible, being reported at only low concentrations. Technologies included in the treatment trains for removal of oil, if present, include an oily water separator and/or dissolved air floatation, with coagulant dosing.

10.12 ***Contamination***

10.13 *11. There is insufficient information with respect to existing contamination at the Site and its management for a proper assessment of the risks of the Development to be undertaken. Approval of the development is not consistent with SEPP 55 Remediation of Land.*

10.14 *Particulars:*

10.15 *c. There are potential health and safety risks inherent in excavating into the waste including exposure to waste contaminants, asbestos and potential medical waste and leachate.*

10.16 **Response:**

10.17 The leachate is to be extracted using a combination of a horizontal gallery well and spears.

10.18 Establishment of the extraction system will need to be managed. Work instructions and methods will need to be developed following hazard and risk assessment, including HAZOB and HAZOP assessment. Contractor training and awareness of the hazards and the appropriate working methods required to establish the well and spears would need to be provided by competent professionals. Hazards to be addressed will need to include biohazard, explosive gases, toxic gases and liquids.

10.19 Once established the well and spears will allow leachate to be pumped from the landfill, without workers being exposed directly to the leachate, save the treatment plant operator and sampling personnel. Similar hazard management training would need to be provided to these personnel as well as site and facility management. The environment of the treatment is not considered any more hazardous than that experienced daily by utility works operating community sewerage facilities, including reticulation and treatment personnel.

10.20 d. The site is a former landfill which is identified in SEPP 55 as an activity that may cause contamination, and investigations have identified the presence of contamination at the site. Significant earthworks and reworking of landfill material are proposed as part of the development however a remedial action plan (RAP) has not been prepared which is a requirement of SEPP 55.

10.21 **Response:**

10.22 The leachate treatment plant details have been provided by me to Dr Wood for inclusion in the site RAP.

10.23 f. A Site Audit Statement (SAS) was prepared in 2001 and required the imposition of a number of conditions, which needed to be fulfilled for the site to be considered suitable for a materials recycling facility. The application does not adequately consider the Site Audit Statement findings and the conditions. The following Site Audit Statement conditions were not adequately considered in the original application material:

iii. There was no detailed assessment of the groundwater impacts or ongoing monitoring of groundwater to identify impacts from landfill leachate.

10.24 **Response:**

10.25 Once the leachate dewatering and treatment plant are operational the risk of groundwater and riverine contamination by raw leachate is expected to be reduced. The leachate plant treatment trains are expected, subject to detailed design, to allow the release of treated waters that should be benign to the receiving environment of the release points.

10.26 Discharge water quality recommended for release to the Georges River is at a standard expected to be better than the river water quality.

10.27 Discharge water quality recommended for release to sewer is at the acceptance standard specified by the sewer operator, Sydney Water.

10.28 h. Information has since been provided to address these conditions in part. In reports by Dr Sophie Woods filed 6 June 2016, including the Environmental Site Assessment (SA) and Draft Operations Environmental Management Plan (Draft Operations EMP). Review of these documents by a Site Auditor would be required to confirm that they are adequate to address the previous SAS conditions and confirm that the Site can be made suitable for the intended use. Such a review would normally be undertaken in conjunction with review of a RAP prior to development approval (Section B Site Audit).

10.29 **Response:**

10.30 The recommended leachate treatment systems details have been provided to Dr Wood for inclusion in the site RAP, and will be subject to review. The release point adopted to discharge the treated leachate from the site will be subject to review and approval by the regulating authority (NSW EPA for the Georges River and Sydney Water for Sewer).

10.31 *The Project Approval requires a Site Audit upon completion of earthworks, however, requirements for the protection of human health and the environment identified at the completion of earthworks (including in relation to the adequacy of capping, quality of material to be reused as capping and leachate management requirements) may not be able to be retrospectively incorporated into the proposed Development. The detail of these requirements should therefore be considered before approval of the Development.*

10.32 **Response:**

10.33 The concept design outlined in this report for the leachate treatment plant provides details on the raw leachate, treated leachate water quality and treatment processes to be employed.

10.34 A preliminary and/or detailed design has not been conducted at this time, pending determination of the treatment plant volumetric capacity (m^3/day).

10.35 This will be determined from consideration of:

i. The volume of leachate to be dewatered and treated;
ii. The rate of raw leachate withdrawal from the landfill;
iii. The rate at which the treated leachate can be discharged to the release point;
iv. Intended operating hours of the treatment plant;
v. Required operating hours for stable plant operation;
vi. Approvals for the release point.

10.36 Once approval for one of the identified release points is obtained, preliminary and detailed designs can be developed. It would be normal for these designs to be developed following granting of a development approval for subsequent approval prior to/for construction.

10.37 *j. A RAP would also include validation requirements to demonstrate achievement of critical elements for the protection of human health and the environment. Review of the validation requirements by a Site Auditor prior to approval of the Development would ensure that the validation information that will ultimately be required by a Site Auditor to demonstrate that the Site is suitable is collected during the development works.*

10.38 **Response:**

10.39 Once approval for one of the release points is achieved, a preliminary and detailed design can be developed. Ultimate approval of either of the proposed treatment facilities will rest with the appropriate administering authority, namely NSW EPA for a Georges River discharge or Sydney Water for a Sewer discharge. Any further auditing of the leachate treatment system has limited utility and is unnecessary and unreasonable.

10.40 *n. The SA prepared by Sophie Wood on 6 June 2016 is stated to be a preliminary assessment and the report acknowledges that "Further phases of investigation may be needed". The SA concluded. inter alia:*

i. the groundwater/leachate within the landfill contains elevated concentrations of ammonia, petroleum hydrocarbons and some metals;

ii. groundwater downgradient of the landfill is also affected by elevated ammonia and petroleum hydrocarbons;

iii. methane and carbon dioxide were detected in gas wells across the majority of the landfill area with high concentrations and flows reported within the northern portion of the landfill;

iv. the calculated gas screening value of 4.33L/hr indicated that the site is classified as a moderate to high risk site requiring the implementation of appropriate mitigation measures to manage the risk of influx of ground gases into buildings;

v. monitoring of surface emissions has reported trace concentrations of methane across the landfill: and

vi. potentially complete source-pathway-receptor linkages are present in relation to impacted groundwater and ground gases which may require further assessment and management.

10.41 **Response:**

10.42 The pollutants in the leachate are acknowledged and the recommended concept design presented in this report responds, to ensure these pollutants (particularly ammonia, organic carbon, hydrocarbons and trace metals) are reduced to concentrations suitable for discharge to one of the two release points identified.

10.43 p. The groundwater Investigation documented in the SA has indicated an increasing degree of impact to groundwater due to landfill leachate (using ammonia as an indicator) between 2001 and 2016 (including monitoring in 2004 and 2009). This is contrary to the expectation of the previous SAS findings which required "continued monitoring of the groundwater in select wells for a sufficient period to confirm that the discharge of leachate from the landfill has been minimised by the Improved capping of the filled area and will not significantly affect the ecosystems of the Georges River". Further information is required regarding leachate management proposed during the earthworks and contingencies for the ongoing management of leachate (post development).

10.44 **Response:**

10.45 The management of leachate through treatment and release provides a proactive and positive management response to leachate accumulation and ongoing management post development. The recommended treatment processes use well understood treatment processes that, subject to detailed design, can be expected to deliver robust treatment of the leachate. Their operation by a qualified and competent operator, supported by documented operation and maintenance procedures and routine monitoring can be expected to produce treated leachate water quality of acceptable quality for release to the environment.

10.46 r. The Bulk Earthworks Consent, Condition 22, required "A detailed groundwater assessment report shall be submitted to Council for approval by the Department of Environment and Conservation prior to issue of a Construction Certificate for the earthworks". The groundwater investigation undertaken by EIS (2009) and submitted to Council for this purpose was not adequate to address the requirements of a "detailed groundwater assessment". In addition there is no evidence of Department of Environment and Conservation (now NSW EPA) approval of the groundwater assessment report.

10.47 **Response:**

10.48 Approval for any of the release points is yet to be obtained.

10.49 Sydney Water has been approached to consider an application for discharge of treated leachate to their sewer system. A suitable connection is available at the entrance to the site in Newbridge Road. The available sewer connection point is a large 375mm sewer that has an inherently significant capacity (at 1-3% grade +200-350L/sec).

10.50 s. The project Environmental Assessment does not adequately consider impacts to groundwater from landfill leachate since it relies on these issues having been addressed in response to the Bulk Earthworks Consent (which was not the case as noted above).

10.51 **Response:**

10.52 The recommended leachate treatment systems are expected to deliver good water quality outcomes, appropriate for the release points identified.

10.53 u. The impact of the proposed Development on the groundwater system has not been assessed, and cannot be properly assessed without further information in relation to existing site groundwater conditions.

10.54 **Response:**

10.55 The installation and operation of a leachate treatment plant to dewater the landfill will allow leachate levels to be reduced.

10.56 Treated leachate is proposed to be release to either:

i. The Georges River at ANZECC Marine Water Quality Limits or
ii. The sewer at Sydney Water's sewer acceptance standard

10.57 There is no proposal to dispose of treated leachate to groundwater.

10.58 Logically this will reduce the subsequent impact risk of leachate on groundwater.

10.59 ***Waste Management***

10.60 12. The Development will change the footprint of the landfilled area with a portion of the southern part of the landfill being excavated and moved to the northern section. There is insufficient information to determine the impact of the Development on the former landfill and its management to ensure minimisation of the risk of leachate impacts on the Georges River, of tidal influences on the groundwater in the landfill, and of the potential for landfill gas to migrate to adjoining properties.

10.61 Particulars

10.62 f. An Environmental Management Plan (EMP) must be provided for assessment by the Court. Such an EMP must deal with hazardous materials, gases and liquids that may be encountered during all works and activities to be carried on the site. The EMP should include:

iii. details of leachate extraction, treatment and disposal during earthworks

10.63 **Response:**

10.64 The concept design outlined in this report for the leachate treatment plant provide details on the raw leachate, treated leachate water quality, likely release points and treatment processes to be employed.

10.65 A preliminary and/or detailed design has not been conducted at this time, pending determination of the treatment plant volumetric capacity (m^3/day).

10.66 This will be determined from consideration of:

i. The volume of leachate to be dewatered and treated;
ii. The rate of raw leachate withdrawal from the landfill;
iii. The rate at which the treated leachate can be discharged to the release point;
iv. Intended operating hours of the treatment plant;
v. Required operating hours for stable plant operation;
vi. Approvals for the release point.

10.67 Once approval for one of the identified release points is obtained, preliminary and detailed designs can be developed. It would be normal for these designs to be developed following granting of a development approval for subsequent approval prior to/for construction.

10.68 h. A site specific environmental management plan for the former landfill was not presented as part of the Development application. The EMP which was prepared by Sophie Wood on 6 June 2016 on behalf of the Respondent does not provide guidance on issues associated with earthworks construction activities as part of the Site redevelopment nor does it deal with all types of hazardous materials that may be encountered on the Site, for example asbestos. This includes whether such materials are already on the site or within the existing landfill, or whether such materials are brought to the Site during the operations of the proposed facility.

10.69 **Response:**

10.70 The leachate treatment plant proposed in this report is responsive to the raw leachate water quality reported by Dr Wood. The concept design has been developed to remove a wide range of hazardous contaminants, including acid/alkali, ammonia, petroleum hydrocarbons, and heavy metals.

10.71 k. Data indicates that landfill leachate has had an impact on the groundwater system outside of the landfill site. There is no information available to enable a proper assessment of methods proposed to collect any leachate in the landfill, treat it and take it off site for disposal. These details are required for during the bulk earthworks (EMP requirements noted above) and during landfill operation (ongoing leachate management requirements).

10.72 **Response:**

10.73 The concept design outlined in this report for the leachate treatment plant provide details on the raw leachate, treated leachate water quality, likely release points and treatment processes to be employed.

10.74 l. Council notes that Dr Sophie Woods (the contamination expert for Moorebank Recyclers), in her Expert Contamination Report filed 6 June 201 6, in section 4.4 in response to Council's contention 14(d), recommended that "leachate treatment and disposal is necessary during the earthworks". In addition she concludes that "Once the development is completed, leachate pumping to maintain low leachate head may or may not be necessary". The Draft Operations EMP, also filed on 6 June 20'16, proposes an action level for leachate extraction if the standing level of leachate within the landfilled area is gauged to be higher than ·1 metre above the base of the waste, to prevent seepage from occurring. The monitoring frequency proposed is quarterly for the first year with a reduced frequency thereafter. More frequent monitoring of the standing level of leachate would be required, including potentially in response to rainfall events, to ensure

the prevention of seepage. Details of contingency leachate extraction infrastructure are required prior to approval to ensure they can be incorporated into the completed development.

10.75 **Response:**

10.76 The concept design outlined in this report for the leachate treatment plant provide details on the raw leachate, treated leachate water quality, likely release points and treatment processes to be employed.

11. CONSIDERATION OF THE STATEMENT OF EVIDENCE OF ANDREW KOSCIUSZKO AND ROWENA SALMON

11.1 ***Statement of Andrew Kosciuszko***

11.2 I have read the statement of evidence of Andrew Kosciuszko dated 18 July 2016.

11.3 I note that his statement deals with a range of matters and my response is limited to consideration of his statements regarding leachate. Mr Kosciuszko provides the following on leachate:

11.4 *5.1 Leachate*

11.5 *There does not appear to any significant discussion of leachate issues on the site in the EA. Leachate is not currently collected from the landfill and treated or taken off site for disposal and one can only assume that any leachate generated in the landfill migrates from the site into the groundwater and ultimately into the Georges River as this is the low point for the site, as the water gradient would be expected move in that direction.*

11.6 *If the bulk earthworks are to proceed, then it is recommended that a leachate interception trench be installed at the base of the new batter slope of the landfill in the sections that are to be excavated, with a sump and leachate riser pipe so that leachate can be collected and extracted on a continuous basis, or as required, to mitigate any ground water impacts for the site. Any leachate collected would need to be treated to reduce ammonia levels to a level suitable for discharge to sewer or transported to a facility licensed to accept this liquid. This collection and treatment of leachate would need to continue until such time as the leachate generated on the site is benign and would not impact on the ground water. The use of leachate for dust suppression may not be possible due to odour and contamination issues.*

11.7 *A series of ground water monitoring wells located on the ground water down gradient eastern and southern part of the site should be part of the revised licence conditions for the site. These wells should be monitored at least quarterly during the initial works on the site. The frequency of monitoring can be reviewed once a substantial history of ground water measurements has been accumulated to show a decreasing impact on ground water.*

11.8 **Response**

11.9 I understand that a leachate interception trench is now proposed (provided as a horizontal extraction well) and a series of spears for the extraction of leachate from the disused landfill.

11.10 The extracted leachate is proposed to be treated to reduce the pollutants identified and reported by Dr Wood in the Environmental Site Assessment. The treatment train implementation is dependent on approvals being obtained for one of two likely release points (The Georges River or the sewer). The detail in this report provides concept design details on likely treatment systems.

11.11 I concur with Mr Kosciuszko that for a sewer discharge the ammonia concentration will need to be reduced. The proposed treatment plant for this release point does so by shandying the waste and partial oxidation/release to atmosphere via a dissolved air floatation treatment system.

11.12 I do not consider tankering leachate from the landfill to be an efficient solution and consequently I have not considered it further.

11.13 I concur that the treatment of leachate will need to continue until the volume of leachate retained in the landfill is controlled and the cap re-established to prevent further leachate entering the landfill in significant quantities. Even so, I expect that leachate removal, treatment and disposal is likely to be required in the future for the ongoing successful management of the disused landfill. The volumes requiring management post cap re-establishment would be significantly smaller than that requiring dewatering, and may be amenable to tankering from the site from time to time, or management through a smaller treatment facility or batching treatment through the initial dewatering treatment facility.

11.14 ***Statement of Rowena Salmon***

11.15 I have read the statement of evidence of Rowena Salmon of 4 August 2016.

11.16 I note that her statement deals with a range of matters and my response is limited to consideration of her statements regarding leachate. Ms Salmon provides the following on leachate:

11.17 *Page 7*:

11.18 *12. The bulk earthworks which are proposed for the current development pose a number of issues including:*

11.19 *c) The management of leachate resulting from the site compaction and dewatering of the areas from which the fill material will be excavated*

11.20 *d) Potential odour Issues relating to dewatering of the excavated areas and exposure of wastes*

11.21 **Response:**

11.22 The proposed leachate treatment system enables positive management of the landfill leachate, both to prepare the site for redevelopment and for its ongoing management.

11.23 The treatment system includes odour control devices fitted to nominated process units likely to release odour, namely the blending tank and dissolved air floatation system. Odour control is proposed to be managed using activated carbon and/or biofilters as appropriate.

11.24 *36. Leachate control is required both during the development earthworks and for the ongoing operation. Further discussion is provided under Contention 12, Particular k, below*

11.25 *37. The EA and PPR do not describe in detail how leachate will be managed (including extraction and treatment) during development and do not contemplate long term leachate management.*

11.26 **Response:**

11.27 I concur that leachate control is likely to be required both during the site redevelopment and for the ongoing management of leachate.

11.28 The details provided in this report outline the proposed leachate treatment system, subject to detailed design and final approved release point.

11.29 The proposed leachate treatment plant provides an appropriate response for the management of leachates from the landfill during site re-development and post development for the ongoing management of leachate levels in the disused landfill.

11.30 *48. Information recently provided including the SA by ERM (2016) and the Draft Groundwater Assessment by EIS (June 2010) has provided sufficient information to understand the existing site groundwater conditions. However, potential Impacts of the proposed development on the groundwater system are dependent on the details of the earthworks and the proposed method of leachate control during development earthworks and for the long term operation of the facility. These details have not been provided in the development documentation prepared to date (discussed further In relation to leachate under Contention 12, below). A clear description of the works and an assessment of the potential impact on the groundwater system should be provided in a RAP.*

11.31 *49. The Project Approval requires a Site Audit upon completion of earthworks, however, leachate management requirements identified at that stage may not be able to be incorporated into the proposed development. If the need for leachate management is identified, this is best addressed in conjunction with the proposed development design. Leachate control measures that may be required (contingency control measures) should therefore be considered before approval of the development.*

11.32 **Response:**

11.33 The proposed leachate treatment outlined in this report provides additional information on the management of leachate from the disused landfill. Whilst additional detail will be required to construct the plant, the concept design presented outlines clearly the treatment intention.

11.34 *67. A management plan for dewatering has not been prepared to my knowledge and no document has considered leachate volumes and the specifics of any treatment methods. Further detail on the proposed management of leachate during the earthworks is required and should be documented in the RAP.*

11.35 **Response:**

11.36 The treatment systems as outlined in this report provide appropriate detail on the treatment regimen proposed to implement positive control over leachate levels in the disused landfill.

11.37 The details of the proposed treatment regimen have to my knowledge been included in the proposed site RAP drafted by Dr Wood.

11.38 *69. It is noted that earlier documentation (E&P EMP (2005)) proposed irrigation of extracted leachate for dust suppression. The leachate extracted from the site as part of the dewatering for the bulk earthworks could be quite odourous and hence may not be able to be used for dust suppression.*

11.39 **Response:**

Whilst the treatment plant will be fitted with odour control measures, the treated leachate is not expected to be odourous. The treatment process is such that odourous compounds are either oxidised or removed. A portion of the treated leachate volume could be used for dust suppression.

12. COMMENTS ON PROJECT APPROVAL CONDITIONS

I have considered the project approval conditions issued 11 September 2015 and have identified three conditions, C33, D1 and D2, that may relate to leachate management and hence leachate treatment.

These conditions require the preparation of a Landfill Management Plan, a Construction Environmental Management Plan and an Operational Environmental Management Plan. These plans are required to address and control amongst other things:

a. Landfill Management Plan –
    i. describe measures to ensure the ongoing integrity of the land fill and landfill cap,
    ii. include a program of ongoing water table monitoring
b. Construction Environmental Management Plan
    i. describe actions to be taken to address adverse impacts on soil & water and
    ii. ongoing land fill management
c. Operational Environmental Management Plan
    i. describe actions to be taken to address adverse impacts on soil & water and
    ii. ongoing land fill management

The provision of a leachate extraction and treatment system, with release/disposal of treated leachates effectively off site provides proactive and controlled management of leachates accumulated in the landfill. The concept design presented once fully detailed, coupled with the development of documented operating and maintenance procedures should provide adequate detail for inclusion in these conditioned site based management plans.

13. GLOSSARY OF TERMS

Term	Definition
ADWF	Average dry weather flow
Alum	Aluminium sulphate ($Al_2SO_4.14H_2O$)
BOD_5	5-day biochemical oxygen demand
BTEX	Benzene, Toluene, Ethylene and Xylene. A test group for Aromatic hydrocarbons
CCP	Critical control point
Coagulation	The act of breaking a colloid emulsion using a coagulant chemical. Generally achieved by charge neutralisation, which allows smaller particles to 'clump' together via van-der-waals forces
Coagulant	A chemical that causes coagulation
COD	Chemical oxygen demand – a measure of all oxidisable material within a sample of water
Colloid	Solid particles that generally will not settle under gravity settling
Conductivity	A measure of the salt content of a water sample
CST	Capillary suction time
DAF	Dissolved air floatation
DCS	Distributed control system
DNA	Deoxyribonucleic acid, a macromolecule found within a cell that carries the majority of information that controls cellular development, function and growth
DO	Dissolved oxygen
DOL	Direct online – a form of motor starter whereby power is directly connected to the motor. This kind of motor starter has a large current draw on start-up limiting its use to smaller motors
E. coli	*Escherichia coli*, a Gram-negative, facultative anaerobic, rod-shaped bacterium of the genus *Escherichia* that is commonly found in the lower intestine of warm-blooded animals (e.g. Humans). Used as an indicator of faecal contamination
EIS	Environmental impact assessment

Term	Definition
EMPs	Environmental management programs
Emulsion	Suspension of colloidal particles
EPPs	Environmental protection policies
ERA	Environmentally relevant activity (Specific to Queensland legislation, may also be used for Environmental Risk Assessment)
ES	Effective size (of granular media)
Thermotolerant Coliforms	A range of coliform bacteria generally used as an indicator of faecal contamination.
Flocculate/ Flocculation	The act of solid particles clumping together to form larger settleable aggregates, often referred to as 'flocs'
Flocculant Aid	A polymer based chemical utilised to enhance flocculation. The polymer forms a 'net' like complex when diluted, which acts to capture many smaller particles, creating a larger, generally more stable floc. Various flocculant aid exist, generally grouped based upon charge (Cationic, Anionic or Non-ionic). Best type of flocculant aid is usually selected via jar test
FRP	Filterable reactive phosphorus
HDG	Hot dipped galvanised
HDPE	High density polyethylene – a form of plastic often used in the construction of pipes and tanks
HMI	Human machine interface
Jar Testing	Jar Testing, sometimes referred to as coagulation testing or flocculation testing (depending upon what is being optimised) is a scaled-down lab test simulating the coagulation and flocculation reactions occurring within the clarifier of a water plant. This test allows for the evaluation of new flocculant aids, new coagulants, or the assessment of varied dose rates
Macromolecule	A large molecule commonly made up of polymer sub-units. A term commonly used in genetics and biology
MCC	Motor control centre
MCRT	Mean cell residence time. The average time a bacterial cell can expect to remain within the process. Another measure of 'sludge age'
ML	Mixed liquor

Term	Definition
MLSS	Mixed liquor suspended solids – a measure of the biomass within a treatment plant using total solids as a proxy
NFR	Non filterable residue, analogous to total suspended solids
Nitrate	An oxide of nitrogen with the molecular formula NO_3^-
Nitrite	An oxide of nitrogen with the molecular formula NO_2^-
Nm^3/hr	"Normal" cubic meters per hour – a measure of air flow normalised to 20^oC and one atmosphere of pressure
Orthophosphate	A form of phosphorus with the formula PO_4. It is biologically available for use by plants, algae and bacterium
PAC	Powdered activated carbon
PDWF	Peak dry weather flow – the peak flow that is expected to enter the plant during dry weather. Is often assumed to be 3x the ADWF
PLC	Programmable logic controller - an electronic device that allows for logical control over a piece of equipment
POEO	Protection of the environment operations (part of the NSW acts governing sewage treatment plants)
PVC	Polyvinyl chloride – a form of plastic used for a variety of the construction of pipes. Various forms are commercially available including un-plasticised (upvc), oriented (opvc) and modified (mpvc)
PWWF	Peak wet weather flow – the flow that is expected to enter the plant during a wet-weather event. Is often assumed to be 5x the ADWF
QA	Quality assurance
REF	Review of environmental factors
RNA	Ribonucleic acid – a macromolecule found within in a cell, is an intermediary between gene coding and protein synthesis
RPZ	Reduced pressure zone device. A type of backflow prevention device used to protect water supplies from contamination
RTU	Remote telemetry unit
SBR	Sequencing batch reactor – a form of suspended growth wastewater treatment technology

Term	Definition
SCADA	Supervisory control and data acquisition. A system operating with coded signals over communication channels to provide control of remote equipment and the acquisition of equipment and sensor data
SDS	Safety data sheet
Sludge Age	Refers to the average 'age' of the sludge in an activated sludge wastewater treatment system. The sludge within the system will, on average, be refreshed once every sludge age
SOP	Standard operating procedure
SRT	Sludge/solids retention time. Also referred to as the 'sludge age'
STP	Sewage treatment plant (nay also refer to Standard Temperature and Pressure)
TDS	Total dissolved solids. Generally a measure of salt concentration or salinity. May be converted to conductivity using a conversion factor
TKN	Total kjeldahl nitrogen – a measure of the Organic nitrogen plus Ammonia nitrogen
TN	Total nitrogen - the concentration of organic plus inorganic nitrogen
TOG/FOG	Total oil and grease/ Fats, oil and grease
TP	Total phosphorus - the concentration of organic plus inorganic phosphorous
TPH	Total Petroleum Hydrocarbons. A measure of (generally polar) hydrocarbons in water. Non-polar hydrocarbons are removed using silica gel
TRH	Total Recoverable Hydrocarbons. A measure of all hydrocarbons (both polar and non-polar) in water
TRH-Silica	Same as TPH
TSS	Total suspended solids
UV	Ultra violet light – an invisible light at a wavelength ranging between 10nm to 400nm
VDC	Volts direct current
VSD/VFD	Variable speed drive/ variable frequency drive - a form of motor control that allows for AC motor speed to be ramped up and down electronically,

Term	Definition
	without the use of a gear-box
VSS	Volatile suspended solids
WTP	Water treatment plant
WWTP/WwTP	Wastewater treatment plant

APPENDIX A:

Curriculum Vitae – David Bristow

Simmonds & Bristow Pty Ltd

The Regional and Remote Water Specialist

DAVID BRISTOW *BE(Chem), MIEAust, CPENG, RPEQ, FAIM*

Managing Director

About David

David is a third generation water engineer with more than 25 years post graduate experience in water and wastewater engineering throughout Australia, PNG, Indonesia and the South Pacific

Qualifications and Affiliations

David completed his Bachelor of Engineering in 1986 at the University of Queensland. He's a Chartered Professional Engineer, member of the Institute of Engineers Australia, the Chemical College of IEAust, The Executive Connection and the Australian Water Association He's also a Registered Professional Engineer of Queensland, and a Fellow of the Australian Institute of Management.

Industry Experience

David is a registered and chartered professional engineer, and a recognized water industry expert in water, wastewater and waste treatment and disposal, water and soil chemistry and microbiology, systems constructions, maintenance and operation, and infrastructure management. He has extensive experience in the design, procurement, construction and operation of water and wastewater reticulation/collection, treatment, storage and reticulation systems across a wide range of technologies and operating environments, as well as assessment and design of land disposal system, effluent outfalls, recycle/reuse for domestic non potable supplies and industrial use, as well as WSUD and sediment and erosion control on land and water courses.

David as extensive experience undertaking modelling of processes, water supply and sewerage and reuse water balances, including dynamic and static steady state modelling, MEDLI modelling of effluent reuse schemes, MUSIC modelling of stormwater systems, Water & Sewer CAD/GEMS modelling of pipe networks, in house dilution and process engineering model design & development to assess impacts on surface and ground water, soils, existing and future infrastructure, and environment and public health.

He has been heavily involved in setting national water industry competency standards and is regularly called in to give expert testimony to the Supreme Court and Planning and Environment Courts in Queensland, the Land & Environment Court of New South Wales, and Supreme Court and Tribunal of Tasmania, as well as providing evidence to the Building Services Tribunal.

David is responsible to each client for the performance of his team and liaison with each client, regulative authorities, project consultants and contractors to ensure each project achieves its objectives.

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Education

- Bachelor of Engineering 1986 - Division of Chemical Engineering U of Qld
- Certificate II - Train the Trainer
- Certificate IV - Workplace Trainer & Assessor

Professional Experience

- Review of hardened concrete testing techniques - Simmonds & Bristow Pty Ltd
- Odour control by natural biodegradation of a hide curing works effluent - FH Edwards
- Review of chlorination sanitation for Hayman Is Resort's 6 ML swimming pool in North Queensland - Maunsell & Partners
- Lake Water quality maintenance system sizing, utilising tidal flushing - Tieney Luke, Yamba
- Detailed evaluation of a piggery effluent treatment plant in South West Queensland - Pittsworth Shire Council
- Evaluation of recreational lake systems water quality (6 lakes) - Albert Shire Council, 1987- 1990
- Evaluation, engineering design, installation & commissioning of polyelectrolyte dosing systems for Teddington Weir WTP - Maryborough City Council, 1987
- Evaluation of water treatment plant for Annan River District, including engineering design of static flocculator and spirator (lime water saturator) - MacDonald Wagner/Cook Shire Council, 1987
- Water mains chlorination and testing: Hendra Wool Corporation, Qld Government Chemical Laboratory, Nathan, Qld Consolidated RutileQld
- Treatment system evaluation and design for liquid transport company - Golden Circle Transport
- Determination and engineering design of Treatment system for mine pit water prior to discharge to the environment - Gold Copper PtyLtd
- Alpha Factor determination of dirty waters - Various (Murgon Leather Co, Aquatec Maxcon, EPCO, Warman International, Walter Constructions)
- Sulphide odour investigation - Hayman Island Resort
- Flow equalisation modifications for Great Keppel Island Resort sewage treatment plant
- Detailed review of water supply and sewerage infrastructure including recommendations and preliminary design of required upgrades and implementation of water quality monitoring program for:
  - Cape York Wilderness Lodge - Badu Is Community
  - Lizard Island Resort- Mornington Is Community
  - Bedarra Bay Resort- Boigu Is Community
  - Bedarra Hideaway Resort- Damley Is Community
  - Great Keppel Island Resort- York Is Community
  - South Molle Island Resort- Coconut Is Community
  - Cradle Mt Lodge - Yam Is Community
  - Keppel Haven Resort - Murray Is Community
  - Hayman Is Resort - Saibai Is Community
  - Heron Is Resort - Maibiag Is Community
  - Silky Oaks Resort - Warrabarls Community
  - Hamilton Is Resort.

Recent Projects

David has recently been responsible for the following projects:

- Expert Witness for a court case involving the EPA and local government concerning a sewage spill and the water quality in the Nerang River
- Design, Commissioning and Training of staff for new sewage treatment plants in several Indigenous communities in Queensland and the Torres Strait
- Detailed review of water supply and sewerage infrastructure, including recommendations and design upgrades, and water quality monitoring for regional resorts in Queensland

- Planning and Environmental Court – Neilsen vs Brisbane City Council - Riverine impacts on sand and gravel processing including sediment and erosion control, sediment transport and stormwater harvesting in a flood plain.
- Planning and Environmental Court – North East Business Park – review of water equality impacts, surface and ground water and acid sulphate soils, sediment erosion control measures including riverine erosion, drudge impacts and channel migration zone assessment.
- Engineering Design and Planning Report, and Business case for putrescible Biogas from organic waste streams including embedded co-generation plant, water reclamation plant and organic fertiliser facility, NSW
- Planning and Environment Court for Heilbron vs Gold Coast City Council (Broad Lakes) - Expert witness in water quality and stormwater management for GCCC
- Application and Approval of network operator and retail operator licenses for sewerage infrastructure under the Water Industry Competition Act administered by NSW IPART.

Routine Sewage Treatment Plant Performance Evaluations

- Tangalooma Island Resort, South Molle Island Resort, Hayman Island Resort, Contiki Whitsunday Resort, Lindeman Is Resort, Hinchenbrook Is Resort, Hamilton Is Resort
- Albert Shire Council – Merrimac, Helensvale, Beenleigh, Burleigh Park
- Redland Shire Council
  - Capalaba
  - Cleveland
  - Mt Cotton
  - Point Lookout
  - Thornside
  - Victoria Point
- Hervey Bay Town Council
  - Pulgul Creek
  - Eli Creek Landsborough Shire Council
  - Caloundra
  - Kawana
- Maleny CSIRO Long Pocket Laboratories (Oxidation Ditch) Australian Airlines Resorts
- Great Keppel Island Resort (Act Sludge)
- Bedarra Bay Resort (RBC)
- Bedarra Hideaway Resort (SBR)
- Dunk Island Resort (SBR)
- Brampton Island Resort (RBC)
- Cape York Wilderness Lodge (Septic Systems)
- Lizard Is Resort (Trickling filter & Act Sludge) P&O Resorts
- Cradle Mt Lodge
- Heron Is Resort (Activated Sludge Seawater Plant - with nutrient removal)
- Lizard Is Resort Activated Sludge - with nutrient Removal)
- Silky Oaks Lodge (Activated Sludge - with Nutrient Removal)
- Brampton Is Resort (RBC & Activated Sludge - with Nutrient Removal)
- Bedarra Bay Resort (RBC & Activated Sludge - with Nutrient Removal)
- Dunk Is Resort (SBR Activated Sludge - Nutrient Removal)

Sewage and Water Treatment Plants - Operator Training Programmes

- Heron Island STP Operators - 1988
- Cradle Mountain Lodge STP Operators - 1990, 1994, 1995
- Binna Burra Lodge STP Operators - 1990
- Parks, W ildlife & Heritage STP Operators - 1990
- MQF PtyLtd WTP Operators - 1991
- South Molle Island WTP, STP Operators - 1991
- Lindeman Island WTP, STP Operators Course - 1992
- Petrosea WTP, STP Operators Course - 1992

- Placer PNG WTP, STP Operators Course - 1992
- Cradle Mountain Lodge STP Operators - 1992
- ARBN! STP Operators Course - 1993
- Gordonstone Coal Management WTP Operators - 1993
- Silky Oaks Lodge STP Operators - 1993, 1995
- Binna Burra Lodge STP Operators - 1993
- BHP Goonyella/Riverside Mine STP & WTP - 1993
- BHP Blackwater Mine STP & WTP Operators - 1993
- Qld Rail STP, WTP & Swimming Pool Operators - 1995
- Palm Is Community WTP & STP short Course and Cert II - 2000
- Leiner Davis Gelatine WWTP (Anaerobic systems) and WTP Cert II & Cert III 2000,
- 2001 & 2002
- Resthaven Retirement Village STP - short course
- Torres Strait Outer Is Communities Cert II in Water Industry Operations 2002-2003
- Darnley Is STP Cert II - Erub Community 2003
- Voyagers Resorts Cape Tribulation Properties - STP Short Course 2003
- P&O Resorts - STP Short Course Dunk Is - 2004
- Development and review of National Water Industry competency standards at AQF level 2-6
- Preparation and writing National Water Industry competency standards at AQF 5&6

Sewage and Wastewater Treatment Plant Operating Manuals and Troubleshooting Guides

- Keppel IslandCSIRO, Long Pocket Laboratories, MQF Pty Ltd, Binna Burra Lodge, South Molle Island, Lindeman Island Resort, Placer PNG, Cradle Mountain Lodge, Petrosea Gas Mine Indonesia, Lake Barrington Rowing Course, Heron Island Resort, Bedarra Bay Resort, Darnley Is Community (Design & Review only)
- Detailed Review of Water and Sewage Treatment Plants Performance and Serviceability, including engineering design and Recommendations for upgrade/improvement with Technical and Economic Justification
- Lake Barrington sewage treatment plant, Tasmania Ben Lomond sewage treatment plant, Tasmania Rest Haven Retirement Village sewage treatment, Qld Australian Resource Recovery water treatment plant, Qld Emu Park Hotel/Motel sewage treatment plant, Qld Tieri Township water treatment plant, Ben Lomond water treatment, Binna Burra Lodge sewage treatment plant, Qld Palmer Tube Mills lube water treatment system, Qld Montville Hotel proposal, review of sewage and water treatment facilities including
- Review of sewage treatment plant requirements and second hand plants for caravan holiday resort proposal, Sunshine Coast, Simon Reed, Architects
- Inspection and Review of campground and ranger station sewage treatment facilities, Cynthia Bay, Tasmania, DeptParks, Wildlife & Heritage
- Inspection and Review of campground sewage treatment facilities, Carnarvon Gorge National Park Qld, Qbuild
- Inspection and Review of Sewage treatment and water treatment systems, Torres Strait Communities of Yam Is, Boigu Is, Saibi Is, Badu Is, Murray Is, Coconut Is, Warrabar Is, St Pauls, Kubin, Yorke Is, Darnley Is, Hammond Is, including statement of fitness for purpose and upgrade recommendations - DNRM Qld
- Inspection & Review of Couran Cove Resort STP to determine plant upgrade requirements, including detailed process modelling of nutrient removal using fixed film technology - Enviroflow Wastewater treatment
- Review of Yam Is, Murray Is, Boigu Is, Saibai Is (Torres Strait) STPs, for performance improvement, including detailed modelling of nutrient removal using fixed film technology - Enviroflow Waste water treatment
- Review of Rendering House wastewater treatment plant, to improve performance, and reduce odours,

Oxygen Uptake/Transfer Determinations to ASCE standards

- Australian Resource Recovery, Diffused Air System, Marsden Plant, Qld
- Ebenezer Mine sewage treatment plant, Diffused Air System, Qld
- CSIRO Long Pocket, Brush Rotor System, Qld
- Murgon Leather Co, Aspirating Surface Aerator System, Qld
- Moree Sewage Treatment Plant surface Aerators - Warman International, NSW
- Rous Sewage Treatment Plant Surface Aerators - Warman International, NSW
- Hat Head Sewage Treatment Plant - Fine Bubble Diffused Aeration - ESI, NSW
- Darnley Is Sewage Treatment Plant Course Bubble Aeration - EPCO, Qld
- Richmond Sewage Treatment Plant Surface Aerators - Warman International NSW
- Wetalla Sewage Treatment Plant - Fine Bubble Diffused Aeration - Rehau, Qld
- Wujal Wujal Sewage Treatment Plant - Course Bubble Aeration - EPCO, Qld

Pilot Plant Treatability Studies

- South Stradbroke Island Resort, water treatment plant evaluation of coagulants and activated carbon systems for colour removal, Tremlett PtyLtd
- Tieri Township water treatment plant, evaluation of polyelectrolyte coagulant supplements, Ullman & Nolan
- Grease trap facility, evaluation of grease-cutting enzymes, Australian Resource Recovery

Process Design and Specification of Treatment Plants

- Printing works waste effluent disposal plant - Redland Times
- Prawn farm dechlorination plant - Department of Primary Industries
- Chlorination plant for Hayman Island swimming pool
- Toxic wastewater treatment plant - John Flynch & Associates
- Eumundi Brewery wastewater treatment plant - John Flynch & Associates
- Heron Island seawater sewage treatment - M.E Wrighton & Associates
- Annan River water treatment plant chemical dosing and flocculation equipment - Macdonald W agner Pty Ltd
- Iron, manganese and fluoride removal plant for Horn Island water supply - Torres Strait Gold Pty Ltd
- Tertiary treatment plant for effluent reuse for irrigation and flow equalisation equipment - Hayman Island sewage treatment plant - Maunsell & Partners
- Water treatment plant design for Doomadgee Aboriginal Community, far north west Queensland
- Process design and economic evaluation of water treatment plant - Stradbroke Island Resort Development - Cardno & Davies
- Process design and economic evaluation of water treatment plant - Great Keppel Island effluent reuse scheme - Australian Airlines
- Process design and economic evaluation of water treatment plant - Mayfair Retirement Resort, Eumundi, TDC Group Pty Ltd
- Process design and economic evaluation of water treatment plant - Brampton Island Resort effluent reuse scheme - Australian Airlines
- Water treatment facility for Great Keppel Island Resort - Australian Airlines
- Cradle Mountain Lodge, Tasmania - sewage treatment plant - M.E Wrighton & Associates
- Waldheim Lodge, Cradle Mountain Heritage Area - sewage treatment plant - M.E Wrighton & Associates
- Pre-treatment plant for plasma cutting torch using Brisbane water - Steelmark Industries
- Yandina Ginger Factory washwater treatment plant
- Specifications and commissioning of polyelectrolyte plant - Maryborough City Council,
- Design, specification and project management of water supply and sewerage facilities for a South Stradbroke Island Resort - Tremlett Pty Ltd
- Review, design and economic appraisal of milling lubricant quality control system - Palmer Tube Mills Process design of Sugar Refinery wastewater treatment plant, EPCO Aust
- Review and redesign of Lake Barrington Rowing Course sewage treatment plant (Tasmania) - M.E Wrighton & Associates
- Process design and Specification of Water Treatment Plant 1300 m3/DMC Coagulation,

sedimentation, filtration, carbon absorption, disinfection (UV and Cl2) with full auto control - Hamilton Island

- Review of boat maintenance wastewater arrangements - Heron Is
- Process Design & Specification for Industrial area WWTP Processes include Coagulation, sedimentation, Carbon Absorption using Biologically Active Carbon, Effluent Recycling - Curragh Mine
- Review, design and specify tannery wastewater treatment plant - Farr Evrat & Associates
- Review, design, specify and project management, meat processing and abattoir factory - MQF Pty Ltd
- Review, design, specify and project management - Binna Burra Lodge sewage treatment plant - Nature Australia
- Design and Specification of marine slipway treatment plant – Tasmania
- Process design of water treatment plant - Placer PNG Ltd
- Review and design of water treatment plant - Port Arthur Historic Site Authority
- Review and design sewage treatment plant for Coles Bay Chateau - M.E Wrighton & Associates
- Review of Marina wastewater treatment system for vessel bilge water discharge -Gladstone
- Process design and commissioning of U.V disinfection system for mine drinking water - Consolidated Rutile
- Process Design and Specification of Prison Waste Water Treatment Plant incorporating Wetlands, Sand Filtration, UV disinfection and effluent irrigation of pasture and forests - Project Services Borallon Correctional Centre
- Process Design of new Water & Sewage infrastructure for Palm Is Aboriginal Community Nth Qld
- Engineering Design of an Acetic Acid Wastewater reclamation plant, including full capital & operating cost estimations - PT Tira Austenite - Indonesia
- Engineering Design of a Motor Vehicle (Hyundi) manufacturing plant wastewater treatment plant, including full capital & operating cost estimations - PT Tira Austenite - Indonesia
- Engineering design of Longreach Water Treatment Plant (Coagulation, Flocculation, sedimentation, filtration plant) - Longreach Shire Council
- Engineering Design & Commissioning of Bedarra Bay STP incl conversion from RBC to Act Sludge with nutrient removal - P&O Resorts
- Engineering Design and Specification of Mornington Is Water Treatment Plant based on direct filtration technology - AF Project Management
- Engineering design of Darnley Is Sewage Treatment Plant including nutrient removal using fixed film technology- EPCO Australia
- Engineering design and specification of Wujal Wujal Sewage Treatment Plant including nutrient removal using fixed film technology- AF Project Management & EPCO Australia
- Engineering Design Review of Darnley Is Sewage Treatment Plant including nutrient removal using fixed film technology- EPCO Australia

Planning Reports

- Nature Australia, Lamington National Park Qld, Water and sewage infrastructure upgrade reports, including capital and operating cost considerations
- Australian Resorts, review of water and sewage infrastructure for 7 island resort communities, including upgrade recommendations
- Palm Is Community Water Supply and Sewerage System upgrade, including full capital and O&M budgets for 10 year lifecycle costings - Neil McKee & Associates Qld
- PT Prima Design - Landfill design review - Central Java regional landfill - Indonesia
- CSR Oberon MDF Plant Water/Wastewater reclamation Plant Upgrade, including BOO proposals for Advance Energy, based on 10 year lifecycle costing, SVA and WACC analysis techniques- NSW
- Devro Teepak Wastewater treatment Plant Upgrade, including BOO proposals for
- Advance Energy, based on 10 year lifecycle costing, SVA and WACC analysis techniques- NSW Australian Hardboards, Wastewater upgrades options report, including 10 year lifecycle costing analysis- Qld
- BHP Coal, Blackwater mine, water and sewerage infrastructure redevelopment and automation report- Qld
- Rockdale Beef Feedlot & Abotoir Water/Wastewater Energy Conversion & reclamation Plant using anaerobic & aerobic biological systems, including BOO proposals for Country Energy, based on 10

year lifecycle costing, SVA and WACC analysis techniques- NSW

- Inspection and Review of Mornington Is Community Water and Sewage Infrastructure, including detailed engineering recommendations for upgrade over 10 years, capex and opex estimates

Investigations

- Lagoon discolouration - Twin Waters 1990 - 1991
- Groundwater contamination at an aerodrome Army 1990 - 1991
- Chlorine demand and water quality survey with recommendations for system upgrades - Beenleigh greater area - Albert Shire Council, 1989
- Sulphide generation in rising mains from industrial estate - Albert Shire Council, 1991
- Water management strategy and sedimentation lagoon sizing and operation - New Hope Collieries, 1990
- Investigation into irrigation dam contamination with township sewage, effects on crop yield and health risks- Tasmania 1990
- Canal discolouration - Noosa Waters – 1991
- Environmental Impact Assessment Marina Development - Logan River
- Contaminated Land Investigations – Site Types
    - Rifle Ranges x2
    - Battery Dump x1
    - Service Stations x 12, including remediation x3
    - Aluminium Anodising Works including remediation
    - Slipway and Workshop
    - Printing Works
    - Small Railway yard
    - Paint Works (factory)

Corrosion Assessments

- Bundaberg area irrigation pipeline - Queensland Resources Commission
- Sand mine cooling water circuit - Consolidated Rutile
- Woongarra Shire Council water supply pipeline
- Childers area irrigation pipeline, Qld Water Resources Commission
- Tip Top Bakeries chilling circuit heat exchanger - Tip Top Bakeries, Qld
- German Creek Coal Preparation plant water sources - Capcoal Management
- Tarong Power Station water sources investigation- Tarong Energy
- Staining Corrosion of Hospital Surgical Instrument Washer and Instruments – QEII
- Isolation Valve and Water Meter corrosion and failure analysis into CO2 corrosion of copper based water reticulation fittings – Various Indigenous Communities - FNQ

MEDLI Modelling, including Land Suitability, Soil, Runoff and Groundwater Impact Assessments (Selection Only)

- Brampton Is Resort STP Effluent Disposal Scheme – Sand and Loam/Flat Coastal
- Bedarra Island Resort STP Effluent Disposal Scheme – Volcanic Soil/Step Slopes
- Silky Oaks Resort STP Effluent Disposal Scheme – Volcanic Soils/Step Slope
- Palm Is Aboriginal Community STP Effluent Disposal Scheme/Sandy Soils/Loams
- People First Retirement Village STP Effluent Disposal Scheme – Sand Soils/Shalow Groundwater
- Huon Aquaculture Fish Factory Effluent Disposal Scheme – Clay and Brown Earth
- Mornington Is STP Effluent Disposal Scheme – Sandy and clay soils
- Couran Point Resort STP Effluent Disposal Scheme – Sand Island, shallow groundwater
- Keppel Haven Resort – STP Effluent Disposal Scheme and Groundwater recharge – Sandy soils
- Mt Isa City – Effluent Reuse Scheme – iron stone soils
- Sheffield Council STP – Effluent disposal River Valley and plateau well drained and water logged clay and red earth soils
- Peregian Caravan Park – STP & Onsite effluent Disposal – Sandy Soils, shallow groundwater
- Heron Is Resort Effluent Disposal – Coral Cay shallow groundwater

- Long Island Resort STP Effluent Disposal sandy soils moderate depth to groundwater
- Lizard Island Resort STP & Effluent Disposal – sandy soils and shallow groundwater
- Dunk Island Resort ST & Effluent Disposal – red/brown earth deep groundwater
- Osprey STP & Effluent Disposal Byron Bay – Clay soils
- Seadrift STP & Effluent Disposal Byron Bay – Sandy Soil shallow Groundwater
- Seaview STP & Effluent disposal Byron Bay – sandy soil shallow groundwater
- Rainbow Shores Stage 2 (6500ep) – Water Recycling Reuse and Land disposal
- Tallowwood Ridge Mullumbimby - STP & Effluent Disposal – red brown soils moderate depth to groundwater
- Port Hinchinbrook Resort STP & Effluent Disposal – sandy soils over ASS shallow groundwater
- Seagrove STP & Effluent Disposal Byron Bay – sandy soils and shallow groundwater
- Majura AFP site Canberra – STP and Effluent Disposal black soils moderate depth to groundwater
- Ella Bay Resort FNQ STP & Effluent Disposal – volcanic and alluvial soil steep slopes.
- Wonga Beach Developments FNQ, 2 development sites – onsite treatment and disposal of effluents sand soils with shallow groundwater

Litigation Support (Selection Only)

- Appearance as expert witness at Local Government Court hearing for development appeal, Esteedog Pty Ltd
- Maleny Golf Course proposal, review of sewage and water treatment facilities including recommendations for suitable processes for effluent reuse, prevention of groundwater contamination Ove Arup & Partners
- Eden Rainforest Sanctuary Retirement Village, review of sewage treatment plant requirements and recommendations for proposal upgrade, Eden Rainforest Sanctuary
- Gold Coast City Council v Heilbronn - Broadlakes - P&E Court Qld - Water Quality & Stormwater management 74 Ha Residential Development on the Merrimac Flood Plain
- Childs v Byron Shire Council - Osprey - L&E Court NSW -Environment impact to surface and groundwater, Stormwater management, On Site Sewage Treatment and disposal of effluents - - 1 Ha, 30 Unit residential Development Byron Bay
- Maunabout v Byron Shire Council - Seadrift - L&E Court NSW - Environment impact to surface and groundwater, Stormwater management, On Site Sewage Treatment and disposal of effluents, groundwater impacts, SEPP 55 contaminated land assessment 1 Ha, 20 Unit residential Development Byron Bay
- People First v Moreton Bay Regional Council – P&E Court QLD - STP & Effluent Disposal, groundwater impacts
- Brio v Byron Shire Council - Seadrift - L&E Court NSW - Environment impact to surface and groundwater, Stormwater management, On Site Sewage Treatment and disposal of effluents groundwater impacts- 1 Ha, 30 Unit residential Development Byron Bay
- Fabcot v Byron Shire Council – L&E Court NSW – Shopping Centre Development – Sewage Treatment Recycled water, soil, surface water and ground water impacts.
- Broken Head Coastal Foundation v Byron Shire Council - L&E Court NSW – Sewage Treatment & Land disposal, surface and groundwater contamination
- Blue Eagle v Beaudesert Shire Council – P&E Court Qld – Stormwater & water quality
- Bundaberg Christian College v Bundaberg City Council – P&E Court Qld – Water supply, Sewerage, effluent disposal, groundwater impacts
- Connelly v Byron Shire Council – L&E Court NSW – STP, Effluent Disposal, Land Contamination, Acid Sulfate Soils, groundwater
- Auspacific v Beaudesert Shire Council – P&E Court QLD – Water Supply, Stormwater, Sewerage
- Pintarn v GCCC – P&E Court – Infrastructure Charges Stormwater
- Delfin v GCC – P&E Court – Infrastructure Charges Stormwater
- Jimboomba Turf v GCCC – Onsite effluent treatment and disposal, Stormwater and sediment and erosion control.
- Purche v Wet Tropics Management Authority – P&E Court – STP & Effluent Disposal
- Geolink v Bennette – Supreme Court NSW – PI Action – Environmental Engineering
- Cullen v Hall – P&E Court – Feedlot water quality, groundwater waste management and stormwater
- Eureka 1 & 2 v GCCC – P&E Court QLD – Industrial Developments Yatala, Stormwater and water

quality

- Lyrebird Ridge v GCCC – P&E Court QLD – STP & Effluent disposal – rainforest & steep slopes
- Friends of Springbrook v GCCC etal – P&E Court QLD – STP & Effluent Disposal – rainforest and steep slopes
- PEET & Ausbuild v Redlands City Council – P&E Court QLD – Water & Sewerage network impacts
- Taipai v GCCC & Logan City Council – P& E Court QLD – Stormwater & water quality
- Tinpeck v Beaudesert Shire Council & Logan City Council – P & E Court Water Supply, Sewerage , Onsiet Effluent disposal, Stormwater.
- Neilsen Quarries v EPA – Kin Kin Quarry EPO Water Quality, Sediment & Erosion Control & Stormwater Management
- Rainbow Shores v Gympie Regional Council, Water Quality, Sediment and Erosion Control, Land Disposal of Effluent, Water Supply and Sewerage Treatment, Water Recycling, Ground Water Impacts
- Rainbow Shores v Gympie Regional Council, Water Quality, Sediment and Erosion Control, Land Disposal of Effluent, Water Supply and Sewerage Treatment, Water Recycling, Ground Water Impacts
- Neilsen vs Brisbane City Council - Riverine impacts on sand and gravel processing including sediment and erosion control, sediment transport and stormwater harvesting in a flood plain.
- North East Business Park – review of water equality impacts, surface and ground water and acid sulphate soils, sediment erosion control measures including marina, riverine erosion, drudge impacts and channel migration zone assessment.

Conferences Attended

- February 1986 - Mini Symposium on "New Engineering Materials, University of Queensland, St Lucia, Brisbane Conducted by Institution of Engineers Australia, Institution of Chemical Engineers, The Plastics and Rubber Institute, The Australasian Corrosion Association, and the Department of Chemical Engineering, University of Queensland
- July 1986 - "Principles of Wastewater Treatment Design and Operation" - Gold Coast, Queensland Conducted by the Department of Chemical Engineering, University of Queensland and The School of Civil Engineering, University of New South Wales
- September 1986 - Pergamon Info line Seminar - Brisbane Queensland, conducted by Saztec Information Retrieval Services, Crows Nest, NSW
- November 1986 - "Treatment and Disposal of Industrial Wastes", Sydney NSW Conducted by the Sydney University Chemical Engineering Association, University of Sydney, NSW
- March 1987 - NATSPEC Educational program - Brisbane
- November 1987 - AWWA Seminar "Water and Sewage for Remote Developments", Brisbane - conducted by Australian Water & Wastewater Association
- May 1988 - Beaudesert '88 LOGOV Seminar for operators of local authority swimming pools, water supply and sewerage systems - Beaudesert, Qld Conducted by Queensland Department of Local Government
- March 1989 - 13th Federal Convention AWWA – Canberra Theme: "Investing in Water Futures: The Australian Water Industry in the 1990's'
- November 1990 - Design and Operation of Wastewater Treatment Ponds, University of Queensland, Department of Chemical Engineering
- February 1991 - Financial Management for Small Business, TAFE
- March 1991 - "Project Management", IRR Brisbane
- May 1991 - Invited participant in review of guidelines for planning and design of sewerage systems - Queensland Water Resources Commission
- April 1993 - AWWA Federal Convention, Jupiter Casino, Gold Coast
- May 1992 - Water Industry Workshop (Formerly Lagou) Capricorn Resort, Yepoon
- March 1992 - 1st National Hazardous and Solid Waste Convention - AWWA, Sydney
- May 1992 - Water Industry Workshop - Water Resources Commission - Yeppoon
- August 1995 - Emerging Technologies - WEF - Toronto
- August 2000 - Water Industry Workshop - Mackay
- July 2001 - Regional Conference AWA - Toowoomba
- June 2002 - Water Industry Workshop - Brisbane Exhibition Brisbane
- June 2004 -Heat Transfer - IEAust Professional Development Program
- July 2008 – Sediment and Erosion Control Workshop – AAE Brisbane

- Oct 2009 – TAMS Local Government Engineering Conference & Tradeshow – Devonport
- Jun 2010 – Taswater Conference & Tradeshow – Hobart
- Aug 2011 – Sustainable Resources Industry Training – Ground Water Hydrology and Impact Assessment.
- 2006–2015 TEC Executive Coaching, Mentoring and Training Programme (TEC33 & 44 & TECR220)
- March 2015 – Lean thinking knowledge and awareness – SA Partners/Cardiff University

Papers Published & Workshop Presentations:

- Sampling Techniques and Considerations Beaudesert '88 LOGOV Seminar, May 1988
- Effluent Reuse in Small Communities, Yeppoon, 1992, Water Industry Workshop, May 1992
- Water, Wastewater and Solid Waste Management for Sustainable Ecotourist Development and Design, Sustainable Design for Ecotourism Seminar - Principles in Practice, Hobart 6 November 1994
- Sampling Techniques for EPA compliance - Australian Water Association Regional Conference - Toowoomba 2001
- Designing and implementation of Monitoring Programs - Brisbane 2001 – ONEDO
- Water Use and Conservation – Coal Industry Workshop Brisbane 2008
- Water Sensitive Urban Design & Stormwater Management – TAMS Conference Tasmania Devonport 2009

Memberships

- Member of Institute of Engineers, Australia
- Member Australian Water & W astewater Association
- Registered Professional Engineer of Queensland
- Associate Fellow of the Australian Institute of Management
- Member of Chemical College of IEAust
- Member of The Executive Connection (TEC)

Association Involvement

- Secretary of Chemical Branch - I.EAust., Queensland Branch-1987
- Board of Management, Australian Indonesian Business Council - 1995 - 1998
- Board of Management and Treasurer, Water Industry Training Association 1995-1998
- Member of the National Water Industry Reference Group - National Utilities & Electrotechnology Industry Training Advisory Board-1995 - 2003

Employment History:

- 1981-1995 Member of Australian Army Reserve - Achieved rank - Captain
- 1989-Present Simmonds & Bristow Pty Ltd - Managing Director & Principal Engineer
- 1986-1989 Simmonds & Bristow Pty Ltd - Chemical Engineer

APPENDIX B:

Leachate Water Quality Results with Comparison Against ANZECC Guidelines and Sewer Acceptance Limits

Moorebank Recycling P/L - Leachate Water Quality Results from ERM Environmental Site Assessment June 2016

NOTE: Highlighted colours indicate the lowest trigger value exceeded with, e.g. a yellow cell exceeds ANZECC 80% protection limits and any higher trigger values from other guidelines. Unshaded cells comply with all limits (if any are applicable).

Test	UoM	LOR	ANZECC ESTUARY TRIGGER LIMITS	ANZECC 80% PROTECTION LIMITS - MARINE WATER	SEWER ACCEPTANCE LIMITS	Min	Max	Average	Surface Water Adjacent Northern boundary of Landfill		Leachate from Landfill																Groundwater Beyond the Landfill Eastern Boundary	
									SW2_130416	SW3_130416	MW11	JK1	JK2	D01_120416	D02_120416	BH202	BH203	BH206	BH207	BH214	BH217	MW6	0229	WSP4757	R01_120416	R01_130416	T01_120416	SKP14	GWB
Ammonia (as N)	mg/L	0.01	0.015	1.7	100	0.61	530	146			60	91	120	59	110	0.61	9.5	42	61	530	250	400						3.1	21
Chloride	mg/L	1	-	-	-	53	3500	1188			1900	88	53	2000	54	771	210	3300	980	1100	300	3500						11000	2100
Nitrate (as N)	mg/L	0.02	0.015	-	-	0.05	0.52	0			0.06		0.52		0.24		0.05											0.21	
Sulphate (as S)	mg/L	5	-	-	2000	120	440	299			440		420	430	390	120	270	160	160									430	
TDS	mg/L	10	-	-	10000	1100	6300	2942			3900	1200	2500	3700	2200	1800	2100	5700	2000	2800	1100	6300						19000	2600
TKN (as N)	mg/L	0.2	-	-	-	1.7	700	172			60	91	120	61	110	1.7	9.5	45	61	700	400	400						1.9	19
TOC	mg/L	5	-	-	-	20	280	87			140	44	27	130	20	57	39	75	73	94	69	280						21	110
TN	mg/L		0.3	-	150	1.7	700	172			60	91	121	61	110	2	10	45	61	700	400	400						2	19
EC (µS/cm)			-	-	14286	1571	9000	4202			5571	1714	3571	5286	3143	2571	3000	8143	2857	4000	1571	9000						27143	3714
Alkali Metals																													
Calcium	mg/L	0.5	-	-	-	14	630	180			21	220	620	22	630	31	190	240	14	49	100	18						160	6
Magnesium	mg/L	0.5	-	-	-	28	120	68			98	72	48	100	48	43	100	120	28	69	43	45						490	23
Potassium	mg/L	0.5	-	-	-	20	770	116			96	28	21	93	20	39	27	85	49	120	49	770						150	35
Sodium	mg/L	0.5	-	-	-	75	1800	687			1100	120	75	1200	76	430	360	1600	540	740	200	1800						3800	550
Heavy Metals																													
Arsenic	mg/L	0.001	-	-	1	0.001	0.006	0.003	0.003	0.003	0.0030			0.0030		0.0050	0.0010	0.0010	0.0020	0.0060	0.0020	0.0030					0.0030		0.0020
Boron	mg/L	0.05	-	-	100	0.09	4.2	1.5	0.98	1.2	1.50	0.80	1.00	1.50	0.83	0.86	1.00	1.70	1.00	3.10	1.70	4.20			0.09			2.20	0.88
Cadmium	mg/L	0.0002	-	0.036	1	0.0003	0.0003	0.0003														0.0003							
Chromium	mg/L	0.001	-	0.1756	3	0.003	0.037	0.012			0.010	0.010	0.012	0.010	0.012	0.003		0.004	0.003	0.037	0.005	0.028					0.011		0.004
Cobalt	mg/L	0.001	-	0.15	5	0.001	0.017	0.004			0.003	0.003	0.001	0.003	0.001	0.001	0.003	0.002		0.017	0.004	0.011							0.005
Copper	mg/L	0.001	-	0.008	5				0.002	0.002												0.001							
Lead	mg/L	0.001	-	0.012	2	0.001	0.001	0.001	0.003																				
Mercury	mg/L	0.0001	-	0.0014	0.03	0.0001	0.0001	0.000												0.0001									
Molybdenum	mg/L	0.005	-	-	100	0.005	0.011	0.008	0.007	0.007							0.005			0.011									
Nickel	mg/L	0.001	-	0.56	3	0.002	0.069	0.015	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.003	0.006	0.004	0.002	0.069	0.045	0.048					0.003		0.009
Selenium	mg/L	0.001	-	-	5	0.001	0.014	0.004	0.001		0.002		0.001	0.002	0.014			0.002	0.001	0.001		0.001					0.010		0.004
Tin	mg/L	0.005	-	-	10	0.013	0.013	0.013												0.013									
Zinc	mg/L	0.001	-	0.043	5	0.001	0.026	0.009	0.016	0.018	0.013	0.001	0.002	0.014		0.013	0.026	0.002	0.006	0.005	0.003	0.006			0.003		0.024	0.023	61.000
Alkalinity (speciated)																													
Bicarbonate alkalinity as CaCO3	mg/L	20	-	-	-	41	3000	1187			71	1600	1100	97	1100		880	570	41	3000	1600	3000						240	
Carbonate alkalinity as CaCO3	mg/L	10	-	-	-																								
Total alkalinity as CaCO3	mg/L	20	-	-	-	41	3000	1187			71	1600	1100	97	1100		880	570	41	3000	1600	3000						240	
BTEX																													
Benzene	mg/L	0.001	-	1.3	0.1	0.003	1.1	0.17				0.003	0.012		0.012					0.014	0.037	0.015		1.10					
Toluene	mg/L	0.001	-	-	0.5	0.002	0.97	0.33				0.004								0.002				0.97					
Ethylbenzene	mg/L	0.001	-	-	1	0.066	0.89	0.48														0.066		0.89					
m&p Xylenes	mg/L	0.002	-	-	-	0.002	0.88	0.30												0.002		0.017		0.88					
o-Xylene	mg/L	0.001	-	-	-	0.001	0.87	0.29				0.001								0.001				0.87					
Total xylenes	mg/L	0.003	-	-	1	0.003	0.88	0.23				0.003								0.003		0.017		0.88					
TRH - 1999 NEPM fractions																													
TRH C6-C9	mg/L	0.02	-	-	-	0.08	0.94	0.37												0.12	0.08	0.34		0.94					
TRH C10-C14	mg/L	0.05	-	-	-	0.12	1.4	0.49			0.24	0.29	0.24	0.62	0.23					0.61	0.66	1.40							
TRH C15-C28	mg/L	0.1	-	-	-	0.20	3.7	1.31			0.60	1.10	0.90	0.90	1.00				0.12	0.20	1.30	3.70							
TRH C29-C36	mg/L	0.1	-	-	-	0.10	0.60	0.28			0.10			0.20							0.10	0.60							
TRH C10-C36	mg/L	0.1	-	-	-	0.32	5.7	1.95			0.94	1.40	1.10	1.70	1.20				0.32	3.10	2.10	5.70							
TRH - 2013 NEPM fractions																													
Napthalene	mg/L	0.01	-	0.12	-	0.02	1.0	0.35												0.02		0.03		1.00					
TRH C6-C10	mg/L	0.02	-	-	-	0.1	0.95	0.39												0.12	0.10	0.38		0.95					
TRH C6-C10 less BTEX	mg/L	0.02	-	-	-	0.06	0.28	0.15												0.10	0.06	0.28							
TRH C10-C16 less Naphthalene	mg/L	0.05	-	-	-	0.1	1.6	0.57			0.33	0.48	0.37	0.61	0.36				0.10	0.83	0.73	1.60					0.24		
TRH - 2013 NEPM fractions																													
TRH C10-C16	mg/L	0.05	-	-	-	0.1	1.6	0.57			0.33	0.48	0.37	0.61	0.36				0.10	0.85	0.73	1.60					0.24		
TRH C16-C34	mg/L	0.1	-	-	-	0.3	4.0	1.2			0.60	0.90	0.80	0.90	0.90				0.30	2.30	1.20	4.00					0.31		
TRH C34-C40	mg/L	0.1	-	-	-	0.1	0.1	0.10														0.10							
Total Petroleum Hydrocarbons			-	-	10																								
C6-C9	mg/L	0.02	-	-	-																								
C10-C14	mg/L	0.05	-	-	-	0.10	0.10	0.10																			0		
C15-C28	mg/L	0.1	-	-	-	0.4	0.4	0.40																			0		
C29-C36	mg/L	0.05	-	-	-	0.06	0.06	0.06																			0		
C10-C36	mg/L	0.05	-	-	-	0.56	0.56	0.56																			1		
PAH																													
Acenaphthene	mg/L	0.001	-	-	-	0.005	0.005	0.005					0.005		0.005														
Fluorene	mg/L	0.001	-	-	-	0.002	0.002	0.002					0.002		0.002														
Naphthalene	mg/L	0.001	-	0.12	-	0.008	0.018	0.014												0.017	0.008	0.018							
Total PAH	mg/L	0.001	-	-	5	0.007	0.021	0.012					0.007		0.007					0.021	0.008	0.018							
Phenols (Halogenated)																													
4-Chloro-3-methylphenol	mg/L	0.01	-	-	-	0.02	0.06	0.04				0.02								0.06									
Total Halogenated Phenol	mg/L	0.01	-	0.72	0.05	0.02	0.06	0.04				0.02								0.06									

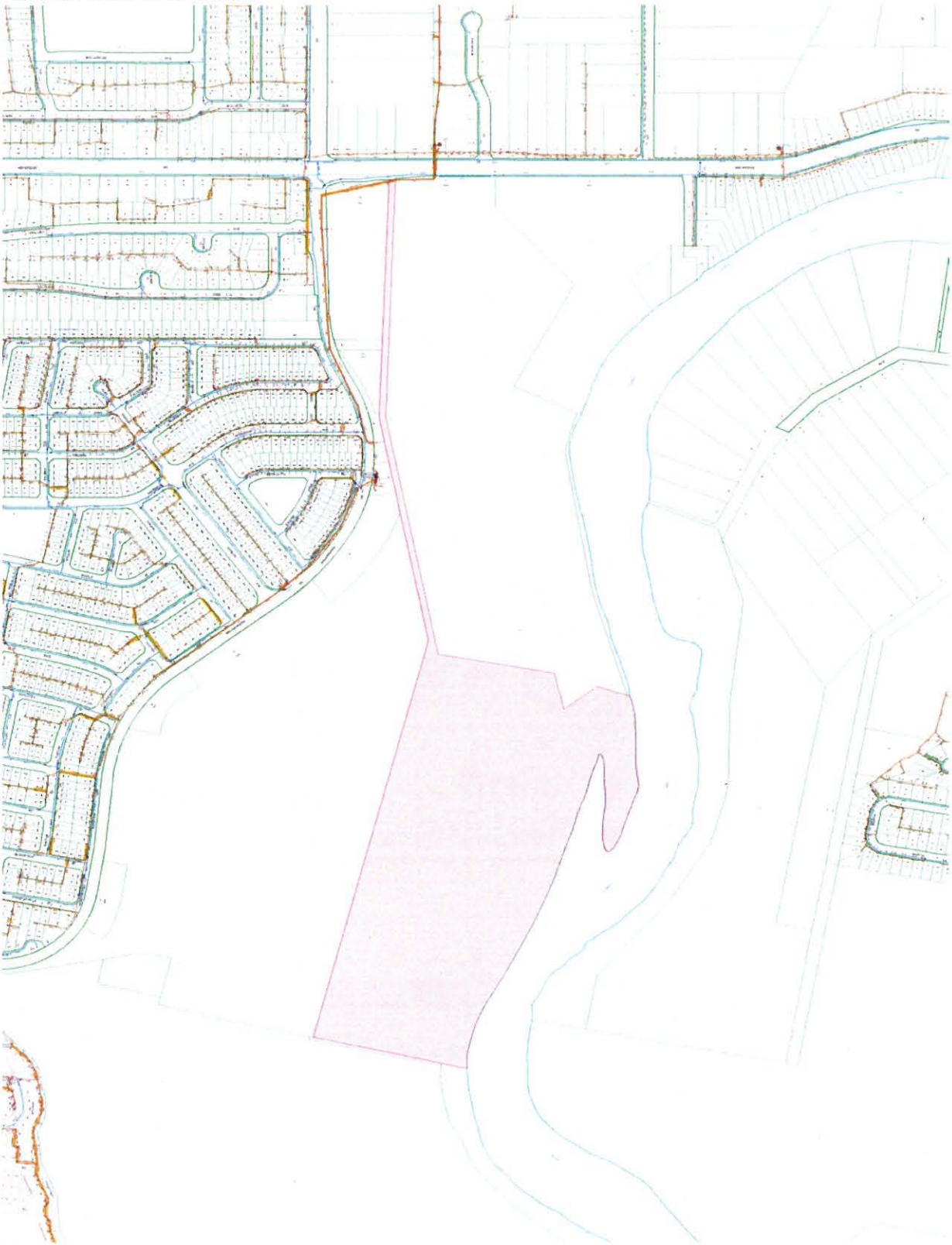
APPENDIX C:

Sydney Water Sewer Access Report

Sydney WATER

Service Location Print

Application Number: 109186



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NOTE: This diagram only indicates availability of a sewer and any sewerage service shown as existing in Sydney Water's records. The existence and position of Sydney Water's sewers, stormwater channels, pipes, mains and structures should be ascertained by inspection of maps available at any of Sydney Water's Customer Centres. Position of structures boundaries and sewerage services shown hereon are approximately only.

Sydney Water Corporation ABN 49 776 225 038
1 Smith St Parramatta 2150 | PO Box 399 Parramatta 2124 | DX 14 Sydney | T 13 20 92 | www.sydneywater.com.au
Delivering essential and sustainable water services for the benefit of the community

Sydney WATER

Asset Information

Legend

Sewer

Sewer Main (with flow arrow & size type text) 225 PVC
Disused Main
Rising Main
Maintenance Hole (with upstream depth to invert) 1.7
Sub-surface chamber
Maintenance Hole with Overflow chamber
Ventshaft EDUCT VSE
Ventshaft INDUCT VSI
Property Connection Point (with chainage to downstream MH) 10.6
Concrete Encased Section Concrete Encased
Terminal Maintenance Shaft TMS
Maintenance Shaft MS
Rodding Point RP
Lamphole
Vertical VERT
Pumping Station SP0882
Sewer Rehabilitation

Pressure Sewer

Pressure Sewer Main
Pump Unit (Alarm, Electrical Cable, Pump Unit)
Property Valve Boundary Assembly
Stop Valve
Reducer / Taper
Flushing Point FP

Vacuum Sewer

Pressure Sewer Main
Division Valve
Vacuum Chamber
Clean Out Point

Stormwater

Stormwater Pipe
Stormwater Channel
Stormwater Gully
Stormwater Maintenance Hole

Property Details

Boundary Line
Easement Line
House Number
Lot Number
Proposed Land
Sydney Water Heritage Site (please call **132 092** and ask for the **Heritage Unit**)

Water

WaterMain - Potable (with size type text) 200 PVC
Disconnected Main - Potable
Proposed Main - Potable
Water Main - Recycled
Special Supply Conditions - Potable
Special Supply Conditions - Recycled
Restrained Joints - Potable
Restrained Joints - Recycled
Hydrant
Maintenance Hole
Stop Valve
Stop Vale with By-pass
Stop Valve with Tapers
Closed Stop Valve
Air Valve
Valve
Scour
Reducer / Taper
Vertical Bends
Reservoir
Recycled Water is shown as per Potable above. Colour as Indicated

Private Mains

Potable Water Main
Recycled Water Main
Sewer Main
Symbols for Private Mains shown grey

NOTE: This diagram only indicates availability of a sewer and any sewerage service shown as existing in Sydney Water's records. The existence and position of Sydney Water's sewers, stormwater channels, pipes, mains and structures should be ascertained by inspection of maps available at any of Sydney Water's Customer Centres. Position of structures boundaries and sewerage services shown hereon are approximately only.

Sydney WATER

Pipe Types

ABS	Acrylonitrile Butadiene Styrene	**AC**	Asbestos Cement
BRICK	Brick	**CI**	Cast Iron
CICL	Cast Iron Cement Lined	**CONC**	Concrete
COPPER	Copper	**DI**	Ductile Iron
DICL	Ductile Iron Cement (mortar) Lined	**DIPL**	Ductile Iron Polymeric Lined
EW	Earthenware	**FIBG**	Fibreglass
FL BAR	Forged Locking Bar	**GI**	Galvanised Iron
GRP	Glass Reinforced Plastics	**HDPE**	High Density Polyethylene
MS	Mild Steel	**MSCL**	Mild Steel Cement Lined
PE	Polyethylene	**PC**	Polymer Concrete
PP	Polypropylene	**PVC**	Polyvinylchloride
PVC - M	Polyvinylchloride, Modified	**PVC - O**	Polyvinylchloride, Oriented
PVC - U	Polyvinylchloride, Unplasticised	**RC**	Reinforced Concrete
RC-PL	Reinforced Concrete Plastics Lined	**S**	Steel
SCL	Steel Cement (mortar) Lined	**SCL IBL**	Steel Cement Lined Internal Bitumen Lined
SGW	Salt Glazed Ware	**SPL**	Steel Polymeric Lined
SS	Stainless Steel	**STONE**	Stone
VC	Vitrified Clay	**WI**	Wrought Iron
WS	Woodstave		

Further Information

Please consult the Dial Before You Dig enquiries page on the Sydney Water website.

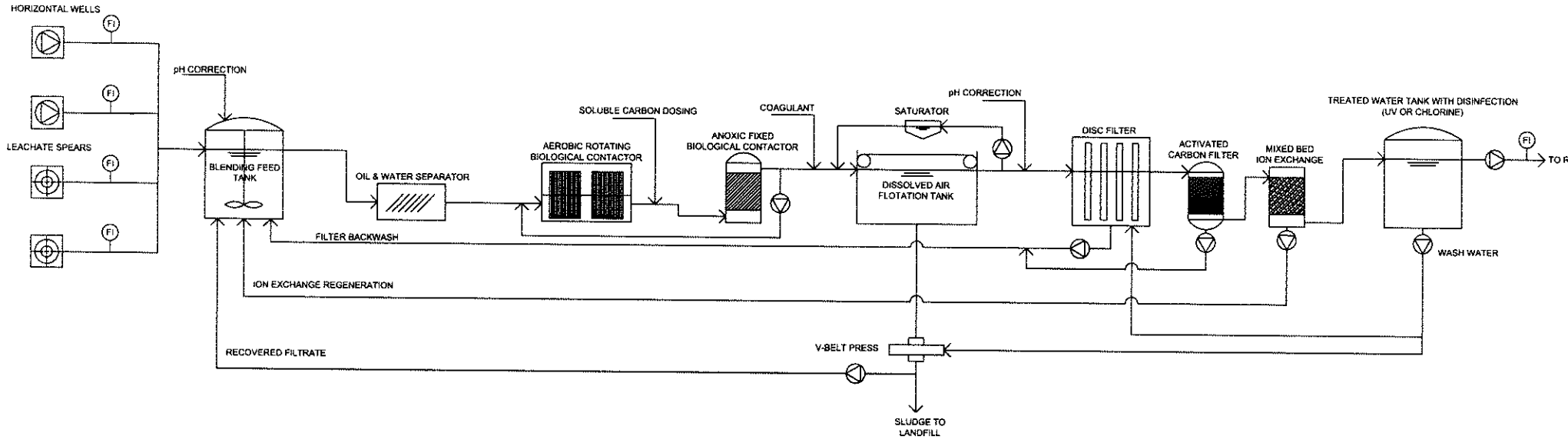
For general enquiries please call the Customer Contact Centre on 132 092

In an emergency, or to notify Sydney Water of damage or threats to its structures, call 13 20 90 (24 hours, 7 days)

NOTE: This diagram only indicates availability of a sewer and any sewerage service shown as existing in Sydney Water's records. The existence and position of Sydney Water's sewers, stormwater channels, pipes, mains and structures should be ascertained by inspection of maps available at any of Sydney Water's Customer Centres. Position of structures boundaries and sewerage services shown hereon are approximately only.

APPENDIX D:

Recommended Treatment Train Process Flow Diagram – River Discharge



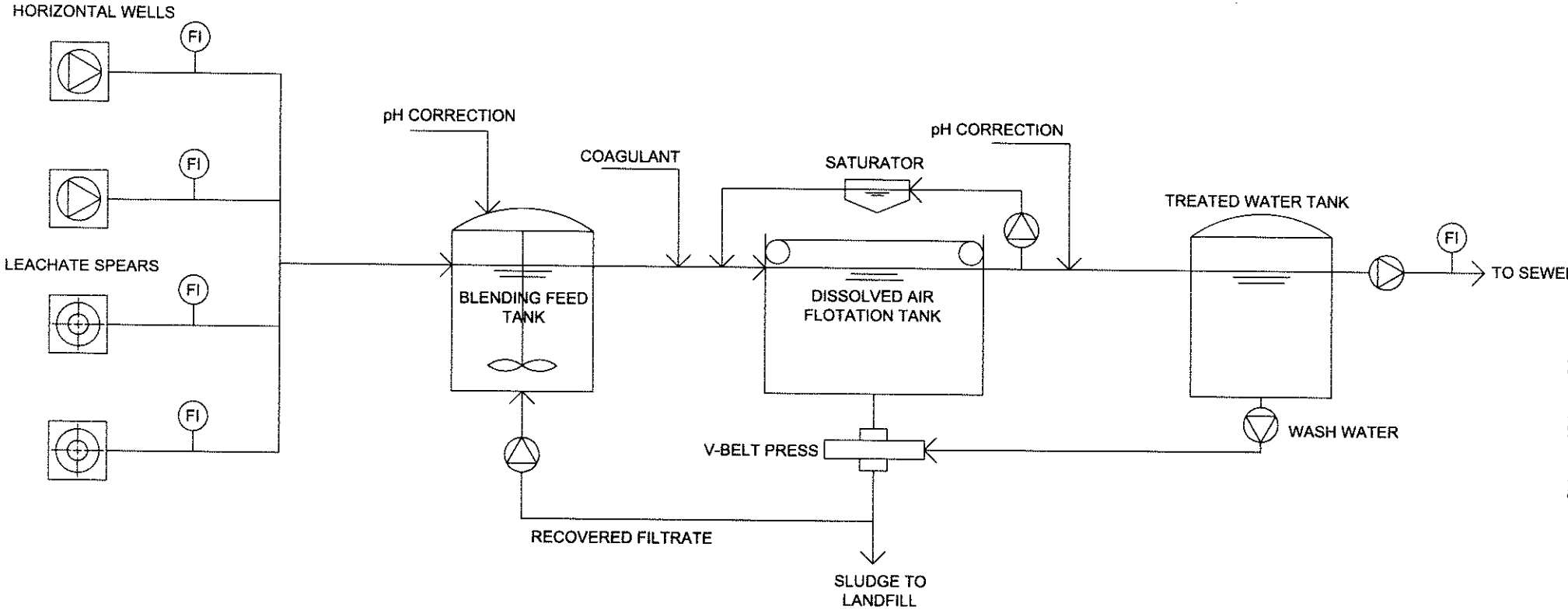
NOTE: FI = FLOW METER WITH TOTALISER

23/08/2016

CLIENT DETAILS: MOOREBANK RECYCLING	JOB NAME: LEACHATE TREATMENT PLANT	REVISION SCHEDULE: B 16/8/16 ADDED ACTIVATED C FILTER MR; A 9/8/16 INITIAL DRAWING MR	DATUM	Simmonds & Bristow Pty Ltd — The Regional and Remote Water Specialist	DRAWING TITLE: DISCHARGE TO RIVER; SCALE: NTS; JOB/PROPOSAL No.: L1607-905; DRAWING STATUS: INFORMATION ONLY; PLOT NUMBER: DATE: 16/8/2016; DWG. No.: L1607-905-001; REV.: B
			DESIGNED: GJB; DRAWN: MR; CHECKED: GJB; SIGNED: ; DATE:		

APPENDIX E:

Recommended Treatment Train Process Flow Diagram – Sewer Discharge



NOTE: FI = FLOW METER WITH TOTALISER

CLIENT DETAILS: MOOREBANK RECYCLING	JOB NAME: LEACHATE TREATMENT PLANT	REVISION SCHEDULE: A	9/8/16	INITIAL DRAWING	MJR	DATUM	
		REV	DATE	COMMENTS	INITIAL	DESIGNED	
						DRAWN	
						CHECKED	
						SIGNED	
						DATE	

Simmonds & Bristow Pty Ltd
The Regional and Remote Water Specialist

DRAWING TITLE: DISPOSAL TO SEWERAGE	SCALE: NTS	23/08/2016	
	JOB/PROPOSAL No: L1607-905		
DRAWING STATUS: FOR INFORMATION	DWG. No: L1607-905-001	REV: A	
PLOT NUMBER:	DATE: 9/8/2016		

APPENDIX F:

Copy of Solicitors Instructions

Mark McDonald & Associates

MARK MCDONALD & ASSOCIATES
LAWYERS PTY LTD
ABN: 31 109 593 731
MARK MCDONALD-DIRECTOR
Town Planning & Environment Lawyer
Accredited Specialist Local Government & Planning Law

Our Ref: MGM/01/239

16 August 2016

Lawyers

Level 29
Chifley Tower
2 Chifley Square
Sydney 2000
Tel: 02 9293 2519
Fax: 02 9375 2121

mgmcdonald@ozemail.com.au

Mr David Bristow
Managing Director
Simmonds Bristow
Unit 2A
40 Reginald Street
ROCKLEA
QLD 4106

By Email

Dear Sir

MOOREBANK RECYCLERS PTY LTD ATS LIVERPOOL CITY COUNCIL & ORS; LAND AND ENVIRONMENT COURT PROCEEDINGS 2016/159652 & 2016/157848

I refer to the above proceedings.

I am instructed by Moorebank Recyclers Pty Ltd (**Moorebank**) in respect of the above proceedings.

Moorebank owns Lot 6 in DP 1065574, being land at Moorebank in New South Wales (**Site**).

I am instructed to retain you to prepare an expert report in the above proceedings.

I note that my firm has previously provided you with a copy of the following documents:

1. Division 2 of Part 31 of the Uniform Civil Procedure Rules 2005 (**UCPR**);

2. The Expert Witness Code of Conduct at Schedule 7 of the UCPR;

3. The amended Statement of Facts and Contentions filed on behalf of Liverpool City Council (**Council**) in the above proceedings (**Council SOFAC**);

4. The amended Statement of Facts and Contentions filed on behalf of Benedict Industries Pty Ltd and Tanlane Pty Ltd (**Benedict**) in the above proceedings (**Benedict SOFAC**);

5. Expert report of Andrew Kosciuszko dated 18 July 2016 (**Kosciuszko Report**) which has been filed on behalf of the Council in the above proceedings; and

6. Expert report of Rowena Salmon dated 4 August 2016 (**Salmon Report**) which has been filed on behalf of the Council in the above proceedings.

You report should:

(a) respond to the following contentions in Part B of the Council SOFAC, to the extent that these contentions relate to the treatment of leachate: 9(b), (d), (e) and (f), 11(c), (d), (f)(iii), (h), (i), (j), (n), (p), (r), (s) and (u) and 12(f)(iii), (h), (k) and (l);

(b) respond to the matters in respect of leachate in the Kosciuszko Report and the Salmon Report; and

(c) prepare an appropriate leachate treatment system to treat leachate from the landfill on the Site.

Yours faithfully

Mark McDonald
Townplanning & Environment Lawyer
Acc. Spec. (Loc. Govt. & Plan. Law)

APPENDIX G:

Pilot Test Results of Mr Mangraviti of UWWS

Unique
WasteWater
Services

Progress Report for Moorebank Groundwater Bench Trial Work

21st July 2016

EIS sampled Job Number E22833K (Moorebank Groundwater) for Concrete Recyclers. 7 sample points were taken in 500mL amber glass bottles and labeled accordingly (19th July 2016). EIS obtained a composite sample from all 7 bottles (MB1) and sent to Envirolab Services (20th July 2016) for a full analysis based on past test results.

Multiple bottles of each sample point were taken for Unique Waste Water Services (UWWS) to conduct various bench testing. Samples were picked up from EIS office at the North Ryde on 20th July 2016.

The following bench tests were performed after combining all 7 samples points to create a composite sample (identical to the untreated sample MB1). On the 21st July, 4 treated samples were returned to EIS for various analyses.

4 Samples labeled as follows:

1 – A (Aeration only)

2 – CT (Chemical treatment)

3 – AC (Activated carbon)

4 – SF (Surface Flocculation)

The aim of this test work was to reduce/eliminate all pollutants in the ground water, for discharge to natural waterway or to sewer.

The entire sample was mixed to ensure homogeneity and processed using the following test procedures:

1. Aeration Treatment (A)

The 7L composite sample was a turbid pale orange colour, containing fine black particulates. In a 20L pail, aeration using a ceramic disc (2.8L/min) was constant for 8hrs. Starting pH was 7.0. After 1hr the pH increased to 8.0 and the colour changed to a more brownish/grey. Odour also changed from strong hydrocarbon to a mild hydrocarbon odour. Strong odour of Ammonia

After 8 hrs the final pH was 8.85 with a faint hydrocarbon odour. Slight turbidity

Samples was taken and placed in appropriate jars for analysis (A).

2. Chemical Treatment:

5L of the above-aerated sample (A) was removed and treated with a flocculent (CT). Within a few minutes large flocs formed, eliminating suspended particles to achieve low turbidity after 10 minutes settling time.

Samples were decanted and placed in appropriate jars for analysis (CT).

The settled solids were light brown in colour and volume was <5% of the wet sample.

3. Filtration Treatment:

1kg of Activated Carbon was washed with distilled water and air-dried. This was used in the filtration treatment stage.

3L of the chemically treated sample (CT) was slowly filtered using the above Activated Carbon (contact time was 30 minutes). No noticeable odour detected.

Samples was taken and placed in appropriate jars for analysis (AC).

4. Surface Flocculation:

A composite sample was prepared using all 7-sample points.

A flocculent was added to create larger particles. Within 15 minutes all suspended solids had settled and the supernatant was clear and colourless. There was still a noticeable hydrocarbon odour.

Samples were decanted and placed in appropriate jars for analysis (SF).

Results:

1. Aeration has reduced light hydrocarbons C6 – C10 but no major reductions in other pollutants.

Elevating pH levels above 9 preferably 10.5 would be effective at stripping Ammonia. Air Scrubbing to capture strong ammonia smells.

2. Chemical treatment after aeration will reduce suspended solids to <50ppm and most heavy metals/TRH.

3. Activated Carbon was excellent at removing organics but not the heavy TRH levels.

4. Surface Flocculation removed suspended solids but not effective for TRH or ammonia removal.

Conclusion:

If sewer discharge is available for this site then this is the preferred option. Ammonia removal using air stripping techniques or biological treatment is needed. Chemical treatment combined with the DAF operation will achieve suspended solids discharge limits to sewer as well as heavy metal/TRH reductions.

Regards,

Eric Mangraviti
(0448 419 004).

ENVIROLAB GROUP
ENVIROLAB SERVICES
mpl

12 Ashley Street, Chatswood, NSW 2067
tel: +61 2 9910 6200

email: sydney@envirolab.com.au
envirolab.com.au

Envirolab Services Pty Ltd · Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 150436

Client:
Environmental Investigation Services
PO Box 976
North Ryde BC
NSW 1670

Attention: Katrina Taylor

Sample log in details:

Your Reference:	**E22833K, Moorebank**
No. of samples:	1 Water
Date samples received / completed instructions received	20/07/16 / 20/07/16

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	25/07/16 / 26/07/16
Date of Preliminary Report:	25/07/2016

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

David Springer
General Manager

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

VOCs in water Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- - ----------	150436-1 MB1 19/07/2016 Water
Date extracted	-	21/07/2016
Date analysed	-	21/07/2016
Dichlorodifluoromethane	µg/L	<10
Chloromethane	µg/L	<10
Vinyl Chloride	µg/L	<10
Bromomethane	µg/L	<10
Chloroethane	µg/L	<10
Trichlorofluoromethane	µg/L	<10
1,1-Dichloroethene	µg/L	<1
Trans-1,2-dichloroethene	µg/L	<1
1,1-dichloroethane	µg/L	<1
Cis-1,2-dichloroethene	µg/L	<1
Bromochloromethane	µg/L	<1
Chloroform	µg/L	<1
2,2-dichloropropane	µg/L	<1
1,2-dichloroethane	µg/L	<1
1,1,1-trichloroethane	µg/L	<1
1,1-dichloropropene	µg/L	<1
Cyclohexane	µg/L	<1
Carbon tetrachloride	µg/L	<1
Benzene	µg/L	12
Dibromomethane	µg/L	<1
1,2-dichloropropane	µg/L	<1
Trichloroethene	µg/L	<1
Bromodichloromethane	µg/L	<1
trans-1,3-dichloropropene	µg/L	<1
cis-1,3-dichloropropene	µg/L	<1
1,1,2-trichloroethane	µg/L	<1
Toluene	µg/L	<1
1,3-dichloropropane	µg/L	<1
Dibromochloromethane	µg/L	<1
1,2-dibromoethane	µg/L	<1
Tetrachloroethene	µg/L	<1
1,1,1,2-tetrachloroethane	µg/L	<1
Chlorobenzene	µg/L	73
Ethylbenzene	µg/L	4
Bromoform	µg/L	<1
m+p-xylene	µg/L	<2
Styrene	µg/L	<1
1,1,2,2-tetrachloroethane	µg/L	<1
o-xylene	µg/L	<1

VOCs in water Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- - ---------- 	150436-1 MB1 19/07/2016 Water
1,2,3-trichloropropane	µg/L	<1
Isopropylbenzene	µg/L	4
Bromobenzene	µg/L	<1
n-propyl benzene	µg/L	3
2-chlorotoluene	µg/L	<1
4-chlorotoluene	µg/L	6
1,3,5-trimethyl benzene	µg/L	<1
Tert-butyl benzene	µg/L	<1
1,2,4-trimethyl benzene	µg/L	3
1,3-dichlorobenzene	µg/L	<1
Sec-butyl benzene	µg/L	<1
1,4-dichlorobenzene	µg/L	13
4-isopropyl toluene	µg/L	<1
1,2-dichlorobenzene	µg/L	1
n-butyl benzene	µg/L	<1
1,2-dibromo-3-chloropropane	µg/L	<1
1,2,4-trichlorobenzene	µg/L	<1
Hexachlorobutadiene	µg/L	<1
1,2,3-trichlorobenzene	µg/L	<1
Surrogate Dibromofluoromethane	%	89
Surrogate toluene-d8	%	87
Surrogate 4-BFB	%	89

vTRH(C6-C10)/BTEXN in Water		
Our Reference:	UNITS	150436-1
Your Reference	----------	MB1
	-	
Date Sampled	----------	19/07/2016
Type of sample		Water
Date extracted	-	21/07/2016
Date analysed	-	21/07/2016
$TRHC_6$ - C_9	µg/L	130
$TRHC_6$ - C_{10}	µg/L	130
$TRHC_6$ - C_{10} less BTEX (F1)	µg/L	110
Benzene	µg/L	12
Toluene	µg/L	<1
Ethylbenzene	µg/L	4
m+p-xylene	µg/L	<2
o-xylene	µg/L	<1
Naphthalene	µg/L	23
Surrogate Dibromofluoromethane	%	89
Surrogate toluene-d8	%	87
Surrogate 4-BFB	%	89

svTRH (C10-C40) in Water		
Our Reference:	UNITS	150436-1
Your Reference	----------	MB1
	-	
Date Sampled	----------	19/07/2016
Type of sample		Water
Date extracted	-	21/07/2016
Date analysed	-	22/07/2016
$TRHC_{10}$ - C_{14}	µg/L	320
$TRHC_{15}$ - C_{28}	µg/L	1,300
$TRHC_{29}$ - C_{36}	µg/L	<100
$TRH>C_{10}$ - C_{16}	µg/L	510
$TRH>C_{10}$ - C_{16} less Naphthalene (F2)	µg/L	490
$TRH>C_{16}$ - C_{34}	µg/L	1,100
$TRH>C_{34}$ - C_{40}	µg/L	<100
Surrogate o-Terphenyl	%	99

OCP in water - Trace level		
Our Reference:	UNITS	150436-1
Your Reference	----------	MB1
	-	
Date Sampled	----------	19/07/2016
Type of sample		Water
Date extracted	-	22/07/2016
Date analysed	-	25/07/2016
HCB	µg/L	<0.001
alpha-BHC	µg/L	<0.001
gamma-BHC	µg/L	<0.001
beta-BHC	µg/L	<0.001
Heptachlor	µg/L	<0.001
delta-BHC	µg/L	<0.001
Aldrin	µg/L	<0.001
Heptachlor Epoxide	µg/L	<0.001
gamma-Chlordane	µg/L	0.003
alpha-Chlordane	µg/L	0.003
Endosulfan I	µg/L	<0.001
pp-DDE	µg/L	<0.001
Dieldrin	µg/L	0.008
Endrin	µg/L	<0.001
pp-DDD	µg/L	<0.001
Endosulfan II	µg/L	<0.002
DDT	µg/L	<0.001
Endosulfan Sulphate	µg/L	<0.03
Mirex	µg/L	<0.002
Methoxychlor	µg/L	<0.001
Surrogate TCMX	%	110

HM in water - dissolved		
Our Reference:	UNITS	150436-1
Your Reference	----------	MB1
	-	
Date Sampled	----------	19/07/2016
Type of sample		Water
Date prepared	-	21/07/2016
Date analysed	-	21/07/2016
Arsenic-Dissolved	µg/L	3
Boron-Dissolved	µg/L	1,800
Beryllium-Dissolved	µg/L	<0.5
Cadmium-Dissolved	µg/L	<0.1
Cobalt-Dissolved	µg/L	6
Chromium-Dissolved	µg/L	10
Copper-Dissolved	µg/L	<1
Mercury-Dissolved	µg/L	<0.05
Manganese-Dissolved	µg/L	290
Nickel-Dissolved	µg/L	39
Lead-Dissolved	µg/L	<1
Zinc-Dissolved	µg/L	5

Miscellaneous Inorganics		
Our Reference:	UNITS	150436-1
Your Reference	----------	MB1
	-	
Date Sampled	----------	19/07/2016
Type of sample		Water
Date prepared	-	20/07/2016
Date analysed	-	20/07/2016
Ammonia as N in water	mg/L	200

Method ID	Methodology Summary
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Org-012	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS.
Metals-022 ICP-MS	Determination of various metals by ICP-MS.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Soils are analysed following a KCl extraction.

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
Date analysed	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
Dichlorodifluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Chloromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Vinyl Chloride	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Bromomethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Chloroethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Trichlorofluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
1,1-Dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Trans-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	98%
Cis-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Chloroform	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	105%
2,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	99%
1,1,1-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	95%
1,1-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Cyclohexane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Carbon tetrachloride	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Dibromomethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Trichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	89%
Bromodichloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	98%
trans-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
cis-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1,2-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Dibromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	97%
1,2-dibromoethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Tetrachloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	93%
1,1,1,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Chlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Ethylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromoform	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
m+p-xylene	µg/L	2	Org-013	<2	[NT]	[NT]	[NR]	[NR]
Styrene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1,2,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
o-xylene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
1,2,3-trichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Isopropylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
n-propyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
2-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
4-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3,5-trimethyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Tert-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,4-trimethyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Sec-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,4-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
4-isopropyl toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
n-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dibromo-3-chloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,4-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Hexachlorobutadiene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,3-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-013	98	[NT]	[NT]	LCS-W1	96%
Surrogate toluene-d8	%		Org-013	91	[NT]	[NT]	LCS-W1	103%
Surrogate 4-BFB	%		Org-013	85	[NT]	[NT]	LCS-W1	100%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
Date analysed	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
TRHC6 - C9	µg/L	10	Org-016	<10	[NT]	[NT]	LCS-W1	94%
TRHC6 - C10	µg/L	10	Org-016	<10	[NT]	[NT]	LCS-W1	94%
Benzene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	98%
Toluene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	95%
Ethylbenzene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	91%
m+p-xylene	µg/L	2	Org-016	<2	[NT]	[NT]	LCS-W1	92%
o-xylene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	95%
Naphthalene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-016	98	[NT]	[NT]	LCS-W1	96%
Surrogate toluene-d8	%		Org-016	91	[NT]	[NT]	LCS-W1	103%
Surrogate 4-BFB	%		Org-016	85	[NT]	[NT]	LCS-W1	100%

QUALITY CONTROL svTRH (C10-C40) in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
Date analysed	-			21/07/2016	[NT]	[NT]	LCS-W1	21/07/2016
TRHC10 - C14	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	110%
TRHC15 - C28	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	113%
TRHC29 - C36	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	125%
TRH>C10 - C16	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	110%
TRH>C16 - C34	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	113%
TRH>C34 - C40	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	125%
Surrogate o-Terphenyl	%		Org-003	60	[NT]	[NT]	LCS-W1	90%

QUALITY CONTROL OCP in water - Trace level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
Date analysed	-			25/07/2016	[NT]	[NT]	LCS-W1	25/07/2016
HCB	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
alpha-BHC	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	122%
gamma-BHC	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
beta-BHC	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	130%
Heptachlor	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	112%
delta-BHC	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
Aldrin	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	130%
Heptachlor Epoxide	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	113%

QUALITY CONTROL OCP in water - Trace level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
gamma-Chlordane	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
alpha-Chlordane	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
Endosulfan I	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
pp-DDE	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	120%
Dieldrin	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	111%
Endrin	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	100%
pp-DDD	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	113%
Endosulfan II	µg/L	0.002	Org-005	<0.002	[NT]	[NT]	[NR]	[NR]
DDT	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	LCS-W1	133%
Mirex	µg/L	0.002	Org-012	<0.002	[NT]	[NT]	[NR]	[NR]
Methoxychlor	µg/L	0.001	Org-005	<0.001	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%		Org-005	90	[NT]	[NT]	LCS-W1	105%
QUALITY CONTROL HM in water - dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			21/07/2016	[NT]	[NT]	LCS-W2	21/07/2016
Date analysed	-			21/07/2016	[NT]	[NT]	LCS-W2	21/07/2016
Arsenic-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	99%
Boron-Dissolved	µg/L	5	Metals-022 ICP-MS	<5	[NT]	[NT]	LCS-W2	105%
Beryllium-Dissolved	µg/L	0.5	Metals-022 ICP-MS	<0.5	[NT]	[NT]	LCS-W2	103%
Cadmium-Dissolved	µg/L	0.1	Metals-022 ICP-MS	<0.1	[NT]	[NT]	LCS-W2	105%
Cobalt-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	98%
Chromium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	94%
Copper-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	93%
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	[NT]	[NT]	LCS-W2	100%
Manganese-Dissolved	µg/L	5	Metals-022 ICP-MS	<5	[NT]	[NT]	LCS-W2	97%
Nickel-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	99%
Lead-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	104%
Zinc-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W2	100%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			20/07/2016	[NT]	[NT]	LCS-W1	20/07/2016
Date analysed	-			20/07/2016	[NT]	[NT]	LCS-W1	20/07/2016
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	[NT]	[NT]	LCS-W1	104%

Report Comments:

OCP analysed by MPL Laboratories, report number 183501
OCP: PQL has been raised due to interference from the sample matrix.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NR: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

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CERTIFICATE OF ANALYSIS 150529

Client:
Environmental Investigation Services
PO Box 976
North Ryde BC
NSW 1670

Attention: K Taylor

Sample log in details:

Your Reference:	**E22833K, Moorebank**
No. of samples:	4 waters
Date samples received / completed instructions received	21/07/16 / 21/07/16

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

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Results Approved By:

David Springer
General Manager

VOCs in water Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-3 3-AC Water	150529-4 4-SF Water
Date extracted	-	22/07/2016	22/07/2016
Date analysed	-	22/07/2016	22/07/2016
Dichlorodifluoromethane	µg/L	<10	<10
Chloromethane	µg/L	<10	<10
Vinyl Chloride	µg/L	<10	<10
Bromomethane	µg/L	<10	<10
Chloroethane	µg/L	<10	<10
Trichlorofluoromethane	µg/L	<10	<10
1,1-Dichloroethene	µg/L	<1	<1
Trans-1,2-dichloroethene	µg/L	<1	<1
1,1-dichloroethane	µg/L	<1	<1
Cis-1,2-dichloroethene	µg/L	<1	<1
Bromochloromethane	µg/L	<1	<1
Chloroform	µg/L	<1	<1
2,2-dichloropropane	µg/L	<1	<1
1,2-dichloroethane	µg/L	<1	<1
1,1,1-trichloroethane	µg/L	<1	<1
1,1-dichloropropene	µg/L	<1	<1
Cyclohexane	µg/L	<1	<1
Carbon tetrachloride	µg/L	<1	<1
Benzene	µg/L	<1	8
Dibromomethane	µg/L	<1	<1
1,2-dichloropropane	µg/L	<1	<1
Trichloroethene	µg/L	<1	<1
Bromodichloromethane	µg/L	<1	<1
trans-1,3-dichloropropene	µg/L	<1	<1
cis-1,3-dichloropropene	µg/L	<1	<1
1,1,2-trichloroethane	µg/L	<1	<1
Toluene	µg/L	1	<1
1,3-dichloropropane	µg/L	<1	<1
Dibromochloromethane	µg/L	<1	<1
1,2-dibromoethane	µg/L	<1	<1
Tetrachloroethene	µg/L	<1	<1
1,1,1,2-tetrachloroethane	µg/L	<1	<1
Chlorobenzene	µg/L	<1	45
Ethylbenzene	µg/L	<1	2
Bromoform	µg/L	<1	<1
m+p-xylene	µg/L	<2	<2
Styrene	µg/L	<1	<1
1,1,2,2-tetrachloroethane	µg/L	<1	<1
o-xylene	µg/L	<1	<1
1,2,3-trichloropropane	µg/L	<1	<1

VOCs in water Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-3 3-AC Water	150529-4 4-SF Water
Isopropylbenzene	µg/L	<1	1
Bromobenzene	µg/L	<1	<1
n-propyl benzene	µg/L	<1	<1
2-chlorotoluene	µg/L	<1	<1
4-chlorotoluene	µg/L	<1	<1
1,3,5-trimethyl benzene	µg/L	<1	<1
Tert-butyl benzene	µg/L	<1	<1
1,2,4-trimethyl benzene	µg/L	<1	1
1,3-dichlorobenzene	µg/L	<1	<1
Sec-butyl benzene	µg/L	<1	<1
1,4-dichlorobenzene	µg/L	<1	5
4-isopropyl toluene	µg/L	<1	<1
1,2-dichlorobenzene	µg/L	<1	<1
n-butyl benzene	µg/L	<1	<1
1,2-dibromo-3-chloropropane	µg/L	<1	<1
1,2,4-trichlorobenzene	µg/L	<1	<1
Hexachlorobutadiene	µg/L	<1	<1
1,2,3-trichlorobenzene	µg/L	<1	<1
Surrogate Dibromofluoromethane	%	103	98
Surrogate toluene-d8	%	91	88
Surrogate 4-BFB	%	84	95

vTRH(C6-C10)/BTEXN in Water Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-2 2-CT Water	150529-3 3-AC Water	150529-4 4-SF Water
Date extracted	-	22/07/2016	22/07/2016	22/07/2016
Date analysed	-	22/07/2016	22/07/2016	22/07/2016
TRHC6 - C9	µg/L	34	<10	83
TRHC6 - C10	µg/L	42	14	100
TRHC6 - C10 less BTEX (F1)	µg/L	34	13	91
Benzene	µg/L	<1	<1	8
Toluene	µg/L	2	1	<1
Ethylbenzene	µg/L	<1	<1	2
m+p-xylene	µg/L	2	<2	<2
o-xylene	µg/L	3	<1	<1
Naphthalene	µg/L	<1	<1	16
Surrogate Dibromofluoromethane	%	99	103	98
Surrogate toluene-d8	%	101	91	88
Surrogate 4-BFB	%	96	84	95

svTRH (C10-C40) in Water Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-2 2-CT Water	150529-3 3-AC Water	150529-4 4-SF Water
Date extracted	-	22/07/2016	22/07/2016	22/07/2016
Date analysed	-	22/07/2016	22/07/2016	22/07/2016
$TRHC_{10}$ - C_{14}	µg/L	350	120	500
$TRHC_{15}$ - C_{28}	µg/L	1,500	670	3,100
$TRHC_{29}$ - C_{36}	µg/L	<100	<100	290
$TRH{>}C_{10}$ - C_{16}	µg/L	570	190	920
$TRH{>}C_{10}$ - C_{16} less Naphthalene (F2)	µg/L	[NA]		
$TRH{>}C_{16}$ - C_{34}	µg/L	1,300	620	2,900
$TRH{>}C_{34}$ - C_{40}	µg/L	<100	<100	150
Surrogate o-Terphenyl	%	77	80	#

OCP in water - low level Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-3 3-AC Water	150529-4 4-SF Water
Date extracted	-	22/07/2016	22/07/2016
Date analysed	-	22/07/2016	22/07/2016
HCB	µg/L	<0.01	0.02
alpha-BHC	µg/L	<0.01	<0.01
gamma-BHC	µg/L	<0.01	<0.01
beta-BHC	µg/L	<0.01	<0.01
Heptachlor	µg/L	<0.01	<0.01
delta-BHC	µg/L	<0.01	0.03
Aldrin	µg/L	<0.01	<0.01
Heptachlor Epoxide	µg/L	<0.01	<0.01
gamma-Chlordane	µg/L	<0.01	<0.01
alpha-Chlordane	µg/L	<0.01	<0.01
Endosulfan I	µg/L	<0.01	<0.01
pp-DDE	µg/L	<0.01	0.02
Dieldrin	µg/L	<0.01	0.02
Endrin	µg/L	<0.01	<0.01
pp-DDD	µg/L	<0.01	<0.01
Endosulfan II	µg/L	<0.01	<0.01
DDT	µg/L	0.01	<0.006
Endrin Aldehyde	µg/L	<0.01	<0.01
Endosulfan Sulphate	µg/L	<0.01	<0.01
Methoxychlor	µg/L	<0.01	<0.01
Surrogate TCMX	%	#	#

HM in water - dissolved Our Reference: Your Reference Type of sample	UNITS ---------- - ----------	150529-2 2-CT Water	150529-3 3-AC Water	150529-4 4-SF Water
Date prepared	-	22/07/2016	22/07/2016	22/07/2016
Date analysed	-	22/07/2016	22/07/2016	22/07/2016
Arsenic-Dissolved	µg/L	3	3	3
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	7	5	7
Copper-Dissolved	µg/L	2	7	7
Lead-Dissolved	µg/L	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	51	44	39
Zinc-Dissolved	µg/L	2	10	17
Boron-Dissolved	µg/L	2,100	1,900	2,000
Beryllium-Dissolved	µg/L	<0.5	<0.5	<0.5
Cobalt-Dissolved	µg/L	7	6	3
Molybdenum-Dissolved	µg/L	6	8	4

Miscellaneous Inorganics					
Our Reference:	UNITS	150529-1	150529-2	150529-3	150529-4
Your Reference	----------	1-A	2-CT	3-AC	4-SF
Type of sample	- ----------	Water	Water	Water	Water
Date prepared	-	21/07/2016	21/07/2016	21/07/2016	21/07/2016
Date analysed	-	21/07/2016	21/07/2016	21/07/2016	21/07/2016
pH	pH Units	8.6	8.5	7.8	7.5
Ammonia as N in water	mg/L	190	170	160	150

Method ID	Methodology Summary
Org-013	Water samples are analysed directly by purge and trap GC-MS.
Org-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
Org-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-005	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC with dual ECD's.
Metals-022 ICP-MS	Determination of various metals by ICP-MS.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Soils are analysed following a KCl extraction.

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
Date analysed	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
Dichlorodifluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Chloromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Vinyl Chloride	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Bromomethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Chloroethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
Trichlorofluoromethane	µg/L	10	Org-013	<10	[NT]	[NT]	[NR]	[NR]
1,1-Dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Trans-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	73%
Cis-1,2-dichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Chloroform	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	74%
2,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	76%
1,1,1-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	78%
1,1-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Cyclohexane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Carbon tetrachloride	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Dibromomethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Trichloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromodichloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	74%
trans-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
cis-1,3-dichloropropene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1,2-trichloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3-dichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Dibromochloromethane	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	76%
1,2-dibromoethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Tetrachloroethene	µg/L	1	Org-013	<1	[NT]	[NT]	LCS-W1	80%
1,1,1,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Chlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Ethylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromoform	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
m+p-xylene	µg/L	2	Org-013	<2	[NT]	[NT]	[NR]	[NR]
Styrene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,1,2,2-tetrachloroethane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
o-xylene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL VOCs in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
1,2,3-trichloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Isopropylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Bromobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
n-propyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
2-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
4-chlorotoluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3,5-trimethylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Tert-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,4-trimethylbenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,3-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Sec-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,4-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
4-isopropyl toluene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
n-butyl benzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2-dibromo-3-chloropropane	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,4-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Hexachlorobutadiene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
1,2,3-trichlorobenzene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-013	91	[NT]	[NT]	LCS-W1	89%
Surrogate toluene-d8	%		Org-013	93	[NT]	[NT]	LCS-W1	101%
Surrogate 4-BFB	%		Org-013	82	[NT]	[NT]	LCS-W1	83%

QUALITY CONTROL vTRH(C6-C10)/BTEXN in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
Date analysed	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
TRHC6 - C9	µg/L	10	Org-016	<10	[NT]	[NT]	LCS-W1	73%
TRHC6 - C10	µg/L	10	Org-016	<10	[NT]	[NT]	LCS-W1	73%
Benzene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	76%
Toluene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	75%
Ethylbenzene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	71%
m+p-xylene	µg/L	2	Org-016	<2	[NT]	[NT]	LCS-W1	72%
o-xylene	µg/L	1	Org-016	<1	[NT]	[NT]	LCS-W1	71%
Naphthalene	µg/L	1	Org-013	<1	[NT]	[NT]	[NR]	[NR]
Surrogate Dibromofluoromethane	%		Org-016	101	[NT]	[NT]	LCS-W1	89%
Surrogate toluene-d8	%		Org-016	99	[NT]	[NT]	LCS-W1	101%
Surrogate 4-BFB	%		Org-016	101	[NT]	[NT]	LCS-W1	83%
QUALITY CONTROL svTRH (C10-C40) in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
Date analysed	-			22/07/2016	[NT]	[NT]	LCS-W1	22/07/2016
TRHC10 - C14	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	114%
TRHC15 - C28	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	108%
TRHC29 - C36	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	125%
TRH>C10 - C16	µg/L	50	Org-003	<50	[NT]	[NT]	LCS-W1	114%
TRH>C16 - C34	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	108%
TRH>C34 - C40	µg/L	100	Org-003	<100	[NT]	[NT]	LCS-W1	125%
Surrogate o-Terphenyl	%		Org-003	67	[NT]	[NT]	LCS-W1	91%
QUALITY CONTROL OCP in water - low level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			22/07/2016	[NT]	[NT]	LCS-W2	22/07/2016
Date analysed	-			22/07/2016	[NT]	[NT]	LCS-W2	22/07/2016
HCB	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
alpha-BHC	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	92%
gamma-BHC	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
beta-BHC	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	77%
Heptachlor	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	91%
delta-BHC	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
Aldrin	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	113%
Heptachlor Epoxide	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	85%
gamma-Chlordane	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]

QUALITY CONTROL OCP in water - low level	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
alpha-Chlordane	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
Endosulfan I	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
pp-DDE	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	94%
Dieldrin	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	91%
Endrin	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	99%
pp-DDD	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	89%
Endosulfan II	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
DDT	µg/L	0.006	Org-005	<0.006	[NT]	[NT]	[NR]	[NR]
Endrin Aldehyde	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
Endosulfan Sulphate	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	LCS-W2	79%
Methoxychlor	µg/L	0.01	Org-005	<0.01	[NT]	[NT]	[NR]	[NR]
Surrogate TCMX	%		Org-005	75	[NT]	[NT]	LCS-W2	92%
QUALITY CONTROL HM in water - dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			22/07/2016	[NT]	[NT]	LCS-W3	22/07/2016
Date analysed	-			22/07/2016	[NT]	[NT]	LCS-W3	22/07/2016
Arsenic-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	93%
Cadmium-Dissolved	µg/L	0.1	Metals-022 ICP-MS	<0.1	[NT]	[NT]	LCS-W3	105%
Chromium-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	90%
Copper-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	91%
Lead-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	104%
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	[NT]	[NT]	LCS-W3	98%
Nickel-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	92%
Zinc-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	96%
Boron-Dissolved	µg/L	5	Metals-022 ICP-MS	<5	[NT]	[NT]	LCS-W3	111%
Beryllium-Dissolved	µg/L	0.5	Metals-022 ICP-MS	<0.5	[NT]	[NT]	LCS-W3	110%
Cobalt-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	91%
Molybdenum-Dissolved	µg/L	1	Metals-022 ICP-MS	<1	[NT]	[NT]	LCS-W3	97%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			21/07/2016	150529-1	21/07/2016 II 21/07/2016	LCS-W1	21/07/2016
Date analysed	-			21/07/2016	150529-1	21/07/2016 II 21/07/2016	LCS-W1	21/07/2016
pH	pH Units		Inorg-001	[NT]	150529-1	8.6 II 8.6 II RPD: 0	LCS-W1	101%
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	150529-1	190 II 190 II RPD: 0	LCS-W1	100%

QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	150529-2	21/07/2016
Date analysed	-	[NT]	[NT]	150529-2	21/07/2016
pH	pH Units	[NT]	[NT]	[NR]	[NR]
Ammonia as N in water	mg/L	[NT]	[NT]	150529-2	#

Report Comments:

MISC_INORG: # Percent recovery is not possible to report due to the high concentration of the compound/s in the sample/s. However an acceptable recovery was obtained for the LCS.

TRH_W_NEPM:# Percent recovery is not possible to report as the high concentration of analytes in the sample/s have caused interference.

OC_W_LL_ECD: # Percent recovery is not possible to report due to interference from analytes (other than those being tested) in the sample/s.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NR: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.