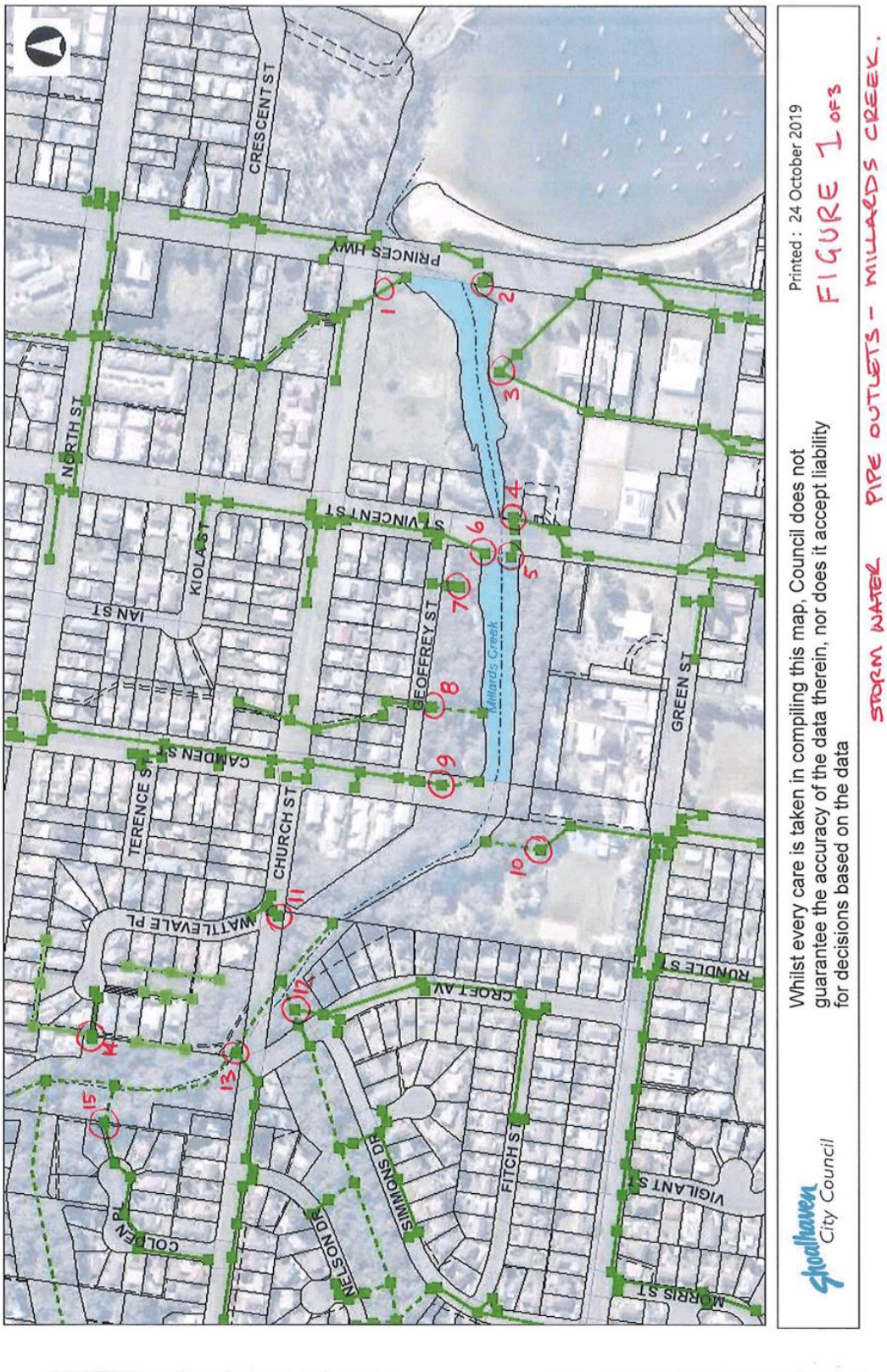
Strategy and Assets Committee

Meeting Date: Tuesday, 12 November, 2019
Location: Council Chambers, City Administrative Centre, Bridge Road, Nowra

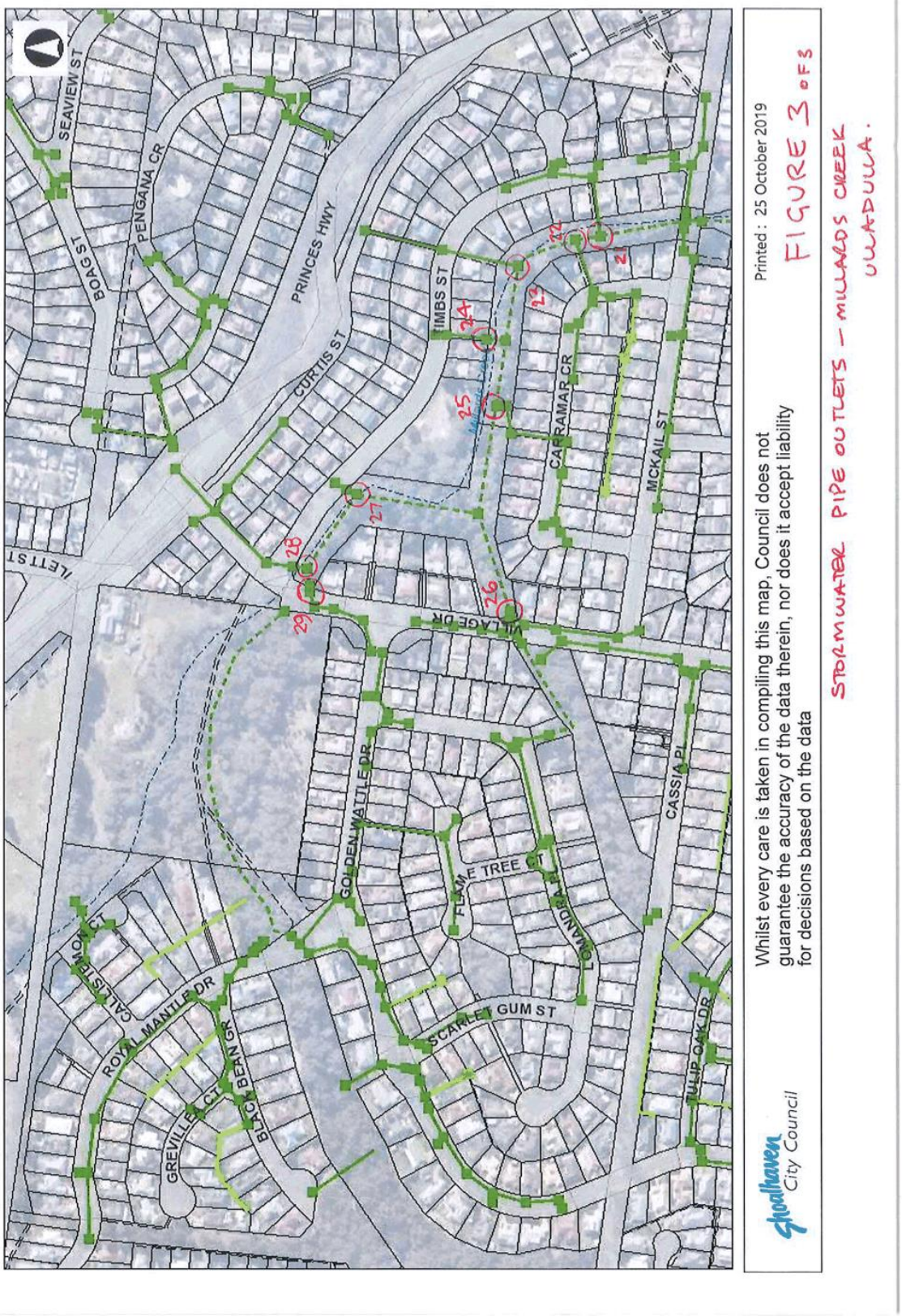
Attachments (Under Separate Cover)

Index



SA19.175 - Attachment 2

SA19.175 - Attachment 2



SA19.175 - Attachment 2

Stormwater Pipe Outlets - Millards Creek Ulladulla

Picture 1 – 1200 RCP Asset ID352267 – Ecosol RSF4000 GPT

Picture 2 – 300 RCP – Asset ID352476

Picture 3 - Gross Pollutant Trap

Picture 4 – 900 RCP – Asset ID352454

Picture 5 – 375 RCP – Asset ID351951

Picture 6 – 450 RCP – Asset ID352742

Picture 7 – 375 RCP – Asset ID352741

Picture 8 – 675 RCP – Asset ID352157

Picture 10 – 900 RCP – Asset ID352664

Picture 11 – 375 RCP – No Asset ID

Picture 12 – 450 RCP – Asset ID352389

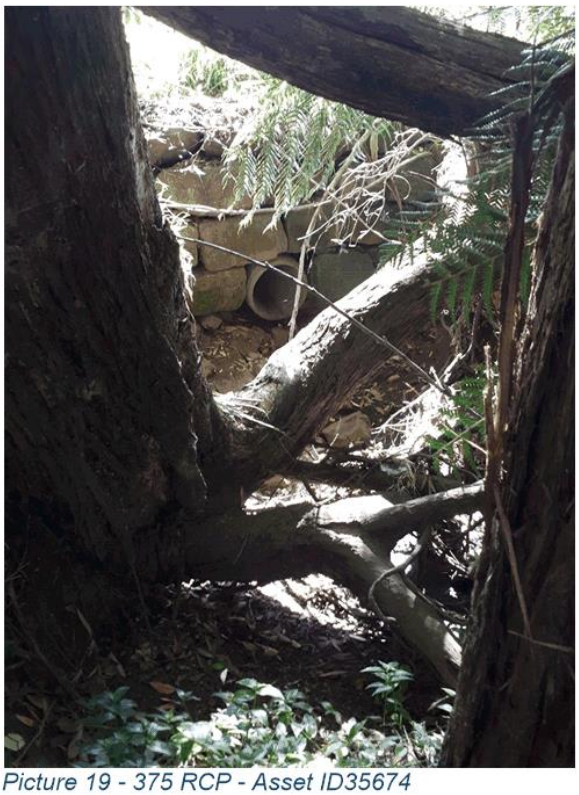
Picture 13 – 450 RCP – Asset ID352199

Picture 14 – 375 RCP – No Asset ID

Picture 16 – 375 RCP – Asset ID351882

Picture 18a – 600 RCP – Asset ID352060

Picture 18b – downstream erosion



Picture 19 - 375 RCP - Asset ID35674

Picture 20 – 450 RCP – Asset ID351815

Picture 22 – 375 RCP – Asset ID351751

Picture 23a – 600 RCP – Asset ID351804

Picture 23b – 600 RCP – Asset ID351804

Picture 24 - 450 RCP - Asset ID351806

Picture 25a – 375 RCP - Asset ID352067

Picture 25b - 375 RCP - Asset ID352067

Picture 26- 375 RCP - Asset ID352470 + 375mm RCP Asset ID352471 + 3 Cell road culvert

Picture 27 – 450 RCP – Asset ID351808

Picture 28 – 525 RCP – Asset ID352310

Picture 29 – 375 RCP – Asset ID351991

Picture 30a – 450 RCP – Asset ID352396

Picture 30b – Downstream erosion - 450 RCP – Asset ID352396

ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
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Shoalhaven City Council
City Administrative Centre
PO Box 42, Nowra, NSW 2541

Date Issued: 30th October 2019
Project No.: ENRS1154

Attention: Waste Services

SUBJECT SOIL & GROUNDWATER INVESTIGATION
LAKE CONJOLA WASTE TRANSFER STATION

INTRODUCTION

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent environmental consultants by *Shoalhaven City Council* (the client) to conduct a soil and groundwater investigation at the Lake Conjola Waste Transfer Station, Lake Conjola, NSW, 2539 (herein referred to as the Site).

ENRS understand this assessment is required to consider the potential for land and water contamination from previous landfill activities at the Site.

This letter report documents the results of field inspections and laboratory analysis obtained from soil and groundwater investigations conducted between April and October 2019. Site investigations, soil and groundwater sampling were conducted in general accordance with consideration of the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), and the guidelines made and approved under Section 105 of the *Contaminated Land Management Act* 1997 (the Act), namely the Guidelines for Consultants Reporting on Contaminated Sites (OEH;2011); and the Guidelines for the Assessment and Management of Groundwater Contamination (DEC;2007).

SCOPE OF WORK

The aim and scope of this investigation comprised;

- Site works – Inspect for surface water to facilitate sampling after rainfall events. Conduct soil and groundwater sampling to screen for a wide range of Contaminants of Potential Concern (CoPC) associated with the Site history of landfill activity;
- Submit soil and groundwater samples to a NATA accredited laboratory for analysis;
- Conduct screening of NATA analysis results against NSW EPA endorsed Site Assessment Criteria (SAC); and
- Document investigation results – Prepare a letter report with assessment of potential Site contamination and recommendations for additional investigation works and environmental management, if required.

SITE ASSESSMENT CRITERIA (SAC)

ENRS have adopted the most appropriate criteria in accordance with current state and national guidelines. Where available, Australian and NSW EPA endorsed guidelines have been referenced in preference to international standards. The NSW EPA has endorsed the use of the Health Investigation Levels (HILs) documented in the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* 'Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater'. The NEPM provide a framework for risk-based assessment of soil and groundwater contamination. HILs are provided for four (4) land use categories outlined below in **Table 1**. The Heads of EPA (HEPA;2018) National Environmental Management Plan (NEMP) for per-and poly-fluoroalkyl substances (PFAS) was also referenced to assess levels of PFAS contamination.

Table 1: Summary of NEPM Land Use Categories

NEPM	Description of Land use Categories
HIL A	Residential A with garden/accessible soil also includes children's day care centres, preschools and primary schools.
HIL B	Residential B with minimal opportunities for soil access; includes buildings with fully and permanently paved yard space such as high-rise buildings and apartments.
HIL C	Recreational C includes public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and unpaved footpaths.
HIL D	Commercial/industrial D includes premises such as shops, offices, factories and industrial sites.

Given the current and proposed ongoing land use and adjoining bushland the adopted Site Assessment Criteria for this investigation is **ASC NEPM HIL 'A'** which represents the most sensitive HIL for residential land use.

In addition to the HILS the amended ASC NEPM (2013) provides Groundwater Investigation Levels (GILs) which should be applied based on the receiving environment and groundwater resources. GILs are provided in NEPM Table 1C for; Fresh Waters, Marine Waters and Drinking Waters. The groundwater assessment criteria adopted for this investigation are presented in **Table 2**.

The Heads of EPA (HEPA;2018) National Environmental Management Plan (NEMP) for per-and poly-fluoroalkyl substances (PFAS) was also referenced to assess levels of PFAS in soil and groundwater.

Table 2: Groundwater Assessment Criteria

	Analyte	Units	Fresh Water[A]	Marine Waters[A]	Drinking Water[B]
PAHs	Naphthalene	µg/L	16	50	-
	Benzo(a) pyrene	µg/L	-	-	0.01
	Benzo(a)pyrene TEQ	µg/L	-	-	-
	Total PAH	µg/L	-	-	-
Metals & Metalloids	Antimony	µg/L	-	-	3
	Arsenic	µg/L	24 as As(III) 13 as As(V)	-	-
	Cadmium	µg/L	0.2	0.7	-
	Chromium, Cr (III)	µg/L	-	27	-
	Chromium, Cr (VI)	µg/L	1	4.4	-
	Cobalt	µg/L	-	1	-
	Copper	µg/L	1.4	1.3	-
	Lead	µg/L	3.4	4.4	-
	Manganese	µg/L	1900	-	500
	Mercury	µg/L	0.06	0.1	-
	Nickel	µg/L	11	7	-
	Silver	µg/L	0.05	1.4	100
	Zinc	µg/L	8	15	-
Phenols	Phenol	µg/L	320	400	-
	2-Chlorophenol	µg/L	340	-	300
	4-Chlorophenol	µg/L	220	-	-
	2,4-Dichlorophenol	µg/L	120	-	200
	2,4,6-Trichlorophenol	µg/L	3	-	20
	2,3,4,6-Tetrachlorophenol	µg/L	10	-	-
	Pentachlorophenol	µg/L	3.6	11	10
	2,4-Dinitrophenol	µg/L	45	-	-
BTEX	Benzene	µg/L	950	500	1
	Toluene	µg/L	-	-	800
	Ethyl benzene	µg/L	-	-	300
	m+p-Xylene	µg/L	200	-	600
	o-Xylene	µg/L	350	-	600
TRH	TRH C6-C10	µg/L	-	-	-
	TRH C10-C16	µg/L	-	-	-
	TRH C16-C34	µg/L	-	-	-
	TRH C34-C40	µg/L	-	-	-

SAMPLE METHODOLOGY (SOIL)

ENRS carried out a site inspection and soil sampling on the ***16th April 2019***. Soil samples were collected from three (3) locations; upgradient, adjacent and downgradient of the Site. Sample locations were selected with consideration of the ASC NEPM (2013) Schedule B2 Section 6, guidelines on Sampling Design (NEPC;2013). Samples were collected in general accordance with the principals described in AS4482.1- 2005: Guide to sampling and investigation of potentially contaminated soil (Part 1: Non-volatile and semi-volatile compounds) and AS4482.2-1999: Guide to sampling and investigation of potentially contaminated soil (Part 2: Volatile compounds).

SAMPLE METHODOLOGY (SURFACE WATER)

The Site was inspected after significant rainfall events in April, June and October 2019. On all occasions no surface water or ponded water was observed to facilitate sampling. As no surface water was observed at the Site the potential for runoff and surface water contamination from the Site is considered low.

SAMPLE METHODOLOGY (GROUNDWATER)

ENRS carried out a site inspection and groundwater sampling supported on the ***16th October 2019***. Groundwater samples were obtained from two (2) monitoring Wells on Site. MW01 provides and indicator of conditions downgradient of the Site, whilst MW02 (located on the edge of bushland upgradient of the Site) provides an assessment of naturally occurring background levels.

Prior to sampling, the depth to the water table was measured from the top of casing using a hydrocarbon-water interface probe. The bores were inspected for the presence of hydrocarbon and any Phase Separated Hydrocarbon (PSH) both manually using a hydrocarbon interface probe and visually in clear disposable bailers. Field measurements were recorded on designated sample field sheets. The two (2) monitoring wells, MW01 and MW02 were sampled using a disposable bailer, to visually observe the presence of hydrocarbons.

Samples were sealed in laboratory-prepared sampling containers appropriate for the analysis and clearly labelled with the sample identification. All samples were stored on ice immediately after their collection and transported to the laboratory under Chain of Custody (COC) documentation.

Any loss of volatile compounds was kept to a minimum by employing the following sampling techniques:

- Minimal practical disturbance during sampling;
- Samples placed immediately in sample containers with zero headspace;
- Samples placed directly on ice and transported to the laboratory as soon as possible; and
- Employing the most appropriate analytical method to minimise volatile losses at the laboratory.

ALS, a NATA registered laboratory was contracted to undertake the laboratory analysis in accordance with NATA approved methods. The laboratory was NATA accredited and the Limit of Reporting (LOR) were within the acceptable levels for the investigation criteria. Laboratory COA indicate that for the samples collected during the scope of works, sampling techniques,

transport procedures and laboratory analysis were satisfactory. The QA/QC indicators either all complied with the required standards, or showed variations that would have no significant effect on the quality of the data or the conclusions of this Water Quality Assessment. It is therefore concluded that the QA/QC results are adequate and the quality of the ***data is acceptable for use in this assessment***.

RESULTS & CONCLUSIONS

The following points summarise the sample results reported in the NATA accredited Certificate of Analysis (COA):

- Results for soil report concentrations below the adopted Site Assessment Criteria for residential land use or the Laboratory Limit of Reporting (LOR), for all tested analytes including; heavy metals, PCBs, OC & OP Pesticides; Monocyclic Aromatic Hydrocarbons; Oxygenated compounds; Halogenated Aliphatic Compounds; Trihalomethanes; Phenolic compounds; Polynuclear Aromatic Hydrocarbons (PAHs); Petroleum Hydrocarbons; and PFAS;
- The results did not report any elevated levels of contaminants in soil to trigger any further investigation;
- Site inspections in April June and October did not observe any available surface water to facilities sampling, hence no testing was possible, and the risk for contamination of surface water is considered low. The Site observations and results of this assessment do not trigger any further investigation for surface water;
- Monitoring Wells at the Site are screened to intercept shallow unconfined groundwater. Sampling in MW01 provides an indicator of conditions downgradient of the Site, whilst MW02 is located on the edge of bushland up gradient of the Site to provide an assessment of naturally occurring background levels;
- Results for groundwater do not report any significant exceedances of the Australian Drinking Water Guidelines (2018) Trigger Values for Health for; heavy metals; Petroleum Hydrocarbons; BTEXN; PAHs; PFAS; Ammonia; Fluoride; Sulphate; Nitrate; Nitrite; and Phosphorus, which is satisfactory;
- The groundwater results indicate the area is characterised by naturally slightly acidic groundwater with elevated salinity and levels of some heavy metals associated with mineral dissolution from the host clay and shale. For example concentrations of lead are elevated in MW02 in the area upgradient of the Site;
- Importantly, the concentrations of heavy metals and Contaminants of Potential Concern in MW01 downgradient of the Site are below the Site Assessment Criteria or within the range of background levels which indicates the groundwater conditions at the Site are satisfactory and unlikely to result in offsite impacts; and
- Should any change in Site conditions or incident occur which causes, a suitable environmental professional should be notified to further assess the Site and consider requirements for any additional assessment.

This report must be read in full in conjunction with the attached Statement of Limitations. Should the reader have any queries regarding this letter report, please do not hesitate to contact the author for further information or assistance.

Yours sincerely

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LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to Site.

ENRS derived the data in this report primarily from visual inspections, and, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

Limitations also apply to analytical methods used in the identification of substances (or parameters). These limitations may be due to non-homogenous material being sampled (i.e. the sample to be analysed may not be representative), low concentrations, the presence of 'masking' agents and the restrictions of the approved analytical technique. As such, non-statistically significant sampling results can only be interpreted as 'indicative' and not used for quantitative assessments.

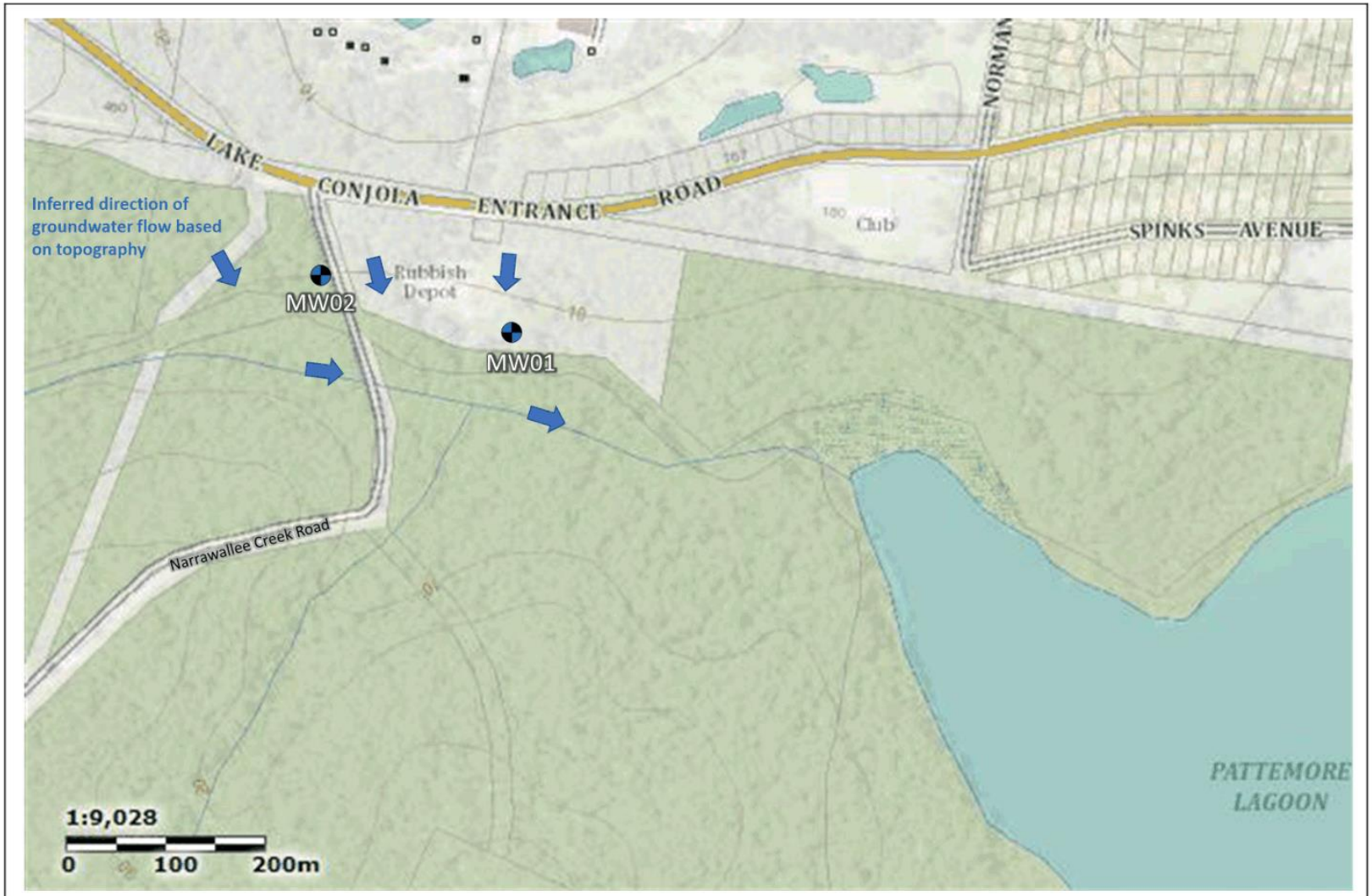
The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of Site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g. changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between ENRS and the Client. ENRS accepts no liability or responsibility whatsoever and expressly disclaims any responsibility for or in respect of any use of or reliance upon this report by any third party or parties.

It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

ENRS Environment & Natural Resource Solutions 108 Jerry Bailey Road, Shoalhaven Heads, NSW, 2535 Tel: 02 4448 5490 Fax: 02 90374708 projects@enrs.com.au www.enrs.com.au	Client:	Shoalhaven City Council	Drawn:	RL	Figure:	A
	Project:	ENRS1154	Source:	nsw globe	Date:	24/10/2019
	Location:	Lot 2 DP777956, 488 Lake Conjola Entrance Road.	Scale:	scale bar	Title:	Groundwater Monitoring Well Location Plan – Lake Conjola Transfer Station
			Status:	Rev 1		

SA19.185 - Attachment 2



ENRS Environment & Natural Resource Solutions 108 Jerry Bailey Road, Shoalhaven Heads, NSW, 2535 Tel: 02 4448 5490 Fax: 02 90374708 projects@enrs.com.au www.enrs.com.au	Client:	Shoalhaven City Council	Drawn:	RL	Figure: B
	Project:	ENRS1154	Source:	nsw globe	Date: 24/10/2019
	Location:	Lot 2 DP777956, 488 Lake Conjola Entrance Road.	Scale:	scale bar	Title: Groundwater Monitoring Well Location Plan – Lake Conjola Transfer Station
			Status:	Rev 1	

SA19.185 - Attachment 2

Attachment 1

Table 3: Total Concentrations – Soil

ALS		27/04/2019	Sample	ID 1			SS01/0.3	SS02/0.3	SS03/0.3
EW1901700	Results			Date Sampled			17/04/2019	17/04/2019	17/04/2019
				Order #	NEPM 2013 HIL 'A'	PFAS NEMP 2018 HIL 'A'	EW1901700002	EW1901700005	EW1901700008
Analyte	CAS #		Units	LOR	Guideline Limit	Guideline Limit	SOIL UPGRADIENT	SOIL ADJACENT	SOIL DOWNGRADIENT
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2		mg/kg	5	100		<5	<5	18
Barium	7440-39-3		mg/kg	10			220	90	120
Beryllium	7440-41-7		mg/kg	1	60		1	2	4
Boron	7440-42-8		mg/kg	50	4500		<50	<50	<50
Cadmium	7440-43-9		mg/kg	1	20		<1	<1	<1
Cobalt	7440-48-4		mg/kg	2	100		4	<2	5
Lead	7439-92-1		mg/kg	5	300		24	24	29
Manganese	7439-96-5		mg/kg	5	3800		6	10	6
Molybdenum	7439-98-7		mg/kg	2			<2	<2	2
Nickel	7440-02-0		mg/kg	2	400		15	5	20
Selenium	7782-49-2		mg/kg	5	200		<5	<5	<5
Silver	7440-22-4		mg/kg	2			<2	<2	<2
Vanadium	7440-62-2		mg/kg	5			23	44	52
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6		mg/kg	0.1	40		<0.1	<0.1	<0.1
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9		mg/kg	0.5	100		<10.0	<10.0	<10.0
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5		mg/kg	1			2	5	2
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser									
Weak Acid Dissociable Cyanide			mg/kg	1			1	3	<2
EK040T: Fluoride Total									
Fluoride	16984-48-8		mg/kg	40			130	110	90
EP066: Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls			mg/kg	0.1	1		<0.1	<0.1	<0.1
EP068A: Organochlorine Pesticides (OC)									
4.4`-DDD	72-54-8		mg/kg	0.05			<0.05	<0.05	<0.05
4.4`-DDE	72-55-9		mg/kg	0.05			<0.05	<0.05	<0.05
4.4`-DDT	50-29-3		mg/kg	0.2			<0.2	<0.2	<0.2
Aldrin	309-00-2		mg/kg	0.05			<0.05	<0.05	<0.05
alpha-BHC	319-84-6		mg/kg	0.05			<0.05	<0.05	<0.05
alpha-Endosulfan	959-98-8		mg/kg	0.05			<0.05	<0.05	<0.05
beta-BHC	319-85-7		mg/kg	0.05			<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9		mg/kg	0.05			<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9		mg/kg	0.05			<0.05	<0.05	<0.05
delta-BHC	319-86-8		mg/kg	0.05			<0.05	<0.05	<0.05
Dieldrin	60-57-1		mg/kg	0.05			<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8		mg/kg	0.05			<0.05	<0.05	<0.05
Endrin	72-20-8		mg/kg	0.05	10		<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4		mg/kg	0.05			<0.05	<0.05	<0.05
gamma-BHC	58-89-9		mg/kg	0.05			<0.05	<0.05	<0.05
Heptachlor	76-44-8		mg/kg	0.05	6		<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3		mg/kg	0.05			<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1		mg/kg	0.05	10		<0.05	<0.05	<0.05
Total Chlordane (sum)			mg/kg	0.05			<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2		mg/kg	0.05			<0.05	<0.05	<0.05
EP068B: Organophosphorus Pesticides (OP)									
Chlorpyrifos	2921-88-2		mg/kg	0.05	160		<0.05	<0.05	<0.05
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup									
>C10 - C16 Fraction			mg/kg	50			<50	<50	<50
>C10 - C40 Fraction (sum)			mg/kg	50			<50	<50	<50
>C16 - C34 Fraction			mg/kg	100			<100	<100	<100
>C34 - C40 Fraction			mg/kg	100			<100	<100	<100
EP071 SG-S: Total Petroleum Hydrocarbons in Soil - Silica gel cleanup									
C10 - C14 Fraction			mg/kg	50			<50	<50	<50
C10 - C36 Fraction (sum)			mg/kg	50			<50	<50	<50
C15 - C28 Fraction			mg/kg	100			<100	<100	<100
C29 - C36 Fraction			mg/kg	100			<100	<100	<100
EP074A: Monocyclic Aromatic Hydrocarbons									
Benzene	71-43-2		mg/kg	0.2			<0.2	<0.2	<0.2
Ethylbenzene	100-41-4		mg/kg	0.5			<0.5	<0.5	<0.5
meta- & para-Xylene	108-38-3 106-42-3		mg/kg	0.5			<0.5	<0.5	<0.5
ortho-Xylene	95-47-6		mg/kg	0.5			<0.5	<0.5	<0.5
Styrene	100-42-5		mg/kg	0.5			<0.5	<0.5	<0.5
Toluene	108-88-3		mg/kg	0.5			<0.5	<0.5	<0.5
EP074B: Oxygenated Compounds									
2-Butanone (MEK)	78-93-3		mg/kg	5			<5	<5	<5
EP074E: Halogenated Aliphatic Compounds									
1.1.1.2-Tetrachloroethane	630-20-6		mg/kg	0.5			<0.5	<0.5	<0.5
1.1.1-Trichloroethane	71-55-6		mg/kg	0.5			<0.5	<0.5	<0.5
1.1.2.2-Tetrachloroethane	79-34-5		mg/kg	0.5			<0.5	<0.5	<0.5
1.1.2-Trichloroethane	79-00-5		mg/kg	0.5			<0.5	<0.5	<0.5
1.1-Dichloroethene	75-35-4		mg/kg	0.5			<0.5	<0.5	<0.5
1.2-Dichloroethane	107-06-2		mg/kg	0.5			<0.5	<0.5	<0.5
Carbon Tetrachloride	56-23-5		mg/kg	0.5			<0.5	<0.5	<0.5
Methylene chloride	75-09-2		mg/kg	0.5			<0.5	<0.5	<0.5
Tetrachloroethene	127-18-4		mg/kg	0.5			<0.5	<0.5	<0.5
Trichloroethene	79-01-6		mg/kg	0.5			<0.5	<0.5	<0.5
Vinyl chloride	75-01-4		mg/kg	4			<4	<4	<4
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7		mg/kg	0.5			<0.5	<0.5	<0.5
EP074G: Trihalomethanes									
Chloroform	67-66-3		mg/kg	0.5			<0.5	<0.5	<0.5
EP075(SIM)A: Phenolic Compounds									
2.4.5-Trichlorophenol	95-95-4		mg/kg	0.5			<0.5	<0.5	<0.8
2.4.6-Trichlorophenol	88-06-2		mg/kg	0.5			<0.5	<0.5	<0.8
2-Methylphenol	95-48-7		mg/kg	0.5			<0.5	<0.5	<0.8
3- & 4-Methylphenol	1319-77-3		mg/kg	1			<1	<1	<2
4-Chloro-3-methylphenol	59-50-7		mg/kg	0.5			<0.5	<0.5	<0.8
Pentachlorophenol	87-86-5		mg/kg	2	100		<2	<2	<2
Phenol	108-95-2		mg/kg	0.5	3000		<0.5	<0.5	<0.8
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Acenaphthene	83-32-9		mg/kg	0.5			<0.5	<0.5	<0.8
Acenaphthylene	208-96-8		mg/kg	0.5			<0.5	<0.5	<0.8
Anthracene	120-12-7		mg/kg	0.5			<0.5	<0.5	<0.8
Benz(a)anthracene	56-55-3		mg/kg	0.5			<0.5	<0.5	<0.8
Benzo(a)pyrene	50-32-8		mg/kg	0.5			<0.5	<0.5	<0.8
Benzo(a)pyrene TEQ (half LOR)			mg/kg	0.5	3		0.6	0.6	0.6
Benzo(a)pyrene TEQ (LOR)			mg/kg	0.5	3		1.2	1.2	1.2
Benzo(a)pyrene TEQ (zero)			mg/kg	0.5	3		<0.5	<0.5	<0.5
Benzo(b+j)fluoranthene	205-99-2 205-82-3		mg/kg	0.5			<0.5	<0.5	<0.8
Benzo(g.h.i)perylene	191-24-2		mg/kg	0.5			<0.5	<0.5	<0.8
Benzo(k)fluoranthene	207-08-9		mg/kg	0.5			<0.5	<0.5	<0.8
Chrysene	218-01-9		mg/kg	0.5			<0.5	<0.5	<0.8
Dibenz(a.h)anthracene	53-70-3		mg/kg	0.5			<0.5	<0.5	<0.8
Fluoranthene	206-44-0		mg/kg	0.5			<0.5	<0.5	<0.8
Fluorene	86-73-7		mg/kg	0.5			<0.5	<0.5	<0.8
Indeno(1.2.3.cd)pyrene	193-39-5		mg/kg	0.5			<0.5	<0.5	<0.8
Naphthalene	91-20-3		mg/kg	0.5			<0.5	<0.5	<0.8
Phenanthrene	85-01-8		mg/kg	0.5			<0.5	<0.5	<0.8
Pyrene	129-00-0		mg/kg	0.5			<0.5	<0.5	<0.8
Sum of polycyclic aromatic hydrocarbons			mg/kg	0.5	300		<0.5	<0.5	<0.5

ALS	27/04/2019	Sample	ID 1			SS01/0.3	SS02/0.3	SS03/0.3
EW1901700	Results		Date Sampled			17/04/2019	17/04/2019	17/04/2019
			Order #	NEPM 2013 HIL 'A'	PFAS NEMP 2018 HIL 'A'	EW1901700002	EW1901700005	EW1901700008
Analyte	CAS #	Units	LOR	Guideline Limit	Guideline Limit	SOIL UPGRADIENT	SOIL ADJACENT	SOIL DOWNGRADIENT
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction		mg/kg	10	-		<10	<10	<10
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	mg/kg	10	-		<10	<10	<10
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	mg/kg	0.0002	-		<0.0002	<0.0002	<0.0002
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	mg/kg	0.0002	-	0.009	<0.0002	0.0036	0.0022
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	mg/kg	0.0002	-	0.009	<0.0002	0.0029	0.0021
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	mg/kg	0.001	-		<0.001	<0.001	<0.001
Perfluoroheptanoic acid (PFHpA)	375-85-9	mg/kg	0.0002	-		<0.0002	<0.0002	0.0002
Perfluorohexanoic acid (PFHxA)	307-24-4	mg/kg	0.0002	-		<0.0002	0.0002	0.0005
Perfluorooctanoic acid (PFOA)	335-67-1	mg/kg	0.0002	-	0.1	<0.0002	0.0003	0.0006
Perfluoropentanoic acid (PFPeA)	2706-90-3	mg/kg	0.0002	-		<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	mg/kg	0.0005	-		<0.0005	<0.0005	<0.0005
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	mg/kg	0.0005	-		<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	mg/kg	0.0005	-		<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	mg/kg	0.0005	-		<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums								
Sum of PFAS (WA DER List)		mg/kg	0.0002	-		<0.0002	0.007	0.0056
Sum of PFHxS and PFOS	355-46-4/1763-23-1	mg/kg	0.0002	-		<0.0002	0.0065	0.0043
Applied Guideline:	**NEPM TABLE 1-A 2013 (SOIL) - HIL A**							
Color Key:	Within Guideline							

Attachment 2

Table 4: Total Concentrations – Groundwater

ENRS

TABLE 4: Groundwater Monitoring Event (GME) Results
Lake Conjola - October 2019

			Aluminium - Dissolved	Arsenic - Dissolved	Barium - Dissolved	Cadmium - Dissolved	Chromium - Dissolved	Cobalt - Dissolved	Copper - Dissolved	Lead - Dissolved	Mercury - Dissolved	Manganese - Dissolved	Nickel - Dissolved	Zinc - Dissolved	TRH C6 - C9	TRH C10 - C36	F1 TRH C6 - C10	F2 TRH >C10 - C16	F3 TRH >C16 - C34	F4 TRH >C34 - C40	Benzene	Toluene	Ethylbenzene	m+p-xylene	o-xylene	Naphthalene	Benzo (a) Pyrene	Total PAH	Perfluorohexane sulfonic acid (PFHxS) (NEMP 2017)	Perfluorooctane sulfonic acid (PFOS) (NEMP 2017)	Perfluorooctanoic acid (PFOA) (NEMP 2017)	Ammonia	Fluoride	Sulphate, SO4 (mg/L)	Nitrate as N in water	Reactive Phosphorus as P	Total Phosphorus as P	pH - Lab	pH - Field	Redox / ORP	Electrical Conductivity (Lab)	Electrical Conductivity (field)	Temperature	Comment
ANZECC 2000 -Trigger Values for Freshwater (Protection of 95% of Species)			55	24 (As III)	-	0.2	1.0 (CrVI)	-	1.4	3.4	0.6	1900	11	8	-	-	-	-	-	-	950	-	-	200	350	16	-	-	-	0.13	220	0.9	-	-	0.7	0.02	0.05	6.5 - 8.0	6.5 - 8.0	-	2200	2200	-	
ANZECC 2000 - Trigger Values for long-term irrigation			5000	100	-	10	100	50	200	2000	2	200	200	2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	0.05	-	-	-	-	-	-	
Australian Drinking Water Guidelines (2016)[1]		Health	-	10	2000	2	50	-	2000	10	1	500	20	-	-	-	-	-	-	-	1	800	300	600	600	-	0.01	-	0.07	0.07	0.56	-	1.5	500	50	-	-	6.5 - 8.0	6.5 - 8.0	-	-	-	-	
		Aesthetic	200	-	-	-	-	-	1000	-	-	100	-	3000	-	-	-	-	-	-	-	25	3	20	20	-	-	-	-	-	-	0.5	-	250	-	-	-	6.5 - 8.0	6.5 - 8.0	-	-	-	-	
Lab Report No.	Sample ID.	Date Sampled																																										Comment
		Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	20	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH units	pH units	mV	µS/cm	µS/cm	°C	
		Limit of Reporting	10	1	1	0.1	1	1	1	1	0.1	1	1	5	10	125	10	50	100	100	1	1	1	2	1	1	1	0.1	0.02	0.01	0.01	0.01	0.1	1	0.005	0.01	0.01	0.01	0.01	0.01	1	1	0.1	
EW1904499001	MW01	16/10/2019	750	2	365	<0.1	<0.01	15	<1	<1	<0.1	122	-	111	<20	<50	<20	<100	<100	<100	<1	<2	<2	<2	<2	<5.0	<0.5	<0.5	0.06	0.02	0.02	0.05	0.2	40	<0.01	<0.01	1.76	5.45	4.66	115	2340	2210	15.8	SWL 3.2 mbtoc (Down-gradient)
EW1904499002	MW02	16/10/2019	4360	2	39	<0.1	<0.1	11	7	16	<0.1	36	-	56	<20	<50	<20	<100	<100	<100	<1	<2	<2	<2	<2	<5.0	<0.5	<0.5	<0.02	<0.01	<0.01	0.03	<0.1	28	0.02	<0.01	0.28	6.23	5.45	73	269	283	16.6	6.05 mbtoc, silty (Up-gradient)

SA19.185 - Attachment 2

Attachment 3

NATA Laboratory Certificates of Analysis

ENRS
Environment & Natural Resource Solutions

Chain of Custody

ALS

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samplereceiptsydney@alsglobal.com

UNIWARA 4/13 Chain Place North Nowra NSW 2541
Ph: 02 4423 2063 E: nowra@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT:	ENRS	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)	
OFFICE:	108 Jerry Bailey Rd, Shoalhaven Heads		☒ Non Standard or urgent TAT (List due date): Results required by 26/4/19	Custody Seal Intact?	Yes No N/A
PROJECT:	Lake Conjola Waste Depot	ALS QUOTE NO.:		Free ice / frozen ice bricks present upon receipt?	Yes No N/A
PROJECT NUMBER:	ENRS1154 PO. No.: ENRS1154	COUNTRY OF ORIGIN:	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER:	Rohan Last	CONTACT PH: 0401 518 443	OF: 1 2 3 4 5 6 7	Other comment:	
SAMPLER:	MK	SAMPLER MOBILE: 0490 069 216	RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY: / RECEIVED BY:
COC Emailed to ALS?	YES	EDD FORMAT (or default):	DATE/TIME: 17/04/2019	DATE/TIME: 17/4/19	DATE/TIME: / DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed):	lab@enrs.com.au				
Email Invoice to (will default to PM if no other addresses are listed):	accounts@enrs.com.au				
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:					

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).									Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	Hold	P-714 Short	PFAS - Short	Additional Metals (B, Ba, Be, Co, Mn, Se, V)							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	SS01/0.15	16/04/2019	Soil	Unpreserved Glass	1										
2	SS01/0.3	16/04/2019	Soil	Unpreserved Glass		1		x							
3	SS01P/0.3	16/04/2019	Soil	Unpreserved Glass			x								
4	SS02/0.15	16/04/2019	Soil	Unpreserved Glass	1										
5	SS02/0.3	16/04/2019	Soil	Unpreserved Glass		1		x							
6	SS02P/0.3	16/04/2019	Soil	Unpreserved Glass			x								
7	SS03/0.15	16/04/2019	Soil	Unpreserved Glass	1										
8	SS03/0.3	16/04/2019	Soil	Unpreserved Glass		1		x							
9	SS03P/0.3	16/04/2019	Soil	Unpreserved Glass			x								
				TOTAL	3	3	3	3							

Environmental Division
Wollongong
Work Order Reference
EW1901700

Telephone : 02 42253125

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ENRS (SH/02)

Form Page 1 of 1

Approved Date: 09/02/2014

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EW1901700	Page	: 1 of 9
Client	: ENVIRONMENT & NATURAL RESOURCE SOLUTIONS	Laboratory	: Environmental Division NSW South Coast
Contact	: Mr Rohan Last	Contact	: Aneta Prosaroski
Address	: 25 River Rd Shoalhaven Heads 2535	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: ----	Telephone	: +61 2 4225 3125
Project	: ENRS1154	Date Samples Received	: 17-Apr-2019 12:38
Order number	: ENRS1154	Date Analysis Commenced	: 17-Apr-2019
C-O-C number	: ----	Issue Date	: 29-Apr-2019 13:09
Sampler	: M K		
Site	: Lake Conjola Waste Depot		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 6		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics, Mayfield West, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini		Sydney Organics, Smithfield, NSW

Page	:	2 of 9
Work Order	:	EW1901700
Client	:	ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project	:	ENRS1154

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG048G:: LOR raised for Alkyl Hexavalent Chromium on various samples due to sample matrix.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero
- EG048G: Poor spike recovery for Alkyl Hexavalent Cheomium due to matrix interferences.
- EP075(SIM): LOR for sample raised due to high amount of moisture present.

Page	: 3 of 9
Work Order	: EW1901700
Client	: ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project	: ENRS1154

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS01/0.3	SS01P/0.3	SS02/0.3	SS02P/0.3	SS03/0.3
				Client sampling date / time	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EW1901700-002	EW1901700-003	EW1901700-005	EW1901700-006	EW1901700-008
					Result	Result	Result	Result	Result
EA055: Moisture Content (Dried @ 105-110°C)									
Moisture Content	----	0.1	%		----	22.6	----	41.7	----
Moisture Content	----	1.0	%		23.5	----	39.5	----	59.2
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	----	<5	----	18
Barium	7440-39-3	10	mg/kg		220	----	90	----	120
Beryllium	7440-41-7	1	mg/kg		1	----	2	----	4
Boron	7440-42-8	50	mg/kg		<50	----	<50	----	<50
Cadmium	7440-43-9	1	mg/kg		<1	----	<1	----	<1
Cobalt	7440-48-4	2	mg/kg		3	----	<2	----	5
Lead	7439-92-1	5	mg/kg		24	----	24	----	29
Manganese	7439-96-5	5	mg/kg		6	----	10	----	6
Molybdenum	7439-98-7	2	mg/kg		<2	----	<2	----	2
Nickel	7440-02-0	2	mg/kg		15	----	5	----	20
Selenium	7782-49-2	5	mg/kg		<5	----	<5	----	<5
Silver	7440-22-4	2	mg/kg		<2	----	<2	----	<2
Vanadium	7440-62-2	5	mg/kg		23	----	44	----	52
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	----	<0.1	----	<0.1
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9	0.5	mg/kg		<10.0	----	<10.0	----	<10.0
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	1	mg/kg		2	----	5	----	2
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser									
Weak Acid Dissociable Cyanide	----	1	mg/kg		1	----	3	----	<2
EK040T: Fluoride Total									
Fluoride	16984-48-8	40	mg/kg		130	----	110	----	90
EP066: Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls	----	0.1	mg/kg		<0.1	----	<0.1	----	<0.1
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
beta-BHC	319-85-7	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
gamma-BHC	58-89-9	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
delta-BHC	319-86-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05

Page : 4 of 9
Work Order : EW1901700
Client : ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project : ENRS1154

ALS

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS01/0.3	SS01P/0.3	SS02/0.3	SS02P/0.3	SS03/0.3
				Client sampling date / time	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EW1901700-002	EW1901700-003	EW1901700-005	EW1901700-006	EW1901700-008
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
Heptachlor	76-44-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Aldrin	309-00-2	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
^ Total Chlordane (sum)	----	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
alpha-Endosulfan	959-98-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Dieldrin	60-57-1	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
4.4`-DDE	72-55-9	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Endrin	72-20-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
4.4`-DDD	72-54-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
4.4`-DDT	50-29-3	0.2	mg/kg		<0.2	----	<0.2	----	<0.2
EP068B: Organophosphorus Pesticides (OP)									
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	----	<0.05	----	<0.05
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup									
>C10 - C16 Fraction	----	50	mg/kg		<50	----	<50	----	<50
>C16 - C34 Fraction	----	100	mg/kg		<100	----	<100	----	<100
>C34 - C40 Fraction	----	100	mg/kg		<100	----	<100	----	<100
^ >C10 - C40 Fraction (sum)	----	50	mg/kg		<50	----	<50	----	<50
EP071 SG-S: Total Petroleum Hydrocarbons in Soil - Silica gel cleanup									
C10 - C14 Fraction	----	50	mg/kg		<50	----	<50	----	<50
C15 - C28 Fraction	----	100	mg/kg		<100	----	<100	----	<100
C29 - C36 Fraction	----	100	mg/kg		<100	----	<100	----	<100
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	----	<50	----	<50
EP074A: Monocyclic Aromatic Hydrocarbons									
Benzene	71-43-2	0.2	mg/kg		<0.2	----	<0.2	----	<0.2
Toluene	108-88-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Ethylbenzene	100-41-4	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Styrene	100-42-5	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
ortho-Xylene	95-47-6	0.5	mg/kg		<0.5	----	<0.5	----	<0.5

Page : 5 of 9
Work Order : EW1901700
Client : ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project : ENRS1154

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS01/0.3	SS01P/0.3	SS02/0.3	SS02P/0.3	SS03/0.3
				Client sampling date / time	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EW1901700-002	EW1901700-003	EW1901700-005	EW1901700-006	EW1901700-008
					Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds									
2-Butanone (MEK)	78-93-3	5	mg/kg		<5	----	<5	----	<5
EP074E: Halogenated Aliphatic Compounds									
Vinyl chloride	75-01-4	4	mg/kg		<4	----	<4	----	<4
1.1-Dichloroethene	75-35-4	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Methylene chloride	75-09-2	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
1.1.1-Trichloroethane	71-55-6	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Carbon Tetrachloride	56-23-5	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
1.2-Dichloroethane	107-06-2	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Trichloroethene	79-01-6	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
1.1.2-Trichloroethane	79-00-5	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
Tetrachloroethene	127-18-4	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
1.1.1.2-Tetrachloroethane	630-20-6	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
1.1.2.2-Tetrachloroethane	79-34-5	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
EP074G: Trihalomethanes									
Chloroform	67-66-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
2-Methylphenol	95-48-7	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
3- & 4-Methylphenol	1319-77-3	1	mg/kg		<1	----	<1	----	<2
4-Chloro-3-methylphenol	59-50-7	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
2.4.6-Trichlorophenol	88-06-2	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
2.4.5-Trichlorophenol	95-95-4	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Pentachlorophenol	87-86-5	2	mg/kg		<2	----	<2	----	<2
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Acenaphthylene	208-96-8	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Acenaphthene	83-32-9	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Fluorene	86-73-7	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Phenanthrene	85-01-8	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Anthracene	120-12-7	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Fluoranthene	206-44-0	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Pyrene	129-00-0	0.5	mg/kg		<0.5	----	<0.5	----	<0.8

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Work Order : EW1901700
Client : ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project : ENRS1154

ALS

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS01/0.3	SS01P/0.3	SS02/0.3	SS02P/0.3	SS03/0.3
				Client sampling date / time	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EW1901700-002	EW1901700-003	EW1901700-005	EW1901700-006	EW1901700-008
					Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Benz(a)anthracene	56-55-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Chrysene	218-01-9	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Benzo(a)pyrene	50-32-8	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg		<0.5	----	<0.5	----	<0.8
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
^ Benzo(a)pyrene TEQ (zero)	----	0.5	mg/kg		<0.5	----	<0.5	----	<0.5
^ Benzo(a)pyrene TEQ (half LOR)	----	0.5	mg/kg		0.6	----	0.6	----	0.6
^ Benzo(a)pyrene TEQ (LOR)	----	0.5	mg/kg		1.2	----	1.2	----	1.2
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	----	<10	----	<10
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg		<10	----	<10	----	<10
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg		----	<0.0002	----	<0.0002	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg		----	<0.0002	----	0.0036	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg		----	<0.0002	----	0.0029	----
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg		----	<0.001	----	<0.001	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg		----	<0.0002	----	<0.0002	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg		----	<0.0002	----	0.0002	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg		----	<0.0002	----	<0.0002	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg		----	<0.0002	----	0.0003	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		----	<0.0005	----	<0.0005	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		----	<0.0005	----	<0.0005	----

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Work Order : EW1901700
Client : ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project : ENRS1154

ALS

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SS01/0.3	SS01P/0.3	SS02/0.3	SS02P/0.3	SS03/0.3
				Client sampling date / time	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00	17-Apr-2019 00:00
Compound	CAS Number	LOR	Unit		EW1901700-002	EW1901700-003	EW1901700-005	EW1901700-006	EW1901700-008
					Result	Result	Result	Result	Result
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued									
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg		----	<0.0005	----	<0.0005	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg		----	<0.0005	----	<0.0005	----
EP231P: PFAS Sums									
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg		----	<0.0002	----	0.0065	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg		----	<0.0002	----	0.0070	----
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	0.1	%		91.8	----	72.7	----	71.8
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.05	%		122	----	94.0	----	77.8
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.05	%		92.0	----	82.9	----	62.1
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.5	%		95.1	----	96.1	----	87.2
Toluene-D8	2037-26-5	0.5	%		87.4	----	84.2	----	78.2
4-Bromofluorobenzene	460-00-4	0.5	%		88.9	----	86.4	----	80.8
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.5	%		89.9	----	75.1	----	71.0
2-Chlorophenol-D4	93951-73-6	0.5	%		104	----	89.5	----	88.8
2.4.6-Tribromophenol	118-79-6	0.5	%		95.4	----	101	----	93.9
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.5	%		121	----	125	----	115
Anthracene-d10	1719-06-8	0.5	%		122	----	116	----	115
4-Terphenyl-d14	1718-51-0	0.5	%		118	----	115	----	107
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.2	%		88.4	----	89.4	----	81.0
Toluene-D8	2037-26-5	0.2	%		95.2	----	92.0	----	85.1
4-Bromofluorobenzene	460-00-4	0.2	%		90.2	----	88.3	----	83.9
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%		----	60.0	----	89.0	----
13C8-PFOA	----	0.0002	%		----	63.0	----	80.5	----

Page : 8 of 9
Work Order : EW1901700
Client : ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project : ENRS1154

ALS

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SS03P/0.3	----	----	----	----
			Client sampling date / time	17-Apr-2019 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EW1901700-009	--------	--------	--------	--------
				Result	---	---	---	---
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**61.9**	----	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids								
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	**0.0022**	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	**0.0021**	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids								
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	----	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	**0.0005**	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	**0.0002**	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	**0.0006**	----	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids								
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	----	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	----	----	----	----
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	----	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	----	----	----	----
EP231P: PFAS Sums								
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	**0.0043**	----	----	----	----
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	**0.0056**	----	----	----	----
EP231S: PFAS Surrogate								
13C4-PFOS	----	0.0002	%	**82.0**	----	----	----	----
13C8-PFOA	----	0.0002	%	**90.5**	----	----	----	----

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Work Order	: EW1901700
Client	: ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project	: ENRS1154

Surrogate Control Limits

Sub-Matrix: SOIL		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	39	149
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	147
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	35	143
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	64	130
Toluene-D8	2037-26-5	66	136
4-Bromofluorobenzene	460-00-4	60	122
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	63	123
2-Chlorophenol-D4	93951-73-6	66	122
2.4.6-Tribromophenol	118-79-6	40	138
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	70	122
Anthracene-d10	1719-06-8	66	128
4-Terphenyl-d14	1718-51-0	65	129
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	133
Toluene-D8	2037-26-5	74	132
4-Bromofluorobenzene	460-00-4	72	130
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

ENRS Environment & Natural Resource Solutions

Chain of Custody

ALS

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com
WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: ENRS Pty Ltd	TURNAROUND REQUIREMENTS : ☐ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE: 108 Jerry Bailey Road, Shoalhaven Heads	(Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☒ Non Standard or urgent TAT (List due date): 18/10/19	Custody Seal Intact? Yes No N/A
PROJECT: SCC Lake Conjola PROJECT NO.: ENRS1154	ALS QUOTE NO.:	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: PURCHASE ORDER NO.: Use Proj No.	COUNTRY OF ORIGIN:	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7
PROJECT MANAGER: lab@enrs.com.au CONTACT PH: 0401 518 443		OF: 1 2 3 4 5 6 7
SAMPLER: MK / TF SAMPLER MOBILE: 0447 195 017	RELINQUISHED BY:	RECEIVED BY:
COC Emailed to ALS? (YES / NO) EDD FORMAT (or default):	T.Flanigan	
Email Reports to (will default to PM if no other addresses are listed): lab@enrs.com.au	DATE/TIME:..... 16/10/2019	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed):		

						RELINQUISHED BY:	RECEIVED BY:
						DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)		Ammonia, TOC, TDS, Potassium, ph, EC	TSS, Total Phosphorus	Alkalinity, Cl, SO4, Ca, Mg, Na, K, HCO3, CO3	Dissolved Al, As, Ba, Cd, Cr, Co, Cu, Pb, Mn, Zn, Hg(Cr+6	Nitrate, Nitrite, Phosphate, TotalPhenolics, Fluoride	TRH (C6-40) / BTEXN	PFAS short Suite		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	MW01	16-10-19	Water	P, SP, N, VOC, AG, SH		1	1	1	1	1	1	1		ALS to select appropriate batch codes
	MW02	16-10-19	Water	P, SP, N, VOC, AG, SH		1	1	1	1	1	1	1		
					TOTAL	0	2	2	2	2	2	2	2	

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ENRM (2041Y2) Form Page 1 of 1 Approved Date: 06/02/2014

SA19.185 - Attachment 2

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EW1904499	Page	: 1 of 8
Client	: ENVIRONMENT & NATURAL RESOURCE SOLUTIONS	Laboratory	: Environmental Division NSW South Coast
Contact	: LAB ENRS	Contact	: Aneta Prosaroski
Address	: 25 River Rd Shoalhaven Heads 2535	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: 02 9037 4708	Telephone	: +61 2 4225 3125
Project	: SCC Lake Conjola	Date Samples Received	: 16-Oct-2019 08:49
Order number	: ENRS1154	Date Analysis Commenced	: 17-Oct-2019
C-O-C number	: ----	Issue Date	: 22-Oct-2019 16:14
Sampler	: M K, Tamika Flanigan		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

Page	:	2 of 8
Work Order	:	EW1904499
Client	:	ENVIRONMENT & NATURAL RESOURCE SOLUTIONS
Project	:	SCC Lake Conjola

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG050G: Poor spike recovery for Hexavalent Chromium due to matrix interferences(confirmed by re-analysis).
- EG050G: LOR raised for Hexavalent Chromium on sample No2 due to sample matrix.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

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Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW01	MW02	----	----	----
			Client sampling date / time	16-Oct-2019 00:00	16-Oct-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EW1904499-001	EW1904499-002	---------	---------	---------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	5.45	6.23	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	2340	269	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	1530	175	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	3380	1350	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	10	25	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	10	25	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	40	28	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	670	45	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	17	5	----	----	----
Magnesium	7439-95-4	1	mg/L	96	4	----	----	----
Sodium	7440-23-5	1	mg/L	233	40	----	----	----
Potassium	7440-09-7	1	mg/L	3	2	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	438	29	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.75	4.36	----	----	----
Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	----	----	----
Barium	7440-39-3	0.001	mg/L	0.365	0.039	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	0.007	----	----	----
Cobalt	7440-48-4	0.001	mg/L	0.015	0.011	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	0.007	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	0.016	----	----	----
Manganese	7439-96-5	0.001	mg/L	0.122	0.036	----	----	----
Zinc	7440-66-6	0.005	mg/L	0.111	0.056	----	----	----

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Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW01	MW02	----	----	----
				Client sampling date / time	16-Oct-2019 00:00	16-Oct-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EW1904499-001	EW1904499-002	--------	--------	--------
					Result	Result	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		<0.01	<0.10	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	<0.1	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.05**	**0.03**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.02**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.02**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**6.3**	**0.8**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**6.3**	**0.8**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**1.76**	**0.28**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**19.9**	**2.35**	----	----	----
ø Total Cations	----	0.01	meq/L		**19.0**	**2.37**	----	----	----
ø Ionic Balance	----	0.01	%		**2.50**	**0.38**	----	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**11**	**4**	----	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	----	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	----	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	----	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	<1.0	----	----	----

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Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW01	MW02	----	----	----
			Client sampling date / time	16-Oct-2019 00:00	16-Oct-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EW1904499-001	EW1904499-002	--------	--------	--------
				Result	Result	----	----	----
EP075(SIM)A: Phenolic Compounds - Continued								
2.4-Dimethylphenol	105-67-9	1.0	µg/L	<1.0	<1.0	----	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L	<1.0	<1.0	----	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L	<1.0	<1.0	----	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L	<1.0	<1.0	----	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L	<1.0	<1.0	----	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L	<1.0	<1.0	----	----	----
Pentachlorophenol	87-86-5	2.0	µg/L	<2.0	<2.0	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----

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Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW01	MW02	----	----	----
				Client sampling date / time	16-Oct-2019 00:00	16-Oct-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EW1904499-001	EW1904499-002	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.02	µg/L		**0.02**	<0.02	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.02	µg/L		**0.06**	<0.02	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.01	µg/L		**0.02**	<0.01	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.1	µg/L		<0.1	<0.1	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.02	µg/L		<0.02	<0.02	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.02	µg/L		**0.02**	<0.02	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.02	µg/L		<0.02	<0.02	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.01	µg/L		**0.02**	<0.01	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.05	µg/L		<0.05	<0.05	----	----	----
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.05	µg/L		<0.05	<0.05	----	----	----

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Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW01	MW02	----	----	----
				Client sampling date / time	16-Oct-2019 00:00	16-Oct-2019 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EW1904499-001	EW1904499-002	--------	--------	--------
					Result	Result	----	----	----
EP231D: (n:2) Fluorotelomer Sulfonic Acids - Continued									
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.05	µg/L		<0.05	<0.05	----	----	----
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.05	µg/L		<0.05	<0.05	----	----	----
EP231P: PFAS Sums									
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.01	µg/L		**0.08**	<0.01	----	----	----
Sum of PFAS (WA DER List)	----	0.01	µg/L		**0.14**	<0.01	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		**20.2**	**17.4**	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		**47.5**	**55.8**	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		**36.9**	**42.8**	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		**75.5**	**82.3**	----	----	----
Anthracene-d10	1719-06-8	1.0	%		**94.4**	**92.6**	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		**67.2**	**65.9**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**120**	**120**	----	----	----
Toluene-D8	2037-26-5	2	%		**111**	**112**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**108**	**108**	----	----	----
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.02	%		**117**	**114**	----	----	----
13C8-PFOA	----	0.02	%		**104**	**101**	----	----	----

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Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128
EP231S: PFAS Surrogate			
13C4-PFOS	----	60	120
13C8-PFOA	----	60	120

REPORT TO

SHOALHAVEN CITY COUNCIL

ON

GEOTECHNICAL ASSESSMENT

OF

EXISTING AND PROPOSED CLIFF TOP LOOKOUTS

AT

PENGUIN HEAD ROAD, CULBURRA, NSW

Date: 31 August 2019
Ref: 32542Rrpt

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DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
32542Rrpt	Final Report	31/8/19

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ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical assessment of the existing cliff top lookouts and the locations of proposed new lookouts at the eastern end of Penguin Head Road, Culburra, NSW. The location of the site is shown in Figure 1. The geotechnical assessment was commissioned by Raymond Massie (Shoalhaven City Council) via Purchase Order Number PG094773, dated 19 July 2019. The commission was on the basis of our fee proposal (Ref. P49841R) dated 10 July 2019.

We understand from Council that the three current lookouts are to be modified as follows:

- The northern lookout (Northern Platform) is to be replaced to "*current standards*".
- The eastern and southern lookouts (Central and Southern Platforms) are to be each replaced with a "cantilevered platform and concrete pathway". The southern lookout concrete pathway will extend south from the adjacent section of roadway.

No other details have been provided and we have assumed typical loadings for this type of development.

We note that the site area was included in our geotechnical assessment report (Ref. 30016ZRrpt) dated 13 December 2016 on selected existing foreshore cliff faces in the Shoalhaven City Council Local Government Area.

The purpose of the assessment was to inspect the cliff top areas at each lookout location and the cliff face below, in order to assess the stability of the cliff face and the current levels of risk, in order to provide our advice on the stability of the site of each lookout, and preliminary comments and recommendations on the geotechnical aspects of the proposed lookout structures and landslide risk management measures.

2 ASSESSMENT METHODOLOGY

The site was inspected by our Principal Associate level engineering geologist on 26 July 2019.

This stability assessment is based upon a detailed inspection of the topographic, surface drainage and geological conditions of the cliff top and the cliff face at the three lookout locations and their immediate environs, from safe vantage points along the cliff top and base of the cliff. A low tidal period was selected for the assessment. These features were compared to those of other similar lots in neighbouring locations to provide a comparative basis for assessing the risk of instability affecting the proposed development. The attached Appendix A defines the terminology adopted for the risk assessment together with a flowchart illustrating the Risk Management Process based on the guidelines given in AGS 2007c (Reference 1).

A summary of our observations is presented in Section 3 below. Our geotechnical advice is provided in Section 5 following our geotechnical assessment.

The geotechnical features described in Section 3 below have been measured by hand held inclinometer and tape measure techniques, where access was possible, or otherwise estimated and hence are only approximate.

3 SUMAMRY OF OBSERVATIONS

The site is situated at the eastern end of asphaltic concrete (AC) surfaced Penguin Head Road and a grass covered reserve area lines the eastern end of the road. The cliff faces form the eastern end of an east-west orientated headland feature with bedrock wave cut platforms lining the base of the cliff faces.

The cliff face was a maximum vertical height of about 8.0m and small shrubs and trees covered the majority of the cliff crest area. Surface run-off from the north-eastern section of the grass covered reserve area to the east of the existing northern lookout had formed an erosion gully (maximum 1.0m depth and 2.2m width) in the upper section of the cliff top area. The sides and base of the erosion gully exposed residual silty clays; see Plate 1. The gully appeared to form an informal access to the base of the cliff.

Plate 1: Erosion Gully to the East of the Northern Lookout

The northern lookout comprised a gravel and grass covered area provided with a timber fence and the northern side of the lookout structure was overgrown and prevented further observations; see Plate 2. The northern edge of the lookout structure was set-back about 4.0m landward of the toe of the steep vegetated upper section of the cliff face which we have inferred to comprise residual clays based on our site observations to the east.

Plate 2: Northern Lookout

Plate 3: Cliff face Below the Northern Lookout

The predominantly sandstone bedrock cliff face was sub-horizontally bedded and contained numerous sub-vertical east-west and north-south orientated joints with lateral joint spacing ranging between about 0.4m and 1.5m; see Plate 3. Undercuts over the upper portion of the cliff face were a maximum estimated height and depth of 1.0m and 1.5m respectively. The claystone bands at the base of the cliff were eroded to form undercuts (maximum 0.3m depth). There were only occasional cobble sized sandstone pieces scattered across the wave cut platform at the base of the cliff.

The existing eastern and southern lookouts comprised timber structures suspended over the cliff face crest area. The eastern lookout was accessed via a gravel surfaced walkway and the southern lookout was accessed via a timber walkway that stepped down from the road; see Plates 4 and 5.

Plate 4: Existing Eastern Lookout

Plate 5: Existing Southern Lookout

The eastern lookout (about 3.0m square in plan) was set-back at least about 0.6m from the edge of the cliff; see Plate 6. Numerous sub-vertical east-west and north-south orientated joints were evident across the cliff top surface and in the cliff faces below the lookout.

Plate 6: South-Eastern Corner of the Eastern Lookout

The form of the predominantly sandstone bedrock cliff face was similar to the area below the northern lookout and the joints were open a maximum width of about 0.1m. The cliff face forming the headland was stepped (in plan) with the joints controlling the form of the cliff faces. The sub-horizontal bedding partings were eroded forming undercuts (maximum depth about 0.5m); see Plates 7 and 8. In addition, below the southern side of the lookout, the base of the cliff was undercut (maximum height and depth about 3.7m and 1.3m, respectively); see Plate 8.

Plate 7: Cliff Face Below Northern and Eastern sides of the Eastern Lookout

Plate 8: Cliff Face Below Southern and Eastern sides of the Eastern Lookout

Sandstone boulders (maximum dimension abut 2.0m) were scattered across the base of the cliff face below the northern and southern sides of the eastern lookout; see Plates 7 and 8.

The southern lookout was set-back about 2.0m from the steep vegetated upper section of the cliff face which we have inferred to comprise residual clays. The remainder of the cliff face below was typically vegetated with boulders covering the base of the cliff; see Plate 9. The presence of small trees across the cliff face has been interpreted to indicate that colluvial clayey soils (with cobble and boulder sized sandstone inclusions) cover the majority of the cliff face. Traces of sub-vertical sandstone cliff faces were evident and were typically undercut (maximum height and depth about 1.0m).

4 GEOTECHNCIAL ASSESSMENT

4.1 Overview

Reference to the 1:250,000 Geological Map of Wollongong indicates that the site is underlain by Permian age Wandrawandian Siltstone; comprising siltstone and silty sandstone, pebbly in parts.

The sandstone (with thin claystone and siltstone bands) formed the cliff face below the lookouts showed signs of on-going weathering and erosion. Erosion was forming undercutting at the base of the cliff and along relatively weaker bedding partings and thin claystone and siltstone bands. The cobbles and boulders along the base of the cliff below the eastern and southern lookouts and the inferred colluvium covering much of the cliff face below the southern lookout represent past rock fall debris. The debris will be eroded over time by wave action.

It is evident that the topography of the cliff face has been influenced by the sub-vertical joints. In addition, the open nature of some of the observed joint planes has been assessed to be the result of the horizontal stress relief movements associated with past erosion of the cliff faces in the recent geological past.

Chemical weathering of bedrock results from hydration and solution due to the interaction between the bedrock exposed in the cliff face and sea water spray is an ongoing process with the conglomerate degrading (and losing strength) at a more rapid rate than the sandstone above and below. This is primarily caused by growth of salt within the rocks introduced by sea spray, and regular wetting and drying of the rocks within the tidal zone. Erosion by rainfall and surface run-off discharging over the cliff face, wave action and 'sand blasting' due to wind action also impacts the cliff face. The impacts of erosion are exacerbated by variations in rock strength; the weaker rocks weather (degrade) and erode more readily and result in undercuts forming below bands of stronger rocks.

Additional triggers to collapse of potentially unstable features such as overhangs, blocks and wedges over the cliff face are:

1. Water pressure developed in the sub-vertical open joints behind potentially unstable features during and following rainfall events. Water may also become trapped in sections of open defects due to the presence of soil infill and/or vegetative matter that has collected in the open defect.
2. Localised tree root 'jacking' where tree roots penetrate sub-vertical open joints landward of potentially unstable features over the cliff faces. In addition, the 'jacking' action of tree roots and growth of tree roots would also lead to a further opening of the joint plane thereby allowing greater quantities of water to accumulate in the defect behind the potentially unstable feature.
3. Water collecting in open defects and decomposing vegetation in the open defects (generating humic acid) resulting in continued weathering and degradation of the bedrock forming the defect face. This process of weathering and degradation can then lead to weakening of the intact bedrock in and around the defect area, thus increasing the potential for tensile failure of the intact bedrock.
4. Expansion and contraction of the bedrock can also be expected as a response to temperature variations. This would lead to lateral expansion and contraction of the bedrock surfaces forming the open and possibly infilled defect, with additional soil entering the open defect during periods of expansion. The

increased quantity of soil infill within the defect would then inhibit the contraction of the bedrock resulting in a build-up of stress, which would lead to further propagation of the defect.

5. Concentrated discharge of run-off along natural surface flow paths over the cliff face, which could result in localised erosion of the areas below overhang features, around 'floaters' and/or increased volumes of water within open defects.

Crucial to these processes and their potential impacts on the likelihood of failure, is the rate at which they are occurring. Based on previous work by Young & Wray 2000, Dragovich 2000 and Crozier and Braybrooke 1992 and our past assessments of cliff face recession rates, we note the following:

- A chemical weathering rate of at least about 2mm per year is considered to be appropriate for the cliff face.
- An average erosion rate of between 5mm and 15mm per year for the cliff face. However, the rates of erosion will vary depending on the dominant wave direction impacting the cliff face, together with the mass characteristic of the rocks forming the cliff face and the presence of rock fall debris along the base of the cliff. Further, lower erosion rates would be applicable for the sandstone bands compared to the claystone bands leading to undercutting, with collapse of the sandstone above controlled by the defect spacing.

4.2 Potential Landslide Hazards

Based on the results of our inspection, the potential geotechnical hazards for the site area are summarised and outlined below:

A. Instability of the upper residual clay profile.
B. Instability of blocks and wedges from the cliff face.
C. Instability of the basal undercut below the southern side of the eastern lookout.
D. Instability of the colluvial soils below the southern lookout.

The lookouts (and proposed lookouts) and persons on the lookouts or at the base of the cliff would be the elements most at risk. During construction of new lookout structures, the elements most at risk would then include workers constructing the platform.

The existing road is set-back sufficient distance not to be affected by the above potential landslide hazards.

It is important to be mindful that rock falls etc can occur at anytime and it would be difficult to impossible to predict when the identified potential hazards will occur. Also, we cannot predict when an extreme or unusual event may occur (such as an earthquake or 1 in 100 year rainfall event etc) and what impact it would have on the stability of the identified potential hazards.

4.3 Risk Analysis

The terminology adopted for this qualitative assessment is in accordance with Table A1 given in Appendix A.

The assessed likelihood of the potential landslide hazards occurring, under existing conditions, is outlined below:

A. Instability of the upper residual clay profile; Possible.
B. Instability of blocks and wedges from the cliff face; Likely.
C. Instability of the basal undercut below the southern side of the eastern lookout; Unlikely.
D. Instability of the colluvial soils below the southern lookout; Possible.

Under existing conditions, the lookout would potentially be impacted. Should either hazards A, B or D occur, the lookout would not be impacted and consequences to property would be regarded as 'insignificant'. However, should hazard C occur, the consequences to the eastern lookout would be 'medium'. Assessed levels of risk to property for all the potential landslide hazards would therefore be at an 'Acceptable' level (low or very low), in accordance with the criteria given in Reference 1.

With regard to risk to life, we have considered two levels of duration of use of the lookouts:

- 5 minutes per day for 9 months of the year: i.e. about 3×10^{-3}, or
- 0.5 hours per day for 9 months of the year: i.e. about 0.02.

For some one walking along the platform at the base of the cliff, we have adopted a duration of use based on an average walking rate of 4 seconds per 5m length per day for 9 months of the year: i.e. 4×10^{-5}.

We have used the indicative probabilities associated with the assessed likelihood of instability to calculate the risk to life. For Hazards A to D, and using the above occupancies and adopting vulnerability and evacuation factors of 0.1 and assuming the person was above or below the hazard when it occurred, the risk to life would be less than 2×10^{-6}, which would be considered 'Acceptable' in accordance with the criteria given in Reference 1.

Following construction of the new southern and central lookouts and replacement of the northern lookout, and assuming they were designed and constructed in accordance with the advice provided in Section 5 below (resulting in a reduced likelihood of Hazard B occurring as selected blocks and wedges would be stabilised, and 'insignificant' consequences and also a reduction in the vulnerability and evacuation factors to 0.01), then the assessed risk levels would be as follows:

- Risk to property (the lookouts): 'Acceptable', in accordance with the criteria given in Reference 1.
- Risk to life: less than 2×10^{-8}, which would be considered 'Acceptable' in accordance with the criteria given in Reference 1.

4.4 Additional Comments

It is recognised that, due to the many complex factors that can affect a site, the subjective nature of a risk analysis, and the imprecise nature of the science of geotechnical engineering, the risk of instability for a site cannot be completely removed. It is, however, essential that risk be reduced to at least that which could be reasonably anticipated by the community in everyday life and that landowners be made aware of reasonable and practical measures available to reduce risk as far as possible. Hence, risk cannot be completely removed, only reduced, as removing risk is not currently scientifically achievable.

In preparing our recommendations given below we have assumed that no activities on surrounding land which may affect the risk on the subject sites would be carried out. We have further assumed that all Council, buried services and other buried services within, and adjacent to the site are, and will be regularly maintained to remain, in good condition.

With the recommendations outlined in Section 5 below implemented, the assessed risk to life and property would remain at 'Acceptable' levels, in accordance with the criteria given in Reference 1.

5 GEOTECHNICAL ADVICE

We provide below recommendations regarding landslide risk management measures and geotechnical design considerations for the proposed new southern and central lookouts and replacement of the northern lookout. These recommendations form an integral part of the Landslide Risk Management (LRM) Process. However, it is a matter for Council how they wish to implement the advice provided below.

5.1 Lookouts

From a geotechnical perspective, the principle design consideration for the lookouts will be to reduce the potential impacts of on-going cliff instability (Hazards A to D described in Section 4 above). In order to achieve this, the lookouts would need to be supported on footings founded in bedrock, with the footings set-back at least 3.0m landward of the edge of the cliff (northern and southern lookouts) and at least 1.0m landward at the central lookout, provided individual blocks and wedges are stabilised. Otherwise a 3.0m set-back would be required. The lookouts would need to be designed to cantilever seaward of the 3.0m set-back zone to maintain the current ocean views offered by the existing lookouts. This would require deeper footings or anchors installed into bedrock.

On the basis of the above, should there be cliff face instability, the lookout footings would be set-back sufficient distance to not be impacted by the above Hazards, and, as noted above the likelihood of Hazard B occurring, assuming stabilisation measures are installed would also be much reduced.

We provide the following geotechnical advice with regard to the proposed new southern and central lookouts and replacement of the northern lookout.

At the commencement of the works, vegetation must be cleared from around the area of the northern and southern lookouts and a further geotechnical inspection completed to check for the presence of any specific potentially unstable features (blocks, wedges, undercuts, 'floaters' etc.) which may need to be stabilised and/or removed.

Clearly, during construction, access to the cliff edge will need to be restricted and no building materials, plant or equipment should be located within at least a 4.0m set-back distance from the cliff edge and excluded from the area of the proposed lookouts. However, during construction some encroachment into this area will be unavoidable and appropriate WHS measures will need to be implemented, such as safety ropes, harnesses etc and an exclusion zones at the base of the cliff below the lookout sites to prevent access.

We recommend that the replacement of the northern lookout include a suspended structure (i.e. similar to the current eastern and southern lookouts) with the footings founded in bedrock at a set-back distance of at least 3.0m landward of the edge of the cliff (i.e. the base of the upper steep soil slope). Forming an on-grade platform similar to that currently provided) would require earthworks plant and equipment working close to the edge of a slope/cliff which could generate vibrations that may cause localised instability.

For the northern and southern lookouts, the footings would be expected to comprise bucket piers or bored piles extending through the soil profile and penetrating bedrock. Augers with rock teeth would be required to form rock sockets. To prevent potential overturning the footings would need to be provided with rock sockets (which may be difficult to achieve without powerful piling equipment) or alternatively connected to sub-vertical or vertical rock bolts installed into bedrock of at least low strength. Alternatively, the footings could comprise sub-vertical rock bolts (i.e. mini piles).

For the central lookout, if the footings ae preferred to be located at a set-back distance of about 1.0m landward of the cliff edge, then the blocks of sandstone defined by the sub-vertical joints would need to be stabilised using rock bolts. Geotechnical inspection would be required to determine the location, length and number of rock bolts; we assume at least two minimum 20mm diameter rock bolts (at least 3.0m long) would be required per block/wedge of sandstone.

Footings founded in weathered sandstone bedrock of at least low strength may be designed using an allowable bearing pressure of 800kPa, subject to geotechnical inspection. All footings should be excavated, inspected and poured with minimal delay. All footings should be free from all loose or softened materials prior to pouring. If water ponds in the base of the footings they should be pumped dry and then re-excavated to remove all loose and any water softened materials.

Any permanent rock bolts should be designed for an allowable bond strength of 200kPa assuming they are installed into sandstone bedrock of at least low strength. Permanent rock bolts will need to be designed with due regard for long term corrosion protection, i.e. fully grouted, sheathed, hot dipped galvanised and provided with a sacrificial thickness or using stainless steel bars.

5.2 Landslide Risk Management Measures

5.2.1 Fencing and Warning Signs

Access to other sections of the crest of the cliff face between the lookouts is currently possible. Council should consider restricting access by erecting a fence. However, we note that it is unlikely to be feasible to completely prevent access to these areas.

In addition to the fence line, Council should consider posting additional warning signs warning of potential cliff instability. Similar signs should also be posted on the wave cut platform area in the vicinity of the cliff face. We also recommend that at the location of the informal access track (east of the northern lookout) to the base of the cliff, unless Council also fence off access to this pathway, warning signs are posted at the crest and toe warning of slip and trip hazards as well as cliff instability.

Council should also seek legal advice in relation to the nature, form and wording of the warning signs and fencing.

5.2.2 On-Going Monitoring

We recommend that Council monitor the site area on an annual basis and after periods of prolonged or heavy rainfall and/or predicted high tidal levels (particularly where they correspond with storm events). The purpose of the monitoring is to assess existing conditions and any indications of deterioration such as cracking of the crest areas of slopes and cliff faces, deformed lookout structures, evidence of rock falls and/or soil slumps at the base of the slopes, etc.

It is imperative that such monitoring be formally documented and that the required frequency of reporting (and to whom) is clearly defined. Where incidents of instability have occurred within the monitoring period then, where possible, we suggest that Council provide relevant details within the monitoring reports. These details would include the date of the incident, the weather conditions on the day and leading up to the incident, a location plan/sketch, photographs and dimensions of the specific features (block sizes, crack widths etc would also need to be recorded). Where new incidents have occurred, the monitoring reports should be provided to the geotechnical engineer so that if there are any causes for concern, further advice can be provided. The need for site specific stabilisation measures can then be better assessed.

In addition, on a 10 yearly basis, a detailed assessment of the site area should be undertaken by experienced geotechnical and coastal engineers to assess current conditions with regard to the contents of this report and the on-going inspection monitoring reports.

Based on previous studies of available rainfall data in relationship to landslide events, in particular a study carried out for the Pittwater area (Walker 2007, Reference 2), we provide the following tentative definition of heavy rainfall and prolonged rainfall:

- Heavy Rainfall: at least 100mm of rainfall in one day, and
- Prolonged Rainfall: at least 150mm of rainfall over a 5 day period.

These amounts of rainfall represent 2 year ARI occurrences for the Pittwater area and are considered reasonable for the Shoalhaven City Council area, unless more specific advice is available to Council.

5.3 Further Geotechnical Input

The following is a summary of the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Inspection of the cliff face areas and detail stabilisation measures at the three lookout locations.
- Inspection of lookout footings.
- Review of monitoring reports.
- Re-assessing the need for stabilisation measures in light of the above monitoring reports.
- Geotechnical re-assessment on a ten yearly basis.

6 GENERAL COMMENTS

It is possible that the subsurface soil, rock or groundwater conditions encountered during implementation of the landslide risk management measures may be found to be different (or may be interpreted to be different) from those inferred from our surface observations in preparing this report. Also, we have not had the opportunity to observe surface run-off patterns during heavy rainfall and cannot comment directly on this aspect. If conditions appear to be at variance or cause concern for any reason, then we recommend that Council immediately contact this office.

REFERENCES

1. Australian Geomechanics Society (2007c) *'Practice Note Guidelines for Landslide Risk Management'*, Australian Geomechanics, Vol 42, No 1, March 2007, pp63-114.
2. Walker B.F (2007), *'Rainfall Data Analysis and relation to the landsliding at Newport'*, Australian Geomechanics, Vol 42, No 1, March 2007, pp197-212.

SA19.192 - Attachment 1

APPENDIX A

LANDSLIDE RISK MANAGEMENT TERMINOLOGY

LANDSLIDE RISK MANAGEMENT

Definition of Terms and Landslide Risk

Risk Terminology	Description
Acceptable Risk	A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.
Annual Exceedance Probability (AEP)	The estimated probability that an event of specified magnitude will be exceeded in any year.
Consequence	The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.
Elements at Risk	The population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.
Frequency	A measure of likelihood expressed as the number of occurrences of an event in a given time. See also 'Likelihood' and 'Probability'.
Hazard	A condition with the potential for causing an undesirable consequence (the landslide). The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the likelihood of their occurrence within a given period of time.
Individual Risk to Life	The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide; or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.
Landslide Activity	The stage of development of a landslide; pre failure when the slope is strained throughout but is essentially intact; failure characterised by the formation of a continuous surface of rupture; post failure which includes movement from just after failure to when it essentially stops; and reactivation when the slope slides along one or several pre-existing surfaces of rupture. Reactivation may be occasional (eg. seasonal) or continuous (in which case the slide is 'active').
Landslide Intensity	A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, or kinetic energy per unit area.
Landslide Risk	The AGS Australian GeoGuide LR7 (AGS, 2007e) should be referred to for an explanation of Landslide Risk.
Landslide Susceptibility	The classification, and volume (or area) of landslides which exist or potentially may occur in an area or may travel or retrogress onto it. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding.
Likelihood	Used as a qualitative description of probability or frequency.
Probability	A measure of the degree of certainty. This measure has a value between zero (impossibility) and 1.0 (certainty). It is an estimate of the likelihood of the magnitude of the uncertain quantity, or the likelihood of the occurrence of the uncertain future event. These are two main interpretations: (i) Statistical – frequency or fraction – The outcome of a repetitive experiment of some kind like flipping coins. It includes also the idea of population variability. Such a number is called an 'objective' or relative frequentist probability because it exists in the real world and is in principle measurable by doing the experiment.

Risk Terminology	Description
Probability *(continued)*	(ii) Subjective probability (degree of belief) – Quantified measure of belief, judgment, or confidence in the likelihood of an outcome, obtained by considering all available information honestly, fairly, and with a minimum of bias. Subjective probability is affected by the state of understanding of a process, judgment regarding an evaluation, or the quality and quantity of information. It may change over time as the state of knowledge changes.
Qualitative Risk Analysis	An analysis which uses word form, descriptive or numeric rating scales to describe the magnitude of potential consequences and the likelihood that those consequences will occur.
Quantitative Risk Analysis	An analysis based on numerical values of the probability, vulnerability and consequences and resulting in a numerical value of the risk.
Risk	A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form.
Risk Analysis	The use of available information to estimate the risk to individual, population, property, or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification and risk estimation.
Risk Assessment	The process of risk analysis and risk evaluation.
Risk Control or Risk Treatment	The process of decision-making for managing risk and the implementation or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.
Risk Estimation	The process used to produce a measure of the level of health, property or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis and their integration.
Risk Evaluation	The stage at which values and judgments enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental and economic consequences, in order to identify a range of alternatives for managing the risks.
Risk Management	The complete process of risk assessment and risk control (or risk treatment).
Societal Risk	The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of a landslide causing a number of deaths, injuries, financial, environmental and other losses.
Susceptibility	See 'Landslide Susceptibility'.
Temporal Spatial Probability	The probability that the element at risk is in the area affected by the landsliding, at the time of the landslide.
Tolerable Risk	A risk within a range that society can live with so as to secure certain net benefits. It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible.
Vulnerability	The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

NOTE: Reference should be made to Figure A1 which shows the inter-relationship of many of these terms and the relevant portion of Landslide Risk Management.

Reference should also be made to the paper referenced below for Landslide Terminology and more detailed discussion of the above terminology.

This appendix is an extract from PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT as presented in Australian Geomechanics, Vol 42, No 1, March 2007, which discusses the matter more fully.

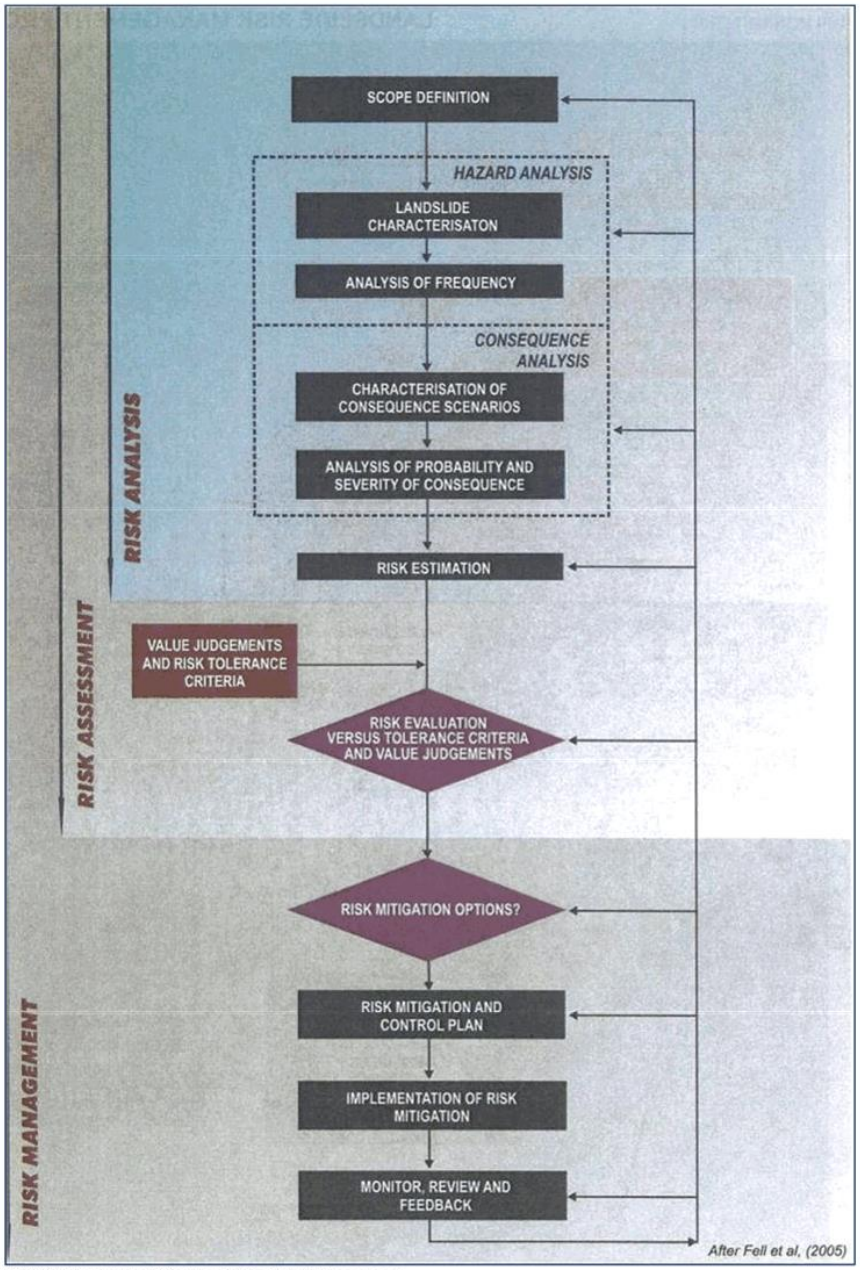

FIGURE A1: Flowchart for Landslide Risk Management.

This figure is an extract from GUIDELINE FOR LANDSLIDE SUSCEPTIBILITY, HAZARD AND RISK ZONING FOR LAND USE PLANNING, as presented in Australian Geomechanics Vol 42, No 1, March 2007, which discusses the matter more fully.

TABLE A1: LANDSLIDE RISK ASSESSMENT
QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	5×10^{-2}	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}		100 years		The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	5×10^{-3}	1000 years	200 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	5×10^{-4}	10,000 years	2000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	5×10^{-5}	100,000 years	20,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}	5×10^{-2}	1,000,000 years	200,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%		Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%	1%	Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa.

Extract from PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT as presented in Australian Geomechanics, Vol 42, No 1, March 2007, which discusses the matter more fully.

TABLE A1: LANDSLIDE RISK ASSESSMENT
QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (continued)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or L (5)
B - LIKELY	10^{-2}	VH	VH	H	M	L
C - POSSIBLE	10^{-3}	VH	H	M	M	VL
D - UNLIKELY	10^{-4}	H	M	L	L	VL
E - RARE	10^{-5}	M	L	L	VL	VL
F - BARELY CREDIBLE	10^{-6}	L	VL	VL	VL	VL

Notes: (5) Cell A5 may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

Extract from PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT as presented in Australian Geomechanics, Vol 42, No 1, March 2007, which discusses the matter more fully.

AUSTRALIAN GEOGUIDE LR2 (LANDSLIDES)

What is a Landslide?

Any movement of a mass of rock, debris, or earth, down a slope, constitutes a "landslide". Landslides take many forms, some of which are illustrated. More information can be obtained from Geoscience Australia, or by visiting its Australian landslide Database at www.ga.gov.au/urban/factsheets/landslide.jsp. Aspects of the impact of landslides on buildings are dealt with in the book "Guideline Document Landslide Hazards" published by the Australian Building Codes Board and referenced in the Building Code of Australia. This document can be purchased over the internet at the Australian Building Codes Board's website www.abcb.gov.au.

Landslides vary in size. They can be small and localised or very large, sometimes extending for kilometres and involving millions of tonnes of soil or rock. It is important to realise that even a 1 cubic metre boulder of soil, or rock, weighs at least 2 tonnes. If it falls, or slides, it is large enough to kill a person, crush a car, or cause serious structural damage to a house. The material in a landslide may travel downhill well beyond the point where the failure first occurred, leaving destruction in its wake. It may also leave an unstable slope in the ground behind it, which has the potential to fall again, causing the landslide to extend (regress) uphill, or expand sideways. For all these reasons, both "potential" and "actual" landslides must be taken very seriously. The present a real threat to life and property and require proper management.

Identification of landslide risk is a complex task and must be undertaken by a geotechnical practitioner (GeoGuide LR1) with specialist experience in slope stability assessment and slope stabilisation.

What Causes a Landslide?

Landslides occur as a result of local geological and groundwater conditions, but can be exacerbated by inappropriate development (GeoGuide LR8), exceptional weather, earthquakes and other factors. Some slopes and cliffs never seem to change, but are actually on the verge of failing. Others, often moderate slopes (Table 1), move continuously, but so slowly that it is not apparent to a casual observer. In both cases, small changes in conditions can trigger a landslide with series consequences. Wetting up of the ground (which may involve a rise in groundwater table) is the single most important cause of landslides (GeoGuide LR5). This is why they often occur during, or soon after, heavy rain. Inappropriate development often results in small scale landslides which are very expensive in human terms because of the proximity of housing and people.

Does a Landslide Affect You?

Any slope, cliff, cutting, or fill embankment may be a hazard which has the potential to impact on people, property, roads and services. Some tell-tale signs that might indicate that a landslide is occurring are listed below:

- Open cracks, or steps, along contours
- Groundwater seepage, or springs
- Bulging in the lower part of the slope
- Hummocky ground
- trees leaning down slope, or with exposed roots
- debris/fallen rocks at the foot of a cliff
- tilted power poles, or fences
- cracked or distorted structures

These indications of instability may be seen on almost any slope and are not necessarily confined to the steeper ones (Table 1). Advice should be sought from a geotechnical practitioner if any of them are observed. Landslides do not respect property boundaries. As mentioned above they can "run-out" from above, "regress" from below, or expand sideways, so a landslide hazard affecting your property may actually exist on someone else's land.

Local councils are usually aware of slope instability problems within their jurisdiction and often have specific development and maintenance requirements. **Your local council is the first place to make enquiries if you are responsible for any sort of development or own or occupy property on or near sloping land or a cliff.**

TABLE 1 – Slope Descriptions

Appearance	Slope Angle	Maximum Gradient	Slope Characteristics
Gentle	0° - 10°	1 on 6	Easy walking.
Moderate	10° - 18°	1 on 3	Walkable. Can drive and manoeuvre a car on driveway.
Steep	18° - 27°	1 on 2	Walkable with effort. Possible to drive straight up or down roughened concrete driveway, but cannot practically manoeuvre a car.
Very Steep	27° - 45°	1 on 1	Can only climb slope by clutching at vegetation, rocks, etc.
Extreme	45° - 64°	1 on 0.5	Need rope access to climb slope.
Cliff	64° - 84°	1 on 0.1	Appears vertical. Can abseil down.
Vertical or Overhang	84° - 90±°	Infinite	Appears to overhang. Abseiler likely to lose contact with the face.

Some typical landslides which could affect residential housing are illustrated below:

Rotational or circular slip failures (Figure 1) - can occur on moderate to very steep soil and weathered rock slopes (Table 1). The sliding surface of the moving mass tends to be deep seated. Tension cracks may open at the top of the slope and bulging may occur at the toe. The ground may move in discrete "steps" separated by long periods without movement. More rapid movement may occur after heavy rain.

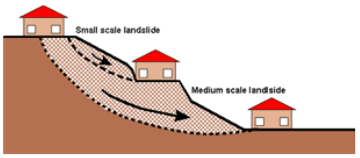

Figure 1

Translational slip failures (Figure 2) - tend to occur on moderate to very steep slopes (Table 1) where soil, or weak rock, overlies stronger strata. The sliding mass is often relatively shallow. It can move, or deform slowly (creep) over long periods of time. Extensive linear cracks and hummocks sometimes form along the contours. The sliding mass may accelerate after heavy rain.

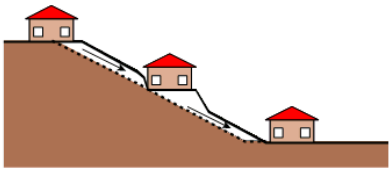
Figure 2

Wedge failures (Figure 3) - normally only occur on extreme slopes, or cliffs (Table 1), where discontinuities in the rock are inclined steeply downwards out of the face.

Rock falls (Figure 3) - tend to occur from cliffs and overhangs (Table 1).

Cliffs may remain, apparently unchanged, for hundreds of years. Collections of boulders at the foot of a cliff may indicate that rock falls are ongoing. Wedge failures and rock falls do not "creep". Familiarity with a particular local situation can instil a false sense of security since failure, when it occurs, is usually sudden and catastrophic.

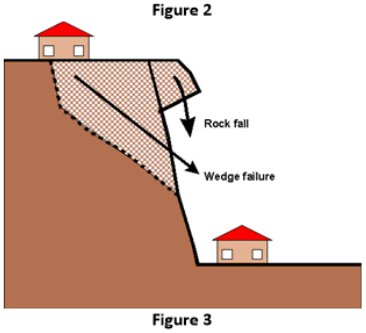

Figure 3

Debris flows and mud slides (Figure 4) - may occur in the foothills of ranges, where erosion has formed valleys which slope down to the plains below. The valley bottoms are often lined with loose eroded material (debris) which can "flow" if it becomes saturated during and after heavy rain. Debris flows are likely to occur with little warning; they travel a long way and often involve large volumes of soil. The consequences can be devastating.

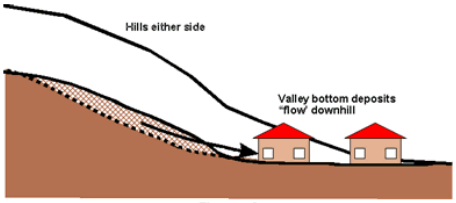

Figure 4

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR3 - Soil Slopes
- GeoGuide LR4 - Rock Slopes
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

AUSTRALIAN GEOGUIDE LR7 (LANDSLIDE RISK)

Concept of Risk

Risk is a familiar term, but what does it really mean? It can be defined as *"a measure of the probability and severity of an adverse effect to health, property, or the environment."* This definition may seem a bit complicated. In relation to landslides, geotechnical practitioners (see GeoGuide LR1) are required to assess risk in terms of the likelihood that a particular landslide will occur and the possible consequences. This is called landslide risk assessment. The consequences of a landslide are many and varied, but our concerns normally focus on loss of, or damage to, property and loss of life.

Landslide Risk Assessment

Some local councils in Australia are aware of the potential for landslides within their jurisdiction and have responded by designating specific "landslide hazard zones". Development in these areas is normally covered by special regulations. If you are contemplating building, or buying an existing house, particularly in a hilly area, or near cliffs, then go first for information to your local council.

Landslide risk assessment must be undertaken by a geotechnical practitioner. It may involve visual inspection, geological mapping, geotechnical investigation and monitoring to identify:

- potential landslides (there may be more than one that could impact on your site);
- the likelihood that they will occur;
- the damage that could result;
- the cost of disruption and repairs; and
- the extent to which lives could be lost.

Risk assessment is a predictive exercise, but since the ground and the processes involved are complex, prediction tends to lack precision. If you commission a landslide risk assessment for a particular site you should expect to receive a report prepared in accordance with current professional guidelines and in a form that is acceptable to your local council, or planning authority.

Risk to Property

Table 1 indicates the terms used to describe risk to property. Each risk level depends on an assessment of how likely a landslide is to occur and its consequences in dollar terms. "Likelihood" is the chance of it happening in any one year, as indicated in Table 2. "Consequences" are related to the cost of the repairs and temporary loss of use if the landslide occurs. These two factors are combined by the geotechnical practitioner to determine the Qualitative Risk.

TABLE 2 – LIKELIHOOD

Likelihood	Annual Probability
Almost Certain	1:10
Likely	1:100
Possible	1:1,000
Unlikely	1:10,000
Rare	1:100,000
Barely credible	1:1,000,000

The terms "unacceptable", "may be tolerable" etc. in Table 1 indicate how most people react to an assessed risk level. However, some people will always be more prepared, or better able, to tolerate a higher risk level than others.

Some local councils and planning authorities stipulate a maximum tolerable risk level of risk to property for developments within their jurisdictions. In these situations the risk must be assessed by a geotechnical practitioner. If stabilisation works are needed to meet the stipulated requirements these will normally have to be carried out as part of the development, or consent will be withheld.

TABLE 1 – RISK TO PROPERTY

Qualitative Risk		Significance - Geotechnical engineering requirements
Very high	VH	**Unacceptable** without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low. May be too expensive and not practical. Work likely to cost more than the value of the property.
High	H	**Unacceptable** without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable level. Work would cost a substantial sum in relation to the value of the property.
Moderate	M	**May be tolerated** in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as possible.
Low	L	**Usually acceptable** to regulators. Where treatment has been needed to reduce the risk to this level, ongoing maintenance is required.
Very Low	VL	**Acceptable**. Manage by normal slope maintenance procedures.

Risk to Life

Most of us have some difficulty grappling with the concept of risk and deciding whether, or not, we are prepared to accept it. However, without doing any sort of analysis, or commissioning a report from an "expert", we all take risks every day. One of them is the risk of being killed in an accident. This is worth thinking about, because it tells us a lot about ourselves and can help to put an assessed risk into a meaningful context. By identifying activities that we either are, or are not, prepared to engage in, we can get some indication of the maximum level of risk that we are prepared to take. This knowledge can help us to decide whether we really are able to accept a particular risk, or to tolerate a particular likelihood of loss, or damage, to our property (Table 2).

In Table 3, data from NSW for the years 1998 to 2002, and other sources, is presented. A risk of 1 in 100,000 means that, in any one year, 1 person is killed for every 100,000 people undertaking that particular activity. The NSW data assumes that the whole population undertakes the activity. That is, we are all at risk of being killed in a fire, or of choking on our food, but it is reasonable to assume that only people who go deep sea fishing run a risk of being killed while doing it.

It can be seen that the risks of dying as a result of falling, using a motor vehicle, or engaging in water-related activities (including bathing) are all greater than 1:100,000 and yet few people actively avoid situations where these risks are present. Some people are averse to flying and yet it represents a lower risk than choking to death on food. The data also indicate that, even when the risk of dying as a consequence of a particular event is very small, it could still happen to any one of us today. If this were not so, there would be no risk at all and clearly that is not the case.

In NSW, the planning authorities consider that 1:1,000,000 is the maximum tolerable risk for domestic housing built near an obvious hazard, such as a chemical factory. Although not specifically considered in the NSW guidelines there is little difference between the hazard presented by a neighbouring factory and a landslide: both have the capacity to destroy life and property and both are always present.

TABLE 3 – RISK TO LIFE

Risk (deaths per participant per year)	**Activity/Event Leading to Death** (NSW data unless noted)
1:1,000	Deep sea fishing (UK)
1:1,000 to 1:10,000	Motor cycling, horse riding, ultra-light flying (Canada)
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1:32,000,000	Lightning strike

More information relevant to your particular situation may be found in other Australian GeoGuides:

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Annual Energy Review
FY 2018-2019

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Document Number: D19/305308
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Contents

Recent solar PV installations by Shoalhaven Council at the Shoalhaven Entertainment Centre (left) and Berry Wastewater Treatment Plant (right).

1 Purpose

At the Shoalhaven City Council Strategy & Assets Committee meeting on 11 December 2018, it was resolved "That the General Manager provide a brief analysis of Council's current electricity usage, such report to include usage by function (water, sewer, leisure centres, street lighting), measures already taken to reduce electricity consumption and potential avenues to further reduce consumption including predictive cost estimates/ROI of those measures" (MIN18.960; HPERM Ref: D18/419995).

The purpose of this report is to present an annual analysis of Council's energy consumption (by functional area), document energy savings measures recently implemented and identify potential cost effective measures for future energy efficiency and renewable energy investment. It is intended that this energy review report will be produced every year as an annual analysis presented to the Strategy & Assets Committee. This report will also track performance of Council towards achieving its energy and emissions reduction targets set out in Council's adopted Sustainable Energy Policy (POL18/44).

2 Introduction

Energy in the form of electricity, gas and vehicle fuel, is an essential resource for the effective operation of Shoalhaven Council. Most of Council's current energy is derived from fossil fuels which are a costly and finite resource which also emit harmful greenhouse gases. From an economical and environmental perspective, it is critical that Council address its future energy needs and commence a strategic transition towards improved energy efficiency and use of more renewable energy. To guide this transition, an annual review of Council's energy usage and energy efficiency measures will be conducted.

Shoalhaven Council is a member of the national Cities Power Partnership (CPP) program. Under the CPP, each member Council makes five action pledges in either renewable energy, energy efficiency, transport or working in partnership to tackle climate change. Progress on the pledges is reported back to the CPP every 6 months. Shoalhaven Council was awarded a 'Highly Commended' award for the Renewable Energy Achievement category at the 2019 CPP national awards, recognising Council's recent efforts in renewable energy policy and solar projects.

Sustainable Energy Policy

Shoalhaven City Council adopted a Sustainable Energy Policy (POL18/44) on 28 May 2019. The Policy aims to ensure access to affordable, reliable, sustainable and modern energy for both its operations and that of the wider Shoalhaven community. To achieve this, the following objectives and targets have been adopted:

- Aim to achieve net-zero greenhouse gas emissions by 2050 (consistent with the United Nations Paris Agreement ratified by the Commonwealth Government and the NSW Government's agreed targets). Interim targets to reduce emissions are 25% by 2025 and 50% by 2030, compared to 2015 levels.
- Seek opportunities to source or generate electricity supply for Council's operations from renewable energy sources, with an interim target of 25% renewables by 2023 and eventually 50% from renewable sources by 2030.
- Promote relevant initiatives to the community and businesses to increase the uptake of installed rooftop solar panels across the Shoalhaven LGA towards a target of 33% of dwellings by 2025.

- Upgrade all street lighting to energy saving LEDs by 2025.

A new Sustainable Energy Strategy is currently being prepared for Shoalhaven Council (due Jan 2020) as an action arising from the Policy. The new Strategy will outline a recommended pathway and initiatives for Council to follow to achieve its energy and emissions targets.

Revolving Energy Fund

Council will implement a Revolving Energy Fund (REFund) from 2019/20 to assist with future funding of energy efficiency and renewable energy projects. Savings made by these approved projects are reinvested back into the REFund to contribute towards future projects. The REFund provides a mechanism to support the implementation of Council's sustainable energy projects. In 2019, Council resolved to 'seed' the REFund with $230,000 to kick start the initiative. These funds will be allocated in 2019/20 towards energy efficiency and renewable energy projects (currently being evaluated) that have short payback periods to ensure the REFund is replenished quickly for future project investment. The REFund is allocated and managed through an internal Council working group and reported back to Council.

3 Understanding Shoalhaven Council's Electricity Supply

The supply of electricity to Council is delivered through three main agreements:

Supply Type	Site Consumption	Number of Sites	FY2019 Consumption (MWh)	FY2019 Total Electricity Spend
Small Sites	<100MWh per Year	~550	5,243	$1.122M
Large Sites	>100MWh per year	44	24,910	$3.268M
Streetlighting	Unmetered	Aggregated	5,407	$820k*
TOTAL			**35,560**	**$5.21M**

**Not including Street Light Use of System (SLUOS) charges (approx. $1.2M)*

Council's electricity costs can be split into three main categories:

Category	Description	Typical Bill %
Energy Costs	Costs associated with electricity generation and reselling, usually contracted through a retailer such as Origin Energy or AGL.	39%
Network Costs	The costs associated with getting electricity from the generators to the customers (the poles and wires) through network operators such as Endeavour Energy	50%
Other	All the other costs associated with environmental, billing, regulator and metering charges.	11%

Figure 1 shows the typical bill breakdown for Shoalhaven Council's Electricity Accounts. Only the energy costs are negotiable (contestable) through retailer agreements.

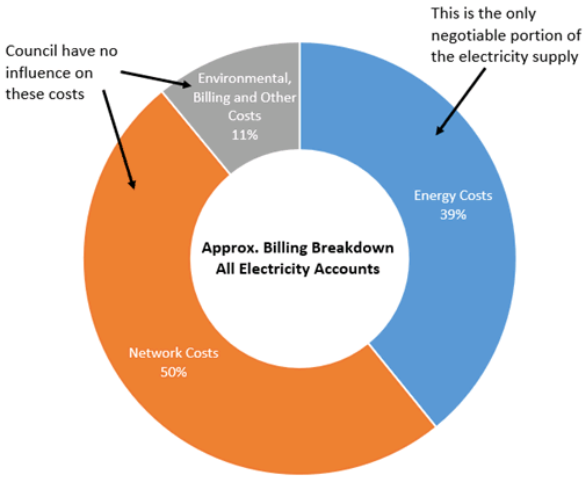


Figure 1. Shoalhaven City Council's typical electricity bill breakdown

4 Electricity Consumption 2018/19

In 2018/19, just under half of Shoalhaven Council's electricity was consumed by Shoalhaven Water's water (27%) and sewerage (22%) operations (Figure 2). In terms of the overall cost, wastewater processing (~$1.4M) was more costly than water supply (~$1.15M), with water supply pumps typically operating during 'Off Peak' periods when electricity pricing is cheaper (Figure 3). The next largest consumer of electricity in terms of cost was street lighting across the Shoalhaven LGA. Although the majority of Shoalhaven's street lights are owned and operated by Endeavour Energy, Council pays for the power that the lights consume (around $800K/pa, Fig. 3). A Street Light Use of System (SLUOS) charge of approx. $1.2M per year is also paid by Council to Endeavour Energy, but this comprises costs mainly arising from the operation, maintenance and capital costs of the street lighting network rather than electricity consumption. Council's Aquatic Centres and Holiday Haven tourist parks then follow in terms of annual electricity costs with approximately $668K and $599K, respectively. These are then followed by community facilities and civic buildings making up $349K and $313K of electricity costs, respectively (Fig. 3). The annual electricity cost breakdown for all of Shoalhaven Council's Large Sites (>100MWh/pa) for 2018/19 are shown in Figure 4.

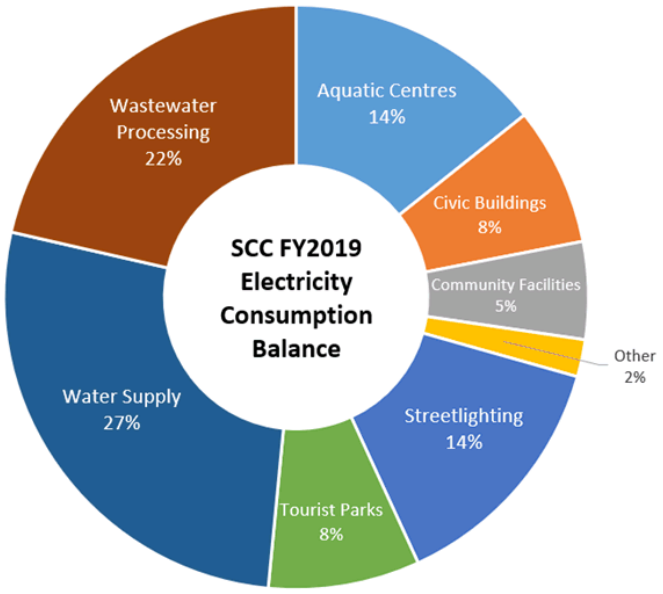


Figure 2. Shoalhaven City Council's 2018-2019 electricity consumption % by functional areas

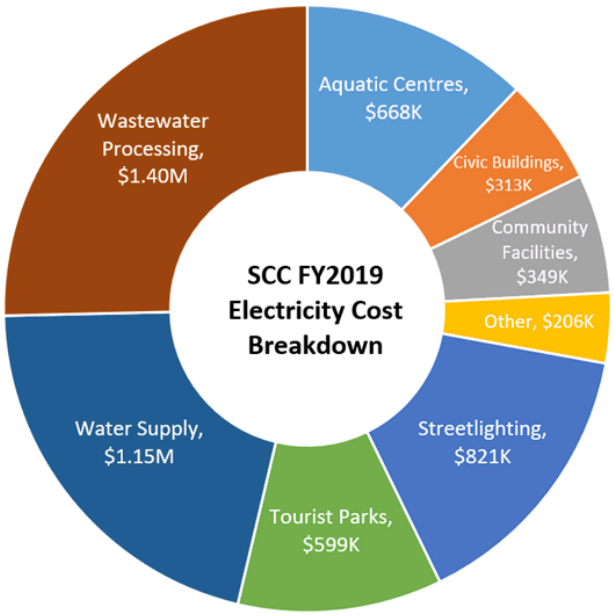


Figure 3. Shoalhaven City Council's 2018-2019 electricity costs by functional areas.

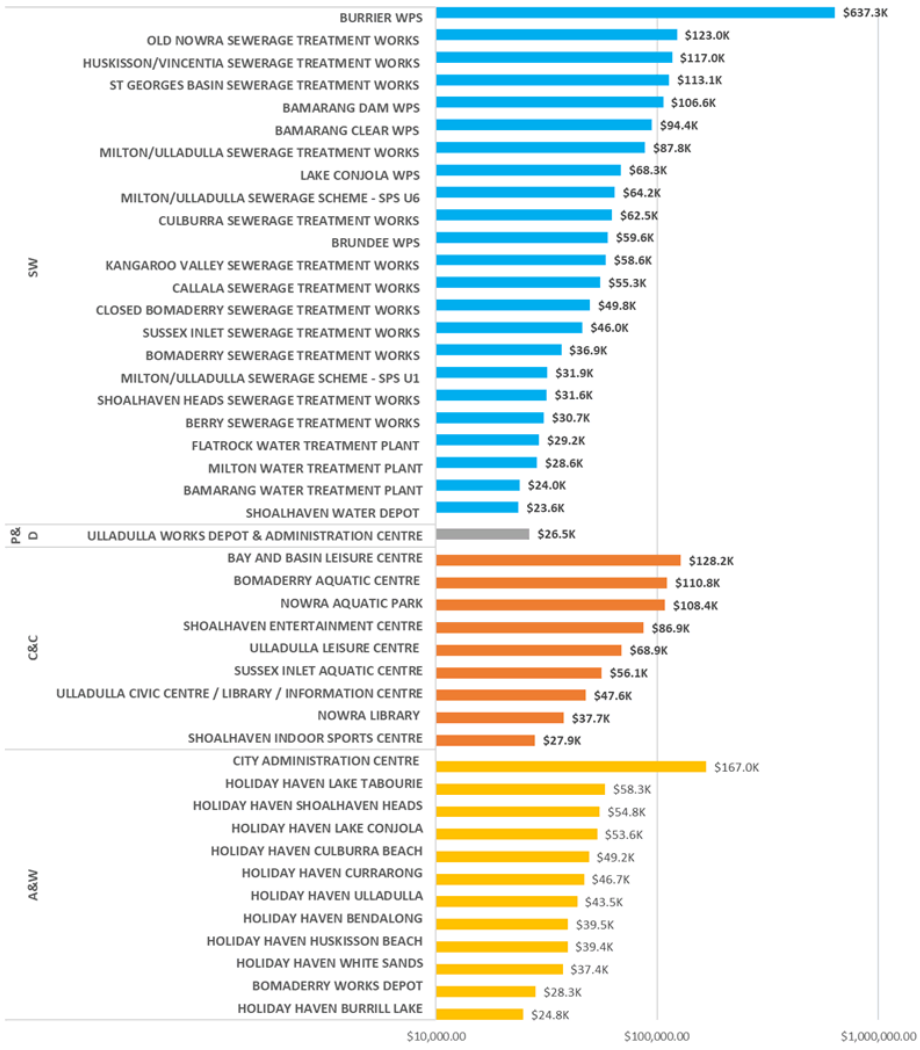


Figure 4. Shoalhaven City Council's 2018-2019 electricity spend by Council Groups.

4.1 Trends by Group

Shoalhaven Council's total electricity consumption (in kWh) has shown an upward trend over the past 6 years (Figures 5 & 6). The largest percentage increases in electricity consumption since 2012-13 have been at the Aquatic Centres, Holiday Haven parks and for the provision of Water Supply (18 to 20% increase, see Fig. 6). These assets are typically energy intensive, and have sometimes been upgraded with new facilities such as heated pools at Holiday Haven parks. With electricity comprising around 50% of Council's corporate greenhouse gas emissions, a continuing upward trend in electricity consumption will move Council further away from achieving its emissions savings targets.

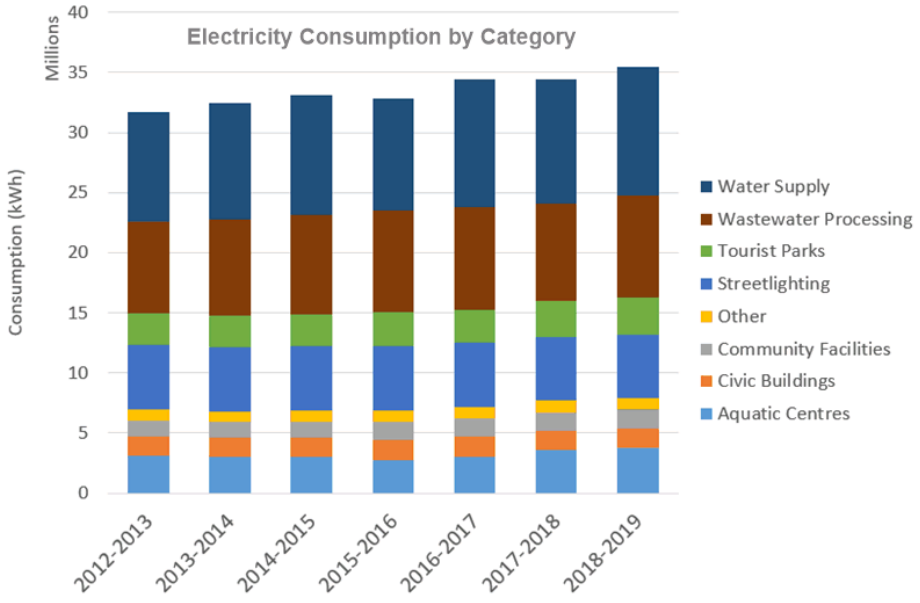


Figure 5. Shoalhaven City Council's annual trend in electricity consumption by group category

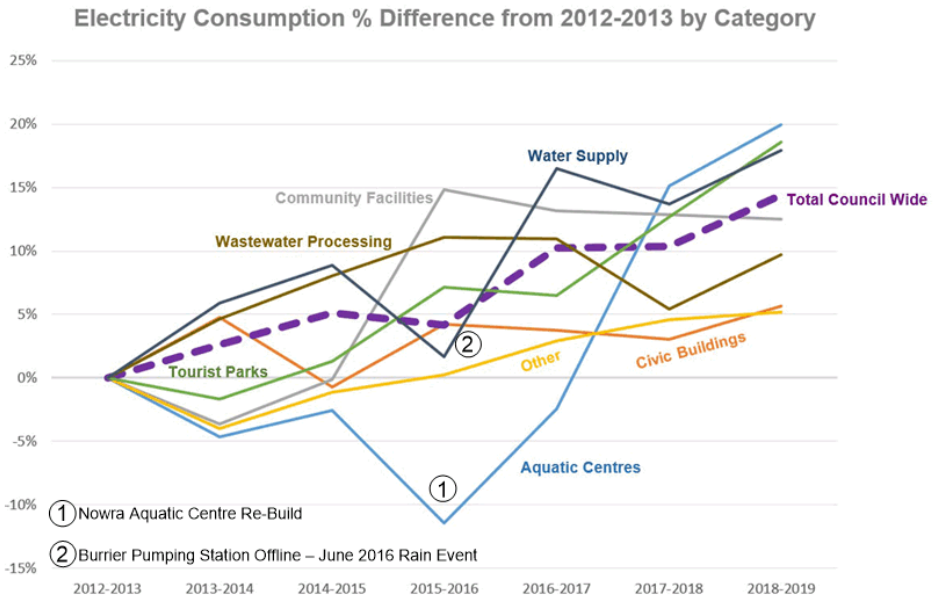


Figure 6. Shoalhaven City Council's annual percentage change in electricity consumption by group category from 2012-2013

5 Gas Consumption

Shoalhaven Council consumes both natural (mains) gas and LPG (bottled gas) at a number of its assets. Natural gas supply is limited to the Nowra and Bomaderry areas due to the gas pipeline coverage. The main Council assets that utilise natural gas include the Nowra Administration Centre, Shoalhaven Entertainment Centre and both the Bomaderry and Nowra Aquatic Centres. Sites that consume LPG bottled gas include the Holiday Haven tourist parks, other Aquatic Centres and the Shoalhaven Crematorium. Consumption of both natural gas and LPG tends to vary from year to year with no obvious trends (Figure 7). The price of bottled LPG gas has increased by 25% since 2015/16 so it makes economic and environmental sense to switch appliances from gas powered to electricity at the end of their working life, where possible. Electrical appliances can also be powered by renewable energy and this reduces their greenhouse gas emissions compared to gas combustion.

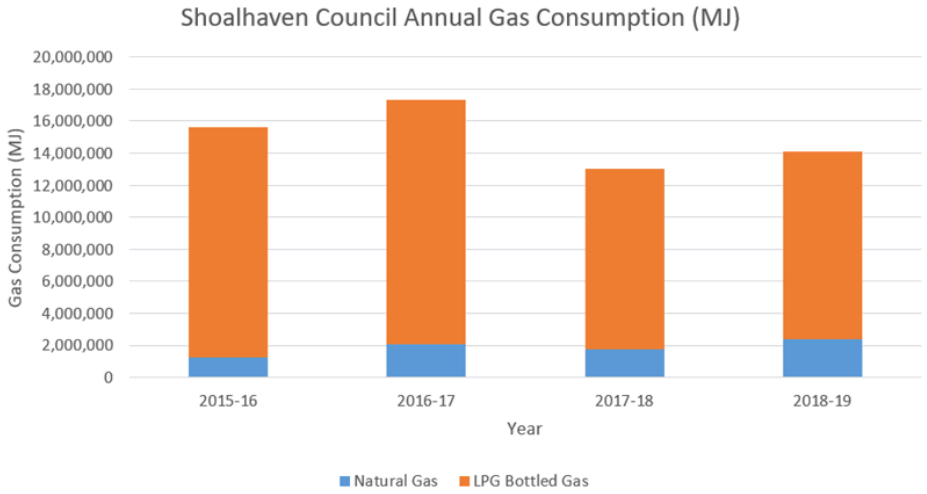


Figure 7. Shoalhaven City Council's annual gas (natural and LPG) consumption.

6 Fleet Vehicle Fuel Consumption

Shoalhaven Council's fleet vehicle fuel consumption decreased substantially by one-third in 2018/19, compared to 2016-17 (Figure 8). Much of this decrease was due to a large decline in diesel fuel usage over this period. In June 2019, Council took delivery of three Hyundai Kona fully Electric Vehicles (EVs) as part of a 2 year trial. The Kona EVs have had vinyl sign wraps attached to them to help promote the uptake of EVs across the region (Figure 9).

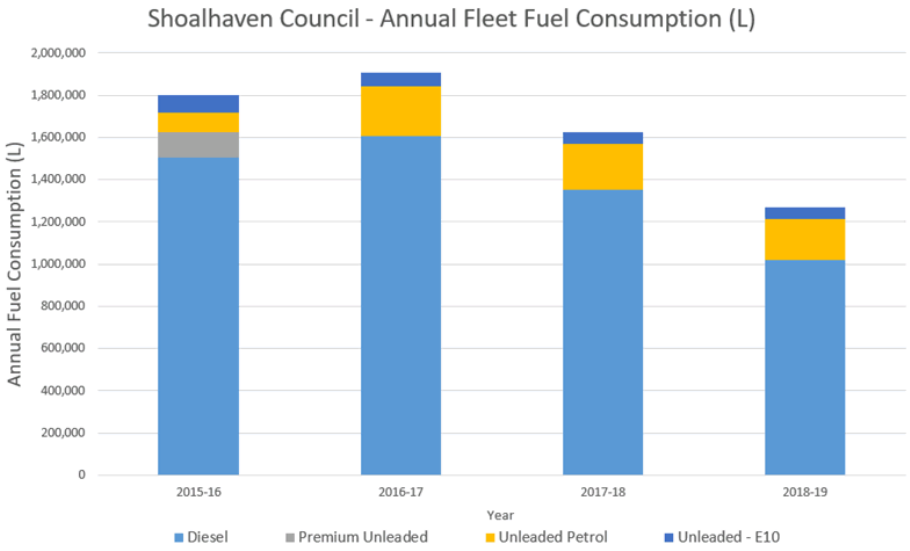


Figure 8. Shoalhaven City Council's annual fleet vehicle fuel consumption.

Figure 9. One of three Shoalhaven City Council fully electric Hyundai Kona fleet cars.

7 Greenhouse Gas Emissions

Shoalhaven City Council's operations emitted a total of 70,146 tonnes of greenhouse gases (carbon dioxide equivalents or CO_2-e) in 2018/19 (Scope 1, 2 & 3 emissions). Council's ***purchased electricity*** contributed to almost half (46%) of Council's total annual corporate greenhouse gas emissions (Figure 10, showing Scope 1, 2 and 3 total emissions). Despite having 328 kW of installed solar panels on Council assets in 2019, this renewable energy represents less than 2% of Council's electricity needs. The remainder of Council's electricity is generated from coal or gas-fired power stations which results in greenhouse gas emissions due to the combustion of these non-renewable fossil fuels. Methane and nitrous oxide emissions from Council's wastewater treatment plants are the second highest source of greenhouse gas emissions at around 29%. Methane emissions from the Council-operated landfill at West Nowra generated the third largest amount of equivalent greenhouse gas emissions at around 17% (despite continually flaring off the gas for emissions reduction). Fleet transport fuels (diesel, petrol etc.) and gas for stationary energy (both natural gas and LPG) make up the remaining 8% of Council's corporate carbon emissions profile.

Figure 11 shows Council's corporate greenhouse gas emissions for the 2015 baseline year, 2018-19 FY and emissions targets for 2025, 2030 and 2050. The initial actual decline in emissions from 2015 to 2018-19 was mainly due to a reduction in legacy methane emissions from West Nowra landfill from 19,072 to 11,796 tonnes of CO_2-e, with some savings in transport fleet fuels as well. All other sources of Council's carbon emissions have either been steady or increased over this same period.

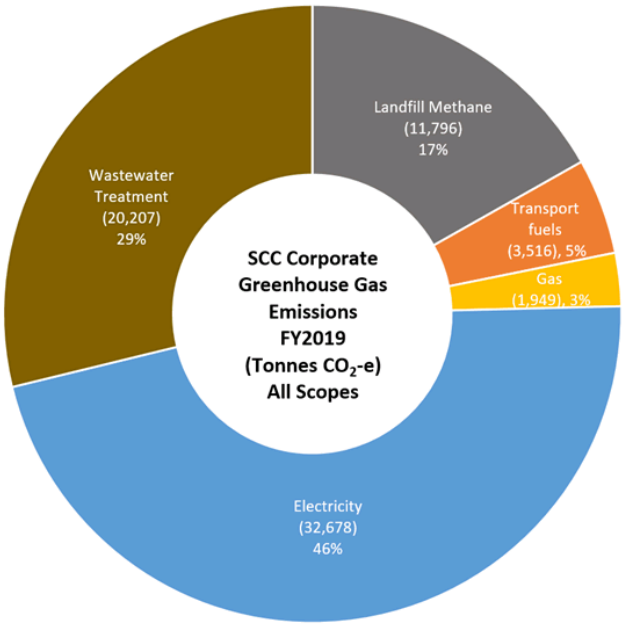


Figure 10. Shoalhaven City Council's corporate greenhouse gas emissions profile for 2018/19.

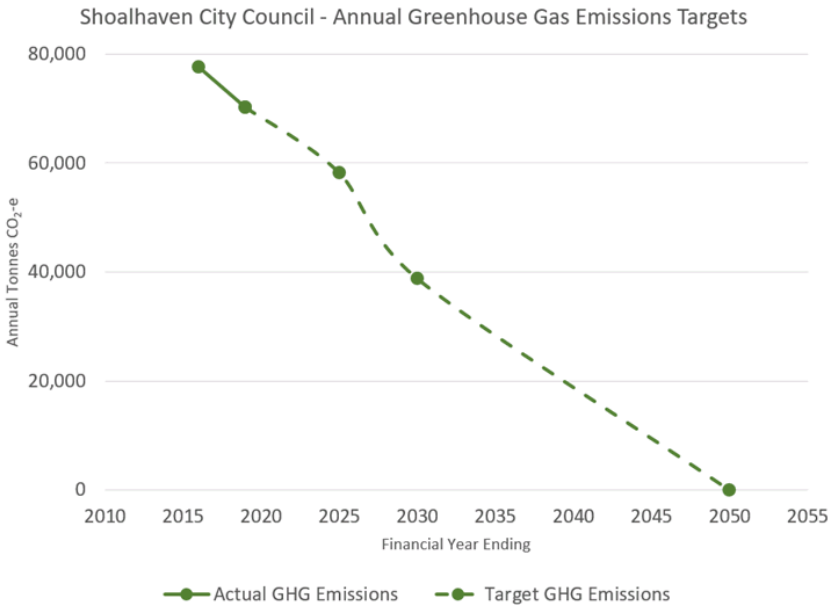


Figure 11. Shoalhaven City Council's corporate greenhouse gas emissions targets and tracking.

8 Shoalhaven Council Energy Savings Initiatives

Implementation of Council's Sustainable Energy Policy has already commenced with numerous energy projects recently completed or commenced in the past 12 months, including:

- Installation of a 25 kW and 22.5 kW solar PV system at Bamarang Water Treatment Plant and Berry Wastewater Treatment Plant, respectively (see performance data in Figures 12 & 13). A 20 kWh storage battery was also installed at the Berry plant to trial how batteries can be integrated into existing wastewater treatment control systems;
- Installation of an 81 kW solar PV system on the rooftop of the Shoalhaven Entertainment Centre;
- Adoption of the 'Electric Vehicle (EV) Charging Stations on Public Land' policy;
- Inclusion of three (3) fully electric Hyundai Kona cars in Council's fleet as part of a trial of EVs and charging infrastructure;
- Creation of an internal Revolving Energy Fund (REFund) with seed funding of $230K to finance energy efficiency and renewable energy projects into the future. The savings in energy charges as a result of the projects will be deposited into the REFund to replenish it for future project funding;
- Replacement of 4,231 residential street lights with energy savings LED lamps commenced in August 2019. This project was part-funded by the then NSW Office of Environment & Heritage, allowing Council to achieve a feasible payback period of <5 years;
- Partnering with a range of stakeholders, including Repower Shoalhaven (a local community energy group), on the Social Access Solar Garden feasibility study. This project is now being further progressed by Repower Shoalhaven to establish a 4 MW community-owned solar farm in the Shoalhaven;
- Membership in the national Cities Power Partnership (CPP) program (around 110 member Councils in total) to implement 5 climate change pledges made by Council. Shoalhaven Council received a 'Highly Commended' for its 'Charging Ahead with Renewables' project entered into the 2019 CPP national awards in the Renewable Energy Achievement category;
- Membership in the NSW Government's Sustainability Advantage Program and working towards a Sustainability Policy and Strategy.

These projects contribute towards the achievement of energy and emissions targets stated in Council's adopted Sustainable Energy Policy. Figures 14 & 15 show the tracking towards these targets to help gauge progress on Council's energy performance and achievement of its goals. Figure 16 shows the tracking of the solarisation of dwellings (residents and businesses) in the Shoalhaven LGA and the community solar energy penetration target of 33% by 2025. Shoalhaven Council is proposing to run some community Sustainable Energy Expos to encourage residents and businesses to take up solar PV on their dwellings.

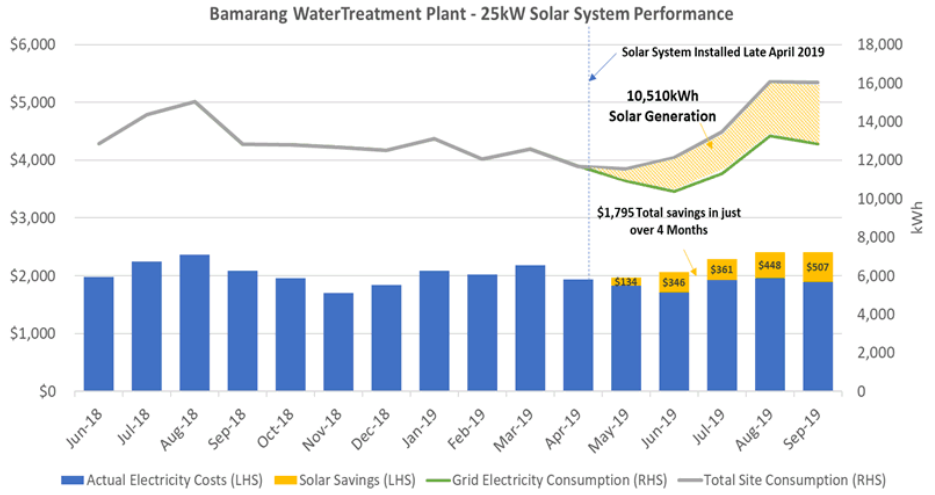


Figure 12. Bamarang Water Treatment Plant solar PV performance to date.

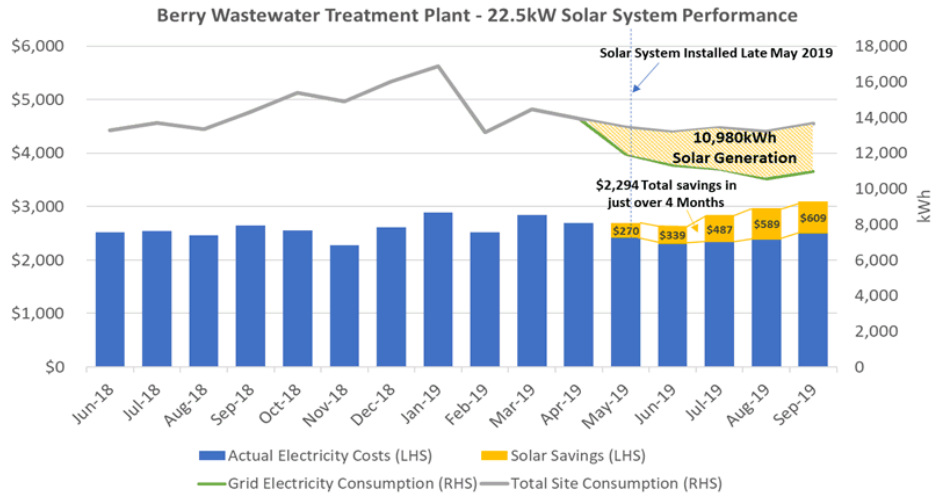


Figure 13. Berry Wastewater Treatment Plant solar PV performance to date.

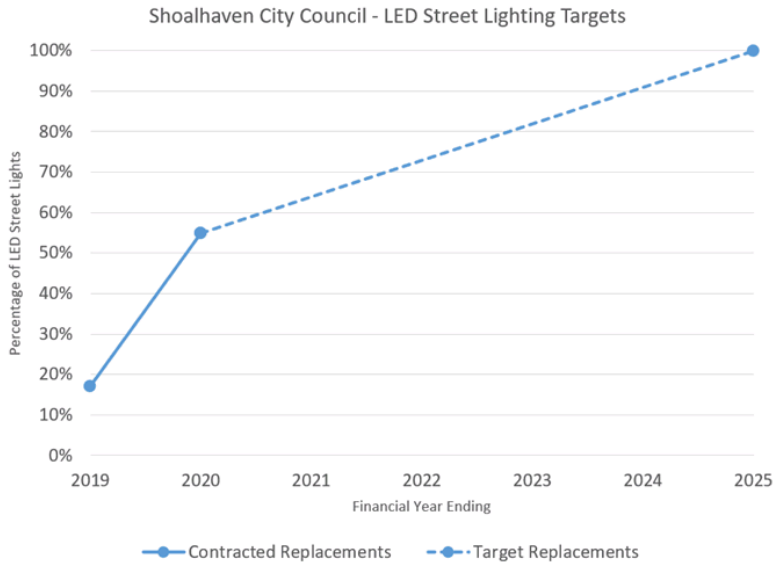


Figure 14. Shoalhaven City Council's street lighting replacement tracking with energy savings LEDs.

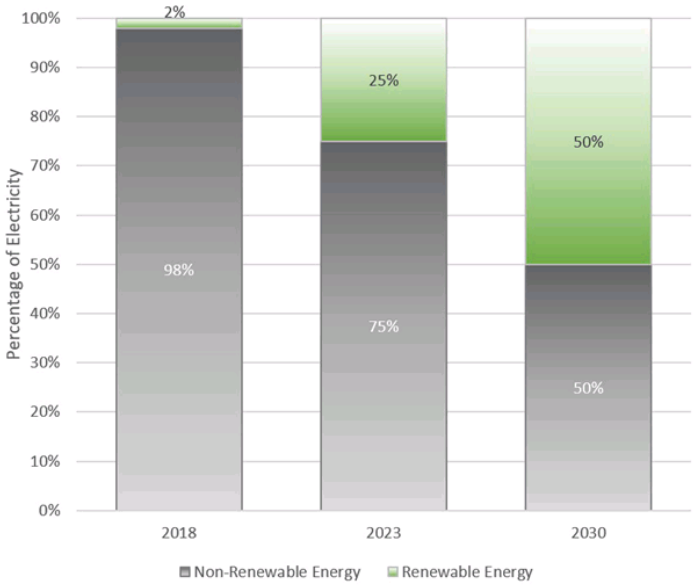


Figure 15. Shoalhaven City Council's percentage of renewable energy consumed – 2018 is actual, 2023 & 2030 are targets.

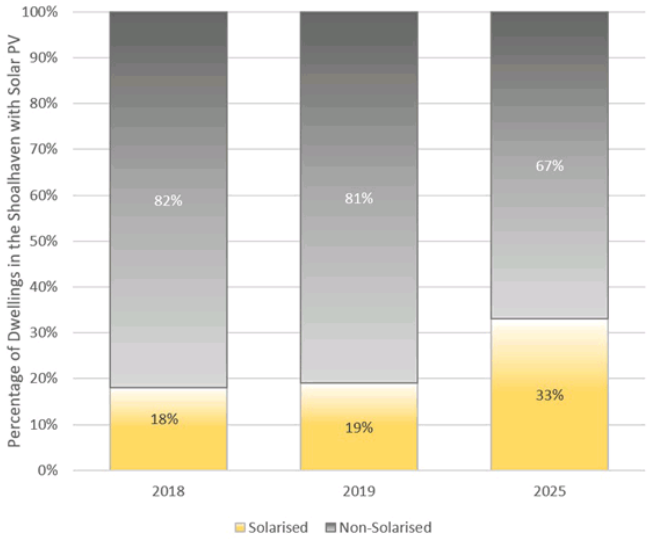


Figure 16. Shoalhaven LGA solar PV installations on dwellings – 2018 & 2019 are actual, 2025 is a target.

Table 1 below identifies the recently completed, in-progress and planned energy savings initiatives at Shoalhaven Council.

Table 1. Energy savings and renewable energy initiatives at Shoalhaven Council.

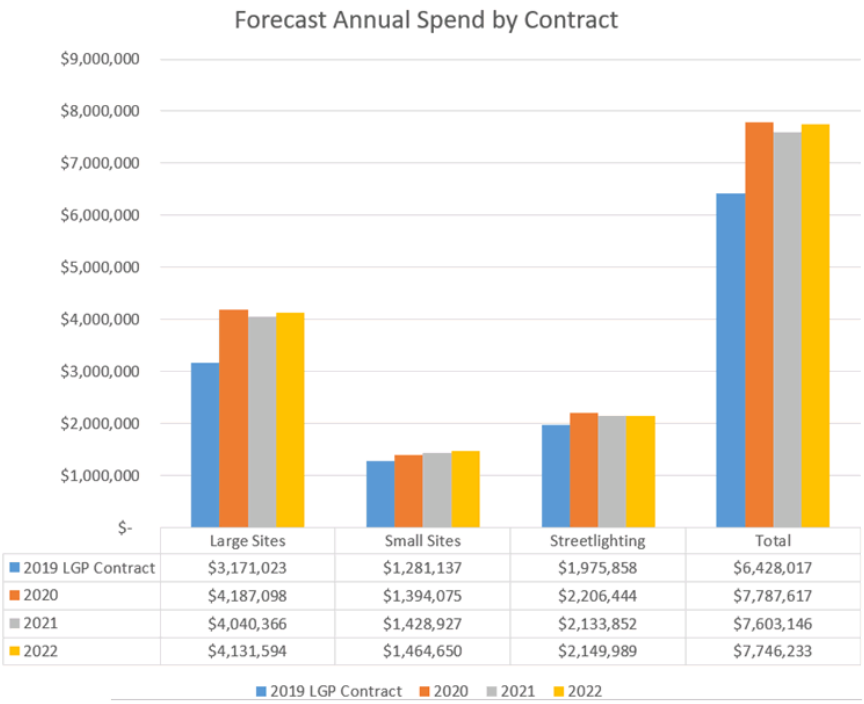
Site	Initiative	Energy Savings kWh/pa	Cost Savings $/pa	Status
Shoalhaven LGA	LED Street Lighting Upgrade	~1,427,647	$235,000	Currently underway, completion due May 2020
Berry Wastewater Treatment Plant (WWTP)	22.5 kW Solar PV and 20 kWh storage battery installation	31,000	~$6,000	Completed March 2019
Bamarang Water Treatment Plant	25 kW Solar PV Installation	35,000	~$6,000	Completed March 2019
Shoalhaven Entertainment Centre	Installation of an 81 kW solar PV system	112,000	~$12,400	Completed Oct 2019
Nowra Library	Installation of energy savings LED lights	TBD	TBD	Under investigation for REFund
Bomaderry Works Depot	Installation of additional LED lighting and solar PV system	TBD	TBD	Under investigation for REFund
Nowra Library	HVAC Upgrade	TBD	TBD	Under investigation and subject to funding
Bomaderry Indoor Sports Stadium	Solar PV installation on rooftop	TBD	TBD	Under investigation and subject to funding
Shoalhaven Water assets	Solar PV installation	TBD	TBD	Under investigation and subject to funding

9 Financial Implications

The proposed energy savings initiatives outlined in Table 1 will all incur a capital cost to implement, however, they also result in cost savings and are therefore a good investment for Council. Even with the option of borrowing low interest funds from TCorp factored in, some of these recommended energy savings initiatives still have a favourable payback period, especially when the new energy contracts come into effect from 1 Jan 2020.

9.1 New Electricity Retail Contracts 2020+

With the procurement process now completed for Shoalhaven Council's new retail electricity contracts beyond 1 January 2020, the financial implications of the new electricity pricing are now able to be analysed. Shoalhaven Council has experienced relatively 'cheap' electricity rates for the past four years and the new 2020+ contracts were always forecast to increase in the vicinity of up to 20% based on the electricity market trends and other Council's current electricity prices. These power price hikes have now eventuated and Shoalhaven Council will pay an additional 21% (approx. $1.4M in total) for electricity across its Large/Small Sites and street lighting in 2020, compared to 2019 (Figure 17). These higher electricity prices continue into 2021 and 2022. Higher electricity charges will mean that payback periods for energy efficiency and renewable energy projects will become much more favourable.



	Large Sites	Small Sites	Streetlighting	Total
2019 LGP Contract	$3,171,023	$1,281,137	$1,975,858	$6,428,017
2020	$4,187,098	$1,394,075	$2,206,444	$7,787,617
2021	$4,040,366	$1,428,927	$2,133,852	$7,603,146
2022	$4,131,594	$1,464,650	$2,149,989	$7,746,233

Figure 17. Shoalhaven City Council's 2019-2022 forecast electricity costs by contract.

Notes and Assumptions for Figure 17:

- This analysis only refers to the retail supply of electricity and does not include any unforeseen impacts of network, billing, environmental, regulator or metering charges.
- The analysis does include a forecast reduction in street lighting due to the LED bulk lamp replacement currently underway (55% of total street lights to be replaced with LEDs by May 2020).
- Includes a 2.5% annual forecast increase in consumption and also an estimated 2.5% annual forecast increase in network charges.
- Small Sites pricing beyond July 2021 (current 776 contract) based on 2020 rates.
- Streetlighting figures include Street Lighting Use Of Service (SLUOS) charges (approx. $1.2M/pa)

10 Recommendations

A number of Council assets have poorly performing and aged air-conditioning units (e.g. Nowra Library) which require considerable work and funds to rectify. Heating, ventilation and air-conditioning, or HVAC as it is known, consumes by far the greatest amount of electricity in large buildings. Nowra Library for instance, has 4 package air-conditioner units in operation with power ratings from 45 to 65 kilowatts each. Good maintenance and operation of HVAC systems at Council assets is critical to ensure they remain as energy efficient as possible. Replacement of aged HVAC systems with more modern units that have better energy efficiency, performance ratings and controls, will be necessary to achieve significant energy savings for Council.

Further upgrades of building lighting to more energy efficient LED lights is also a good investment for Council. LED lighting has a much longer lamp life than conventional lighting so this also reduces costly maintenance requirements. LED lights also use much less electricity to operate and are currently eligible for NSW Government energy savings certificates (rebates). LED lighting upgrades to civic and public buildings with long operating hours incur the best rebates under the NSW Energy Savings Scheme.

Solar PV installations at the new Bomaderry Indoor Stadium and the new Nowra and Bomaderry REMS wastewater treatment plants are also recommended for investigation in the near future. These sites are expected to have substantial daytime electricity loads that make them suitable for solar PV. Once these sites are fully operational and their electricity loads are understood, solar PV systems can be designed accordingly to ensure maximum self-consumption of the generated solar power onsite with minimal export to the grid.

Shoalhaven City Councillors and staff receiving a Highly Commended award in the Renewable Energy Achievement category at the 2019 Cities Power Partnership national awards in Sydney.

Shoalhaven City Council

ENERGY MATTERS

Project Title:
Berry WWTP Solar PV & Battery System Performance Report

Shoalhaven City Council is a member of the national **Cities Power Partnership** program under which Shoalhaven Water pledged to investigate and install renewable energy systems to reduce grid electricity consumption and greenhouse gas emissions.

In May 2019, **Berry Wastewater Treatment Plant** had **68 solar panels (22.5kW)** installed on the roof and along a disused concrete basin.

A **20kWh Battery Storage System** is also being trialled on the site to assist with the intermittent electrical loads and optimise the battery system such that Shoalhaven Water are ready for future energy projects when battery technology becomes much more mainstream.

Since it was installed, the Solar and Battery system has reduced the plant's grid electricity consumption by 17% (see graph below) and will save around 30 Tonnes of CO_2 per annum.

System performance is expected to improve further in the summer months with the increased sunshine and longer daylight hours.

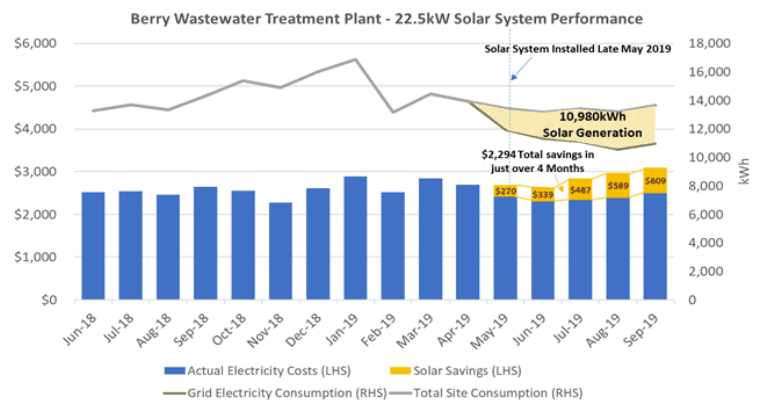
22.5kW Solar Array

30t Annual CO_2-e saved

Clean Energy treating **Waste Water** in the Shoalhaven

17% Reduction in Electricity from Grid

31,000kWh Annual Generation



May 2019
System installed at Berry WWTP

To October 2019
11MWh Generated
~$2,300 of savings

17% reduction in electricity from grid (Winter months)

HPERM Ref: D19/352715 For more information contact: andrew.truran@shoalhaven.nsw.gov.au

ENERGY MATTERS

Project Title:
LED Streetlighting Upgrade - Accelerated

Shoalhaven City Council

Summary:

Across the Shoalhaven, Council currently has approximately 11,000 street lights. Although Council is responsible for the provision and operating costs, the street lighting is actually owned and maintained by Endeavour Energy.

In early 2019, Council received a funding offer from the then NSW Office of Environment & Heritage (OEH) to assist with the cost to replace existing residential street lights with energy efficient Light Emitting Diode (LED) lighting. This will result in savings to Council for costs related to street light maintenance (SLUoS) and electricity charges (NUoS). Council resolved (MIN19.420, 25/6/2019) to take up this financial assistance offer to replace 4,231 Mercury Vapour residential street lights (50 & 80 watts) with 17 watt LEDs at a cost of $1.2M after rebates. Once the accelerated street lighting upgrade is completed, a total of 55% of Council's street lighting will be energy efficient LEDs. The roll out of the LEDs will commence in Nov 2019 and run through until mid-2020. Media releases are being prepared to inform residents.

Benefits:

The modelling undertaken by Endeavour Energy and Council indicates this accelerated street lighting upgrade will generate an annual reduction in SLUoS charges of $15,600 and a reduction in energy costs (NUoS) of $229,000, resulting in a total annual savings of approx. $245,000 in Council's street lighting charges. This results in a non-discounted simple payback calculation of 5 years using current electricity costs. As electricity costs are rising by around 20% from Jan 2020 compared to current energy contracts, the payback period will also reduce accordingly.

Project Team:

Peter Herald, Principal Electrical Engineer, SCC
Darren O'Connell, Energy Management Consultant
Paul Keech, Director Assets and Works, SCC

Progress:

June 2019	Council resolved to enter into agreement with Endeavour Energy to accept the OEH financial assistance for the Accelerated Street Lighting Upgrade program (MIN19.420). SCC CEO signed the Formal Offer to accept the funding.	PK, PH, DOC
Oct 2019	**Roll out of LED street lighting in the Shoalhaven LGA is scheduled to commence in Nov 2019 and be completed by mid-2020**	**PK, PH, DOC**

HPERM – D19/352694

For more information contact: Darren.OConnell@shoalhaven.nsw.gov.au

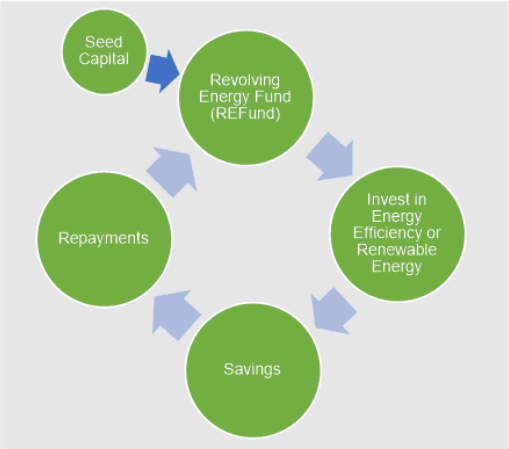
ENERGY MATTERS

Project Title:
Revolving Energy Fund (REFund)

Shoalhaven City Council

Summary:

Shoalhaven Council resolved to establish an internal Revolving Energy Fund (REFund) at the Ordinary Meeting on 25/6/2019 and seed the fund with an initial $230,000 from the 2019/20 budget (MIN19.419). Council also requested a further report early in the 2019/20 FY identifying a prioritised list of energy efficiency projects to be progressed under this initiative. The REFund works by reinvesting the monetary savings made by selected energy efficiency projects back into the fund until the project capital is paid back in repayments. This generates revenue to commence new REFund projects and so the cycle continues (see diagram below). Energy efficiency and renewable energy projects with short payback periods are ideal under the REFund as they replenish the available revenue quickly.



Benefits:

Funding can be a constraint to implementing even high priority energy savings projects. The REFund enables an ongoing internal funding source to contribute towards renewable energy and energy efficiency projects in Council's operations.

Project Team:

Darren O'Connell, Energy Management Consultant
Peter Herald, Project Electrical Engineer, SCC
Paul French, Procurement, SCC
Stephanie Moorley, Finance, SCC

Progress:

July 2019	Council resolved to establish an internal REFund with seed funding of $230,000 in the FY2019/20 budget (MIN19.419). A prioritised list of energy efficiency projects to be progressed under the REFund is being prepared. A REFund Committee will need to be established to administer the fund, repayments, new project selection, etc.	DOC, PH, BD, MP
Oct 2019	**The REFund Committee met on 16 Oct 2019 to discuss the REFund procedure and administration. Priority projects have been listed and will be reported to Council by the end of 2019.**	**DOC, SM, PF, PH**

HPERM – D19/352676

For more information contact: Darren.OConnell@shoalhaven.nsw.gov.au

ENERGY MATTERS

Project Title:
Sustainable Energy Policy & Strategy

Shoalhaven City Council

Summary:
Shoalhaven Council has an adopted Sustainable Energy Policy that identifies a future sustainable energy vision or objectives at both the corporate or community level. To help drive investment in clean and renewable energy, as well as reduce carbon emissions, Council pledged under the Cities Power Partnership in 2017 to 'set city-level renewable energy targets, emissions reduction targets and sustainable energy policies to provide a common goal and shared expectation for residents and businesses'. A comprehensive Sustainable Energy Policy will now lead to a new Sustainable Energy Strategy that will set targets for clean energy and guide action towards energy savings and climate change mitigation for the Shoalhaven region.
A draft Sustainable Energy Strategy is currently in preparation and will be circulated for comment to relevant stakeholders later in 2019. A detailed Annual Energy Review 2018/19 has also been prepared to track performance against the energy and emissions targets.

200 solar panels installed on the rooftop of the Shoalhaven Entertainment Centre in Oct 2019.

Benefits:
Drives direction and investment in solar power, energy efficiency, electric vehicles, climate change mitigation work, etc.

Project Team:
Darren O'Connell, Energy Management Consultant
Stephen Dunshea, CEO, SCC
Group Directors, SCC

Progress:

Nov 2018	Ordinary Council meeting of 13 Nov 2018 resolved to formulate a draft Sustainable Energy Policy for consideration by the Feb 2019 Strategy & Assets Committee meeting.	DOC, General Manager & GDs
March 2019	Draft SCC Sustainable Energy Policy on public exhibition until 18 April 2019.	DOC, GM, GDs
July 2019	SCC's Sustainable Energy Policy (POL18/44, MIN19.354) was adopted at the 28/5/19 Ordinary meeting. The next step is to prepare a Sustainable Energy Strategy by Jan 2020 which is now underway by DOC.	DOC, CEO, GDs
Oct 2019	**Draft Sustainable Energy Strategy in preparation and will be circulated to stakeholders for comment in late 2019.**	**DOC**

HPERM – D19/352685 For more information contact: Darren.OConnell@shoalhaven.nsw.gov.au

Shoalhaven City Council

ENERGY MATTERS

Project Title:
Bamarang WTP Solar PV System Performance Report

Shoalhaven City Council is a member of the national **Cities Power Partnership** program under which Shoalhaven Water pledged to investigate and install renewable energy systems to reduce grid electricity consumption and greenhouse gas emissions.

Bamarang Water Treatment Plant has a large north facing roof with little shading, round the clock site electricity consumption and a favourable electricity network tariff. In April 2019, **76 solar panels (25kW)** were installed on the roof of the plant.

The **25kW** solar system currently provides around 17% of the plant's electricity (see graph below), saves around **30 tonnes** of CO_2 emissions per annum and helps the Shoalhaven produce **clean water** using **clean energy.**

System performance is expected to improve further in the summer months with the increased sunshine and longer daylight hours.

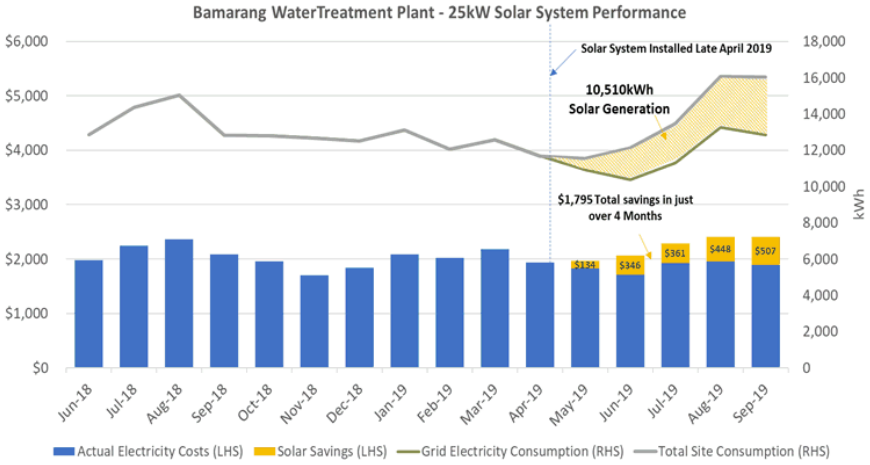
25kW Solar Array

30t annual CO_2-e Saved

Clean **Energy** providing Clean **Water** to the Shoalhaven

17% reduction in electricity from Grid

35,000kWh Annual Generation



April 2019
System installed at Bamarang WTP

To October 2019
10.5MWh Generation
~$1,800 Savings

17% reduction in electricity from grid (Winter months

HPERM Ref: D19/352712

For more information contact: andrew.truran@shoalhaven.nsw.gov.au

Shoalhaven City Council

ENERGY MATTERS

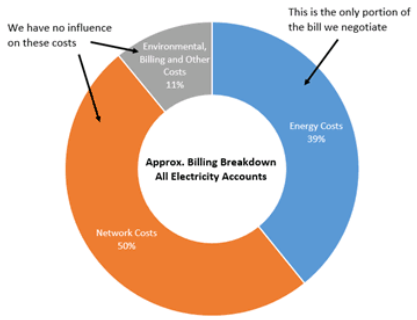
Project Title:
General Supply Electricity Contracts
Electricity agreements beyond 2020

Summary:

SCC has experienced favourable contracted electricity rates for the past four years for its 43 'Large Sites' (>100MWh/yr), Street Lighting and 538 'Small Sites' (<100MWh/yr). The current Energy Contracts all expire on 31 Dec 2019.

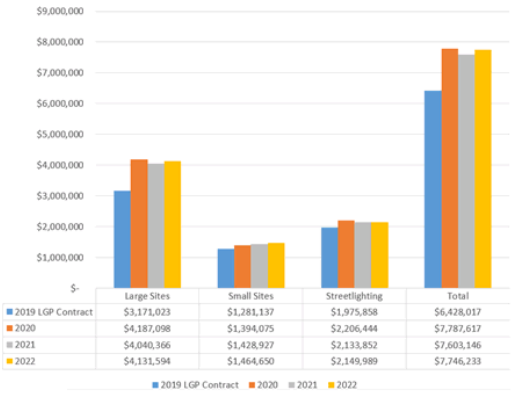
Council formed an internal Energy Contracts Working Group to procure electricity beyond Jan 2020.

For Large Sites and Street Lighting, Council signed up to the LGP tender process and will now buy power from Origin Energy and ERM Power, respectively, from 2020-2022. For Small Sites, Council selected the NSW Govt 776 contract currently with Origin, which is a roll in/out contract. These new contracts come at an increased cost (~$1.4M pa or about 21% extra compared to 2019 – see figures below).



Basic elements of electricity supply

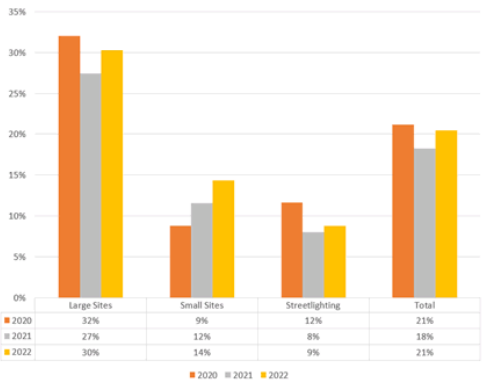
Forecast Annual Spend by Contract



	Large Sites	Small Sites	Streetlighting	Total
2019 LGP Contract	$3,171,023	$1,281,137	$1,975,858	$6,428,017
2020	$4,187,098	$1,394,075	$2,206,444	$7,787,617
2021	$4,040,366	$1,428,927	$2,133,852	$7,603,146
2022	$4,131,594	$1,464,650	$2,149,989	$7,746,233

2019 LGP Contract 2020 2021 2022

Forecast Annual Percentage Difference From 2019 Contract



	Large Sites	Small Sites	Streetlighting	Total
2020	32%	9%	12%	21%
2021	27%	12%	8%	18%
2022	30%	14%	9%	21%

2020 2021 2022

Project Team:

Andrew Truran, Business Analysis Consultant
Darren O'Connell, Energy Management Consultant
Paul French, Supply Chain Manager, SCC
Patricia Hoerlein, Compliance & Accounts, Shoalwater

Progress:

Oct 2019	**SCC have established contracts with Origin Energy and ERM Power through LGP Tender EL0519 for the supply of electricity for Large Sites and Streetlighting respectively, commencing 1st January 2020 for 3 years. The Small sites are migrating to the NSW Govt 776 Contract (agreements in the process of being signed) which is contracted to Origin until July 2021, with extension options. See *D19/333577 - Shoalhaven Council - Financial Impact Report 2020-2022 - Retail Electricity Contracts* for further details**	**AT, DOC, PF, PH**

HPERM Ref: D19/352704 For more information contact: Paul.French@shoalhaven.nsw.gov.au

ENERGY MATTERS

Project Title:

Electric Vehicles (EVs) and EV Charging Stations – Council Trial

Shoalhaven City Council

Summary:

Shoalhaven Council resolved to undertake a 2 year trial of EVs in Council's fleet, report back on the trial and possible scope for additional EVs/hybrids and address a strategy for installing charging systems for its fleet and/or assets (MIN18.916). In June 2019, SCC took delivery of 3 fully electric Hyundai Kona EVs (photo below showing branded car). The Kona EV models have an extended range of around 450 kms, much further than earlier EV models before requiring a recharge.

There is a distinct lack of public EV recharging stations in the Shoalhaven, other than for Tesla EVs. Tesla installed 6 EV superchargers (up to 120 kW DC) at Silos Estate near Berry (see photo right). NRMA installed a 50kW DC fast charger at the Berry Bowling Club in early 2019 (photo right). SCC is now investigating options for installing Council-owned EV charging stations to encourage tourism and increase visitation to the region. A report has been prepared and will soon be submitted to Council. Any EV charging stations will need to adhere to Council's adopted policy 'Electric Vehicle (EV) Charging Stations on Public Land'.

Benefits:

EV uptake in the next decade is predicted to increase rapidly due to more affordable models with longer range entering the Australian market. SCC is being proactive to ensure that EV charging infrastructure is available to encourage EV trips to the Shoalhaven region. Trialling EVs in Council's fleet will provide staff an opportunity to familiarise themselves with the new vehicles.

Project Team:

Darren O'Connell, Energy Management Coord, SCC
Mark Andriske, Coordinator – Fleet Services, SCC
Tom Dimec, Asset Manager, SCC
Thomas Trezise, Strategic Planner, SCC

Progress:

July 2019	3 Hyundai Kona EVs have now arrived as part of Council's fleet. Planning stages are now underway to identify suitable site(s) for Council-owned DC fast EV charger(s) to encourage tourism/visitation to the region e.g. SEC Visitor Centre/café.	MA, DOC, TD
Oct 2019	**A draft report has been prepared on a proposal to install a Council-owned public EV fast charging station and will be submitted to Council soon for consideration.**	**DOC**

HPERM – D19/352680

For more information contact: Mark.Adriske@shoalhaven.nsw.gov.au

Shoalhaven City Council

Project Title:

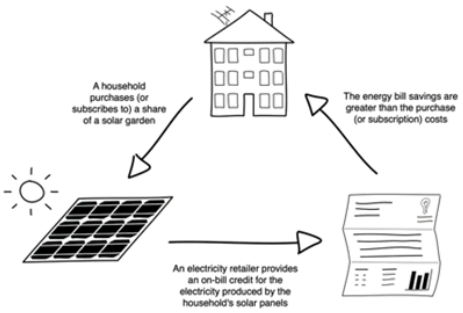
Social Access Solar Garden

ENERGY MATTERS

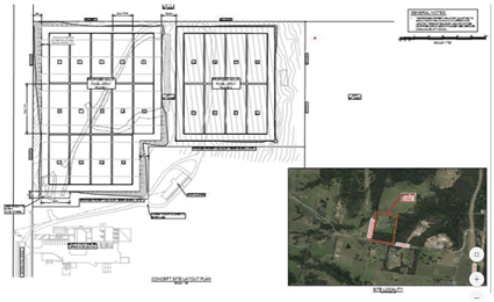
Summary:

The Social Access Solar Garden project was a multidisciplinary team of researchers, Councils and other agencies investigating the potential viability of low income households accessing solar power. Shoalhaven Council, along with Repower Shoalhaven, identified a potential local site for a solar farm that would enable 'locked out' people such as renters and low income earners, to enjoy the benefits of solar power (see schematic diagram).

Repower Shoalhaven have started investigations into using the Old Sanitary Depot site at South Nowra (see map below) for a 4MW solar farm. Repower are looking to apply for a Regional Community Energy grant to assist with the funding. A number of technical and financial considerations are being further progressed by Repower with Council providing assistance, where required.



Proposed site location for the Solar Garden



Benefits:

Low income households, renters, etc. do not always have an opportunity to utilise rooftop solar power. This project investigates the viability of a solar garden to enable these customers to buy solar power from an off-site solar farm.

Project Team:

Peter Herald, Electrical Engineer, SCC
Paul Keech, Director Assets & Works, SCC
Darren O'Connell, Energy Mgt Consultant
Andrew Truran, Business Analysis Consultant
Trevor Cronk, Property Unit, SCC

Progress:

July 2019	Repower Shoalhaven is aiming to submit a grant application in Round 2 of the Regional Community Energy Fund, having missed the Round 1 deadline. SCC resolved (MIN19.223) to make either the old North Nowra tip site or the old Sanitary Depot site available to Repower for a Solar Garden, subject to the necessary approvals.	PK, PH, DOC
Oct 2019	**Repower Shoalhaven continue to liaise with relevant Council staff to define the scope of the project and determine what Council requirements would be e.g. lease arrangements, in-kind solar PV for the Animal Shelter, etc.**	**PK, TC, PH, DOC**

HPERM – D19/352689

For more information contact: Peter.Herald@shoalhaven.nsw.gov.au

ENERGY MATTERS

Project Title:
SCC Solar PV Installations

Shoalhaven City Council

Summary:
Shoalhaven Council's adopted 'Sustainable Energy Policy' aims to seek opportunities to source or generate 25% of its electricity supply for Council's operations from renewable energy sources by 2023. To achieve this target, SCC plans to install solar photovoltaic (PV) systems at its owned assets, where suitable. Solar PV suitability criteria for Council assets include such things as daytime electricity usage profile, roof space/ orientation/quality and electricity tariff. A number of suitable sites have already been recently identified and solar PV systems installed in 2019 including: Shoalhaven Entertainment Centre (81kW); Berry WWTW (22.5kW); and Bamarang WTP (25kW). The Shoalhaven Indoor Sports Stadium has been earmarked for solar PV but only once the centre has commenced operations and an electricity profile established.

Benefits:
Commercial solar PV installations are now good value for money with an estimated pricing of $1,000 per kW installed. SCC currently has a total of 311 kW of installed solar PV on Council assets. The current price per kWh for installed solar power (renewable energy) is now cheaper compared to electricity sourced from the grid (fossil fuel energy), making a strong business case for maximising solar PV on Council assets. From Jan 2020, Council's grid supplied electricity price will increase by around 20%, making the business case for solar PV installations much more favourable.

Project Team:
Darren O'Connell, Energy Management Consultant
Andrew Truran, Business Analysis Consultant
Brad Davis, Manager Asset Strategy, SCC
Tom Dimec, Manager Technical Services, SCC

Progress:

July 2019	SCC Solar PV installations recently completed and in progress: - Shoalhaven Entertainment Centre (81 kW- due Sept 2019) - Berry Wastewater Treatment Plant (22.5 kW + 20 kWh storage battery, completed May 2019) - Bamarang Water Treatment Plant (25 kW, completed April 2019) Potential sites (further analysis required) include, but not limited to: Shoalhaven Indoor Sports Stadium, Shoalhaven Library, Shoalhaven Regional Gallery, Shoalhaven Crematorium, Bomaderry Works Depot, Ulladulla WWTW.	DOC, AT, BD, TD
Oct 2019	**SEC solar PV installation now complete, additional sites being further investigated, including Shoalwater assets.**	**DOC, AT**

HPERM – D19/352667 For more information contact: Darren.OConnell@shoalhaven.nsw.gov.au

ENERGY MATTERS

Project Title:
Cities Power Partnership

Shoalhaven City Council

Summary:
Shoalhaven Council signed up to the CPP in 2017 and agreed to 5 pledges including to set city-level renewable energy targets, emissions reduction targets and sustainable energy policies to provide a common goal and shared expectation for residents and businesses. Pledges are reported on every 6 months to the CPP. A South-East NSW CPP Buddies Group, comprised of Shoalhaven, Kiama, Wingecarribee, Eurobodalla, Bega and Shellharbour Council staff, was formed in early 2018 and communicate regularly. The group won the national Knowledge Sharing Award at the inaugural CP Summit held in Kiama in Oct 2018.

At the 2019 CPP annual awards in Sydney in August, Shoalhaven Council was awarded a 'Highly Commended' in the Renewable Energy Achievement category. Council was recognised for its recent efforts on the Sustainable Energy Policy, Revolving Energy Fund and multiple solar PV installation projects underway.

Shoalhaven City Councillors and staff receiving the 2019 national CPP 'Highly Commended' award at the awards night in Sydney in Aug 2019.

Media releases were prepared and published to promote this recognition of Shoalhaven Council on the national stage.

CITIES POWER PARTNERSHIP

Benefits:

Independent support and networking with Australian local Councils on climate change mitigation and adaptation measures. Sharing of resources and peer support under the Buddies Program.

Project Team:
Darren O'Connell, Energy Management Coord, SCC
Andrew Truran, Business Analysis Consultant, SCC

Progress:

Nov 2018	The 'South East NSW Buddy Group' won the national Knowledge Sharing Award at the CPP Summit in Oct 2018. CPP Pledges to be reported to Strategy & Assets Committee after the disbandment of the Sustainable Futures Committee.	DOC AT
Mar 2019	A CPP Pledge Actions Progress Table has been prepared and circulated to the GDs to track progress on the 5 Pledges – HPERM REF D19/79018	DOC
Aug 2019	**SCC awarded a Highly Commended award at the 2019 CPP National Awards in the 'Renewable Energy Achievement' category.**	**DOC AT**

HPERM – D19/352701 For more information contact: Darren.OConnell@shoalhaven.nsw.gov.au

Project Title:
Electricity Tariff Review - 2019

ENERGY MATTERS — Shoalhaven City Council

Summary:

Endeavour Energy have made some major changes to the tariff structure effective from 1st July 2019. The energy management team have identified that there are significant savings available by optimising tariff allocation for some Shoalhaven assets.

Sites which consume more than 160MWh of electricity per year have little choice with regards tariff, however, there are more options for sites which consume less than 160MWh per year, which also have 'Smart' metering.

Seven Large Market electricity sites have been identified initially to apply for tariff re-allocation with estimated proposed savings of approximately **$32,000** per year.

There are also opportunities for some small market sites and the possibility of upgrading to smart meters where, which will be investigated.

NMI	ASSET DESCRIPTION	FY2019 Usage (kWh)	BAU Tariff	BAU Est. Tariff Costs	Proposed Tariff	Proposed Est. Tariff Costs	Estimated Savings
NEEE003532	BAMARANG WATER TREATMENT PLANT	150504^	N84	$ 13,167	N92	$ 10,059	$ 3,108
4310911256	BERRY SEWERAGE TREATMENT WORKS	168878#	N19	$ 17,201	N92*	$ 10,822	$ 6,380
NEEE001423	BOMADERRY WORKS DEPOT	141730	N19	$ 14,278	N92	$ 8,603	$ 5,675
NEEE001426	BURRILL LAKE TOURIST PARK	142296	N90	$ 12,440	N92	$ 9,068	$ 3,372
NEEE005065	MILTON WATER TREATMENT PLANT	148275	N19	$ 14,840	N92	$ 8,965	$ 5,875
4310833627	SHOALHAVEN WATER DEPOT	138450	N90	$ 12,109	N92	$ 8,932	$ 3,177
NEEE005095	ULLADULLA WORKS DEPOT & ADMIN	135772	N19	$ 13,389	N92	$ 8,103	$ 5,286
							$ 32,873

*Network may require futher time to asses the change
^Solar Installed May 2019, Est reduction of 25,000kWh ongoing.
#Solar Installed May 2019, Est reduction of 27,500kWh ongoing
BAU = Business as Usual

Benefits:

Optimisation of tariff structures, significant electricity bill savings, Council apply through our retailer Origin Energy, most of the administration is handled externally.

Project Team:

Andrew Truran, Business Analysis Consultant, SCC
Darren O'Connell, Energy Management Consultant

Progress:

Aug 2019	Asset custodians have given approval. Request to proceed with application sent to Origin Energy	AT
Oct 2019	**Application Approved for all seven large sites effective 1st September 2019**	**AT**

HPERM: D19/352665 For more information contact: andrew.truran@shoalhaven.nsw.gov.au