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Performance testing of Enviro Australis H45 Oil/Water Separator

AFMG Report A1808005

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Version History

Version	Description	Date	Author
Draft 1	Draft for client comment	22/10/2018	BM
Final	Final report	23/10/2018	BM

CONTENTS

Summary

This report outlines the full scale performance assessment of the Enviro H45 oil/water separator system by the Australian Flow Management Group (AFMG) at the University of South Australia. On 24 September 2018 a representative of the AFMG, Dr Baden Myers, witnessed the testing of the Enviro Model H45 treatment system in accordance with the oil/water separation test detailed in BS EN 858-1:2002 *Separator systems for light liquids (e.g. oil and petrol). Principles of product design, performance and testing, marking and quality control*. The testing undertaken was fully in accordance with the test method except for a slight modification of the inflow arrangement, where in lieu of an open channel approach flowing via a screen into a mixing chamber, oil was added directly into flow characteristic of a stormwater drainage system (e.g. oil was dropped from a height in accordance with the standard directly into a turbulent flow within a stormwater pit structure).

During the testing, treated water samples were collected from a sampling point in accordance with the standard and samples were delivered to a NATA accredited laboratory (ALS Global, Adelaide) for analysis of total recoverable hydrocarbons. Results were received from the laboratory on 26 September 2018. The results indicated that when subjected to the treatment flow rate, the Enviro H45 performance was in accordance with the requirements of a Class 1 oil/water separator as detailed in Section 4 of BS EN 858-1:2002.

1 Introduction

Enviro Australis approached the Australian Flow Management Group to witness testing of an oil/water separator, the Enviro H45. The Enviro H45 is designed to treat stormwater runoff from environments where stormwater runoff may be contaminated with fuel oil. The proposed test procedure for this arrangement was that provided by EN 858-1:2002 *Separator Systems for light liquids (e.g. oil and petrol) Part 1 – Principles of product design, performance and testing, marking and quality control* Section 8.3.3.1.4. The design intent of the Enviro H45 was to reach a Class 1 standard in accordance with the definition in Section 4 of the standard at a treatment flow rate of 4.2 L/s.

2 Methodology

An oil/water separation test rig was prepared by Enviro Australis to measure the oil/water separation performance of the Enviro H45 treatment system. All testing to measure the oil/water separation performance was conducted with a view to replicating field conditions, and was based on the requirements of EN 858-1:2002 *Separator systems for light liquids (e.g. oil and petrol). Principles of product design, performance and testing, marking and quality control*. Drawings of the Enviro H45 system are provided in Appendix A. A diagram of the oil/water separator system arrangement tested is provided in Figure 1. A photograph of the test setup arrangement is shown in Figure 2 (showing the inflow tank and pipework) and Figure 3 (showing the inflow and treatment system setup). A detailed view of inflow of oil and water into the treatment system is shown in Figure 4. The test involved a deviation from the standard test setup where in lieu of a water inflow channel and screened inflow into a mixing chamber as detailed by Section 8.3.3.1.2 of the standard, oil was dropped from the height specified by the standard into a stormwater pit where water was turbulent due to turning a 90° bend (see Figure 5). This deviation was considered to be minor and representative of stormwater flow conditions in the field.

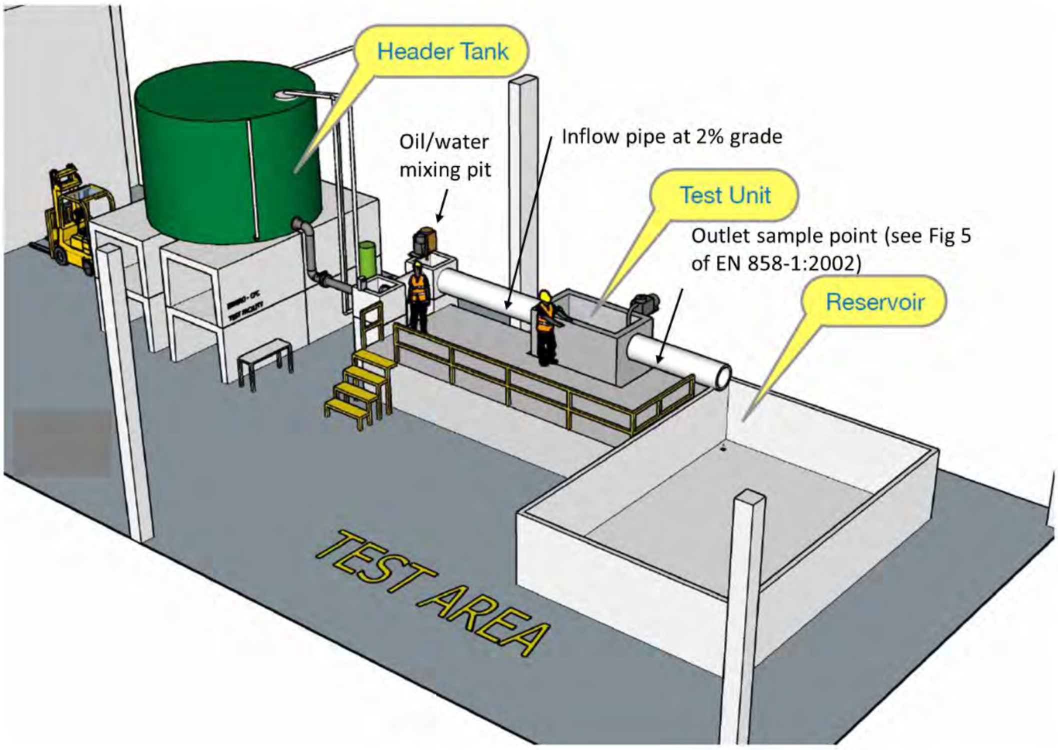


Figure 1 - Diagram of the oil water separator test arrangement. Test components were compliant with EN 858-1:2002 with the exception of the oil/water mixing chamber.

Figure 2 - Photograph of the oil/water separation test setup, showing the inflow water storage and inflow pipework

Figure 3 - Photograph of the oil/water separation test setup, showing the inlet pipework to the treatment chamber (at centre)

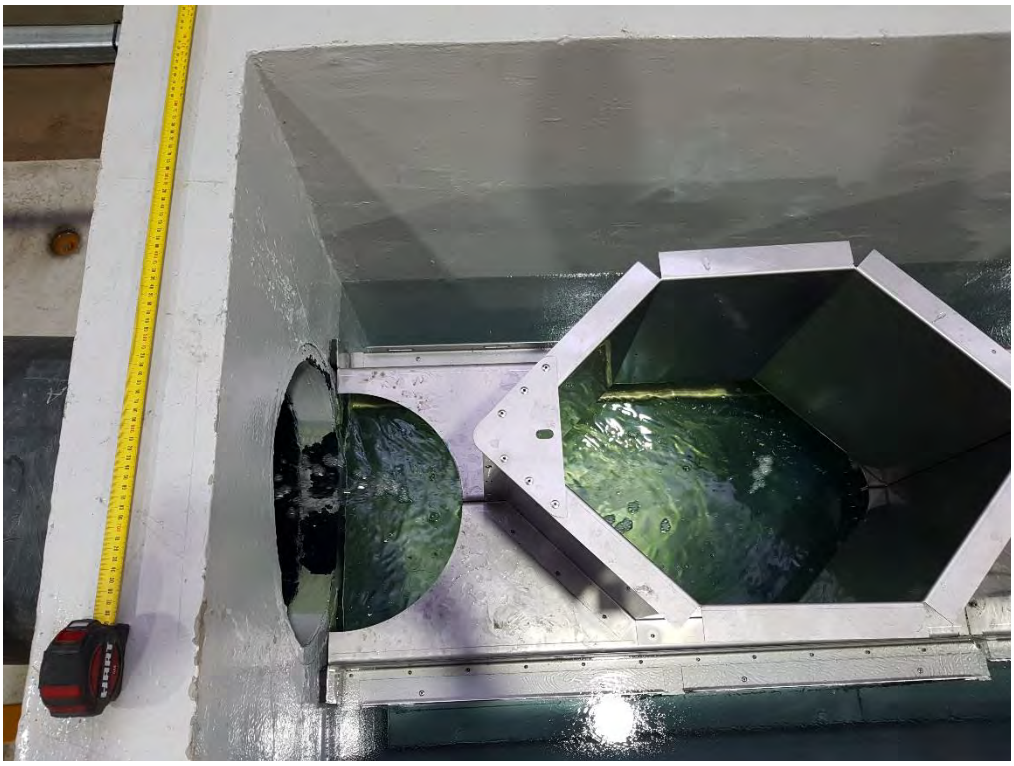


Figure 4 – Detailed view of inflow into the H45 treatment system

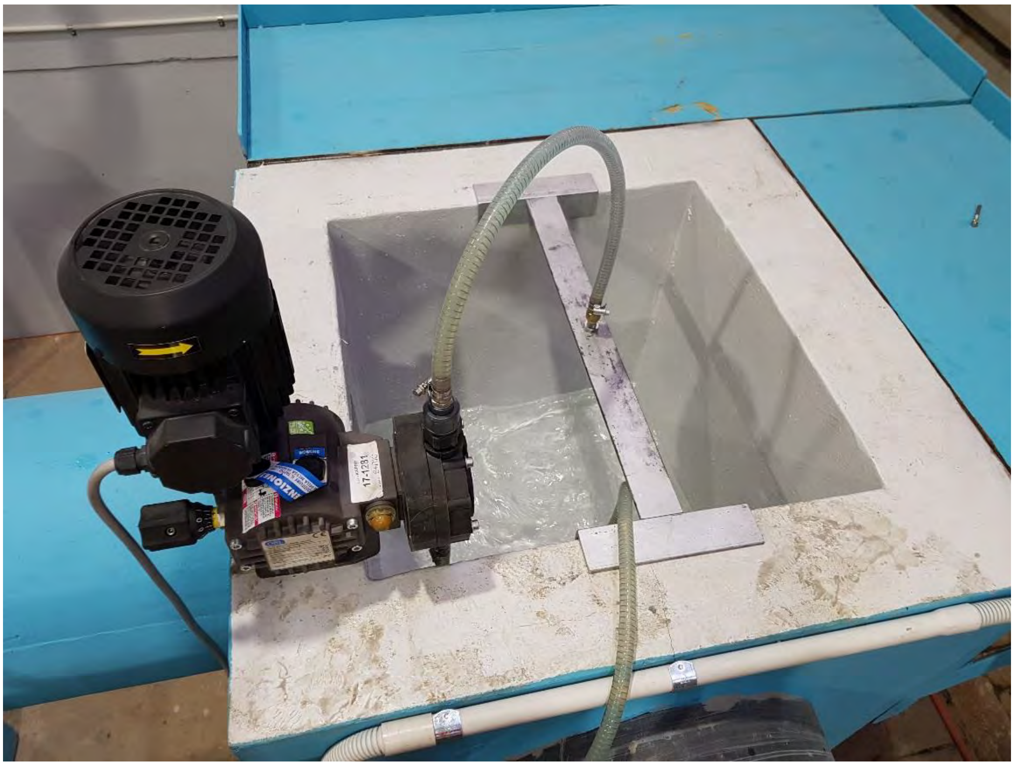


Figure 5 – Detailed view of the oil/water mixing pit upstream of the treatment device

2.1 Oil/Water Separation Test Details

To measure the oil/water separation performance at the nominal flow rate of 4.2 L/s, the test procedure in EN 858-1:2002 Section 8.3.3.1.4 was followed except for the inflow arrangement specified above. The specifications of the equipment and test procedure are presented in Table 1. A conceptual layout of the testing was shown in Figure 1.

Table 1 - Specifications of the equipment and testing for the pumped inflow test

Oil Water separator test unit model:	Enviro H45 unit 1180 L capacity unit (including non-working capacity) Capacity was based on advice from Enviro Australis (see Appendix A).
Flow rate	4 L/s. Flow was measured using the procedures detailed by Enviro Australis in Appendix A.
Inflow concentration of light oil	> 5 mL oil per litre of water (as per EN 858-1:2002 Section 8.3.3.1.3) This equated to 1.2 L/min during the oil/water separation test.
Test period	Run In (20 mins) + Test time (5 mins) = 25 mins
Light oil specification	According to EN 858-1:2002 “The light liquid shall be fuel oil in accordance with ISO 8217, designation ISO-D-DMA, having a density of 0.85 ± 0.015 g/cm^3 at 12 °C”. This corresponds to a Marine Gas Oil product. The closest product available in South Australia is Extra Low Sulphur Diesel fuel oil which is ISO-F-DMA compliant except for its pour point. The product density is between 0.82 to 0.86 kg/L (or g/cm^3).

As noted, the light oil retention test procedure was developed based on European Standard EN 858-1:2002, and an excerpt of the original standard is provided in Appendix B. The procedure used in this test is summarised below.

1. Water was allowed to flow by gravity into the test rig, proceeding first via a pit, to another pit where oil and water were mixed and then to the H45 treatment system.
2. With water flow only, the static water level was measured.
3. Oil contaminant was introduced into the sump/pit at a flow rate to result in the target oil inflow concentration of 5 mL/L (± 5%). This continued for the calculated 'run-in' period (20 mins). The run in period was determined as follows (from EN 858-1:2002 Section 8.3.3.1.3):

$$T_E = \frac{4V_k}{60Q_w}$$

Where:

T_E	=	Is the running in period (minutes); minimum period of 15 minutes
V_k	=	Is the water volume of the separator (in this case the volume used was 1180 L
Q_w	=	Is the maximum allowable flow rate of water through the separator (L/s). In this case the treatment flow rate was used, 4.2 L/s

4. At the completion of the 'run-in' period, the outlet water was sampled via a sample pipe five times at one-minute intervals.

Five effluent samples were sent to an independent NATA accredited laboratory (ALS Global, Adelaide) and were analysed to determine the concentration of total petroleum hydrocarbons and total recoverable hydrocarbons.

2.2 Performance Assessment

When oil water separators are tested in accordance with EN 858-1:2002, there are two classes of oil/water separator system - Class 1 and Class 2. The class of separator is determined based on the individual and average value of the five effluent samples (see Sections 4 and 8.3.3.1.4 of EN 858-1:2002). A Class 1 separator (or coalescing separator) has an average residual oil content less than 5 mg/L, with no sample greater than 10 mg/L. A Class 2 separator (or gravity separator) has an average residual oil content less than 100 mg/L, with no sample greater than 120 mg/L. The results of this test will be reported based on the separation arrangement being equivalent to Class 1 or Class 2 using identical criteria.

According to EN 858-1:2002 Section 6.5.2, oil water separators must also be able to retain at least 15 times their nominal size in litres where automatic closure devices are not fitted. Based on the nominated nominal size of 4, the Enviro Austrlis H45 must be able to retain in excess of (15 x 4) = 60 L of oil to be compliant with the requirements of EN 858-1:2002 Section 6.5.2. This was evaluated at the conclusion of testing.

3 Results

3.1 Oil Water Separation

Testing was conducted on Monday 24 September 2018. Five samples were collected using the outflow arrangement in accordance with EN 858-1:2002. An excerpt of the results of chemical analysis from a NATA accredited laboratory (ALS Laboratory Services) are provided in Appendix C. A summary of the analysis is provided in Table 2. Note that both the total petroleum hydrocarbons (TPH) and total recoverable hydrocarbons (TRH) results are shown. TRH results are those that comply with the current definitions, extracting methods and reporting fractions for hydrocarbon analysis of samples in accordance with the National Environmental Protection (Assessment of Site Contamination) Amendment Measure 2013 (No 1). The TPH results are shown for comparison with previously reported results prior to this standard

Table 2 - Summary of total recoverable hydrocarbons (mg/L)and their individual fractions present in effluent samples

Constituent	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average	Blank**
C6 to C10 Fraction	0.29	0.26	0.29	0.30	3.40	0.30	0.07
C10 to C16 Fraction	1.57	2.16	2.88	1.86	1.94	2.08	0.1
C16 to C34 Fraction	1.47	2.11	2.80	1.88	1.94	2.04	0.17
C34 to C40 Fraction	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total recoverable hydrocarbons (mg/L)	3.04	4.27	5.68	3.74	3.88	4.12	0.27
Total petroleum hydrocarbons (mg/L)*	3.17	4.44	5.92	3.85	4.04	4.28	0.23
* Total petroleum hydrocarbons in an alternate calculation of Total recoverable hydrocarbons and is shown for information only. ** The blank sample was a sample of the inflow water without any oil doing.							

The results of the test procedure indicated that the proposed system design achieved an outflow concentration equivalent to a Class 1 oil water separator in accordance with EN 858-1:2002. The mean concentration of outflow form the arrangement tested was 4.12 mg/L, which is less than the 5 mg/L mean outflow requirement. In addition, there were no samples greater than 5.68 mg/L, less than the individual sample maximum concentration of 10 mg/L. The oil/water inflow testing continued until more than 60 L of oil was passed into the system. This retained volume was greater than 60 L, the minimum storage volume required for a separator system with a nominal size of 4 in accordance with EN 858: 2002 Section 6.5.2 *Storage capacity for light liquids.*

This results indicate that the system has met the requirements of a Class 1 gravity supply device in accordance with EN 858-1:2002. The only exception to the test procedure, the modification of the inlet channel to the system, should be noted but is considered representative of stormwater flow conditions.

4 Discussion and Recommendations

The testing undertaken was fully in accordance with the specified test method except for a slight modification of the inflow arrangement, where in lieu of an open channel approach flowing via a screen into a mixing chamber, oil was added to the water flow in a characteristic of a stormwater drainage system (e.g. oil was dropped from a height in accordance with the standard directly into a turbulent flow within a stormwater pit structure). The impact of this on the testing is uncertain, and may have caused greater or lesser turbulence for oil to mix with water. However it was considered to be characteristics of a stormwater flow arrangement.

5 Conclusion

The results of the oil/water separation test indicate that the arrangement of the oil water separation system met the requirements to be a Class 1 oil/water separation device in accordance with EN 858-1:2002 with a nominal size of 4. The testing undertaken was fully in accordance with the specified test method except for a slight modification of the inflow arrangement, where in lieu of an open channel approach flowing via a screen into a mixing chamber, oil was added directly into flow characteristic of a stormwater drainage system (e.g. oil was dropped from a height in accordance with the standard directly into a turbulent flow within a stormwater pit structure).

Appendix A – Additional Testing Details

The report data overleaf was provided by Enviro Australis and provides additional testing details including the monitoring of flow rate.

ENVIRO

Enviro-Aus Pty Ltd
Oil/Water Separation Testing
Testing Facilities and Preparation

Prepared by: Leo Crasti BE(mech)
Date: 2 October 2018

Testing in accordance with BS EN 858-1:2002 Separator systems for light liquids (e.g. oil and petrol)

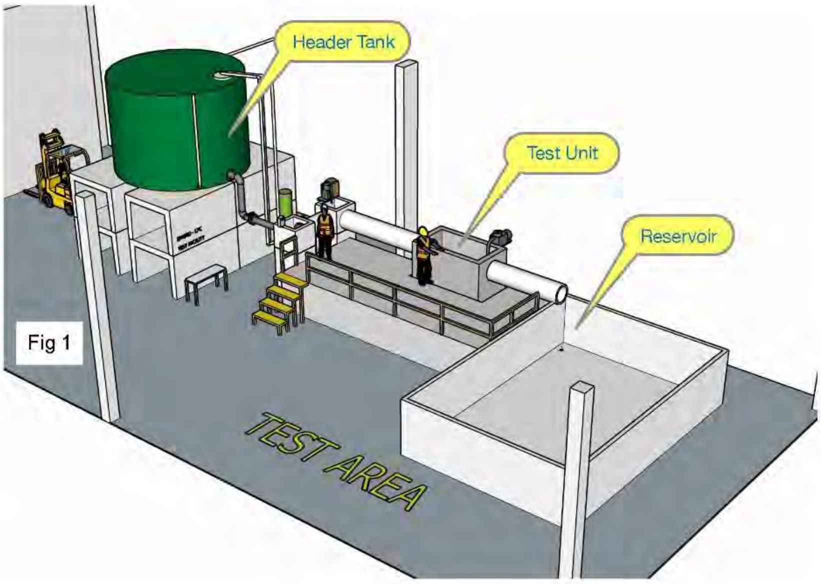
Testing Facilities, Description

Enviro-Aus Pty Ltd, is a private Company established to Research and Develop processes and devices to improve water quality.

The Technical Director brings ten (10) years of experience to Enviro-Aus.

This document summarises testing of a recently developed device which includes oil/water separation as part of the integrated processes. The device includes multi-function processes for the removal of gross pollutants (trash and litter), Suspended Solids (SS) and Nutrients. The separation of oil in accordance with EN 858-1 and gaining of recognition as a Class 1 separator is the aim of this testing program.

A testing facility has been established by Enviro-Aus within the manufacturing premises operated by Cooke Precast Concrete (CPC) at 3 Peachey Road, Edinburgh North SA. An illustration of the the test facilities located in building 'E' is shown in Fig 1.



ENVIRO

Testing set-up in accordance with BS EN 858-1

The Enviro-Aus model subjected to testing is H45. This model can accomodate pipe sizes up to 450 diameter, when operating as multi function device. For the purposes of oil/water separation this pipe size could be 225 dia. The construction is a reinforced concrete chamber, stainless steel grade 304 internal parts and nylon screen material. The assembly is riveted to avoid metallurgical changes caused by welding.

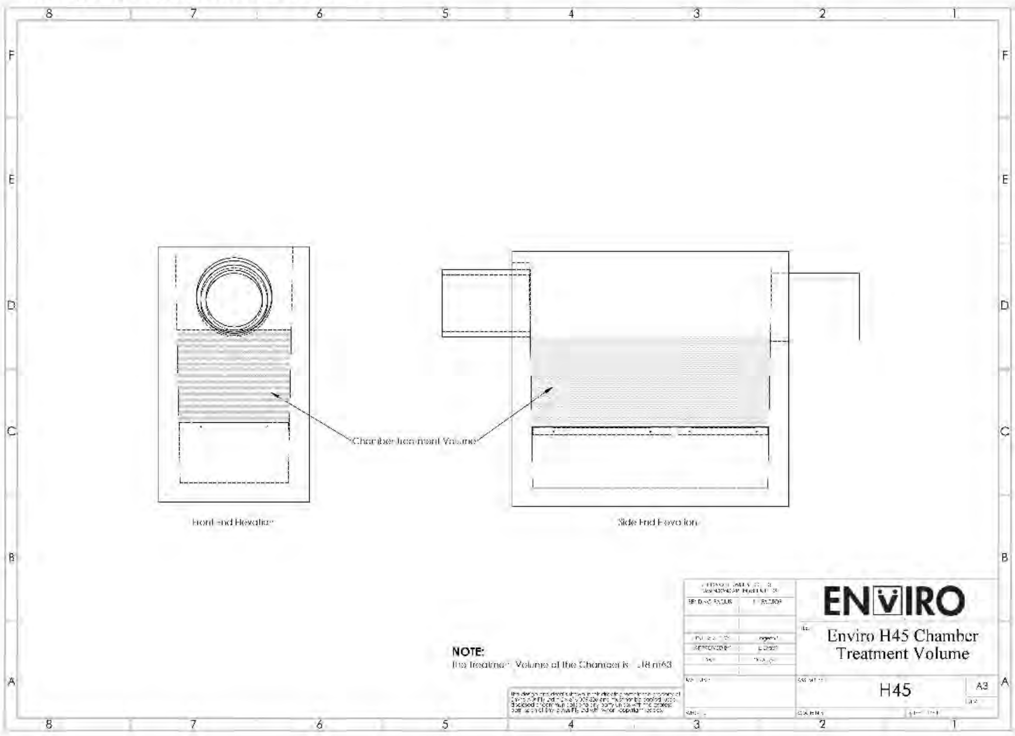
For the purpose of testing, the lower storage chamber was isolated by installing a horizontal blanking plate. The volume for the purposes of the testing program is calculated as 1.18m³ (refer drawing below). The test unit size was determined as $N_s < 100$

In accordance with EN 858-1 section 8.3.3.1.4 The following test parameters were used.

Q_W = 4 litres/sec
V_k = 1,180 litres
T_E = 19.67 minutes
T = 24.67 minutes

Dosing concentration = 5 ml/litre of Q_w

Dosing Rate = 20 ml/sec or 1.2 Litres/min.



Flow Rate Monitoring, Description

During the testing period, flow rate was monitored and controlled by adjusting a gate valve and maintaining a constant flow as displayed on a flow meter.

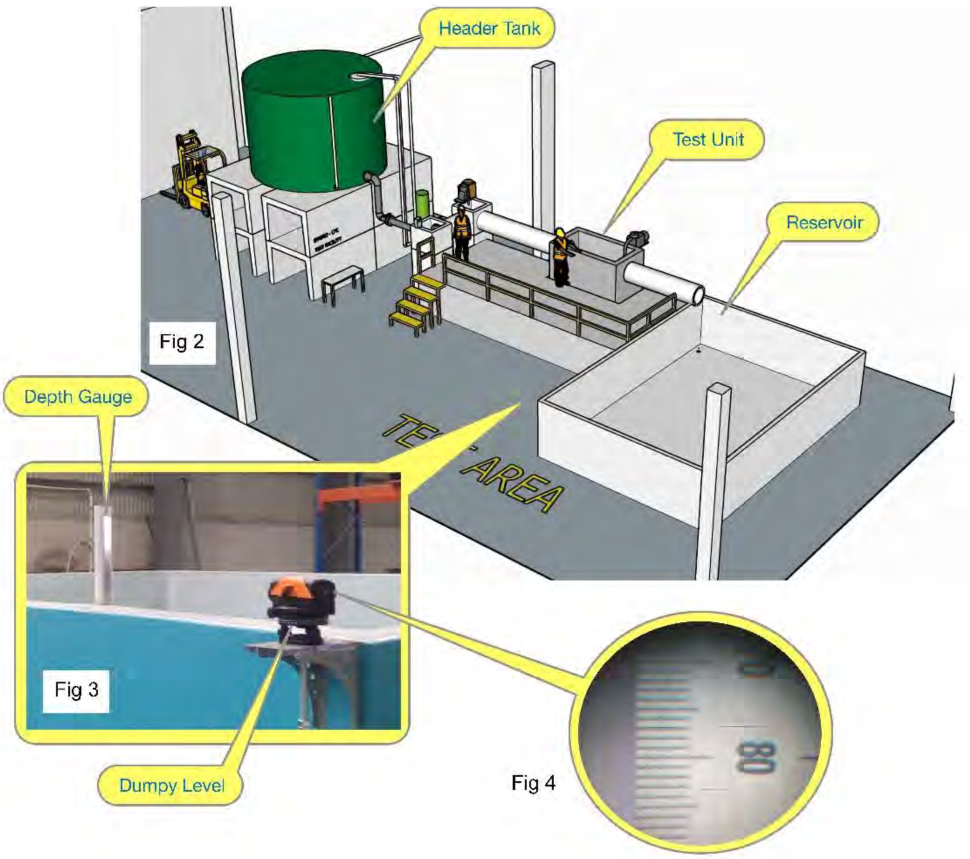
Flow was created by allowing water to flow from a header tank to the reservoir via the test unit. (refer Fig 2) A flow sensor and meter was installed in the header tank discharge pipe.

The flow meter was calibrated by measuring the time to fill the reservoir, being a known volume. To compensate for a reduction in flow rate as head reduced, the flow was measured at a constant head level.

Flow Rate Calibration

The reservoir plan dimensions were measured as 6,339.5mm x 4,213mm giving a plan area of 26.708m². This plan area translates to a volume of 26.7 lites/mm of reservoir depth. The reservoir water depth was measured by installing a floating depth gauge and using a dumpy level telescope at 25 times magnification to read the depth gauge (refer Fig 3 and 4). This provided a readable accuracy of better than 0.5mm or 13.35 litres. The flow rate was established by timing a depth change equal to the 4 x fill volume = 4,720 litres during a 15 minute flow interval.

This provided an accuracy of 13.35/4,720 = 0.28%.



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Oil Dosing, Description

To facilitate accurate dosing a dosing pump, model OBL Blackline M155 was installed and calibrated. Specifications confirmed the pump was capable of pumping the light oil. The pump is a mechanical diaphragm operation which has a positive displacement and variable stoke for dosing adjustment independent of fluid density.

The pump was mounted directly over a mixing pit located 3 metres upstream of the test unit, in accordance with EN 858-1, fig 4

The dosing rate of 1.2 litres/minute was established by pumping 10 litres of water over a period of 8.333 minutes or 8 minutes and 20 seconds. The 10 litre volume was established by using a laboratory beaker and transferring water into a clean bucket. The dosing rate was adjusted until the fill rate for a 10 litre volume equaled 8:20 min:sec.

Oil Storage

As an extension to testing for oil/water separation, storage capacity was also evaluated.

The light oil volume dosed during T was: -

1.2 l/min x 25 minutes = 30 litres

In accordance with EN 858-1 section 6.5.2 the minimum storage volume should be: -

4 litres x 15 = 60 litres

Following the oil/water separation test, the oil present in the test device was 30 litres. An additional 40 litres was added with no discharge of oil. This determined that the storage volume exceeded the minimum requirements.

Test fluids

Water: Town water was used.

Light Liquid:

EN 858-1 section 88.3.3.1.3 specifies a light liquid fuel oil in accordance with ISO 88217, designation ISO-F-DMA. The Australian equivalent used as the test dosing fluid was Caltex Extra Low Sulphur Diesel which is rated insoluble in water with an Sg of 0.82 - 0.85.

APPENDIX B – Test Method (Extract of EN858-1:2002)

The following is extracted from European Standard EN 858-1:2002, Separator systems for light liquids (e.g. oil and petrol) Part 1: Principles of product design performance and testing, marking and quality control, Clause 8.3.3.1.4 Test Procedure.

8.3.3.1.4 Test procedure

Fill the separator with water. Measure the maximum static water level and corresponding volume V_k. At the predetermined maximum allowable flow rate Q_w measure the new water level.

Calculate the total duration of the test T as the sum of the running-in period T_E and the sampling period T_P, so that $T = T_E + T_P$. The running-in period shall be equivalent to the length of time needed to exchange the volume of water V_k four times, with a minimum period of 15 min, and is determined by the following formula:

$$T_E = \frac{4 \times V_k}{Q_w \times 60} \qquad (1)$$

where

T_E is the running-in period, in min, with a minimum period of 15 min;

V_k is the water volume of the separator, in l;

Q_w is the maximum allowable flow rate of water through the separator, in l/s.

The sampling period T_P shall be 5 min.

Maintain the maximum allowable flow rate of water Q_w with a tolerance of ± 2 % and add the light liquid at a constant flow rate of 5 ml/l with a tolerance of 5 % for the total duration of the test T, ensuring no light liquid dwells in the collecting chamber. The effluent shall be discharged through the sampling pipe during the whole of the test T.

[A1) From the beginning of the sampling period T_P, and at 1 min intervals, take one sample, at least 500 ml, from every outlet of the separator via the sampling pipe. This will give a total of five samples per outlet. (A1]

[A1) Analyse the samples by infrared spectroscopy or by gas chromatography in accordance with annex A using the light liquid in accordance with 8.3.3.1.2 as the reference liquid. (A1]

Calculate the content of residual oil as the arithmetical mean value of the samples. No individual sample shall have a higher value than 10 mg/l for class I or 120 mg/l for class II.

Determine the nominal size of the separator in accordance with clause 5, and the class in accordance with table 1.

Add more light liquid when there is no flow until the storage capacity for light liquid has been determined, having regard for whether or not a closure device is to be fitted. The result shall be in accordance with 6.5.2. Measure the light liquid level at storage capacity and determine the maximum operational liquid level. For separators greater than NS 6 the storage capacity and the maximum operational liquid level may be determined by calculation.

Appendix C – Water Quality Results

The following are extracts of Water Quality Results from NATA Accredited laboratory (ALS Global, Workorder EM1815374) The extracts show the front page matter and key results from the testing.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: EM1815374	Page	: 1 of 5
Client	: UNISA - CENTER FOR WATER MANAGEMENT & REUSE	Laboratory	: Environmental Division Melbourne
Contact	: MR BADEN MYERS	Contact	: Customer Services EM
Address	: Mawson Lakes Boulevard Mawson Lakes South Australia, Australia	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 08 8302 3248	Telephone	: +61-3-8549 9600
Project	: AFMG A1808005 Run 3	Date Samples Received	: 25-Sep-2018 10:50
Order number	:	Date Analysis Commenced	: 25-Sep-2018
C-O-C number	: ----	Issue Date	: 26-Sep-2018 15:39
Sampler	: BADEN MYERS		
Site	: ----		
Quote number	: ADBQ/011/10		
No. of samples received	: 6		
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*
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC

RIGHT SOLUTIONS | RIGHT PARTNER

Page	: 3 of 5
Work Order	: EM1815374
Client	: UNISA - CENTER FOR WATER MANAGEMENT & REUSE
Project	: AFMG A1808005 Run 3

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Client sample ID*	ECPC-Run3-1	ECPC-Run3-2	ECPC-Run3-3	ECPC-Run3-4	ECPC-Run3-5
			Client sampling date / time	24-Sep-2018 11:15	24-Sep-2018 11:16	24-Sep-2018 11:17	24-Sep-2018 11:18	24-Sep-2018 11:19
Compound	*CAS Number*	*LOR*	*Unit*	EM1815374-001	EM1815374-002	EM1815374-003	EM1815374-004	EM1815374-005
				Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	210	200	210	220	250
C10 - C14 Fraction	----	50	µg/L	1040	1360	1860	1200	1220
C15 - C28 Fraction	----	100	µg/L	2130	3040	4060	2650	2820
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	3170	4400	5920	3850	4040
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	290	260	290	300	340
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	190	170	190	200	240
>C10 - C16 Fraction	----	100	µg/L	1570	2160	2880	1860	1940
>C16 - C34 Fraction	----	100	µg/L	1470	2110	2800	1880	1940
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L	3040	4270	5680	3740	3880
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	1570	2160	2880	1860	1940
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	1	1	1	1	1
Toluene	108-88-3	2	µg/L	18	18	19	19	20
Ethylbenzene	100-41-4	2	µg/L	18	16	18	18	19
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	30	27	31	33	33
ortho-Xylene	95-47-6	2	µg/L	30	29	31	32	32
^ Total Xylenes	----	2	µg/L	60	56	62	65	65
^ Sum of BTEX	----	1	µg/L	97	91	100	103	105
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	86.2	96.4	100	94.5	102
Toluene-D8	2037-26-5	2	%	93.0	102	106	98.8	103
4-Bromofluorobenzene	460-00-4	2	%	97.3	108	113	106	109