

Peer Review of SPEL Stormceptor/Purceptor performance against the British Water Code of Practice

For SPEL Stormwater

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Summary:	The SPEL Stormceptor/Puraceptor stormwater treatment technology has been tested in the laboratory and field under Australian conditions. This report reviews those results against the British Water Code of Practice for the Assessment of Manufactured Treatment Devices Designed to Treat Surface Water Runoff.

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Executive Summary

The *British Code of Practice (CoP) for the Assessment of Manufactured Treatment Devices Designed to Treat Surface Water Runoff* defines an assessment method that allows product manufacturers to measure the pollutant capture and retention capability. The intention of the CoP is to enable suppliers to declare those capabilities when the product is offered for sale in the United Kingdom (UK).

SPEL Stormwater have had the Stormceptor/Purceptor treatment technology tested in Australia under laboratory and field conditions over many years. This technology is primarily designed to target hydrocarbons and sediment in stormwater.

This Peer Review considers the existing laboratory and field testing performed on the Stormceptor/Purceptor against the CoP requirements and provides a recommendation of the performance that can be applied in the CIRIA SuDS Manual.

This report recommends the use of the following Mitigation Indices for the Stormceptor/Purceptor technology **0.77 TSS, and 0.8 Composite Hydrocarbons**.

1 Introduction

1.1 Background

The *British Code of Practice (CoP) for the Assessment of Manufactured Treatment Devices Designed to Treat Surface Water Runoff* defines an assessment method that allows product manufacturers to measure the pollutant capture and retention capability. The intention of the CoP is to enable suppliers to declare those capabilities when the product is offered for sale in the United Kingdom (UK). The CoP is a voluntary code and cannot be enforced, however, testing in accordance with the protocol allows manufacturers to calculate pollution mitigation indices for use with the CIRIA SuDS Manual.

The CoP is aimed at determining three functional requirements of treatment devices:

1. Typical pollutant capture efficiency for frequent, sub-annual rainfall events;
2. Sediment retention capability for up to 1:2 year rainfall events likely to cause washout; and
3. Capability of filter media to retain dissolved pollutants under the influence of de-icing salt.

The CoP requires that treatment devices be tested for 2 functional requirements;

1. Quantification of connectable area and treatment flowrate based on a 1:1 year rainfall event in the UK (mean intensity = 27 mm/hr); and
2. Capability to safely pass a maximum capacity flow rate equivalent to a 1:30 year rainfall event, utilising bypass design as appropriate.

SPEL Stormwater have been testing the Stormceptor/Puraceptor technology in Australia over many years. Drapper Environmental Consultants have been engaged to consider these reports against the requirements of the CoP and provide an opinion of the appropriate Mitigation Indices to apply.

2 Detailed Stormceptor/Puraceptor Description

2.1 Design Drawings/Dimensions

A typical schematic of a Stormceptor/Puraceptor is shown in Figure 1. The standard Stormceptor/Puraceptor has an overall length of 6540 mm and internal diameter of 1850 mm.

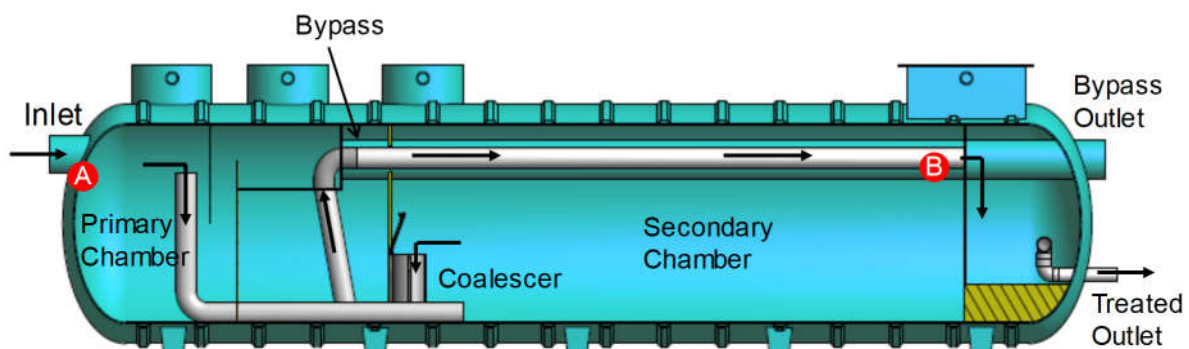


Figure 1. SPEL Stormceptor/Puraceptor schematic

The arrows in Figure 1 show the flow path that treated stormwater takes through the device. The primary chamber of the Stormceptor/Puraceptor is designed to trap gross pollutants and sediment greater than 0.2 mm in diameter, and the coalescer in the secondary chamber is designed to separate hydrocarbons from water. Where the flowrate from the catchment may exceed the treatment

capacity of the device, an internal bypass facilitates higher flows around the second chamber to retain fine sediment and hydrocarbons. The Stormceptor/Purceptor technology is sized to provide a 6 minute residence time for the treatable flow.

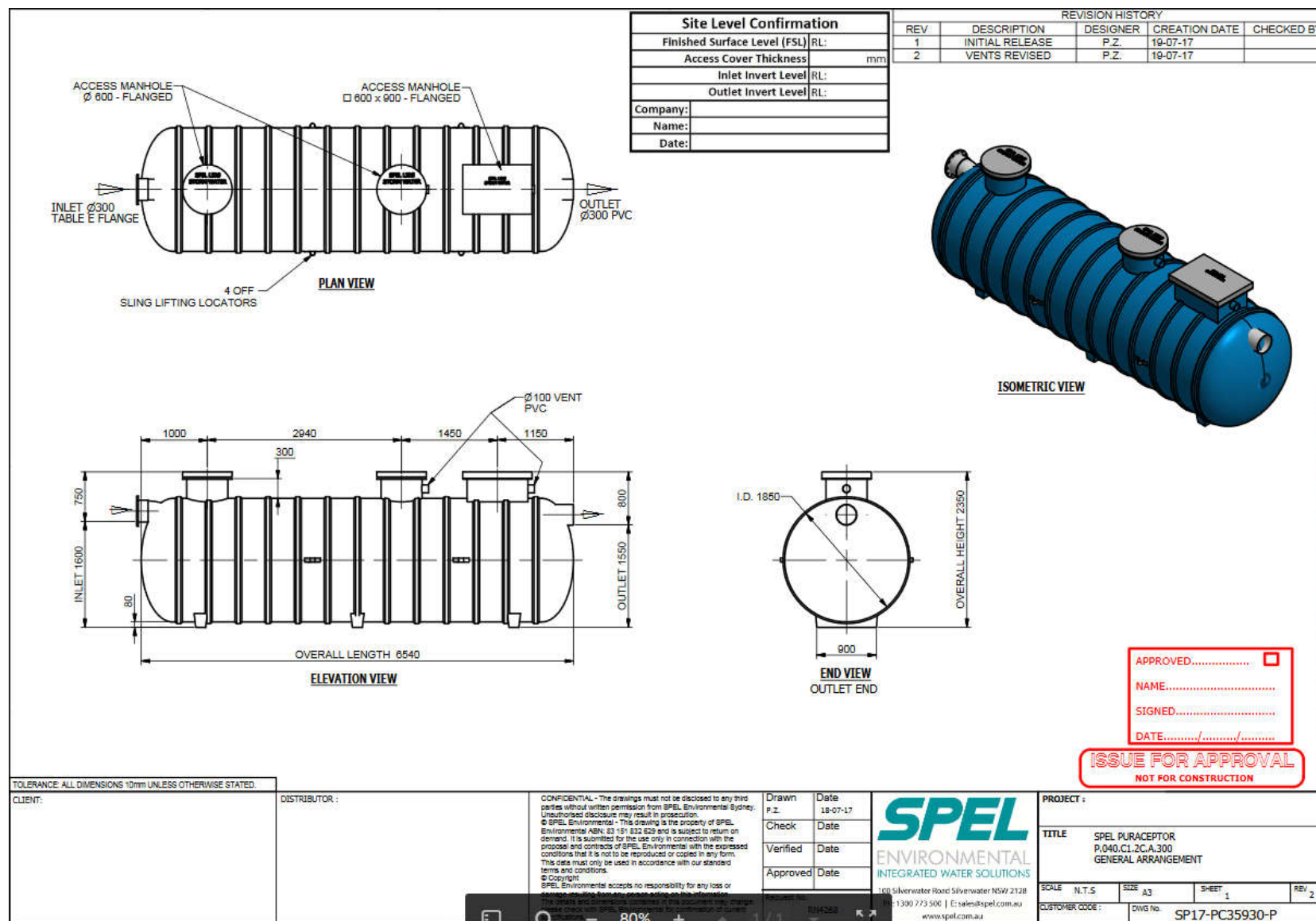


Figure 2. Typical Design Drawings of SPEL Stormceptor/Purceptor (SPEL Stormwater)

3 Code of Practice Methodology

The British Water CoP methodology proposes a laboratory test method for evaluating performance of sediment capture. Table 1 details the requirements for flow rate, the order in which testing should occur and the minimum number of volume exchanges. Minimum test time is specified at 15 minutes.

Table 1. Summary of British Water CoP test requirements

Assessment Order	Flowrate (L/s/ha)	Minimum number of volume exchanges
1	5	10
2	10	10
3	15	10
4	31.5 ¹	10
5	110 ²	20

¹Maximum Treatable Flowrate

²Bypass event/scour test (1:2 yr)

The sizing methodology indicated above varies from the Australian approach in that the catchment area treated by the device is not limited. The Stormceptor/Puraceptor device is designed to provide a specific flowrate and retention time, and the catchment area may increase or decrease depending on the local climatic conditions.

The treatment flowrate (TFR) of the P040 model is 10L/s. Therefore, under the above sizing guidelines, this model would have a maximum treatment catchment area of 3,175 m².

Sediment load for the testing is specified to be 200 mg/L of quartz powder with a D₅₀ of 63 micron. The CoP does not provide guidelines for the evaluation of hydrocarbon capture.

4 Australian Test Reports

The SPEL Stormceptor/Puraceptor technology has been laboratory tested in Australia for hydrocarbon capture in accordance with BS/EN858. It has also been field monitored for total suspended solids (TSS) capture, amongst other parameters. Independent reports have been supplied by the testing organisations as detailed below;

- University of South Australia, 2010, *Performance assessment of the Puraceptor to BS/EN858-1:2002 "Separation systems for light liquids"*, July 2010.
- University of the Sunshine Coast, 2015, *Field Evaluation of Stormwater Treatment Performance of the SPEL Stormceptor Installation at Nambour; Final Report*, 30 June 2015.
- Griffith University, 2018, *Freedom Fuels Stormwater Treatment; Final Report*, Research Report No. 206.2, May 2018.

4.1 University of South Australia – BS/EN858 testing

Testing was conducted at the University of South Australia's laboratory located at the Mawson Lakes campus. The test rig is shown indicatively in Figure 3. Testing was performed by University of South Australia staff and samples were sent to an independent NATA-registered laboratory for hydrocarbon analyses. The test flow rate was 10 L/s. The influent TPH concentration was 5,699 mL/L.

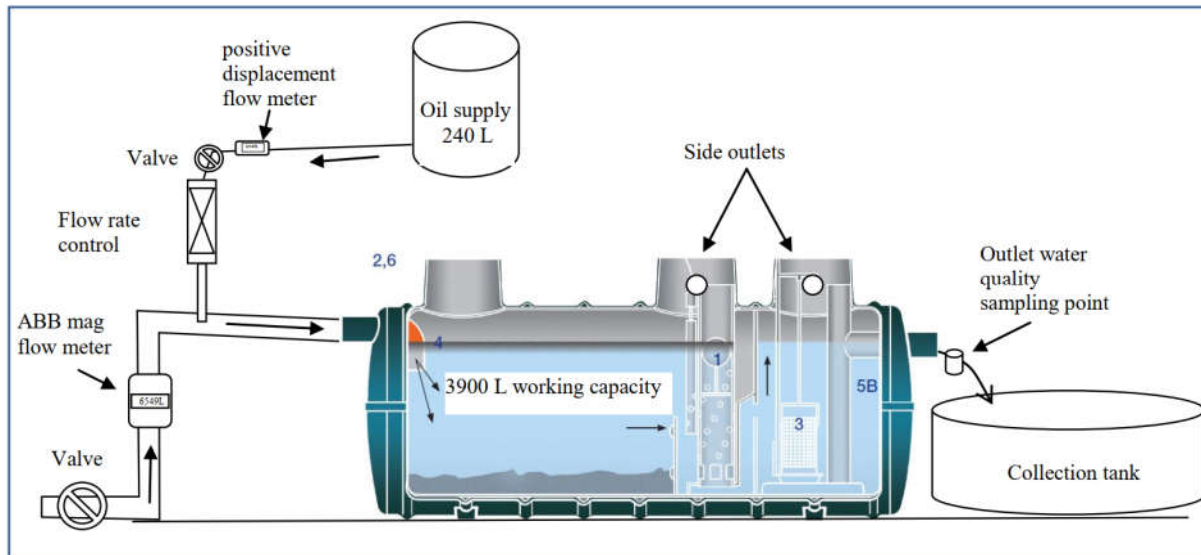


Figure 3. University of South Australia Test rig. (Source: University of South Australia, 2010)

4.2 University of the Sunshine Coast – Nambour Stormceptor Field testing

Field testing was conducted on a Stormceptor installed at commercial premises at Currie St, Nambour, Queensland. The site is ~2,800 m² and 99% impervious consisting of building roof, concrete driveway and hardstand parking areas. A field monitoring methodology based on the Auckland Proprietary Device Evaluation Protocol (PDEP) and USEPA BMP Manual (Geosyntec Consultants et al. 2009) was implemented at the site. The sampling protocol is described in Table 2 below. Additional pollutants to TSS were monitored at this site, but are not the subject of this review.

Table 2. Nambour Field Monitoring Protocol

Requirements	Criteria	Details
Minimum qualifying events	15	To gain enough valid data and achieve statistically significant difference between influent and effluent.
Minimum rainfall depth	0.75 mm	Test and report unless below detectable limits on influent.
Minimum storm duration	5 minutes	Test and report unless below detectable limits on influent.
Minimum dry antecedent period	6 hours	Test and report unless below detectable limits on influent.
Hydrograph sampled	Minimum first 60%	
Minimum number of sample aliquots	2	Minimum volume 180mL
Aliquots volume	60 ml	Minimum sufficient for NATA-registered lab testing
Sample method	Automatic sampler	
Flow weighted samples	Every 1000 L	
Rainfall monitoring	0.2 mm intervals	
TSS	APHA (2005) 2540 D	HDPE or glass bottles, Cool to 4°C, maximum hold time 24

Requirements	Criteria	Details
		hours
Particle Size Distribution	Laser Diffraction (Malvern Mastersizer)	Continuously stirred, without chemical dispersion or sonication
Laboratory Certification	NATA registered	ACCREDITATION NO: 16969
QA/QC	Random duplicates and blanks in accordance with the relevant Australian Standard.	

The monitored site is shown in Figure 4 below.



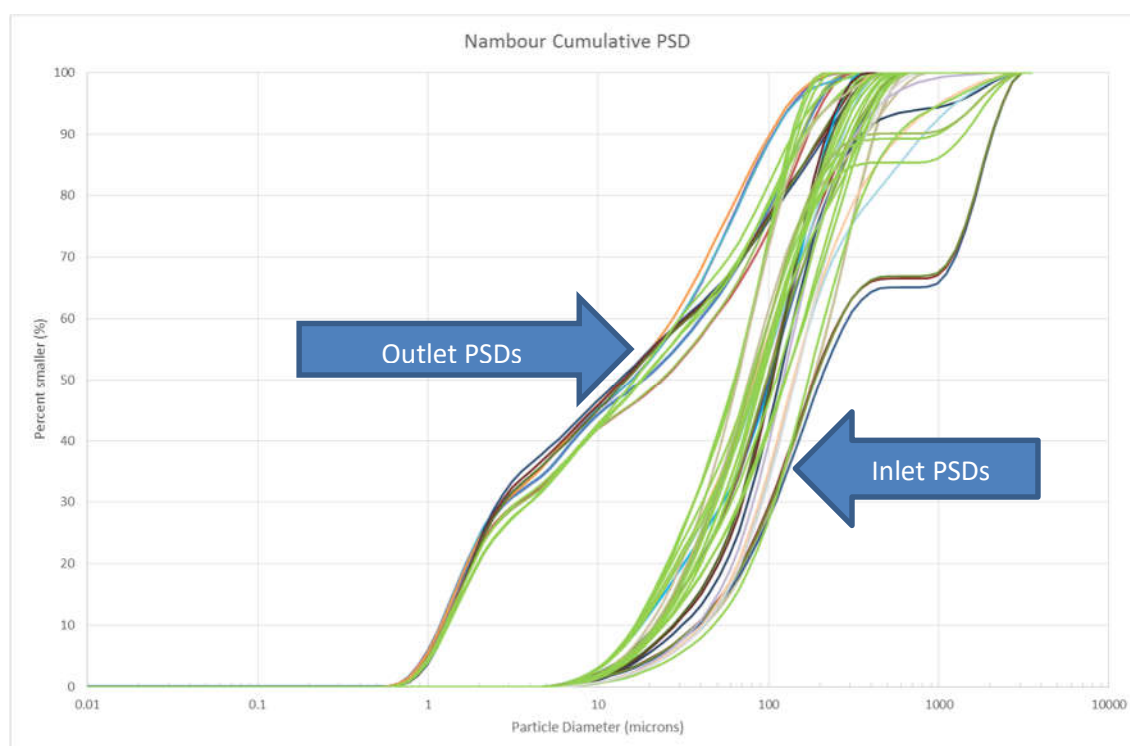
Figure 4. Nambour monitoring site, aerial photo, boundary shown in red

Between 27th March 2014 and 7th April 2015, 18 events qualified with the protocol criteria. Observed influent concentrations were significantly lower than anticipated for catchments with this landuse, as shown in Table 3 below. The particle size distributions curves are presented in Figure 5, with influent samples on the right and effluent samples on the left. As can be seen, many of the influent PSDs have a D_{50} around 100 microns.

Table 3. Nambour Observations compared with Australian guidelines for stormwater quality

Parameter	Typical Australian Guideline Values (Commercial Catchments)			Lower bound (99%) Nambour Influent	Average Nambour Influent	Upper bound (99%) Nambour Influent
	-1SD	Mean	+1SD		Mean	
TSS (mg/L)	60.3	145	347	0.64	35.2	69.7

Reference: Water by Design, 2010.

**Figure 5. Particle Size Distribution Curves for the Nambour site**

4.3 Griffith University – Southport Puraceptor Field testing

Field testing was conducted on a Puraceptor installed at fuel refilling station at Smith St, Southport from August 2014 to March 2018. The site has a catchment area of 3,373 m² with 1,178 m² of roof, 2,037 m² of impervious hardstand and 158 m² of pervious landscaping. An aerial photograph of the site is shown in Figure 6.

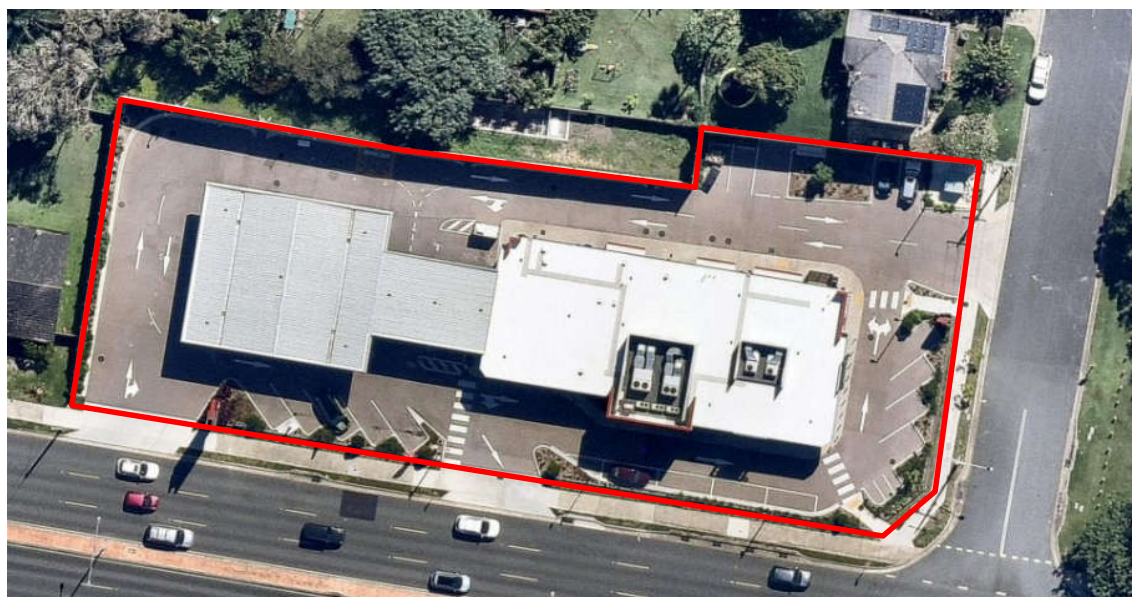


Figure 6. Puraceptor field monitoring site at Southport, Queensland, Australia – boundary in red.

A very similar monitoring protocol was implemented at Southport to that used at the Nambour property (refer Table 4) however, on this site total petroleum hydrocarbons (TPH) were also monitored. Influent TSS concentrations were again observed to be very low in comparison with industry-accepted levels. These are compared in Table 5. During the monitored period 15 events qualified with the methodology.

Table 4. Southport Field Monitoring Protocol

Requirements	Criteria	Details
Minimum qualifying events	15	To gain enough valid data and achieve statistically significant difference between influent and effluent.
Minimum rainfall depth	5 mm	Test and report unless below detectable limits on influent.
Minimum storm duration	16 minutes	Test and report unless below detectable limits on influent.
Minimum dry antecedent period	6 hours	Test and report unless below detectable limits on influent.
Hydrograph sampled	Minimum first 60%	
Minimum number of sample aliquots	8	Minimum volume 180mL
Aliquots volume	200 ml	Minimum sufficient for NATA-registered lab testing
Sample method	Automatic sampler	
Flow weighted samples	Every 50 L	Equivalent to 1mm of rainfall through the Puraceptor catchment
Rainfall monitoring	0.2 mm intervals	
TSS	APHA (2005) 2540 D	HDPE or glass bottles, Cool to 4°C, maximum hold time 24 hours

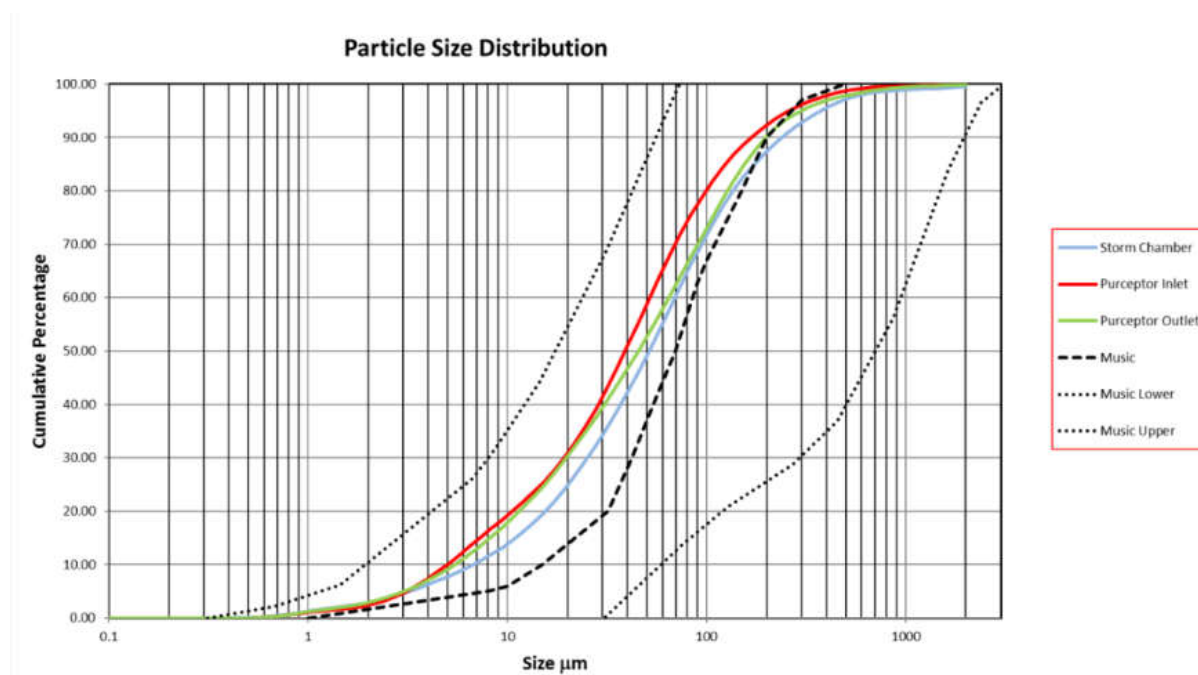
Requirements	Criteria	Details
TPH	ALS EP080/071	Amber glass bottles, Cool to 4°C, maximum hold time 24 hours
Particle Size Distribution	Laser Diffraction (Malvern Mastersizer)	Continuously stirred, without chemical dispersion or sonication
Laboratory Certification	NATA registered	
QA/QC	Random duplicates and blanks in accordance with the relevant Australian Standard.	

Table 5. Southport Observations compared with Australian guidelines for stormwater quality

Parameter	Typical Australian Guideline Values (Commercial Catchments)			Average Influent
	-1SD	Mean	+1SD	
TSS (mg/L)	60.3	145	347	21.6

Reference: Water by Design, 2010.

Particle size distribution curves were evaluated for all of the compliant events and an average presented in the Griffith University report. As can be seen from Figure 7 below, both the average influent and effluent PSDs have D_{50} values less than 50 microns.

**Figure 7. Particle Size Distributions for the Southport Puraceptor (inlet shown in red, outlet shown in green)**

5 Assessment of Testing Methods against British Water CoP

This review considers the existing testing of the Stormceptor/Puraceptor technology against the requirements of the recently released British Water CoP. Table 6 provides a comparison. It is clear from the CoP that it was formulated as a laboratory protocol for sediment and metals determination. Advice on hydrocarbons is limited to a statement regarding the specified sediment PSD that hydrocarbons and heavy metals are found in greatest concentrations.

Table 6. Assessment of Stormceptor/Puraceptor Australian testing against British Water CoP

Requirement	Details	Compliance		
		UniSA test	Nambour field monitoring	Southport Field Monitoring
Sediment capture efficiency	Laboratory Test	Yes	Not relevant	Not relevant
	Quartz Powder	Not applicable, hydrocarbon only	Not applicable, natural sediments	Not applicable, natural sediments
	Specific PSD D ₅₀ = 63 microns	Not applicable, hydrocarbon only	No, natural sediments (D ₅₀ ~ 100 microns)	Yes, natural sediments (D ₅₀ ~ 40 microns)
	Inlet concentration 200 mg/L ± 5%	Not applicable, hydrocarbon only	No, mean TSS concentration much lower (35.2 mg/L)	No, mean TSS concentration much lower (21.6 mg/L)
Flowrates	Multiple flowrates based on catchment area	No, TFR tested as per BS/EN858	Yes, natural flowrates tested	Yes, natural flowrates tested
Flow Volume tested	10 exchanges	4 exchanges	Not relevant	Not relevant
Samples tested	5 pairs	Yes	Not relevant, multiple aliquots across event	Not relevant, multiple aliquots across event

5.1 Results Summary

Table 7 summarises the results from the Australian reports reviewed for this evaluation.

Table 7. Summary of Stormceptor/Puraceptor Australian testing

Testing Organisation	Testing	Location	Results
University of South Australia	BS/EN858 Hydrocarbon testing - Puraceptor	Lab, South Australia	<5mg/L effluent, 99% capture
University of the Sunshine Coast	Field testing, TSS evaluation - Stormceptor	Nambour, QLD	TSS - ER 83%, CRE 71%
Griffith University	Field testing, TPH & TSS evaluation - Puraceptor	Southport, QLD	TSS - ER 58% CRE 43% TPH - ER 92% CRE 67%

5.2 Discussion

The British CoP and Guideline were clearly formulated to provide a consistent, robust, repeatable laboratory protocol for evaluating sediment and heavy metal capture. The Australian testing of the Stormceptor/Puraceptor technology was completed prior to the release of these documents and therefore are unlikely to achieve full compliance with the CoP. Further, the UniSA testing was

completed according to BS/EN858 and was not required to test for sediment. Additionally, the Nambour and Southport programs were field monitoring programs, not laboratory tests, and could be considered more challenging than a laboratory evaluation since the influent concentrations were significantly lower than the target 200 mg/L.

As is typical of environmental field monitoring, both the Nambour and Southport datasets reveal high variability and the ER and CRE metrics for TSS & TPH reduction differ by more than 10%. In this case, the USEPA guidelines and Stormwater Australia SQIDEP recommend that the metrics be averaged. Therefore, the estimated metrics are tabulated below.

Table 8. Summary of Stormceptor/Puraceptor Australian testing

Testing	Results
BS/EN858 Hydrocarbon testing - Puraceptor	TPH - 99%
Nambour Field testing, TSS evaluation - Stormceptor	TSS - 77%
Southport Field testing, TPH & TSS evaluation - Puraceptor	TSS - 51%* TPH – 80%*

* Rounded

It is noted from the Guidelines to the CoP that estimation of the Mitigation Indices for hydrocarbons should be calculated using ~90% sediment-bound and 10% free phase, when considering the BS/EN858 testing, since it is primarily free phase hydrocarbons. Whilst this methodology may be conservative, we consider that the Southport field testing accommodates both sediment-bound and free-phase hydrocarbons. Therefore, we would be comfortable **recommending a TPH capture (Mitigation Index) of at least 80% (0.8).**

Whilst the average D_{50} from the PSD at Nambour was higher than the CoP target of 63 micron, the concentrations were also lower than 200 mg/L. Similarly, the Southport site had a lower D_{50} from the PSDs *and* lower average sediment concentrations. Subsequently, **we consider that the TSS capture rate is likely to be nearer 77% than 51%**, and that averaging this metric is likely to be overly conservative.

6 Summary

The *British Code of Practice (CoP) for the Assessment of Manufactured Treatment Devices Designed to Treat Surface Water Runoff* defines an assessment method that allows product manufacturers to measure the pollutant capture and retention capability. The intention of the CoP is to enable suppliers to declare those capabilities when the product is offered for sale in the United Kingdom (UK).

SPEL Stormwater have had the Stormceptor/Puraceptor treatment technology tested in Australia under laboratory and field conditions over many years. This technology is primarily designed to target hydrocarbons and sediment in stormwater.

This Peer Review considers the existing laboratory and field testing performed on the Stormceptor/Puraceptor against the CoP requirements and provides a recommendation of the performance that can be applied in the CIRIA SuDS Manual.

The CoP is clearly formulated to provide a robust, repeatable laboratory protocol to demonstrate capture of sediment and heavy metals. It is not clear on how field testing might be considered to

address the CoP requirements. This Peer Review evaluates the independent reports prepared for the SPEL Stormceptor/Puraceptor technology and considers their compliance, or otherwise, with the CoP.

This report finds that in many areas the field testing addresses the same parameters that the CoP is attempting to control, but may not be fully compliant since they cannot be controlled in the field. This report recommends the use of the following Mitigation Indices for the Stormceptor/Puraceptor technology **0.77 TSS, and 0.8 Composite Hydrocarbons**.

7 References

1. British Water, 2020, *Code of Practice: Assessment of Manufactured Treatment Devices Designed to Treat Surface Water Runoff*.
2. British Water, 2020, *How to Guide: Applying the CIRIA SuDS Manual Simple Index Approach to Proprietary/Manufactured Stormwater Treatment Devices*.
3. Griffith University, 2018, *Freedom Fuels Stormwater Treatment; Final Report*, Research Report No. 206.2, May 2018.
4. University of South Australia, 2010, *Performance assessment of the Puraceptor to BS/EN858-1:2002 "Separation systems for light liquids"*, July 2010.
5. University of the Sunshine Coast, 2015, *Field Evaluation of Stormwater Treatment Performance of the SPEL Stormceptor Installation at Nambour; Final Report*, 30 June 2015.