J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

BURNUM BURNUM WETLAND
INVESTIGATION OF UPSTREAM DRAINAGE SYSTEM

- DOCUMENT CONTROL SHEET -

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1 INTRODUCTION

This report summarises the investigations into the existing drainage network leading into the Spill Containment Basin/Wetland within Burnum Burnum Sanctuary and has been prepared in response to the concerns raised over its operational integrity. The existing upstream drainage network conveys runoff from the Woronora Bridge and its approaches, through Burnum Burnum Sanctuary and Wetland, and discharges it into the Woronora River (refer to Figure 1). Earlier investigations by J Wyndham Prince (JWP) into the functionality of the Wetland identified issues with the performance of the existing drainage network and recommended that the integrity of the structural elements of the upstream drainage network, be fully investigated. This report addresses those recommendations.

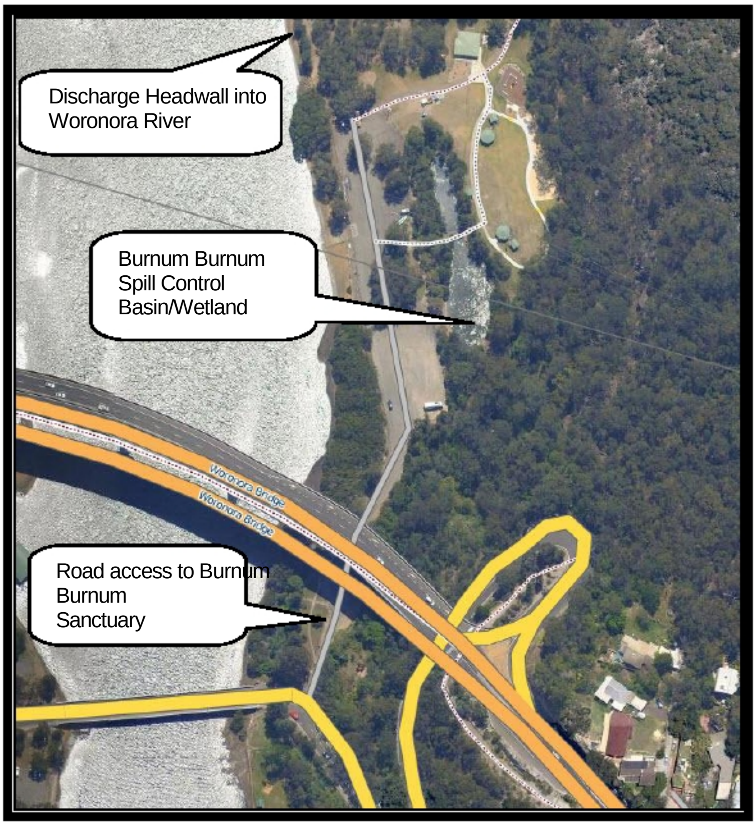

Figure 1 Site Location

Each structural element of the drainage network and its stormwater pollution controls, which have been constructed between the Woronora Bridge and Burnum Burnum Wetland by the Roads and Traffic Authority (RTA now Roads and Maritime Services), have been inspected (refer to Figure 2). The efficiency of the Diversion Pit and Weir (AG5), the Humegard™ (AB2a) gross pollutant trap (GPT) and the Humeceptor™ (AB3) oil & grit separator (OSG), have been investigated and recommendations have been made to rectify specific issues with each structure, where required.

An inspection of the Surcharge Pit (AB4) and bypass reinforced concrete box culvert (RCBC), adjacent to the Humeceptor™ (AB3) upstream of the wetland, were also undertaken. Options to improve their structural integrity and operation have been included.

A separate heading has been devoted to each of the elements within the drainage network. Pit identifiers have been taken from the RTA plans 0663.411.ED.0003 and the headings have been listed in order starting at the top of the drainage network beneath the Woronora Bridge and finishing at the lowest point in the drainage network at the Burnum Burnum spill control basin/wetland.

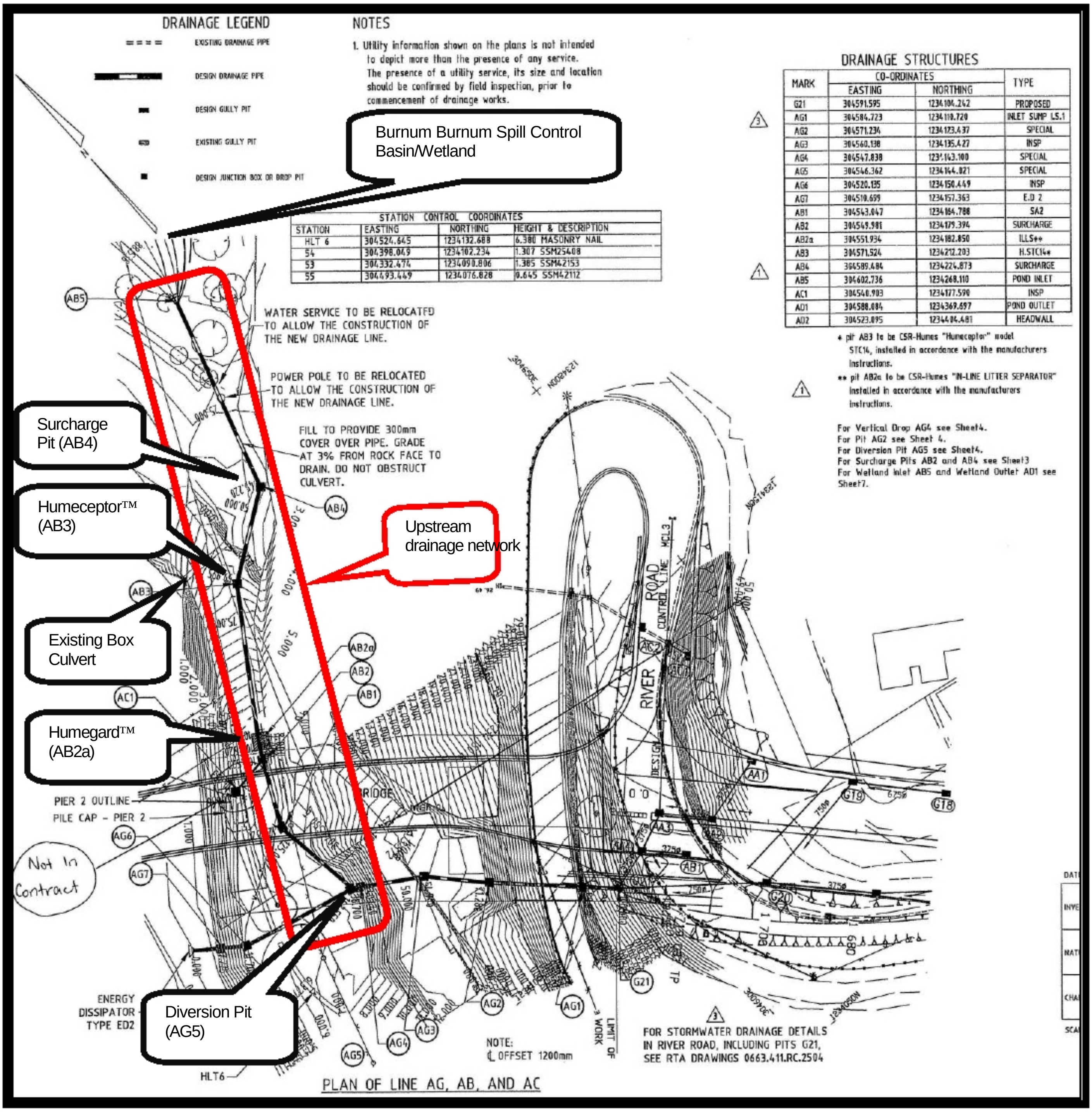

Figure 2 Layout of the Upstream Drainage Network

Adapted from Roads and Traffic Authority of NSW
Water Control Works Plans 0663.411.ED.0003, dated 23-9-98.

2 DIVERSION PIT AG5

To facilitate visual inspections of this pit, a change to the design of the lid to incorporate a grate rather than a sealed lid was suggested. However, the maintenance staff from Sutherland shire Council (SSC) can, without much effort, remove the existing lids using two (2) Gatic Long Handle Manhole Pit Lifters (refer to Photo 3).

Significant volumes of litter were observed adjacent to where the outlet from this pit discharges into the Woronora River. This suggests that the Diversion Pit may not be working as intended and may be diverting some of the low flows to the Woronora River, which would indicate that less volume of runoff is being diverted to the wetland than originally intended.

SSC organised an inspection of the Diversion Pit AG5 on Wednesday 18th January 2012 to confirm the integrity of the diversion weir and its operation. The SSC maintenance crew responsible for the area were present as well as representatives from JWP, and the engineering department of SSC.

The SSC maintenance crew removed the lid to the Diversion Pit and described a previous clean of the pit, which they had carried out concurrently with the commissioning of the Woronora Bridge. A significant amount of sediment was observed upstream of the diversion weir and extending into the low flow outlet, resulting in a shallow pool of standing water upstream of the weir. Pit lids and surrounds appeared to be intact. Free standing water was evident downstream of the weir, indicating a possible blockage in the line leading to the wetland (refer to Photo 4).

Recommended Actions

- CCTV scans of the low flow pipeline between AG5 and AB1 (undertaken on 23/1/12).
- Any sediment present in the pit and pipeline to be removed by SSC contractor using a high pressure jet of water and vacuum eduction during the CCTV inspection.
- Streamlining (channelised benching) within the invert and sides of the pit, upstream and downstream of the weir, to reduce the hydraulic losses through the pit, improve flow characteristic and prevent sediment build-up. Streamlining and benching should also occur within the Kerb Inlet Pit AB1 and the Junction Pit AB2.

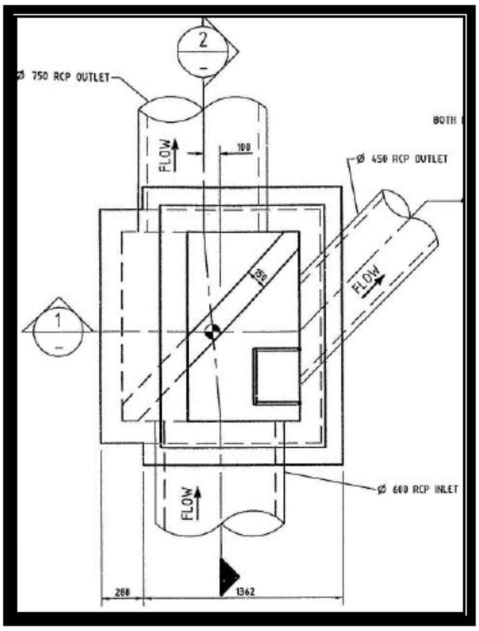

Figure 3 Diversion Pit AG5 (lid removed)

3 PIT AB2A HUMEGARD™ GROSS POLLUTANT TRAP (GPT).

Shown as an In-Line-Litter Separator on the RTA plans. However, these devices are now manufactured by Humes Pty Ltd, and this particular device appears to be a Humegard™ Model HG18. Dimensions are provided in the table below and on Figures 4 and 5.

*Table 6. Humegard™ dimensions and capacity**

Model HG	Overall with (m)	Pipe invert to Bottom of Concrete (m)**	Overall length	Total holding capacity (m³)
18	2.0	1.1	2.1	3
24	2.7	1.7	2.5	8
27	3.0	1.6	2.5	7
30	3.4	2.2	2.5	12
30A	3.4	1.9	2.5	11
35	3.9	2.0	2.5	12
40	4.4	2.0	2.9	16
35A	3.9	1.8	2.5	11
40A	4.4	1.8	2.9	14
40B	4.4	1.6	2.9	12
45	4.9	2.1	2.9	19
45A	4.9	1.9	3.2	19

Upon lifting the lid to access the device, which consists of a floating boom, storage/treatment chamber and screen, the concrete supporting the steel lid surround was observed to be failing with sections of the road pavement falling into the storage/treatment chamber.

The boom operates best when there is a slight backwater effect and the inflow velocities are less than about 1.5 m/s (estimated existing velocity 3.5 m/s upstream and 5.5 m/s downstream). The grade on the outlet pipe is in excess of 7%, which is not conducive to the formation of a backwater effect at the boom (refer to Photo 6).

A large sediment plume was observed immediately downstream of the boom and this needs to be removed as it may hamper the efficient operation of the boom (refer to Photo 7).

Further, a pipe was identified on the western side of the storage/treatment chamber which appears to be the outlet for the Woronora bridge deck drainage system (Pit AC1, Figures 2 and 9). This pipeline was originally intended to be connected to Junction Pit AB2 immediately upstream of the Humegard™ where its energy would be dissipated before entry to the Humegard™. The flows from this pipe are likely to impact adversely on the ability of the storage/treatment chamber to retain light litter and sediment and should be re-constructed to connect to Junction Pit AB2 as originally intended.

Some of the original construction formwork was also observed to be still in place and this material should be removed. Further, the concrete supports for the steel lid surround need to be repaired and these repairs could be carried out at the same time as the other works are undertaken (refer to Photo 8).

Recommended Actions

- Repair the pit lid and frame.
- Clean out the sediment accumulated around the boom and within the storage/treatment chamber.
- Remove the pipe from the Woronora bridge deck from the storage/treatment chamber and re-connect it to the upstream Junction Pit AB2.

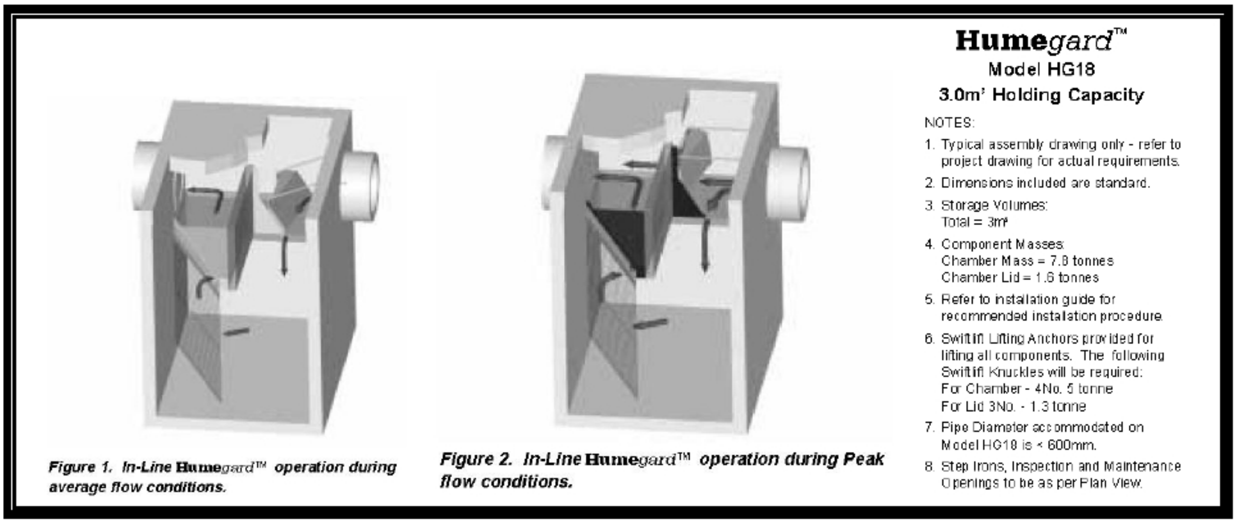

Figure 4 Humegard™ Model HG18 - Internal Workings

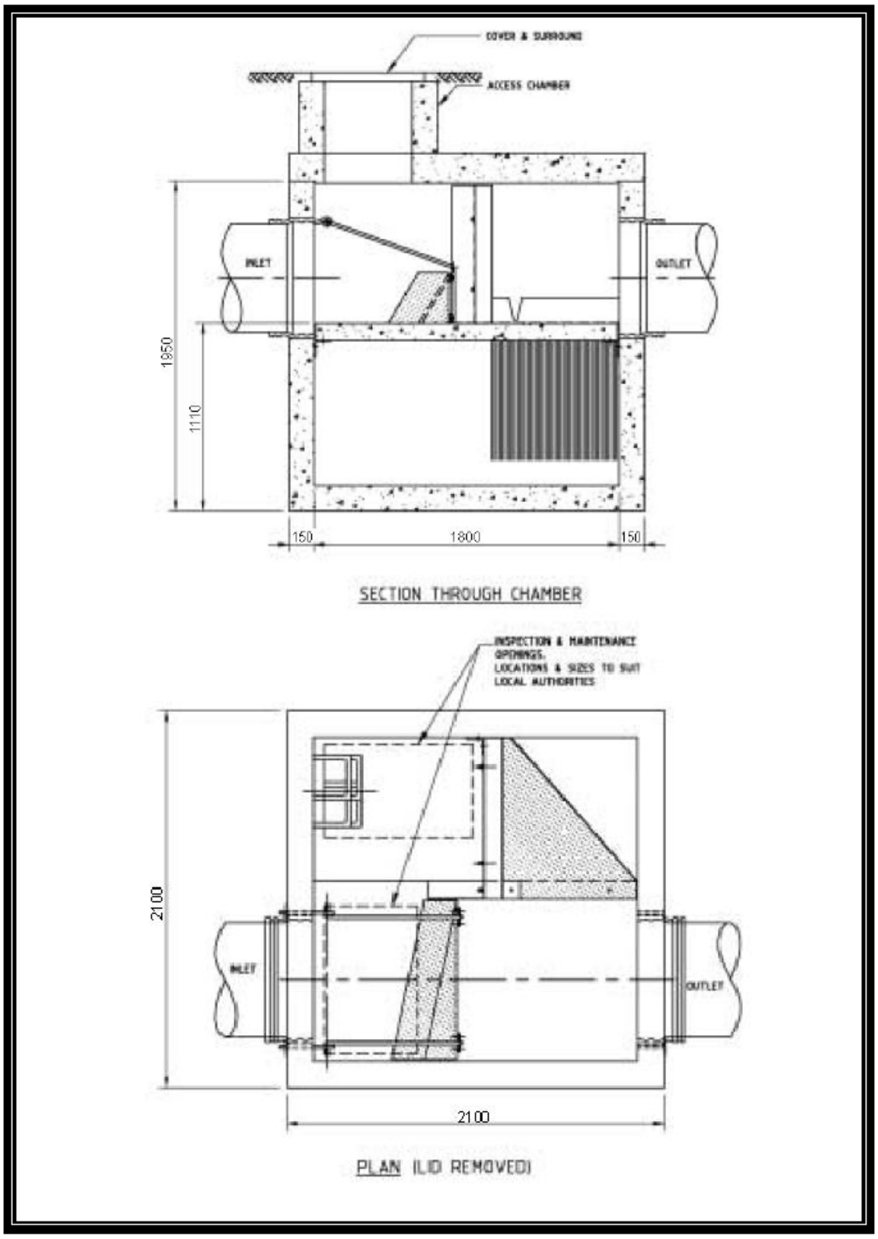

Figure 5 Humegard™ Model HG18 - Plan and Section

4 PIT AB3 HUMECEPTOR™ OIL AND GRIT SEPARATOR (OGS)

According to the RTA design plans, this Humeceptor ™ is an STC14 model, which is manufactured by Humes Pty Ltd. Refer to the table below for unit dimensions and details.

Table 2 – HumeCeptor® model range and details

HumeCeptor® model	Pipe diameter (mm)	Device diameter (mm)	Depth from pipe invert* (m)	Sediment capacity (m^3)	Oil capacity (l)	Total storage capacity (l)
STC 2 (inlet)	100 - 600	1,200	1.7	1	350	1,740
STC 3	100 - 1,350	1,800	1.68	2	1,020	3,410
STC 5			2.13	3		4,550
STC 7			3.03	5		6,820
STC 9		2,440	2.69	6	1,900	9,090
STC 14			3.69	10	2,980	13,640
STC 18		3,060	3.44	14		18,180
STC 23			4.04	18		22,730
STC 27			3.84	20	4,290	27,270

Note:
*Depths are approximate.

The Treatable Flow Rate (TFR) for an STC14 HumeCeptor™ is 30 L/s. However, the peak inflow to the Humeceptor™ is 550 L/s (1-year ARI per Sheet 2 RTA Plan 0663.411.ED.0003). The 3-month ARI (generally the target treatable flow rate for stormwater treatment measures) is estimated to be 290 L/s (extrapolated from the 1-yr ARI). Consequently the Humeceptor™, even if its inlet were not blocked, is unable to control the anticipated volume of oil and grit that would be generated by the upstream catchment during a rainfall event, within the catchment, that generated a depth of flow in excess of 200 mm within a 450 dia pipe (height of the diversion weir within the Humeceptor™).

Inspection of the Pit AB2 identified that the joint between the inlet pipe and the OGS had been compromised, allowing the ingress of tree roots which had subsequently blocked the orifice to the inlet drop pipe (refer to Photo 10). This blockage appears to have resulted in the inflows surcharging the diversion weir and by-passing the treatment chamber altogether.

Internal structural failures were also observed around the frame of the access lid.

Recommended Actions

- Repair the lid surround.
- Remove the tree roots.
- Repair the joint between the inflow pipe and the Humeceptor™.
- Initiate a routine (weekly) inspection regime of the Humeceptor™ (refer to Heading 8.3) and undertake dewatering and de-silting of the Treatment Chamber immediately following any rain event that generates runoff i.e. after a rain event of approximately 15 mm in 24-hours.

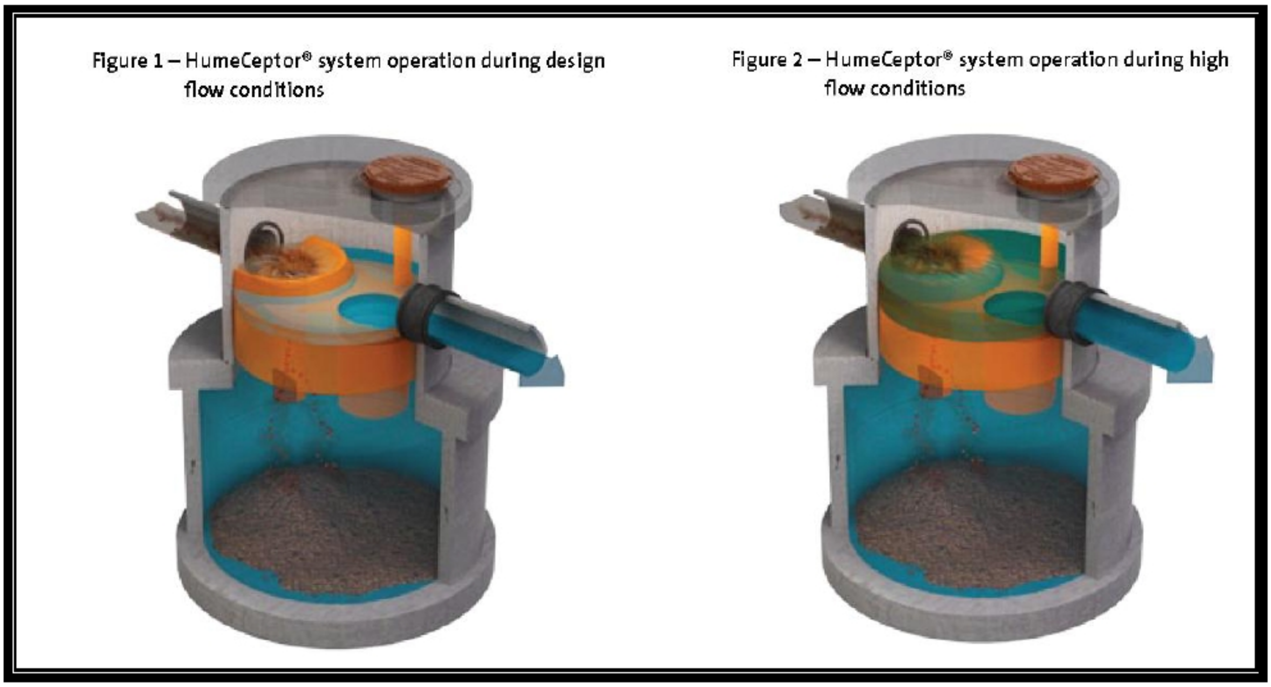

Figure 6 Humeceptor™ Operational Details

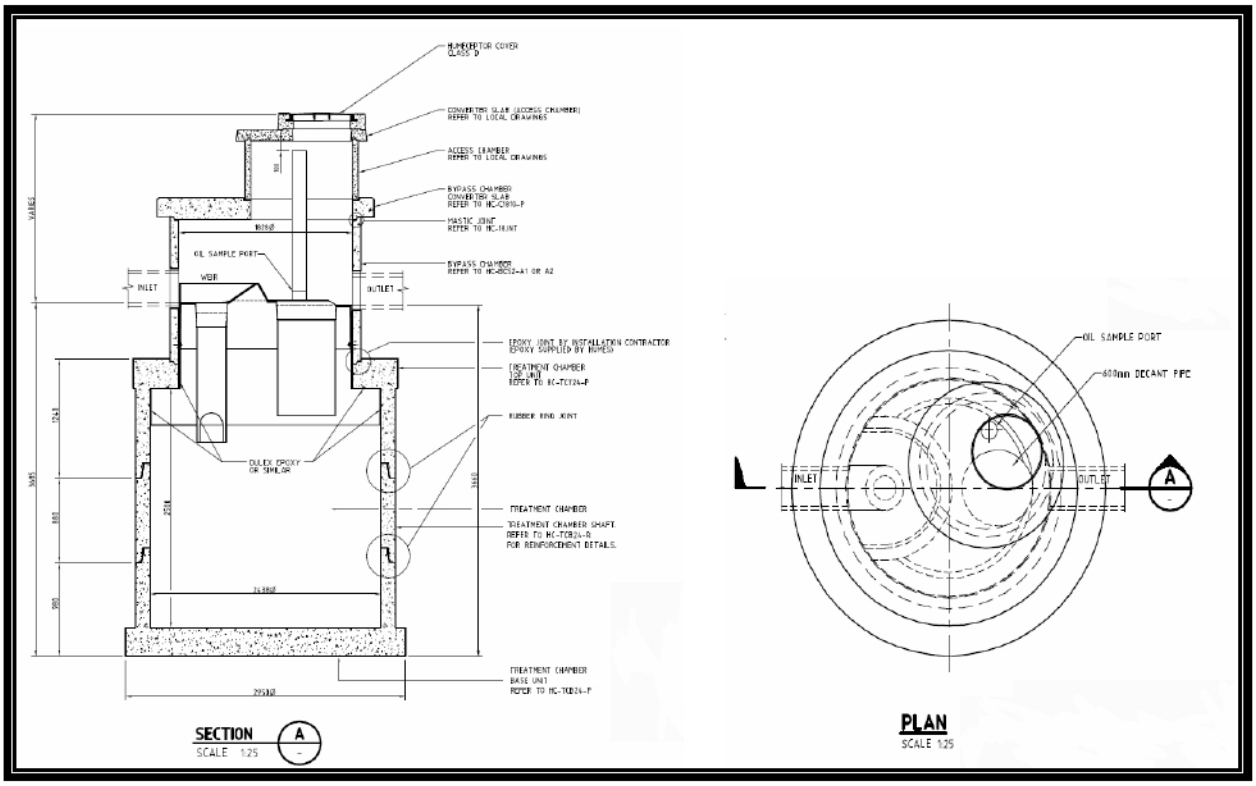

Figure 7 Humeceptor™ STC14 - Plan and Section

5 SURCHARGE PIT AB4 UPSTREAM OF WETLAND

Large volumes of litter and coarse sediment were observed surrounding this pit during the site inspections (refer to Photo 11). The site inspections were post recent storm events and it appears that the grate on the pit is lifting (not desirable) and surcharging large amounts of gross pollutants and coarse sediment. The drainage system has been designed to convey and treat a peak flow equivalent to the 1 in 1-year storm event, or 550 L/s. Consequently it must be assumed that this pit is surcharging at flows less than 550 L/s or more frequently that once every year.

Flows surcharged from Pit AB4, and overland flows from upslope of it, are currently diverted to an existing reinforced concrete box culvert (RCBC), located beneath the access road, and discharges directly into the Woronora River. The Draft Burnum Burnum Wetland Management Plan proposes to raise the entry to the RCBC, which would possibly divert more flow back towards the wetland.

Recommended Actions

- Undertake a detailed hydraulic investigation of the pit and drainage system to determine level of surcharge in comparison to access road levels and backwater effects from wetland.
- Undertake detailed design of modifications to Surcharge Pit AB4 increase flow to wetland.
- Discussions on site indicated that raising the top of the existing Surcharge Pit but keeping the grate slightly lower than the pavement level on the access road may allow more of the low flows to discharge to the wetland before surcharge at the pit occurs. The level for the top of the pit is critical and must allow sufficient head to develop within the Surcharge Pit thereby diverting the majority of the inflow towards the wetland, with the residual diverted to the box culvert without flooding of the access road. This may also require some localised site regrading to allow surcharge flows to enter the wetland via a depressed overland flow path and/or stabilization of the inlet to the existing box culvert.

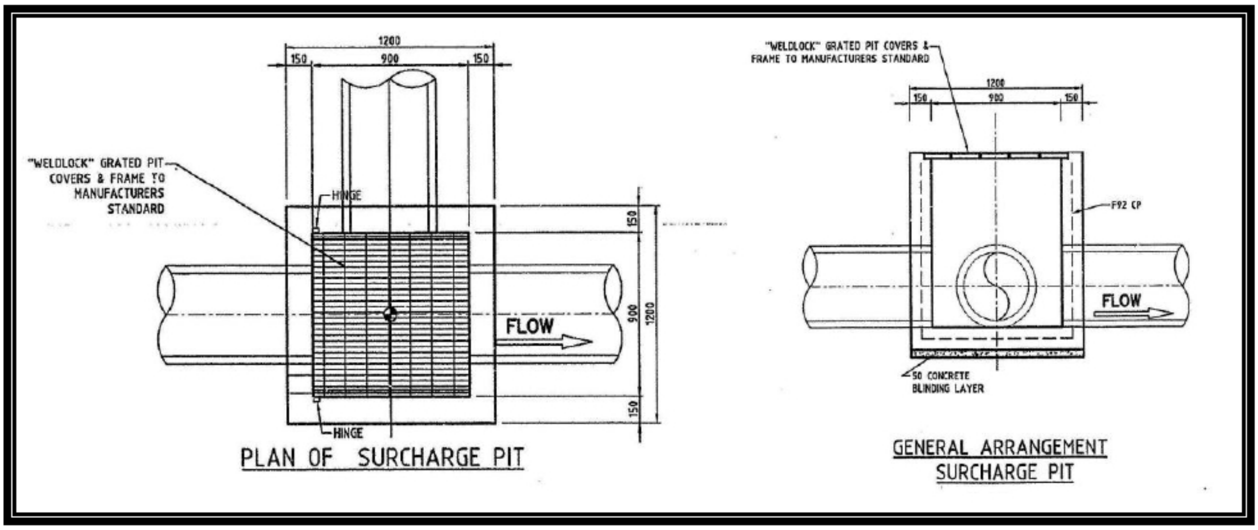

Figure 8 Details of Surcharge Pit AB4 and Junction Pit AB2

6 CONSTRUCTION VARIATIONS DIFFERING FROM THE ORIGINAL DESIGN

The site inspection has revealed that, rather than the drainage system from the bridge deck being connected to the Junction Pit (AB2), it is connected directly into the storage/treatment chamber of the Humegard™ GPT (AB2a).

The changes to the drainage system, made during its construction, have likely resulted in high velocity inflows to the GPT in a location that is likely to affect its ability to settle sediments and retain gross pollutants. Further, it is likely that the changed hydraulics will compromise the operation of the boom diversion system, and gross pollutants may be discharged downstream towards the Humeceptor™ (AB3) and Surcharge Pit (AB4), without being diverted into the storage/treatment chamber.

Action

- Remove the offending pipeline and re-connect it to Junction Pit AB2 as originally intended (refer to Figures 2 and 9)).
- Repair the inside of the storage/treatment chamber that has been compromised by the Woronora Bridge pipeline draining out of the Inspection Pit (AC1).
- Reinstate the pavement on the access road, and connect to the existing Junction Pit (AB2) upstream of the Humegard™ (AB2a).

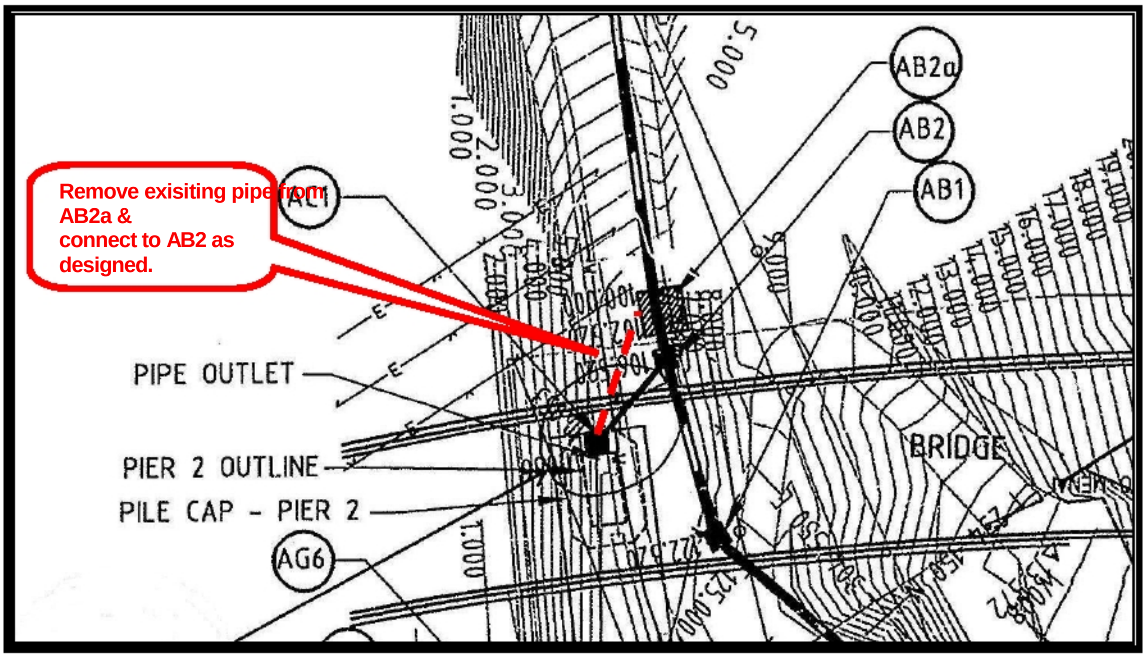

Figure 9 **Details of Drainage Line AC and Intended Connection to Junction Pit AB2**

7 RECOMMENDATIONS

Following are a list of recommendations aimed at restoring the operational integrity of the existing upstream drainage network and "treatment train" of stormwater pollution control devices:

- Removal of sediment upstream of the diversion weir;
- Streamlining of Diversion Pit AG5, upstream and downstream of the weir;
- Repair of the pipeline between AG5 and AB1 to ensure future blockages do not occur;
- Repair the pavement and frame supports in Pit AB2a;
- Clean out the storage/treatment chamber of the Humegard™ GPT within Pit AB2a;
- Remove the pipe outlet from the storage/treatment chamber of Pit AB2a and reconnect it to Pit AB2 as originally intended (refer to Figure 9). Remove any old formwork still within Pit 2a and ensure the proper operation of the boom diversion weir;
- Reinstate the pavement of the access road in the vicinity of Pits AC1, AB1 and AB2a;
- Repair the pavement and frame supports which allow access to the Humeceptor™ in Pit AB3;
- Remove the root mat blocking the inlet to the vertical dropper into the Treatment Chamber of the Humeceptor™ and repair the joints in the pipe system which have allowed their entry into the Pit AB3;
- Clean out the Treatment Chamber in Pit AB3;
- Clean up the rubbish in the vicinity of Surcharge Pit AB4;
- Raise the top of AB4 and reinstall its lid at a level that is 100 mm below the level of the lowpoint in the access road pavement adjacent to the existing box culvert crossing;
- Construct a depressed overland flowpath between the top of Surcharge Pit AB4 and the inlet to the wetland at headwall AB5 (refer to Figure 10);
- Formalise and stabilise the existing depression between the top of Surcharge Pit AB4 and the existing entrance to the box culvert crossing, which drains directly into the Woronora River (refer to Figure 10).

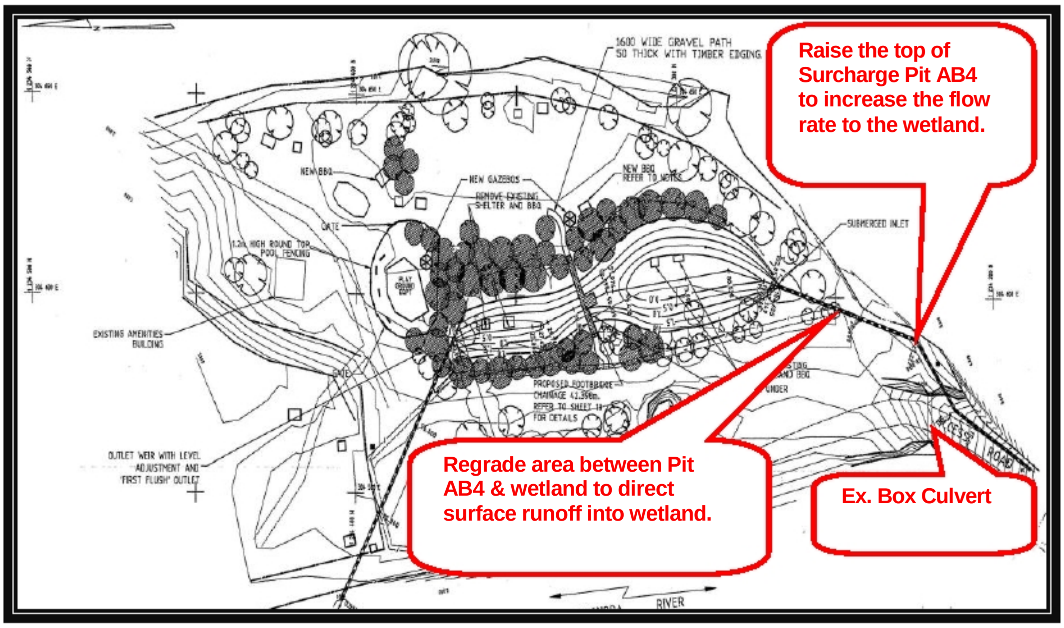

Figure 10
Plan Showing Recommended Actions in vicinity of Surcharge Pit AB4

8 INSPECTION AND CLEANING PROCEDURES

The following procedures have been prepared to assist in the long term cleaning and maintenance of each of the drainage and pollution control elements within the drainage network upstream of the Burnum Burnum Spill Control Wetland.

Where information on the cleaning of proprietary devices e.g. Humegard™ and Humeceptor™ are available, this information has been made relevant to the site with a link to the appropriate website included for reference purposes.

Prior to commencing any cleaning and/or maintenance work a Safe Work Method Statement must be prepared and accepted by Roads and Maritime Services.

8.1 Diversion Pit (AG5)

(Refer to Photographs 3 and 4)

The pit is located on the eastern side of the access road immediately south of the Woronora Bridge deck, at the base of the retaining wall that supports the eastern bridge abutment. There is unobstructed access to the top of the pit for the vacuum eductor truck and the pavement adjacent to the pit is of sufficient integrity to support the truck. Provisions for control of traffic using the access road will be required.

A 450 mm high concrete diversion weir has been constructed diagonally across the base of this pit to divert low flows towards the stormwater pollution controls and the Spill Control Wetland, before finally being discharged into the Woronora River to the north of the carpark.

The weir creates a drop in the energy of the inflows which can result in the larger debris being deposited upstream of the weir. This debris and sediment must be removed by vacuum eduction.

The lids to the pit are intended to be removed with the aid of two (2) Gatic Long Handle Manhole Pit Lifters. Once the lids are removed, access to the invert of the pit from the surface, is possible.

The pit should be inspected as part of the routine inspections of the other pits in the system i.e. at least quarterly (every 3 months) or until sufficient data on the deposition rates has been collected, to install confidence that a longer period is appropriate. The routine quarterly inspections will determine whether or not cleaning and/or any maintenance of the pit is required. However, once the streamlining works within the pit are complete, deposition should be minimal, and regular cleaning should not be required.

8.2 Humegard™ Gross Pollutant Trap (AB2a)

(Refer to Photographs 5 to 8)

The following information has been adapted from the Humegard™ Technical Manual and modified slightly to address the site specific constraints of the existing drainage network.

The unedited Humes manual is available at:

http://www.humes.com.au/en/precast-solutions/stormwater/stormwater-treatment/primary.html

8.2.1 Inspection

The Humegard™ GPT can easily be inspected from the surface by removing the maintenance covers using two (2) Gatic Long Handle Manhole Pit Lifters (refer Photo 3). The amount of floating solid waste can be easily viewed from the surface. Similarly, the depth of sediment can be measured from the surface using a sediment depth measurement device such as a survey stave of calibrated probe.

Any potential obstructions at the inlet or boom can be observed from the surface. The by-pass chamber floor has been designed as a platform for maintenance personnel in the event that obstructions need to be removed, stormwater flushing needs to be performed, or camera surveys are required. Normal safety precautions for confined space access must be followed whenever a person enters a Humegard™.

8.2.2 Cleaning Frequency

It is recommended that a six monthly cleaning frequency be adopted initially. This cleaning frequency may need to be increased or decreased based on the actual volume of solid material removed (i.e. if the storage volume is exceeded by solid waste more quickly than projected, cleaning may be required three monthly; conversely if loads are less than projected, the cleaning frequency interval may be extended).

To establish the required cleaning frequency, a regular level check of the volume of solid waste captured in the storage/treatment chamber every three months is recommended until such time as the anticipated loads can be confidently predicted.

- Sediment within the storage/treatment chamber should be removed before it is more than 500 mm deep or when it is within 2 m of the surface level of the pit, whichever comes first.
- Light litter should be removed at each inspection or before it completely covers the surface of the storage/treatment chamber, whichever occurs first.
- Free oil and hydrocarbons should be removed whenever they are observed floating on the surface of the storage/treatment chamber.

Cleaning of the sediment must be undertaken from the surface using Vacuum Eduction (refer to Photos 1 and 2), whilst removal of the floating light litter can be carried out using a long handled pool scoop.

8.2.3 Spills

Where the Humegard™ is subjected to oil or hydrocarbon spills, the device should be cleaned out immediately by a licenced liquid waste management company e.g. Total Drain Clean refer to Photos 1 and 2). The Regulatory Authority should also be notified in the event of a spill.

8.2.4 Disposal

Waste products collected in the Humegard™ should be removed by a licenced waste management company, and disposed of at an appropriate waste transfer facility.

8.3 Humeceptor™ Oil and Grit Separator (AB3)

(Refer to Photographs 9 and 10)

The following information has been adapted from the Humeceptor™ Maintenance Procedures and modified slightly to address the site specific constraints of the existing drainage network.

The unedited Humes procedures are available at:

http://www.humes.com.au/en/precast-solutions/stormwater/stormwater-treatment/secondary.html

8.3.1 Inspection Frequency

Inspections of the Humeceptor™ can be carried out from the surface by appropriately trained personnel or by a competent waste management company, experienced in the operation of the Humeceptor™.

The lid can be removed using a Gatic Long Handle Manhole Pit Lifter (refer Photo 3).

It is recommended that inspections of the Humeceptor™ be carried out following any rainfall event that generates runoff (i.e after approximately 15 mm of rainfall in 24-hours). This schedule may be relaxed when confidence is gained regarding the actual pollutant load being generated by the upstream catchment, and the rate at which the waste material accumulates in the device.

A more frequent inspection program may be required where there is greater risk of oil spills.

The need for maintenance can be determined by inserting a dipstick in the oil sample port and measuring the depth of oil that has been captured.

Similarly, the depth of sediment can be measured from the surface without entry into the Humeceptor™ through the use of a clear sediment sampling tube, which is inserted into the oil sampler port or the 610 mm opening in the floor of the inlet chamber (refer to Figure 7).

8.3.2 Recommended Cleaning Procedure

Cleaning of the Humeceptor™ is undertaken using vacuum eduction (refer to Photos 1 and 2), which negates the need for entry into the device and the need for compliance with Confined Spaces entry requirements.

During cleaning, oil is removed through the 150 mm oil sample port and sediment is removed through the 610 mm diameter outlet riser pipe. Alternatively, oil may be removed from the 610 mm opening, providing sufficient water is removed from the treatment chamber to lower the oil level to below the bottom of the inlet drop and outlet riser pipes.

Following is a step-by-step procedure for to clean the Humeceptor™ OGS:

- Check for oil (using a dipstick, tube or sampling device).
- Remove and store any anti-freeze oil separately using a small portable pump.
- Decant the relatively clean water from the central zone to either:
  - a) Sewer (requires prior approval from Sydney Water).
  - b) Upstream pipe i.e. the outlet from the Humegard™ GPT at Pit AB2a (position sandbags in the inlet pipe to create temporary storage).

- Remove the sludge/sediment from the bottom of the Humeceptor™ using the vacuum eduction equipment.
- Allow the Humeceptor™ to re-fill with water by removing the sandbag barrier across the inlet.

8.3.3 Cleaning Frequency

Due to the inability of the existing Humeceptor™ to adequately treat the estimated peak runoff from a 3-month rainfall event, it is recommended that it be cleaned after every rainfall event thet produces runoff (i.e. after approximately 15 mm of rainfall in 24-hours).

However, the cleaning frequency will vary depending on the volumes of stormwater pollution generated by the catchment (number of spills, amount of oil and sediment). Consequently, the cleaning frequency may be varied (increased or reduced) based on local conditions, pollutant loads and available storage capacity within the device. If the routine inspection reveals that the treatment chamber is filling more quickly than anticipated, cleaning will be required on a more frequent interval e.g. fortnightly; conversely, if the routine inspection identifies that there is redundant storage capacity within the treatment chamber, cleaning may be delayed. However, the interval between cleans should not exceed six (6) months.

Although, the Humeceptor™ will continue to operate effectively until sediment completely fills the treatment chamber. Good practice and the efficient operation of the device, requires that cleaning should be performed „once the sediment depth exceeds the guide line value" provided in the following table, and/or after 15 mm of rainfall in 24-hour whichever occurs first.

Sediment Depths Indicating Maintenance

Model	Sediment Depth (mm)
14	700

Potential obstructions at the inlet can be observed from the surface (refer to Photo 10). To facilitate access to such obstructions, the fiberglass insert has been designed for use as maintenance platform, to allow for the removal of any obstructions by hand, or flushing of the pipeline, or carrying out a CCTV camera survey. Where entry to the device is required compliance with Confined Spaces Entry requirements must be observed

Solid and liquid waste must be removed from the treatment chamber before: sediment reaches a depth of 700 mm or rises to within 4.5 m of the surface, whichever comes first.

8.3.4 Oil Spills

The Humeceptor™ OGS should be cleaned immediately after any major spill occurs by a licensed liquid waste contractor. The appropriate regulatory agencies must be notified in the event of a spill and the liquid waste disposed of at an appropriately accredited liquid waste facility. The available positively buoyant storage volume is approximately 3 m^3, which equates to a depth of approximately 300 mm of liquid waste on top of the stored water, within the treatment chamber. Consequently, any positively buoyant waste must be removed before it achieves a depth of 300 mm, which can be measured with a dipstick or sampling tube, during the routine inspections.

8.3.5 Disposal of material removed from the Humeceptor™

Testing of the sediment, to determine the presence of any contaminants, will be required before an approval can be issued for it to be disposed of in landfill.

All petroleum waste-products, collected in the Humeceptor™ (oil/chemical/fuel spills), should be removed and disposed of by a licenced waste management company at an appropriate liquid waste disposal facility.

8.4 Surcharge Pit (AB4)

(Refer to Photographs 11 and 12)

Large amounts of debris and sediment have been deposited in close proximity to the pit. This material has been transported from higher in the catchment, conveyed within the pipe network through the Humegard™ GPT (AB2a) and the Humeceptor™ OGS (AB3), to be surcharged at pit (AB4). Its deposition adjacent to the Surcharge Pit, demonstrates the inability of the upstream stormwater pollution control devices to adequately control the runoff from the Woronora bridge.

Surcharge Pit (AB4) should only surcharge in large runoff events. However, it would appear that it is surcharging in smaller events, which results in less runoff entering the Spill Control Wetland, and a reduction in the anticipated flushing of this wetland.

Reconstruction of the pit to a higher level should provide more regular inflows to the wetland which is hoped to increase water circulation and flushing and prevent stagnation.

8.5 Recommended Inspection and Cleaning Frequencies

Following is a table summarising the recommended inspection and cleaning referred to under the preceding headings.

Summary of Recommended Inspection and Cleaning Frequencies

Pit Identification	Inspection Frequency	Cleaning Frequency	Comments
Diversion Pit AG5	3-month	Based on Inspection	Streamlining and benching of the pit and the removal of the blockage in the downstream pipeline is expected to overcome the existing sedimentation issues.
Humegard™ GPT AB2a	3-months	6-months	Inspections average every 3-months. However, cleaning frequency is dependent on the volume available in the storage/treatment chamber, which is to be determined during the routine inspections.
Humeceptor™ OGS AB3	After rainfall	After 15 mm of rainfall	Device undersized for 3-mth flows and must be cleaned after each rainfall to ensure it is operational for next event.
Surcharge Pit AB4	3-months	6-months	Operational status of this pit is dependent on the upstream controls being maintained.

8.6 Conclusions

The operational integrity and effectiveness of the stormwater treatment control within the drainage network (Line AB refer to Figure 1), which discharges runoff from the Woronora bridge to the Woronora River, through the Burnum Burnum Sanctuary and Jannali Reserve is dependent on each element of the "treatment train" (treatment devices arranged in series each targeting a specific pollutant) being operational at the time that the runoff from the bridge deck commences. This can only be achieved if each device has been installed as originally designed, is regularly maintained and cleaned, and is fully operational for the duration of the runoff event.

Without restoring the upstream drainage network to its original design status and ensuring that it is fully operational as specified by the manufacturer the degradation of the Burnum Burnum spill control basin/wetland will continue. However, it is our opinion that carrying out the restoration, maintenance works, and undertaking the recommendations referred to herein, will substantially alleviate the current stagnation and algal bloom issues experienced in the wetland.

- PHOTOGRAPHS -

Vacuum Eduction Equipment

Photo 1 - Vacuum Eduction Truck

Photo 2 - Cleaning an Underground GPT

Diversion Pit AG5

Photo 3 - Removing the Lid from Pit AG5

Photo 4 - Debris & Sediment within Pit AG5

Humegard™ GPT Pit AB2

Photo 5 - Humegard™ and Junction Pit AB2

Photo 6 - Litter & Boom inside Humegard™

Humegard™ GPT Pit AB2 (Continued)

Photo 7 - Sediment Downstream of Boom

Photo 8 - Structural Defects around Frame

Humeceptor™ OGS Pit AB3

Photo 9 - Humeceptor™ OGS Pit AB3

Photo 10 - Inlet Blocked by Tree Roots

Surcharge Pit AB4 and Inlet to the Existing Box Culvert

Photo 11 - Surcharge Pit AB4

Photo 12 - Inlet to Existing Box Culvert