CDS® UNIT TECHNICAL SUMMARY

CAPABILITIES

The CDS® Unit is the most awarded stormwater treatment device. CDS® pioneered the first gross pollutant trap in Australia in 1995 and since then the vast amount of validation and testing performed in Australia and overseas has led to both local and international leadership. Rocla Water Quality has a highly skilled design team devoted to improving stormwater quality. This dedication has made the CDS® Gross Pollutant Trap (GPT) the most efficient, cost effective and easy to clean GPT on the market.

Some the key parameters of the CDS® Units are summarised below;

Features	Benefits
Continuously Deflective Screen	- This insures the screen does not block. - Screens don't require cleaning or maintenance.
Vortex force	- The vortex aids the screen cleaning and draws the waste into the centre and down to the storage sump away from the treatment area.
Screening Chamber	- The sheer plane created by the screen between the vortex flow action keeps the screen clear of trapped pollution to ensure continuous and max treatment performance. - The flow regime in the screening chamber avoids re-suspension and wash-outs of stored pollutants.
Optional Maintenance Procedures	- Can be fully isolated from flow. - Doesn't require confined space entry. - Choice of the most effective cleaning process for the application.
Fixed weir	- Guarantees maximum treatment flow is diverted into screening chamber including all neutrally buoyant material.
Design Service	- Life cycle cost analysis. - Installation supervision. - Stormwater quality assessment. - Complete hydraulic assessment.
Continuous field validation.	- Provide design information for industry on the ability of CDS® Units to meet the latest developments and future demands in stormwater quality.
Design Flexibility	- Can customise designs to suit most applications.
Off-line storage	- Does not allow stored waste to be re-suspended. - Keeps the storage area isolated from the screening area, allowing for continuous and maximum treatment.

TECHNOLOGY

The CDS® Unit utilises the energy of the inflow to create a vortex flow regime within the CDS® screening chamber.

The stormwater inflow is introduced tangentially to the screening chamber via a customised inlet chute. The vortex motion within the screen chamber provides a continuous circular flow that directs the pollutants away from the screen towards the centre. This low energy zone is where most of the pollutants lose buoyancy and sink into the storage sump below.

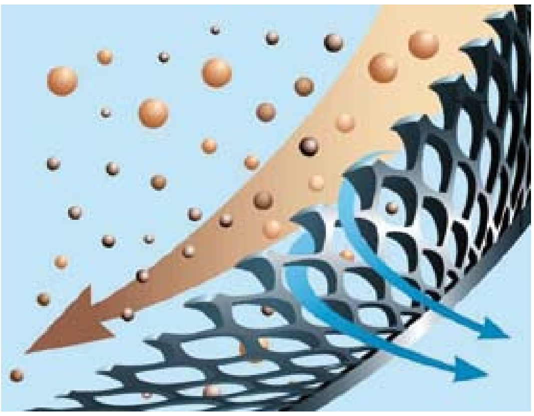


Figure 1: CDS® Unit deflective screen operation

The specially designed deflective screen shields the apertures from the pollution in rotational flow, which improves treatment operation and performance efficiency (as shown in Figure 1). The screen design along with the tangential flow and vortex forces provides all the benefits of a vortex separator and a physical filter without their limitations.

The CDS® Unit simply creates a whirlpool that draws all the deflected and settling pollutants to the centre of the screening chamber where they fall out into the storage sump below.

The pollutant storage sump located below the screening chamber allows pollutants to be removed from the flow path and away from the screens, thus maintaining a reliable treatment efficiency.

The unique CDS® technology is the most reliable way to effectively and efficiently treat gross pollutants in stormwater drainage systems.

FEATURES

The standard CDS® Unit design incorporates the key features shown in Figure 2.

Flexible Diversion chamber:

CDS® Units can be installed on pipe, culvert and open channel drainage systems.

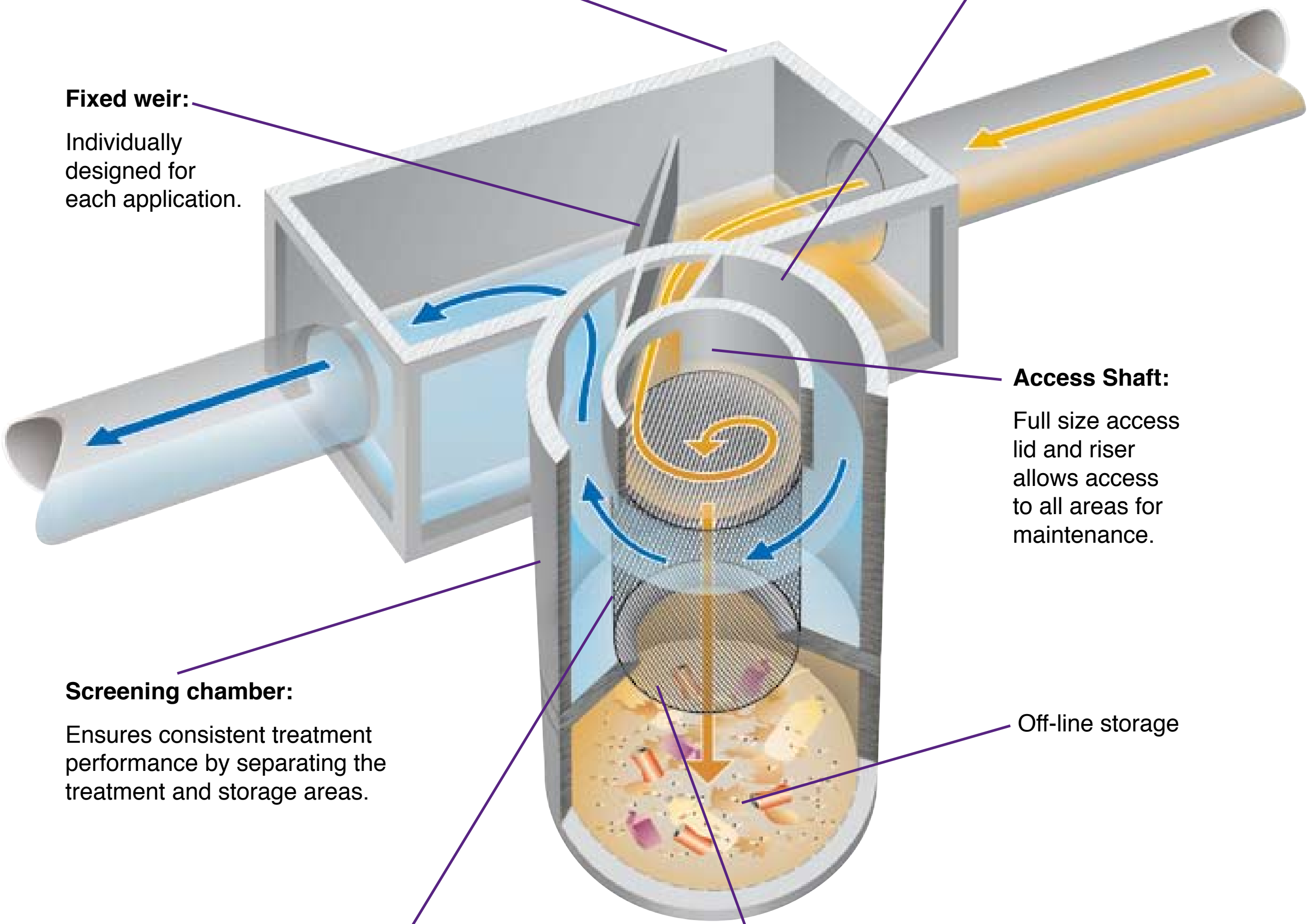
Every diversion chamber is designed to safely by-pass maximum flows.

Diversion chamber can be supplied as precast chambers, slab chambers or box culverts.

Off-line treatment

Fixed weir:

Individually designed for each application.



Access Shaft:

Full size access lid and riser allows access to all areas for maintenance.

Screening chamber:

Ensures consistent treatment performance by separating the treatment and storage areas.

Off-line storage

Deflective screens

Optional Removable Basket:

Flexible storage options allow the most economic and effective maintenance solutions to be utilised.

Figure 2: Key features of CDS® Units

CDS® UNIT PERFORMANCE

Since the inception of CDS® Units, performance has been the highest design imperative. The performance of CDS® Units has been an integral part of shaping stormwater quality standards worldwide. CDS® Units confidently achieve stormwater quality benchmarks even when markets can be focused on less important aspects of stormwater treatment. CDS® Units provide asset owners a high level of trust in stormwater treatment effectiveness and reliability. They can consistently achieve the following stormwater quality parameters:

CAPTURE EFFICIENCY

The screens in a standard CDS® Unit have a 4.7mm aperture, however, due to the deflective nature plus the vortex motion, 95% of material down to 1mm is captured. Although CDS® Units are designed as GPTs it is common to capture high volumes of particles less than 1mm as well. The specific pollutant groups targeted by a CDS® Unit are described following:

Gross pollutants (>5mm)

As per Allison 1996, "Field monitoring suggests that CDS® Units are efficient gross pollutant traps. During the 12 months of monitoring, practically all gross pollutants transported by the stormwater were trapped by the CDS® device".

As per CRCCH 1999 "The CDS® Unit can remove nearly all gross pollutants and a significant proportion of finer pollutants, particularly during storms".

As per CSIRO 1999: Circular Screens (CDS®) were the only category (device) to rate a Very High performance of over 90%. All other devices failed to meet this standard.

Fine particles

As per Portland State University 2002: "the experimental results show that the CDS® Unit generally removed over 95% of particles greater than 215 microns with screen apertures of both 2400microns and 4700 microns."

As per Sansalone Summary 2004: "the CDS® Unit was trapping over 90% of particles down to 75 microns." Also, capture of this particle size range was noted to contain approximately 80% of the heavy metals.

Suspended solids (excluding everything >1mm)

The common definition of Total Suspended Solids (TSS) excludes particles greater than 1mm. In accordance with this, TSS removal rates of CDS® Units exclude gross pollutants, organics, coarse sediment and any particles greater than 1mm. But most importantly the TSS removal rates of CDS® Units have been consistently field validated.

As per Sansalone Summary 2004: there was a notable net removal of particles less than 75 microns by the CDS® Unit. NJCAT removal of 49% TSS (better than any other GPT).

As per CRCCH 1999: "The CDS® trap removes a considerable amount of TSS above background concentrations during storm events, with a mean removal efficiency of approximately 70%".

As per Brevard County 1997: "Monitoring has shown the CDS® Unit has provided an average 52% removal efficiency for total suspended solids".

It is worth noting that devices which store Total Suspended Solids (TSS) in the treatment chamber are highly susceptible to re-suspension and loss.

Nutrients (Phosphorus)

Nutrient removal rates of CDS® Units show a correlation with sediment removal. Independent validation shows insoluble nutrient forms such as Phosphorus (P) are also reliably captured.

As per Brevard County 1997: "Monitoring has shown the CDS® Unit has provided.… 31% removal efficiency for phosphorus".

CRCCH 1999: "The CDS®… consistently retains TP, thought to be because P is in particulate form, with a mean removal efficiency of approximately 30%".

Sansalone Summary 2004: "There was a nett positive removal for TP for all events, with an averaged removal of over 30%".

Oil grease retention

As with nutrient capture there is also a high correlation of oils and grease removal with sediment capture in CDS® Units.

UCLA have reported 50-80% of oil and grease may be attached to sediments.

Hoffman 1982: "Our data confirm the observations of the workers in that hydrocarbons are primarily associated with particulate material (83 – 93%)".

CRCCH 1999: "Colwill found 70% of oil and approximately 85% PAH to be associated with solids in stormwater. That study subsequently demonstrated that over a period of dry weather conditions, increasing concentrations of oil become associated with particulates with the highest oil content found in the sediment range of 200μm to 400μm.

CSIRO 1999: In the category of "attached pollutants" CDS® Units were the only GPT device to even be considered capable of capturing anything.

CDS® Units can also capture free floating oil spills. However, when most of the oil is associated with fine particulates and sediments, CDS® Units remove very high levels of oils and greases due to their very high capture rate of those fine particles. Further information on oil removal can be provided upon request.

CAPTURE PERFORMANCE SUMMARY

A summary of the CDS® Unit performance parameters is outlined in Table 1 below;

Pollutant / Items	Removal Efficiency	Independent Reference Source
Suspended Solids (TSS)	70 %	CRCCH Report 99/2 Feb 1999
Total Phosphorous (TP)	30 %	CRCCH Report 99/2 Feb 1999
Total Nitrogen (TN)	0 %	Scattered results
Gross Pollutants (>5mm)	98 %	CRCCH Report 98/3 Apr 1998
Sediments>0.215mm	95 %	Portland State Uni, Oregon Oct 02
Fine sediment> 75 microns	90 %	Louisiana State University 2004
Heavy Metals	80 %	Louisiana State University 2004
Hydrocarbons, Oils & Grease	82-94 %	UCLA Report 1998

Table 1: CDS® Unit performance summary

ENVIRONMENTAL IMPACT

Anaerobic breakdown is a natural process involving the decay of organic material in drainage pipe systems. However, conventional treatment design practice prefers this process to occur in the CDS® Unit rather than the downstream drainage system. This way the decaying pollution can be more cost effectively controlled and removed from the stormwater system.

Dry sump treatment options do not remove the silts and finer sediments that contain higher stormwater contaminant loads. Therefore these treatment options do not contain the decaying process of these more volatile stormwater contaminants resulting in a less cost effective pollution removal and less environmental benefits.

The ability of the CDS® Unit to remove both coarse and fine organic material results in much better environmental and more cost-effective pollution removal gains.

The volume of a wet sump GPT is very minor in comparison to the volume of water in any one storm event. This means that together with the dilution and aeration of water in the GPT during a storm event the impact of water on a receiving stream would typically not even be measurable. Furthermore the odour generating potential of stormwater is minimal and no odour can be detected outside the CDS® Unit under normal conditions. More information on this subject can be provided upon request.

HYDRAULIC IMPEDANCE (HEAD LOSS)

Rocla Water Quality can provide hydraulic assessment for each project in order to ensure the hydraulic grade line (HGL) remains below ground level for the design storm event. If the HGL is determined to be approaching surface level, multiple options to avoid or minimise this situation are available. The worst case headloss condition is always used in hydraulic assessments of CDS® Units. The worst case K factor of a CDS® Unit is 1.3, which is equally the lowest validated K factor for a stormwater treatment device.

INDEPENDENT (MOSTLY UNSOLICITED) TESTING AND VALIDATION STUDIES OF CDS® UNITS HAVE BEEN PERFORMED BY:

- Allison, 1996
- Wong, 1997
- Brevard County, 1997
- Water Resources Management, 2003
- Cooperative Research Centre for Catchment Hydrology, 1999
- Monash University,
- Portland University, 2002
- Louisiana State University, 2004
- University of California LA
- University of NSW
- NSW Environment Protection Authority, 1997
- Willoughby Council
- Brisbane City Council
- Thiess Environmental Services

Full copies of any of the reports mentioned above are available upon request.

CDS® DESIGN

DESIGN PRINCIPLE

The design of a CDS® Unit for a specific catchment involves numerous parameters and is generally divided into two main steps. The first step in determining the suitability of a specific CDS® model is to consider the catchment and pollution load and the second is a hydraulic assessment.

STEP 1: Catchment Parameters and pollution load

The first step includes considering the following parameters:

- Catchment area;
- Site location and depth to invert;
- Tidal influence or other backwater influence;
- Treatable flow and its relation to the volumetric treatment efficiency;
- Target pollutants and land use;
- Treatment performance;
- Expected pollution loads; and
- Storage volume to minimise lifecycle costs.

Sometimes these parameters have competing project priorities and compromises are required. The CDS® Unit design can account for these and still provide high quality quantifiable treatment outcomes.

However, the CDS® Unit is generally sized on a flow volume basis, therefore the design aim is to treat a sufficient volume of the annual flow and remove a sufficient amount of pollution to meet a project's requirements.

The flow volume is based on the CDS® Unit having a reliable treatment flowrate which in turn means that the CDS® Unit will treat this flowrate in all events. The flowrate can be relied upon because of the Non-blocking functionality of the CDS® screen and the separate treatment/storage zones which provides the ability to treat runoff continuously. Thereby ensuring the stated pollution load is removed from the drainage system.

The patented CDS® Unit offers the most reliable treatable flowrate of any GPT because of these two unique design features. Very high volumetric treatment efficiencies are maintained consistently by lowering the likelihood of blockages as well as treating and storing stormwater pollutants in separate zones.

When using MUSIC modeling the treatment efficiencies of the CDS® Unit provides the highest integrity and most reliable design for stormwater quality treatment. Therefore no safety factors need to be applied to CDS® Unit treatment performance data shown in Table 1.

STEP 2: Hydraulic Analysis

Once a suitable CDS® model has been chosen for the catchment, step two is undertaken, the hydraulic analysis. This step determines whether the CDS® model chosen based on catchment and pollution characteristics will suit the hydraulic capacity of the drainage system. This step will also determine the most suitable position of the CDS® Unit.

Due to the headlosses involved with treating stormwater through any GPT, a weir needs to be installed in the drainage system to divert flow and maintain an energy level difference between the upstream and downstream side of the treatment device. Hydraulic weirs and floating weirs do not provide reliable flow diversion, therefore Rocla Water Quality prefer fixed weirs as best practice.

The hydraulic analysis takes the following important hydraulic parameters into consideration:

- The existing capacity of the drainage system (either closed or open system);
- Physical parameters of existing drainage system such as pipe or channel size and grade etc;
- Tidal influence or other backwater influence;
- Design flow of the system (Q20 or similar);
- Flow velocity;
- Flooding at the site; and
- Other site constraints or opportunities such as multiple pipes, drops, bends or multiple outlets for stormwater harvesting.

Rocla Water Quality uses a variety of design tools to determine the impact on the chosen site of any proposed CDS® Unit. The tool chosen will depend on the drainage system characteristics such as whether or not the system is open or closed and the geometry of the system.

Generally, Manning's equation is used to determine the capacity of the system if sufficient information on drainage geometry and grade is available. In open channel systems, HEC-RAS can be used to determine hydraulic capacity if sufficient information is available to create a reliable model.

The CDS® Unit diversion weir chamber and weir can function in three general ways, these are:

1. Free weir
2. Submerged weir
3. Orifice

It should be noted that Rocla Water Quality utilises the most conservative approach when calculating the depth of water flow over a weir. Sound hydraulic theory and analysis is used to assess proposed CDS® Unit installations on drainage systems. This ensures that it has been designed with sufficient bypass for the capacity or other nominated design events at the location of the weir.

Rocla Water Quality also has the option of using a lower weir with a twin unit arrangement, drop weirs, collapsible weirs, super collapsible weirs, and flume weirs. Where possible the use of moving parts such as a collapsible weir is avoided. Rocla Water Quality do not use hydraulic weirs or weirs incorporating assumptions on kinetic energy since these have proved false and unreliable in the field.

The diversion chamber design assumes that the CDS® Unit has not been maintained and that all flow must divert over the weir. This is the worst case design condition and this K factor of 1.3 for the CDS® Unit is one of the lowest available.

CONSTRAINTS

For any given site, the opportunity to treat the stormwater could be limited by a number of factors, these include:

- Site hydraulics
- Velocity impact
- Tidal or backwater levels
- Access for construction, and/or ongoing maintenance
- Geotechnical considerations such as rock, water or acid sulphate soils
- Physical obstacles such as property boundaries, roads, services, etc
- Budgetary limitations

When any of these factors are prevalent, Rocla Water Quality has more options and solutions than any other proprietor, and always consults with the Designer to find a solution. This can commonly require some compromises, but ultimately it will offer the most cost effective solution for any given site. It is often recommended to visit proposed GPT sites to canvas all available options in consultation with clients.

Following is a list of the more common CDS® Unit design options available;

- Multiple pipe configurations
- Bends and drops
- Various weir options (as per above)
- Extended inlets
- Tidal units with dual inlets
- Stormwater harvesting units with dual outlets
- Pump-down units (dry trap)
- Ex-filtration units (dry trap)
- Sump options (width and depth)
- Baskets
- Screen sizes
- Oil baffle volumes
- Multiple lid options
- Low flow polishing device (upflow media filter at CDS® Unit outlet)
- Multiple cleaning options
- Incorporation of penstocks and drop boards
- Exclusion bars
- Multiple CDS® Unit arrangements

DESIGN CERTIFICATION

CDS® Units have no moving parts, and are manufactured from tough corrosion resistant materials.

A operational life of 50 years for the 316 grade stainless steel and 80 years for the concrete could be expected under standard operating conditions.

The pre-cast concrete components of CDS® Units comply generally with the following Australian Standards, where relevant:

- **AS3600-2001** Concrete structures
- **AS3725-1989** Loads on buried pipes
- **AS3996-1992** Metal access covers, road grates and frames
- **AS4058-1992** Precast concrete pipes (pressure and non-pressure)
- **AS5100.2-2004** Bridge design, Part 2: Design Loads
- **AS5056-2005** Polyethylene and polypropylene pipes and fittings for drainage and sewer applications.

By following these Australian Standards requirements structural integrity is ensured. Additionally, CDS® Units are not affected by ground water buoyancy effects.

Rocla Water Quality have extensive technical resources supporting the CDS® Unit product range. Each model is supplied with a technical drawing including weights and dimensions, or a site specific design usually encompassing a set of drawings, and we provide a comprehensive installation instruction and maintenance manual for each unit. Standard CDS® Unit drawings are available upon request.

CDS® Units can be modified to suit applications. Sump storage sizes are listed on technical drawings. Penstocks, dewatering options, baskets and a variety of diversion options are available on request to suit virtually any application. These modifications are designed by the Rocla Water Quality design staff to ensure peak hydraulic performance, maximum maintenance and cleaning periods and flood risk elimination.

CDS® UNITS INSTALLATION

This information is provided as general guidance to assist with the installation of CDS® Unit Gross Pollutant Traps.

It is the purchaser's responsibility to ensure that installation work is carried out by competent tradespeople in accordance with all relevant drawings, codes of practise, legislation and regulations.

MODEL IDENTIFICATION

2018 L

20	18	L
The Screen Dia is 2.0 metres	The Screen Height is 1.8 metres	The Circular Treatment Chamber is to the LEFT of the pipe or channel

Check that the CDS® Unit model supplied is that which is specified on the project drawing and that the relevant Rocla Water Quality Operation and Maintenance manual has been provided.

INSTALLATION SUMMARY

CDS® Unit models generally consist of two main sections, the Diversion Chamber which is on line (in relation to the drainage system), and the treatment device which is off line and situated to one side of the diversion chamber.

However, for the P0506, P0708 and P0708 MAXI CDS® Unit models the diversion chamber is an integral part of the CDS® device. Hence there is only one section for these models.

When provided, the diversion chamber may be configured in several different ways for which there are separate guides. The customer should refer to the specific project drawings provided for detailed advice on these options.

The following is a general outline of the construction procedures and relevant reference literature;

ORDER	WORK PROCEDURE	REFERENCE
1	Site works and set out	CDS® Unit Model Operation & Maintenance manual
2	Excavate for CDS® Unit	
3	Construct CDS® Unit	
4	Fitting out	
5	Excavate for diversion chamber	Diversion Chamber Guide
6	Construct diversion chamber	
7	Backfilling and lids	Both Guides
8	Waste Removal Basket (if fitted)	Basket Guide

Ensure that all of the required reference manuals and guides are provided and understood before installation is commenced.

TYPICAL COMPONENTS

Diversion Chamber

The type of diversion chamber used will vary with the type of drainage system.

Typically a pre-cast diversion chamber is supplied. However slab chambers may be supplied or an in-situ option specified for the diversion chamber. Therefore refer to the specific project drawing to ensure that all the relevant manuals have been supplied.

Typical precast components for CDS® Unit models (not including diversion chamber) are as follows:

- Sump
- Shear Cone
- Lower Separation Chamber
- Upper Separation Chamber
- Top Hat
- "L" shaped Outlet Wall

Additional pre-cast concrete items that may be required include:

- Access shaft risers (One or more of varying length may be supplied depending on depth required)
- Prefabricated Screen cage

Assembly aids which also may be required and are delivered on a pallet include:

- Fibreglass Inlet Chute
- "H" brackets for assembling major components
- Right Angle Brackets for fixing the access riser
- Angle brackets for fixing screen cage to shear cone
- Bolts and Dynabolts for all the above
- Assorted sealants as required
- Fish plate brackets

CDS® UNITS MAINTENANCE

Whilst the frequency of cleaning will be dependant upon the pollutant loads of each catchment, there are three alternative methods of removing the collected waste from CDS® Units.

The following methods of cleaning can be used individually on any CDS® Unit, even well after installation.

This is a very significant feature that allows asset owners to choose the cheapest option available for ongoing maintenance given the required cleaning frequency and the respective cleaning services and resources available.

The three maintenance options available are described following:

1. MECHANICAL GRAB CLEANING

Cleaning by grab can be carried out without dewatering the unit and is a single person operation in most locations.

This results in a cleaning technique which is generally faster, cheaper and safer. It also allows a visible inspection of the pollution that was captured, as opposed to suction that doesn't. No physical entry is required.

2. BASKET REMOVAL CLEANING

If a waste removal basket is fitted, it can be lifted at any time, without the need for dewatering. Also it provides a safe and cost effective method of cleaning. The cost benefit of this option depends on the CDS® Unit design and on waste disposal requirements. No physical entry is required.

3. SUCTION CLEANING

Due to the dewatering time, costs and disposal of the water, suction cleaning is generally the most expensive cleaning option. However by taking advantage of the large sump volumes available in CDS® Units, it may still be a very cost effective maintenance option.

Suction cleaning is used for most proprietary GPT's. Even if a more cost effective method is used at shorter intervals, suction cleaning is recommended for CDS® Units at one to two year intervals so that a thorough inspection of the screen and lower chambers can be carried out. Physical entry may or may not be required.

Normally a CDS® Unit would be sized with an appropriate sump volume to allow cleaning 3 or 4 times per year. These maintenance cleans would be carried out either by using a basket or a grab, with a single comprehensive clean per year completed by suction.

The best option for any particular unit will depend on tidal or backwater impact, pollution load and cleaning frequency as well as access and disposal costs for pump-down water.

CDS® Units may sometimes be required to use penstocks to isolate the unit during maintenance operations. This would be essential where a unit is affected by backwater and/or high levels of tidal inundation.

The main benefit of removable baskets is their speed and ease of cleaning, particularly in tidal zones. But the storage basket must be smaller than the screen to allow its removal. As such, the volume in a basket will be less than that of a large sump CDS® Unit volume.

Consequently, whilst it may be cheaper, cleaning removable baskets might also be required 4 or 5 times more often.

For larger CDS® Units, the grab truck cleaning option offers the removal of 80 – 90% of the pollution stored in a sump and is subjected to similar constraints as the removable basket option.

When considering GPT maintenance costs and procedures, the three maintenance options of CDS® Units offer greater operational flexibility and low life-cycle cost considerations.

More general GPT maintenance decision methodology information is available in the CDS® Unit Operation and Maintenance manuals or upon request.