Managing Beyond Stormwater Treatment - A New Approach By Ecoclean Technology Using CDS Technology

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ABSTRACT

10 years of experience in the design, construction, performance and operation of a proprietary licensed, non-blocking screening technology referred to as Continuous Deflective Separation (CDS) in Malaysia is reported. Application of this technology to the management of wet weather flows in stormwater, sullage and sewage discharges resulting from Combined Sewer Overflow unit (CSO) or Fine Solid Separation (FSS) unit is discussed. Past performance directed at the high rate separation of flocs from chemically treated raw sewage is also described and typical results presented. Independent monitoring has shown this technology to be highly effective in removing gross solids along with high levels of grits, sediments and the pollutants associated with these from wet weather flows. The addition of a flocculation step following the basic screening process has shown promising results in pilot plant operation and provides an effective pre-treatment prior to disinfection for CSO/FSS abatement. Our recent experiment using a Korean non-chemical flocculation agent followed by trapping the fine flocs using CDS/FSS unit offers a promising real time quick treatment of combined sewage / stormwater and sullage water treatment in seconds which can result in our clean river in the making and provide potential of water re-use from our stormwater run off.

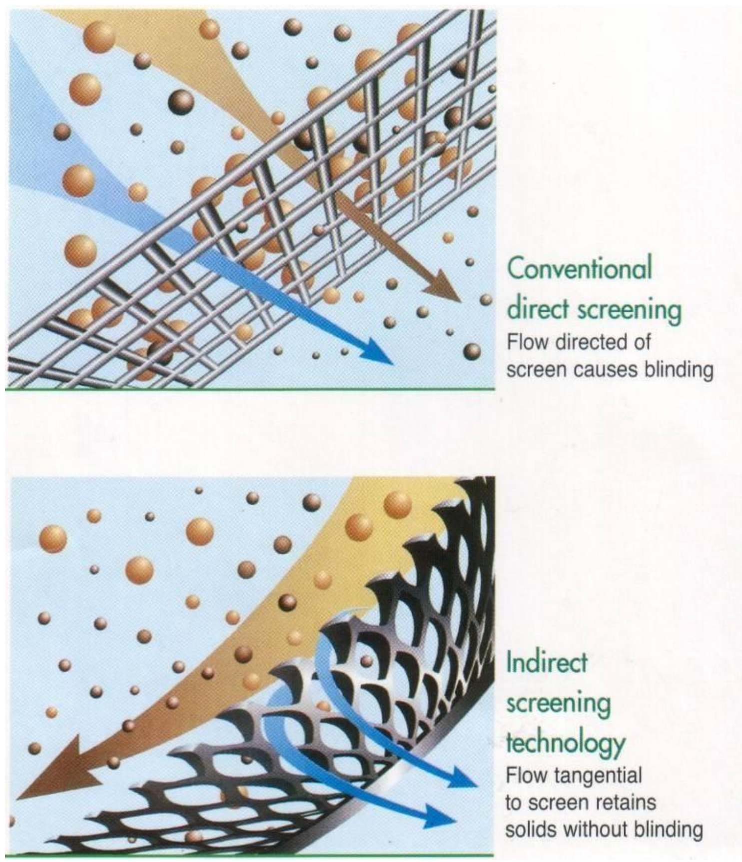
KEYWORDS

CSO/FSS abatement, flocculation, high-rate clarification, non-blocking screening, sewage, sullage, stormwater.

1. INTRODUCTION

Continuous Deflective Separation (CDS) is an innovative screening technology for the separation of solids from liquid streams. Unlike direct screening, which operates by impinging particles in the flow directly onto the screen, CDS utilizes the principle of indirect screening where the particles are carried by the flow across the face of the screen (Fig. 1). This, in conjunction with hydraulic balancing across the screen, delivers a process capable of removing solids from high flows of water and wastewater.

Figure 1 - Illustration of direct (top) and indirect (bottom) Screening



The technology utilizes a cylindrical screen with tangential inlet for the fluid above the screen and a sump below the screen. The tangentially introduced flow rotates inside the screen, keeping the screen surface free of solids while a small proportion of the fluid passes through each of the apertures in the screen. Solids are retained inside the screen on the rotating column of fluid if neutral density, sink into the sump of settleable, or float to the surface of the fluid in the unit.

Characteristics of the technology include non-blinding operation, high loading rates (up to 32 m^3/s), capture performance that is independent of flowrate, and low operation and maintenance requirements.

This technology has found use in several applications; however the most prolific use of the technology is in stormwater remediation. The technology has also been adapted to operate in raw sewage, and is currently installed for CSO/SSO abatement in the USA, UK and Australia. There are also units in use for screening of coolant, food processing, potable water intakes, coal fines separation and washdown yards; to name a few. Today, the range of product include surface and rainwater treatment device, sewer mining process for water re-use, SMART water plant to class A re-use water etc.

2. STORMWATER SCREENING

Over 5000 CDS Gross Pollutant Traps (GPTs) are now installed worldwide for the remediation of stormwater. These units remove solids including man made litter, organic material (leaves, twigs and grass), and sediments from the influent. These units handle flows from less than 30 l/s to in excess of $5m^3/s$ and operate solely on the available head through the drainage system, which does not need to be large.

Today, the range of products include surface / rainwater treatment device, sewer mining process for water re-use, smart water plant (class A re-use water).

2.1. Design and Construction

Units are designed to treat a maximum flow. This maximum flow may be specified by the client, or may be based on pipe size. However, best outcomes in terms of cost and treatment are achieved by carrying out a hydraulic assessment of the catchment area. Typically a unit sized to treat a one in three month event would be recommended to the client. Expected litter loading rates and preferred frequency of unit clean-out may also be taken into consideration.

A diversion weir is sized to divert the maximum flow to be treated. Consideration is taken that this diversion weir does not cause up stream flooding, even under the most severe storm events. A special “collapsible” weir has been developed for shallow and tidal drains that allows a maximum flow to be passed through a unit but has the ability to collapse, reducing the cross section presented to the flow to let high flows pass without causing upstream flooding.

Product development has led to most components being made in fiberglass or precast concrete. Units are installed below ground alongside the existing stormwater line. This stormwater line is cut to allow a diversion chamber to be built in the line. This chamber contains the diversion weir to divert the flow into the unit for treatment (Fig. 2).

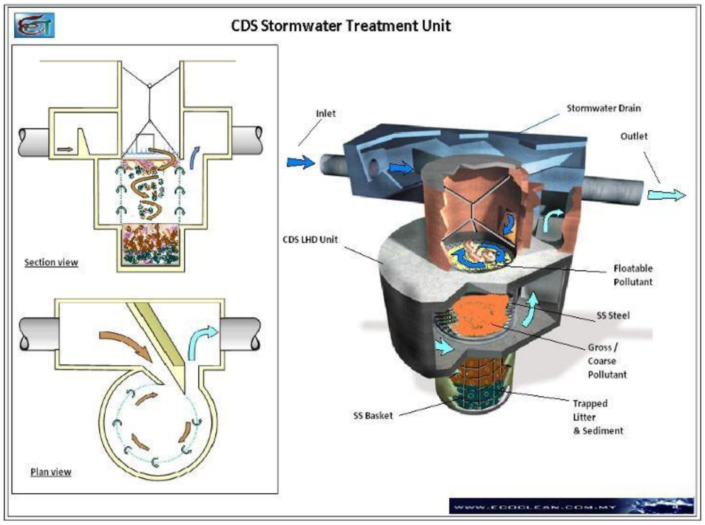


Figure 2

Baskets are manufactured out of polypropylene material with nylon lifting strap. If required for life span usage, stainless steel basket can be supplied.

Ongoing development has allowed cheaper precast concrete units to be built and caisson style construction to be used when difficult site conditions are encountered. We have recently completed several nos. of P3000 series CDS units in Johor using this method. The Senai River Cleaning Project involved CDS Units (Model F0908 to P2028) treating stormwater with ARI 3 month first flush conveyed via interceptor pipe to a stormwater treatment plant downstream before discharge into the Senai River --- this is already a project built beyond the normal stormwater management practice!

Screens are manufactured from 316 stainless steel material. This expanded metal mesh has proven to be the preferred form for the screen material. The aperture size used in the CDS Unit has a short-ways opening of either 4.7 or 2.4mm for stormwater treatment and 1.2mm for sewage treatment.

2.2. Operation and Maintenance

CDS units have no moving parts and require no regular maintenance other than regular removal of the captured solids. In operation the units need no power and are driven entirely by the flow of the stormwater. Importantly the screens are non-blocking and this means that during operation, the headloss across the unit remains constant. This is important as it allows the unit to continuously treat the maximum flow. Direct screening devices normally will have an increasing headloss across the unit as the screen blocks. This will lead to less flow being treated by the unit, and more flow bypassing the unit (or possible up-stream flooding if the unit or bypass system is not properly designed).

As mentioned, the only maintenance required is regular cleaning, typically once every 3 months. A major advantage of the CDS Stormwater Treatment Device is that there is a choice of three methods for cleaning. The design of the unit allows access for a clamshell grab, vacuum eduction or removal of a specially designed basket that contains the trapped solids.

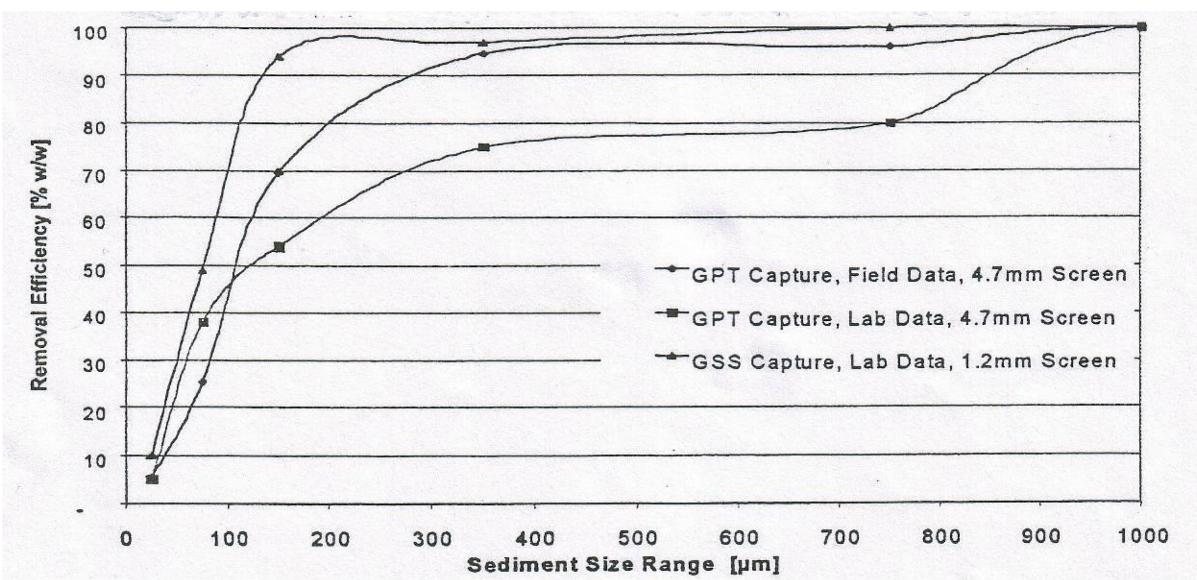
2.3. Monitoring and performance

Over the last 10 years, monitoring of a number of installed stormwater units has been carried out by independent research groups and users. Despite varying size and catchment conditions, this work has shown a general consistency with regard to the treatment efficiency of the units. Capture of gross pollutants is reported to be 100% for the flow treated by the unit (Walker et. Al.1988).

As the screen is non-blocking, the unit will always treat 100% of its design flow. This means, even allowing for periodic bypass of the unit in extreme events, overall gross pollutants capture from a stormwater line is in excess of 95% when the unit is sized to treat a one in 3 months storm event.

It is important to note that due to the nature of indirect screening, the aperture size is not critical in determining the minimum particle size that may be captured. It has been shown in both the field and the laboratory that close to 100% capture of particles at 500 µm may be achieved with a 4.7mm and 98% of 200µm using 1.2mm screen and majority to 100µm aperture screen along with significant capture of particles below this size (Fig. 3). Such results may be improved with finer screens and better hydraulic design in some circumstances.

Figure 3 – Sediment Capture Date for CDS GPT and GSS units



Other important results include a reported overall TSS removal of 70% and Phosphorus removal of 30% during storm events (Wong et. Al.,1999). As a large proportion of the solids removed from the unit is typically organic, the unit also effectively reduces the BOD and Phosphorus, regular cleaning of the units is recommended as studies have also suggested the potential for leaching of these pollutants into the downstream system over longer period of time.

CDS has performed cleaning of installed units and has collected considerable data over a 3-year period. The data shows that the amount of trash and debris collected by units installed in urban catchments ranges from 0.64 – 1.36 m^3/ha/yr, depending on rainfall and catchment type. This is much higher than previously reported (0.23 – 0.4m^3/ha/yr) and is probably due to the increased sediment capture efficiency of these units. The proportion of man-made; organic, and sediment removed by the units varies widely for different catchments but typically sediments comprise around 35% of the load, with man-made materials totaling only about 15%.

Our experience in maintain some CDS units for over a year show that we have doubling amounting of floatables as well as sediment load probably amounting to 2 to 3m^3/ha/year in Malaysia urban area.

3. SEWAGE SCREENING

The same technology has been applied to produce a fine screening device (the Gross Solids Separator or GSS) with enhanced features for the management of sewage and stormwater containing sewage, also at high flow rates. This device splits the influent into a foul stream, which is returned to sewer, and a screened discharge free of all visible solids. The foul stream is removed periodically at an average rate of just 1% of the influent flow rate.

Initially, two test units, one in the USA and one in Australia, were installed in the inlet headworks of sewage treatment plants and evaluated over a two year period, screening raw sewage down to 1mm. Operational histories exceeding 2 years are now available for units installed in several places in Australia and the USA to manage the discharge and remove the gross solids from overflowing sewers. Two of these have a design capacity of 1m^3/s and have operated successfully without blinding of the screen, even under conditions exceeding design capacity.

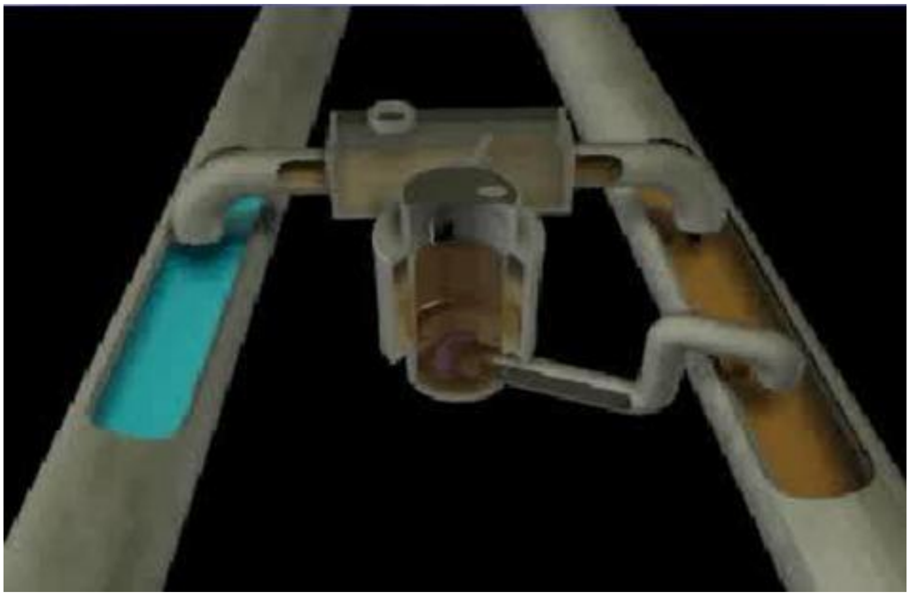
3.1. Design and Construction

The main problems encountered in the adaptation of this technology were due to the fibrous nature of sewage leading to “stapling” of the screens. Solids’ handling for sewage is also much more complex than it is for stormwater as the solids accumulate rapidly and cannot be stored for any length of time. Many subtle design modifications were made to the GPT design to overcome these problems.

Central to these is the selection of the screen type. The 4.7 and 2.4mm screen used for stormwater in the GPT are not satisfactory. For a combination of mechanical robustness and performance a 1.2mm expanded metal mesh screen (316 SS) is used in the GSS. This is plastic coated to minimize attachment of oil and grease.

The installation of the unit is similar to that of the GPT however the diversion chamber is built into the connection between the sewer and the stormwater line (for an SSO as per Fig.4 which shows the sewer on the right and the stormwater line on the left) or into the overflow discharge line (for a CSO). The screened flow is discharged to stormwater, or receiving water, and the purge stream (containing all the solids) to the sewer or storage.

Figure 4 – Configuration of the GSS for SSO Screening



3.2. Operation and Maintenance

As for the GPT the screening operation of the GSS has no moving parts. However, solids handling involves periodically purging the unit while it continues to operate. This is usually achieved with a sump pump as the solids need to be returned to the sewer, which is under pressure. Due to the variable nature of solids encountered in CSO/SSOs the purge has to be through a large diameter underflow pipe, and at a fairly high velocity (>1m/s). However this is only done once every hour or so and the total amount of fluid containing all the solids purged from the unit is less than 1% of the flow treated. Commonly a PLC is used and the entire operation is automated. As such, units require no regular maintenance, cleaning or inspection.

Another feature of the GSS is the use of washdown facility to clean the screen following an event to remove any contaminated material from the unit. As with the purge this operation is entirely automated.

3.3. Monitoring and performance

Pilot plant results and field observations have shown the GSS removes all particles down to 1mm and the majority of grits and settleable solids down to 100 µm. Units require no mechanical cleaning and the screens do not block.

Independent monitoring of overflow events for the large ($0.9m^3/s$) CSO unit in Louisville, Kentucky, has returned results for TSS removal from 22-53%. Significant but variable removal rates were also demonstrated for TS (10-37%), TP (8-22%) and BOD (6-36%) (O'Brien & Gere, 2000).

4. HIGH RATE SEWAGE CLARIFICATION

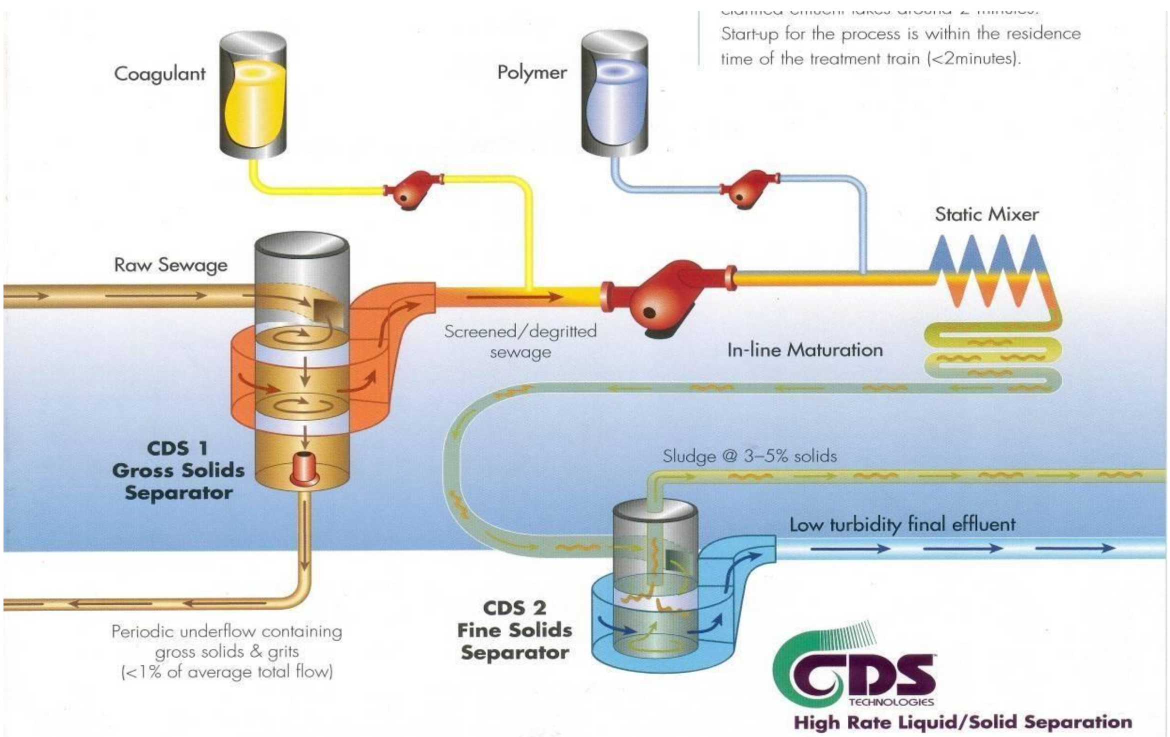
Work over the past year has targeted a high rate separation of sewage fines using flocculation for applications where a clear and/or disinfected discharge is required. Conventional coagulant and flocculants are dosed into screened raw sewage and the flocs formed are separated from the stream using a specially adapted separator. This process, referred to as Fine Solids Separation (FSS), will be ideal for the remediation of CSO/SSO's where disinfection prior to discharge is required.

4.1. Process Description and Design

Raw sewage is screened to remove all solids greater than 1mm and grits down to about 150 µm in a continuous screening operation (A GSS unit). A coagulant is then mixed into this screened sewage stream followed by a polymer to increase floccs strength. A small amount of air is added and the stream is mixed in line, firstly through a static mixer, and then in a gentle hydrodynamic flocculator to achieve maturation of the floccs. The resultant floccs are then screened out through a second screening unit (Fig. 5).

The entire process from raw sewage inlet to final effluent outlet takes approximately 2 minutes at the systems design flow. The process starts up and reaches steady state within the residence time of the treatment train (i.e. approximately 2 minutes).

Figure 5 – The CDS FSS Process



4.2. Results

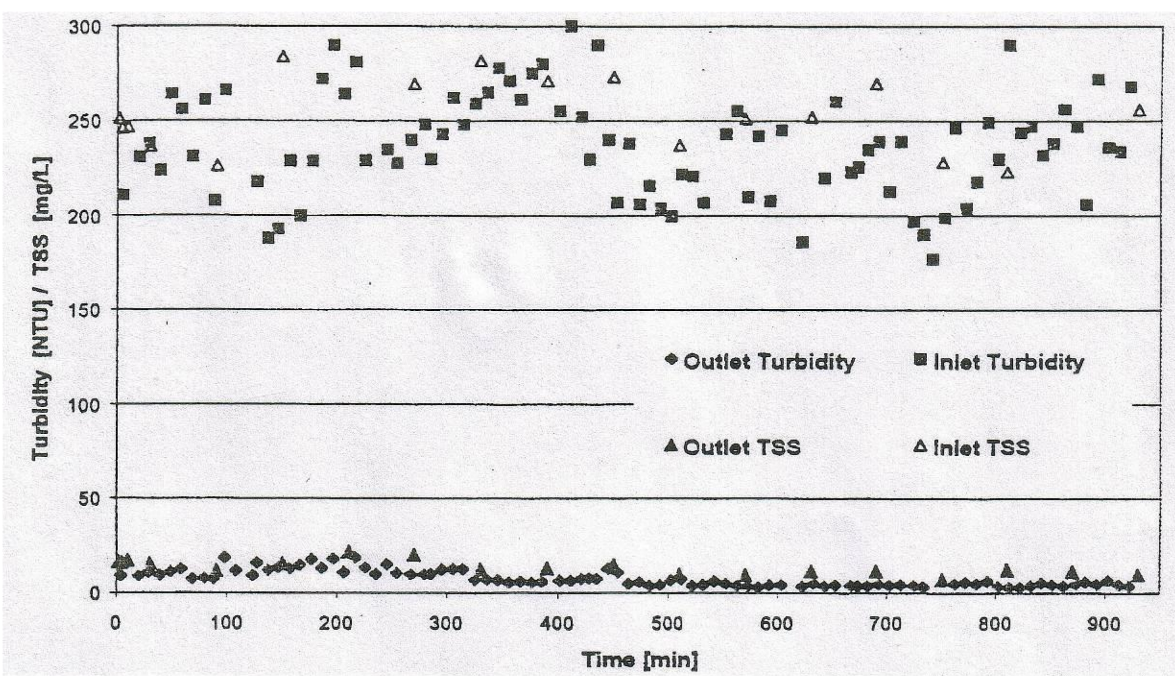
The results shown below (Table) 1 are from a 2.5MLD pilot plant at the Mornington Sewage Treatment Plant, Victoria, operating on raw sewage. During the course of the work turbidity was used as a process control parameter and was measured continuously (Fig. 6). The results for both turbidity and TSS reduction show consistent solids removal is achieved despite significant variations in influent conditions. Other results are from several grab samples taken periodically over the course of a run.

Table 1 – CDS FSS results from a 25 MLD pilot plant

Parameter	Unit	Raw Sewage	Treated Sewage	Removal Efficiency
Turbidity	[NTU]	240 (177-369)	7.6 (3.4-15.2)	97%
TSS	[mg/L]	259 (184-564)	13.5 (4-22)	95%
BOD_5 *	[mg/L]	302 (190-420)	38 (25-46)	87%*
COD *	[mg/L]	531 (454-643)	82 (76-85)	80%*
Faecal Coliforms	[CFU/mL]	$12.5x10^6$ ($5.4-17x10^6$)	$58.6x10^3$ ($30-110 \times 10^3$)	99.5%
Total Phosphorus	[mg/L P]	12 (9.7-17.2)	0.6 (0.4-0.7)	95%
Total Nitrogen	[mg/L N]	71 (60-85)	55 (49-59)	16%
Ammonia	[mg/L NH_4-N]	40 (28-45)	37 (34-39)	8%

*these results are specific for the sewage tested. The sewage entering Mornington STP is domestic and is from a short sewer. As such, virtually all the BOD_5 and COD are expected to be particulate and this high removal efficiencies are achieved through effective particulate solids removal.

Figure 6 – Turbidity and TSS results over a 15 hour run of the FSS process



5. LOCAL DEVELOPMENT OF COMBINED STORMWATER / SEWAGE / SULLAGE WATER TREAMENET

The Korean has discovered a non-chemical mineral based flocculant powder which has proven to be equivalent to chemical coagulant and polymer in Malaysia. They have conducted test in our CDS model and the test proved that our GSS could trap these flocs with simulated condition of wastewater with water from our drains as well as liquid from kitchen oil and grease interceptor.

We then approached Dr. Wong of a major wastewater company in the country and together we have jointly arrived at a solution as per shown in sketch attached which could shed the lights of a next generation treatment plant working on green technology.

The process is similar to the Mornington plant except that we have substituted the coagulant and polymer with this Korean flocculant in powder form. As a result, the sludge collected with a disguised planter box which is a sludge drying bed will not be considered as scheduled waste which is expensive to dispose. On the other hand, there is a potential use of this sludge as fertilizer especially the affluent has no industrial waste water contamination. The treated water pass through a wetland or artificial wetland will certainly complete the “treatment train” process to become re-use water.

We believe this development could push us beyond the current level of managing and treating stormwater flows.

6. CONCLUSIONS

Continuous Deflective Separation (CDS) is a screening technology capable of removing solids from liquid streams at high flows. It utilizes indirect screening, and is therefore non-blocking giving it superior performance to other screening technologies. Its utilization in the remediation of wet weather flows, in particular stormwater, has been extensively monitored and it has been shown to be highly effective. In the field the units achieve 100% capture of gross pollutants and significant capture of TSS and associated pollutants. Current work, directed at the removal of flocculated sewage in a CDS separator, is showing promising results at the pilot plant stage with high removals of TSS, turbidity, BOD, and other pollutants from raw sewage. Based on the success of this process, we have researched and developed a non-chemical flocculation using Korean technology of flocculation agent and power dosing machine to arrive at a stormwater / sewage / sullage treatment plant which will treat up to 3 month ARI event, taking most of the harmful pollutants from the waterways.

7. BIOGRAPHY OF AUTHOR

Mr. Wong founded both companies to represent CDS Technology as Malaysia licensee and Roevec Vacuum Sewerage System as sole distributor respectively for Malaysia and Brunei in the year 2000. Both technologies are now world leading in their respective fields of stormwater treatment and waste water collection.

Mr. Wong has completed Mechanical Engineering Diploma & Post Diploma courses in Singapore Polytechnic and was registered with Engineering Council in UK as Incorporated Engineer. He has also completed an MBA from Henley Management College and conferred a Master Degree from Brunel University, UK

Mr. Wong has close to 40 years experience in which more than 10 years were working abroad. During his 11 years services with McConnell Dowell International (NZ) and 8 years with John Laing International Ltd.(UK), he has undertaken major projects like Master Planning of Mersing Camp for Special Forces ,Nucleus Hospitals for 12 Districts in joint venture with YTL Group,Terebu Layang Layang Naval Outpost, Pasir Gudang Power Station Jetty etc.
He set up Y.Wong & Partners in 1996. As a consultant, he has advised Leighton International for Cabot Submarines Pipelines and SBM Project as well as offering business advices to other international companies like Bilfinger Berger (Germany), Universal Dockyard Ltd (HK) and China Fujian Engineering (China) etc.

The company EcoClean Technology was set up as a JV company with McConnell Group which is privately owned by the McConnell family, the very family who used to own McConnell Dowell .This implied McConnell family has recognized his past contribution and contended with his current leadership of EcoClean Technology Sdn Bhd who is currently the market leader in Stormwater Treatment in Malaysia and undertaking projects all over the Iskandar Region and River of Life, Sg.Klang as well as Melaka River cleanup Projects.

Mr. Wong has been elected as Council Member of the Association of Environment Consultant and Companies in Malaysia in year 2012 and lead the Sewage Water & Wastewater as Committee Chairman.

He is also active in the Alumni of Henly Management College as Committee member.

Mr. Wong has recently acquire 51% of the company Empire Green Industries which is the sole distributor of world's leading Soilless Vertical garden technology for South East Asean region and this company has eco social element as the planting of garden species are carried out by single mother and orphans.

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Project Profile for Pilot Plant at Ijok, Selangor, Malaysia

Treating Raw Water Quality from
Class 4 to Class 2B without any Electrical Power