CWIP

Initial Environmental Review of NWC Treatment Facilities in Montego Bay

ARD

Coastal Water Quality Improvement Project

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INITIAL ENVIRONMENTAL REVIEW OF NWC TREATMENT FACILITIES IN MONTEGO BAY

January 2001

Prepared for the:

Government of Jamaica's
National Environment and Planning Agency

And the

United States Agency for International Development

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Abbreviations

ASP	Activated Sludge Process
BOD	Biochemical Oxygen Demand
C	Degree Centigrade
d	Day
CWIP	Coastal Water Quality Improvement Project
COD	Chemical Oxygen Demand
COD-f	COD of the filtered sample
COD-m	COD of the completely mixed sample
h	Hour
EMS	Environmental Management Systems
FTU	Formazine Turbidity Units
HRT	Hydraulic Residence Time
GOJ	Government of Jamaica
InWaSia	In Waste water Systems interactive (iterative) approach
ISO	International Organisation for Standardisation
kg	Kilogram
L	Litre
m^2	Square Metre
m^3	Cubic Metre
mS	Milli Siemens
mV	Milli Volt
N	Nitrogen
NH_4-N	Ammonia Nitrogen
NO_3-N	Nitrate Nitrogen
NO_2-N	Nitrite Nitrogen
NEPA/NRCA	National Environment and Planning Agency/Natural Resources Conservation Authority
NWC	National Water Commission
P	Phosphorous
o-P	Ortho-Phosphate
PE	Population Equivalent
PS	Pump Sump/Sewage Relift Station
t	Tons (Metric)
SRT	Solids Retention Time
STP	Sewage Treatment Plant
SVI	Sludge Volume Index
TN	Total Nitrogen
TP	Total Phosphorous
UASB	Upflow Anaerobic Sludge Blanket Reactor
WC	Water Column

Nomenclature

On-line is the continuous and interactive measuring by sensors of operating conditions which provides information that facilitates immediate responses to changes.

Environmental aspects are elements or part of an activity or product or service that interacts with or has some relation to the environment.

Environmental impact is a change in the environment that is adverse or beneficial, wholly or partially, resulting from an organisation's activity, product or service.

Clause 4.3.1 of ISO 14001 requires on organisation establishes and maintains procedures to identify aspects which it can control, over which it expects to have an influence and determine those aspects which have or can have significant impacts on the environment. The clause also requires that aspects are considered in setting objectives and that information is kept up to date.

The **redox potential** is given by the formula below. The normal potential (Eo) has different value for each oxidation reduction reaction. n is the number of participating ions. Ox/Red is the concentration ratio of oxidising and reducing ions.

$$\textbf{Redox Potential (E)} = E_o + {}^{0,66}/_{n} \times \log\left({}^{Ox}/_{Red}\right)$$

The redox potential will increase when the concentration of oxidised ions increases in relation to the concentration of reduced ions. Under anaerobic conditions the redox potential may drops to –300 mV or more.

The redox potential can be used to follow redox reactions like denitrification, sulphate reduction, sulphide oxidation, etc.

Background to the Project

The National Environment and Planning Agency / Natural Resources Conservation Authority (NEPA/NRCA) through the Coastal Water Quality Improvement Project (CWIP) Contract Result 3 (CR 3) - Environmental Practices of Industries and Commercial Establishments Improved - has been working to promote the implementation of EMS in support of the development of a national agenda that recognises the role of government, private sector and non-government organisations in environmental management.

Environmental Management Systems (EMS), based on the ISO 14000 series, are being increasingly accepted, adopted, and implemented by industry, the services sector, utilities, local government, and commercial enterprises. It is generally agreed that an EMS is a powerful tool for achieving environmental protection and improved business operation. In this regard, the EMS policy and strategy is viewed by the GOJ/NEPA/NRCA as a step along the sustainable development path which will assist the country's ability to 'grow capital' – the natural, economic and human.

Drivers

Globally, the EMS approach is being rapidly adopted as a tool to achieve improvements in internal efficiencies within operations thereby helping to reduce costs and achieve a competitive advantage. Bankers and insurance companies are requiring assessments of environment risks before funding projects. Governments are moving towards green procurement and regulators are using EMS adoption as a mechanism for regulatory flexibility. The drivers for EMS implementation internationally are as follows:

- Global competition
- Market pressures
- Improving efficiencies
- Public image/Stakeholder demands
- Enhanced competitive advantage
- Environmental protection
- Financial requirements

The guiding principles of the policy and strategy embrace a number of philosophies. These include sustainable growth, implementation of EMS as a fundamental tool to help achieve sustainable development, voluntary implementation of EMS and the full participation of and provision of information to all citizens of Jamaica re the quality of the environment.

The GOJ has taken the stance that it must lead from the front with regards to the promotion of the EMS policy and strategy. In regard, ***Goal 1 Strategy 1.5 Build capacity to plan, implement monitor and evaluate sustainable communities using an EMS approach.***

GOAL 1: To establish the framework within which Environmental Management Systems will be adopted across all sectors of society.

One of the proposed actions is to 'Implement EMS in a regional wastewater division of the NWC'. The leadership of the NWC endorse this approach and have requested that CWIP provide the technical assistance to develop and implement an environmental management system for three of its sewage treatment facilities, Montego Bay; Ocho Rios; and Montego Bay.

Background on the Consultants

CWIP contracted two short-term experts to provide the technical assistance to conduct the initial environmental review and to provide an overview of the performance of the Montego Bay Systems. A brief introduction to the two consultants is found below:

- Robert Wynter is a Chemical Engineer and Management Consultant with wide experience in environmental audits and EMS'.

- Johan Verink is an Environmental Engineer with commitment to the development, adaptation, transfer and implementation of know-how in the wastewater treatment sector.

This document is intended to present a detailed description and interpretation of the investigations at Montego Bay.

Purpose of the Study

The purposes of this study are to:

1. Conduct an initial environment review of the NWC Montego Bay sewage treatment facilities.

2. Provide a performance review of the facilities.

3. Prepare a report on the findings of the initial environmental review to provide data to support the implementation of an EMS.

Tasks

The proposed tasks for the consultant are as follows:

Fig. 1 Review documents related to design, construction, and operations of the systems to be reviewed;

Fig. 2 Determine the flow and influent characteristics of the wastewater going to the sewage treatment facilities using proportional sampling and conductivity measurements;

Fig. 3 Determine plant performance and environmental impact using on-line monitoring and sampling technology.

Fig. 4. Analyse treatment process performance including:

- Impact of wind (mixing, stratification)
- Load distribution in pond (short-circuiting)
- Load distribution
- Daily variations in oxygen concentration and suspended matter in effluent
- Treatment process in relation to pond depth and retention time (Montego Bay)
- Effluent quality

Fig. 5 Review and analyse NWC records describing concentrations of water quality parameters found in the final effluent at the Montego Bay plant since it commenced operation.

Fig. 6 Identify the significant environmental aspects.

Fig. 7 Liase with NWC's operational staff at the Montego Bay facilities re the provision of existing information to be incorporated into the report.

Fig. 8 Prepare the initial environment review report.

Organisation of the Report

Investigations in Montego Bay involved on-line monitoring of the influent at the main pumping station 3 and additional monitoring at the ponds.

This report firstly outlines the findings of the inflow at the pumping station 3 followed by an assessment of the ponds.

Approach

On-line monitoring and sampling technology was at the heart of the approach and was used to provide immediate and valuable information on the operations. The system sampled both time and volume proportionally, and monitored:

- Waste water characteristics
- Flow
- Electricity consumption

An overview of the concept is shown in Fig. 9

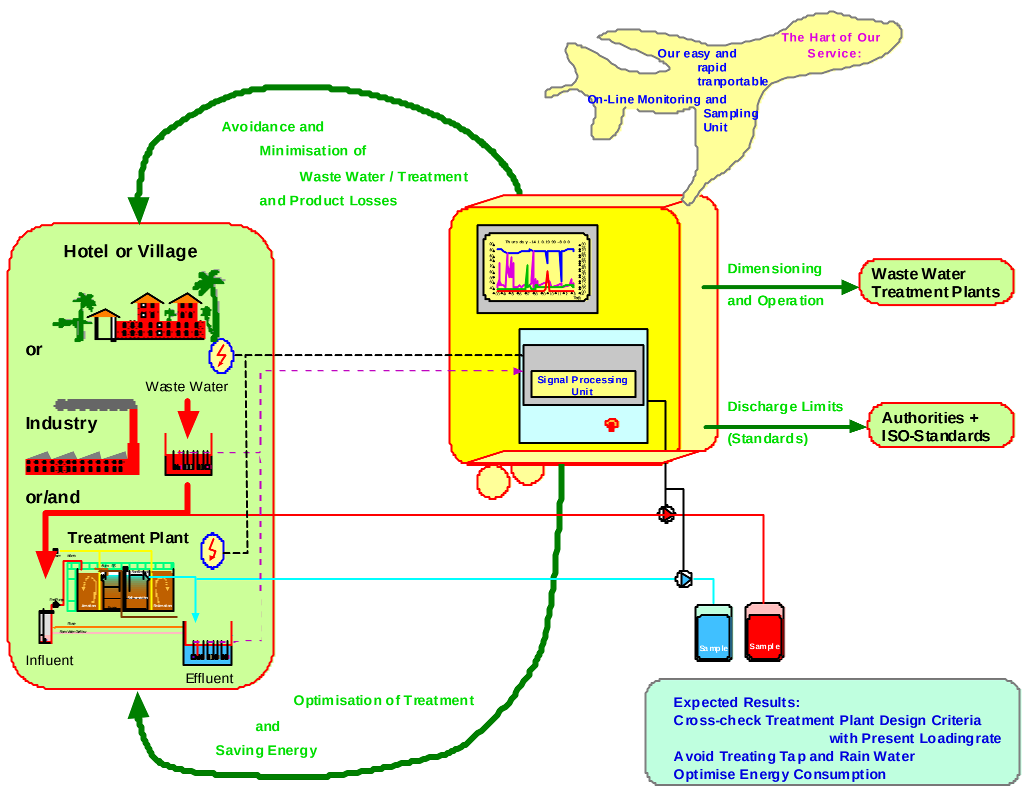


Fig. 9 On-Line Monitoring and Sampling Technology Concept

The benefits of the approach are: avoidance and minimisation of environmental impacts; reduction of product losses; optimisation of wastewater treatment; energy savings; data for treatment plant design and/or upgrade; data for environmental compliance programmes and/or upgrade and data for environmental compliance programmes.

Work Programme

For the Montego Bay Sewage Treatment Facility the following approach was used:

- Preliminary visit to the plant for familiarisation and an initial review of documentation

- Transferred, installed and tested the equipment at pumping station 3
- Commenced on-line measurements and sampling
- Monitoring and sampling at Montego Bay sewage treatment plant from Wednesday 10 until Saturday January 21, 2001

Field Investigations

A computer-controlled unit was used for on-line data monitoring and sampling. The features of the equipment enable one to take different types of samples: grab, continuous, time and volume proportional samples.

The unit was equipped with sensors to monitor the following parameters on line:

- pH
- Temperature
- Conductivity
- Redox potential
- Oxygen
- Solids (Sludge)
- Level (Pressure, height or flow)
- Power Consumption

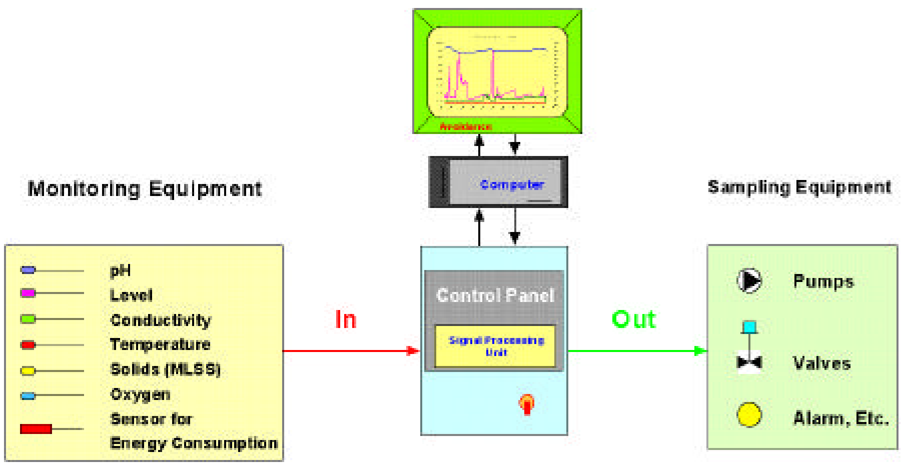


Fig. 10 Overview of the Monitoring and Control Unit

Data Collection

The following sections of the report outline our approach to measure flow and the various sampling techniques.

Flow

At the Pumping Station, a flow-monitoring device was installed at the following locations:

- Incoming sewer
- Pump sump

From the experience gained in the Negril investigations, when the Venturi backed up and flow measurement were incorrect, it was therefore decided to install the flow monitoring in the pump sump. Notably, the same difficulties with the Venturi flow measurement also occurs in Montego Bay with a slight difference that the back up is not due to the screen, but to reduction of the cross-section at the distribution gates to the ponds. A special feature has been developed in the monitoring programme for flow measurement taking the existing structures in the pump sump into account.

Sampling (Volume Proportional)

Pump sump/Pond influent

A hose with a screen was positioned in the pump sump at around 30-cm above the bottom of the sump. Every time the pump sump was emptied, wastewater was pumped into containers of the automatic sampler. In this way, the best possible sampling (volume proportional sampling of the sewage) was ensured.

Pond effluent

For the sampling of the pond effluent qualified grab samples were taken near the overflow of pond 4, at the overflow from pond 5 to pond 6 and at the effluent chamber before the water flows into the Montego River. The other ponds were not being fed with wastewater.

Sampling (Grab)

Grab samples were taken of the effluent from pond 1, 2 and 3 for observations of the daily changes in oxygen concentration.

Chemical Sample Analysis

In situ analyses of settleable solids, pH, redox, conductivity and suspended solids were done. Most of the chemical analysis COD, ammonia, nitrate, total nitrogen, ortho-phosphate and total phosphate were done on site. Faecal Coliforms and BOD were carried out in the laboratories.

Inter-calibration

In an effort to have verification of some of the parameters, some samples were sent to 4 laboratories: NWC laboratory in Montego Bay, Environmental Technical & Analytical Services (ETAS), Environmental Solutions (ESL) and the Jamaica Bureau of Standards. The on-site analyses were used for the basic of the findings in this report.

In conducting the inter-laboratory programme, appropriate chain of command procedures were put in place, and samples were stored and refrigerated while in the field and during transportation to the laboratories.

Data Elaboration

Data collection, elaboration and presentation have been carried out by the use of the following software packages:

- DASYLab, Company WAL, Oldenburg, Germany
- XACT (similar to Excel), Company SciLab, Hamburg, Germany
- Microsoft Word 2000
- Microsoft Excel 97

Overview of the Montego Bay Sewage Treatment Facility

Location: Several pumping stations feed to the main pumping station (No. 3), which conveys the wastewater to the ponds. This pumping station is located at the old Montego Bay treatment plant.

Type: Three parallel operated series of three ponds. Some sedimentation and anaerobic pre-treatment takes place in the primary and secondary sedimentation tanks of the old treatment plant.

Disposal: Screenings at the ponds are removed daily and disposed off. Sludge is deposited in the ponds.

Effluent is discharged into the South Montego Bay River and eventually to Montego Bay.

Photographic Display (See pictorial appendix):

- Old Treatment Plant
- Pump Sump No. 3
- Venturi Canal
- Ponds

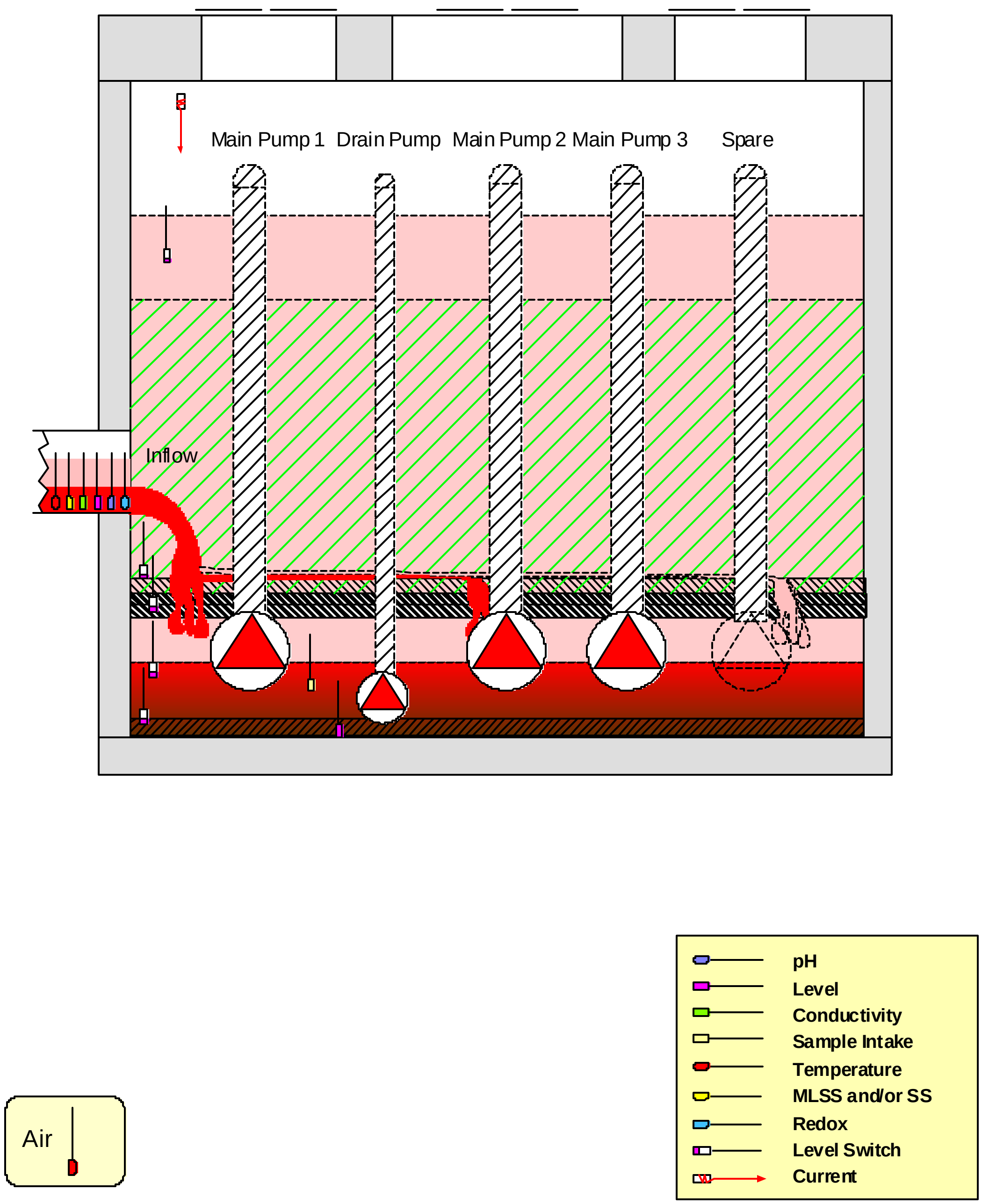


Fig. 3 Cross Section of Pump Sump No. 3

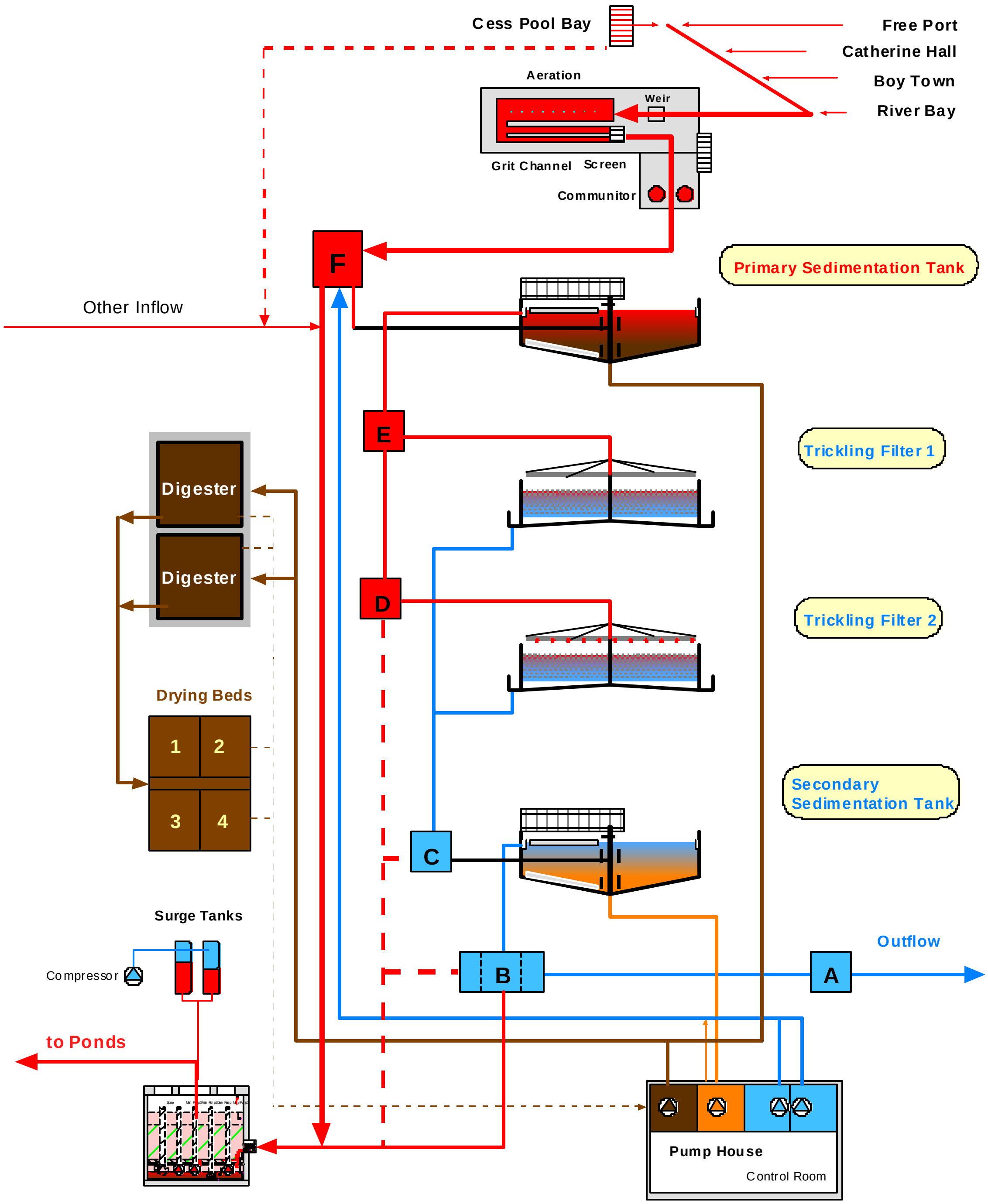


Fig. 4 **Schematic Overview of Montego Bay Old Treatment Ponds**

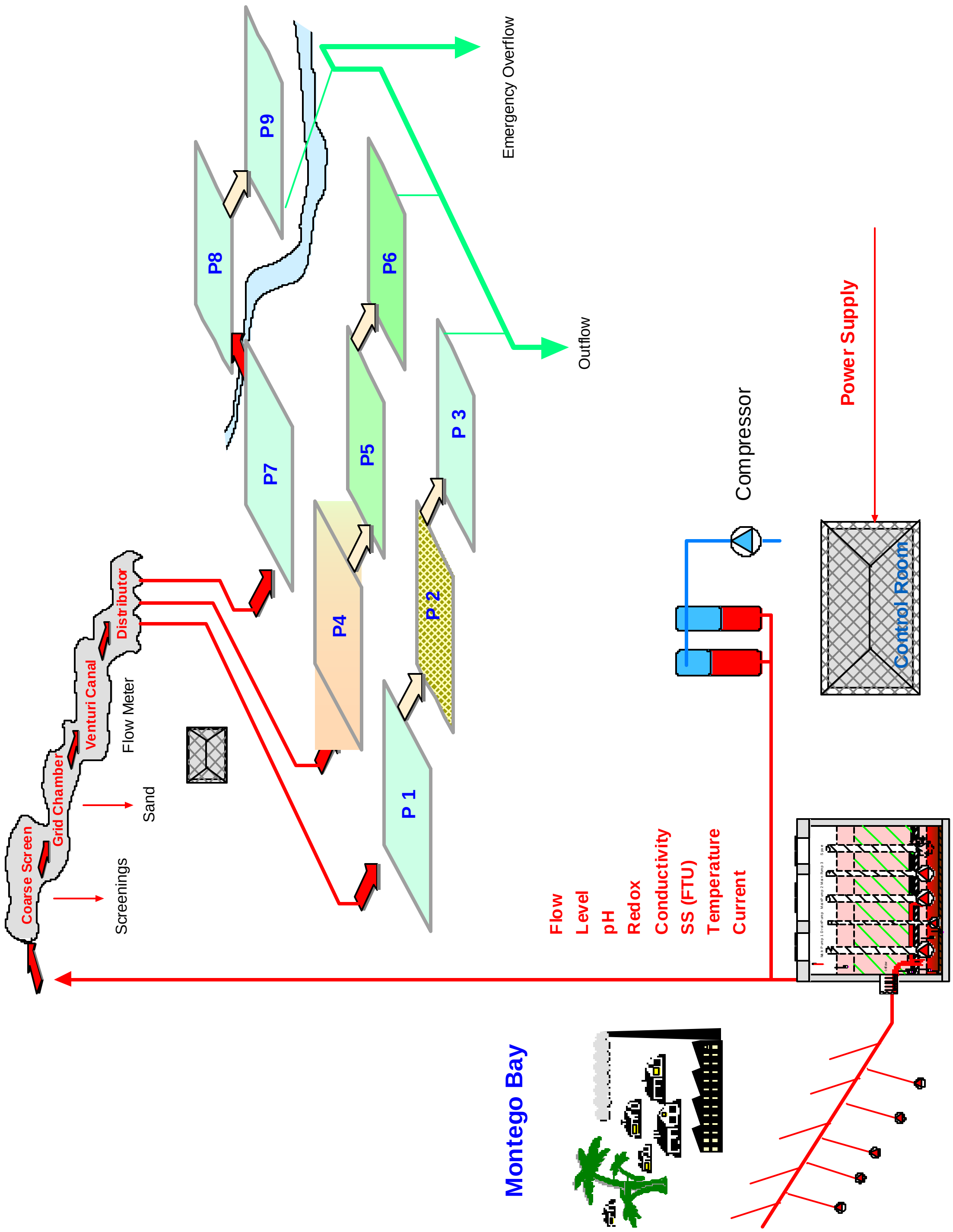


Fig. 5 Schematic of Montego Bay Sewage Collection and Pond Treatment System

The ponds are lined and have a water depth of around 1.5 m for the first pond in a series and 1.25 m for the others. The area data for the ponds numbered from 1 to 9 are as follows:

1. 5.9 ha
2. 3.1 ha
3. 2.9 ha
4. 6.1 ha
5. 3.2 ha
6. 3.0 ha
7. 5.8 ha
8. 3.0 ha
9. 3.7 ha

Findings at Pumping Station # 3

The following section of the report outlines the findings from the monitoring and measurements at the main pumping station.

Flow

The graphical determination of the flow into and from pump sump #3 is shown in Fig. 6. Filling and emptying of the sump is shown in red and the incoming flow is highlighted in blue. The flow is not unusual with peak flows in the day up to 500 m3/h and minimum flows at night of around 300 m3/h.

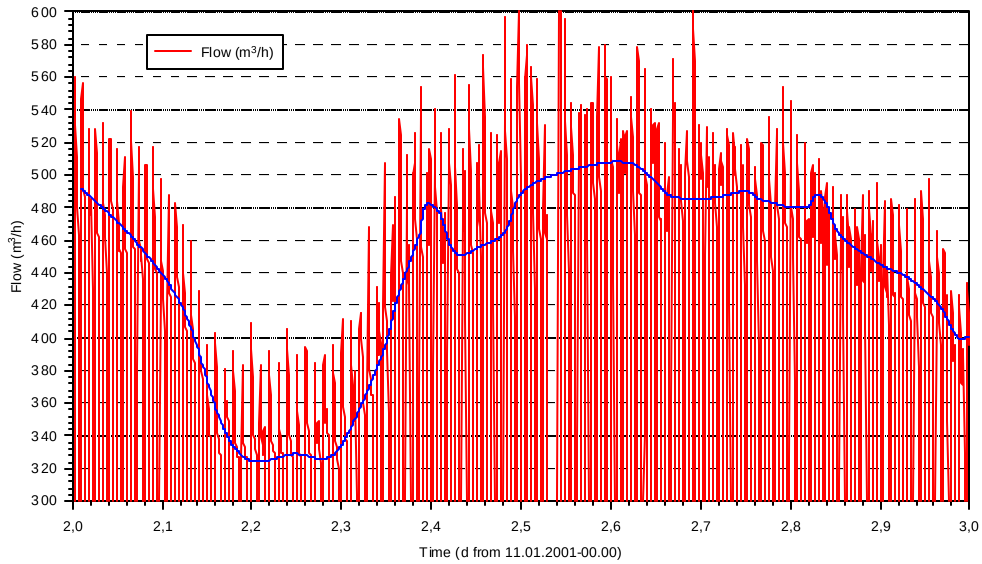


Fig. 6 **Flow Determination with Aid of the On-Line Monitoring Data**

The pattern seen during the filling and emptying of the sump indicate that there are some obstructions in the sump, however this did not effect the determination of the flow pattern.

Power Consumption

Fig. 7 shows the power consumption during the filling and emptying of the sump. The power uptake during operation of the pump varies over the period, which could be due to a number of factors: power supply variation; shifting pumps; debris in pump head or in the sewer line. The electricity consumption varied between 135 and 195 amperes.

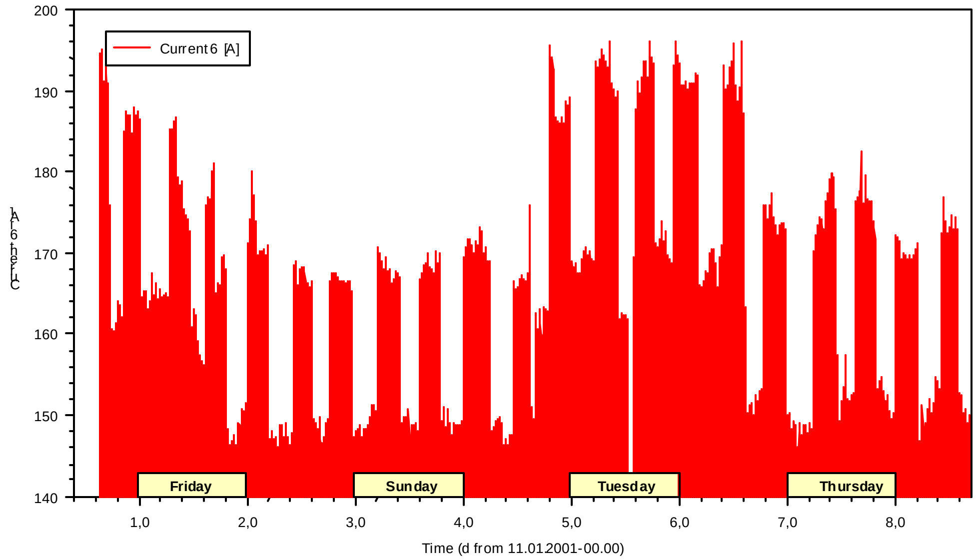


Fig. 7 **Power Consumption at the Main Pumping Station**

Conductivity

The following figure shows the conductivity over the sampling period. The values predominantly around 1 mS/cm, an expected range for sewage. The occasional peaks were up to around 5 mS/cm and associated with batch loads of salty water may be from water treatment plants or a contribution from a sump, infrequently emptied, where salt water has infiltrated.

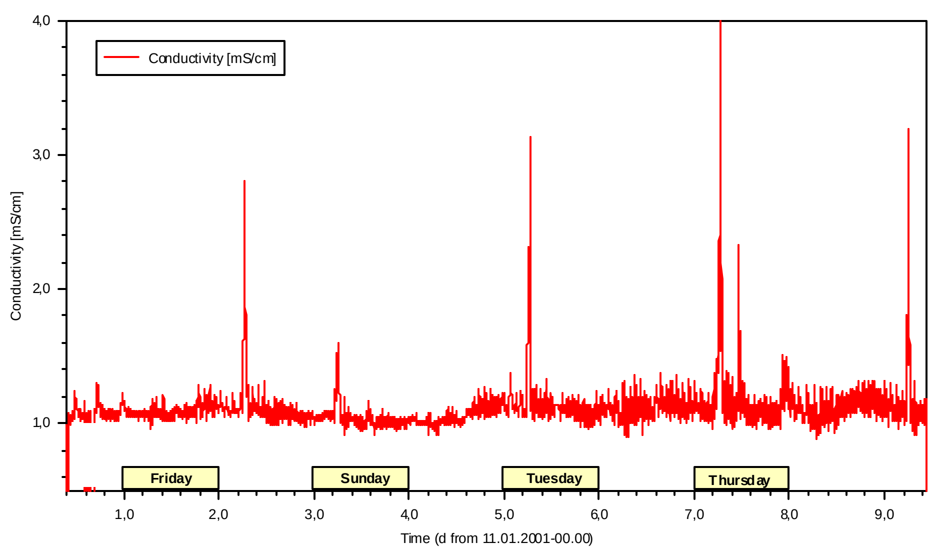


Fig. 8 **Conductivity of Incoming Sewer at Pump Sump #3**

COD

The Chemical Oxygen Demand (COD) of the wastewater was sometimes very strong for sewage (greater than 1000, grab sample of even 2200 mg/L). More often than not during the day the COD readings were in the range of 300 to 400mg/L. At night the values dropped to around 200 mg/L. The high strength waste seems to correlate with the batch discharge of cesspool emptiers at the treatment facility into the inflow. These discharges were observed on a two occasions to be oily waste (diesel smell), perhaps from petrol stations.

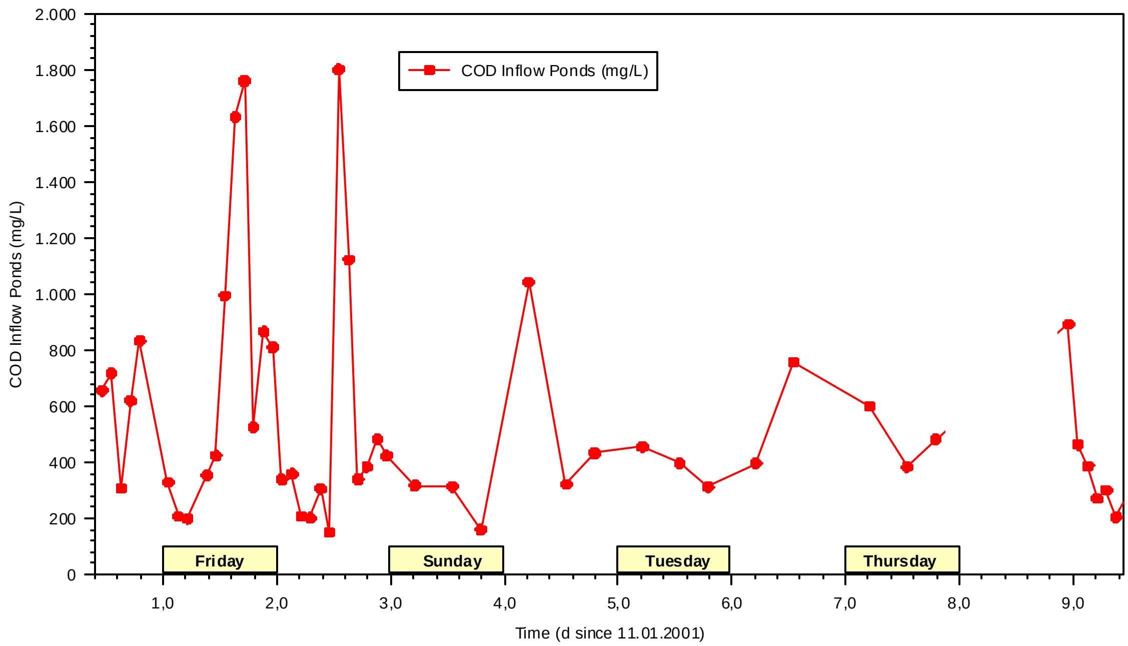


Fig. 9 COD of Composite Influent Samples

Settleable Solids

The settleable solids, not unusually, ranged widely from 1-20 mL/L. This variation in influent characteristics suggests an irregular discharge of settleable matter to the sewer.

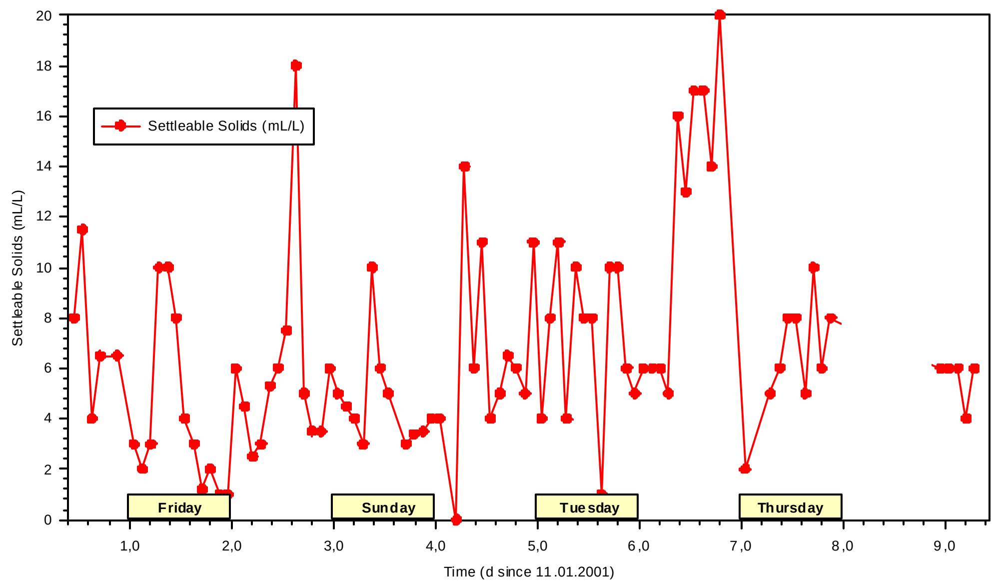


Fig. 10 Settleable solids of Composite Influent Samples

Temperature

The air temperature varied from around 17 and 33 C. The wastewater temperature was around 26 – 27 C.

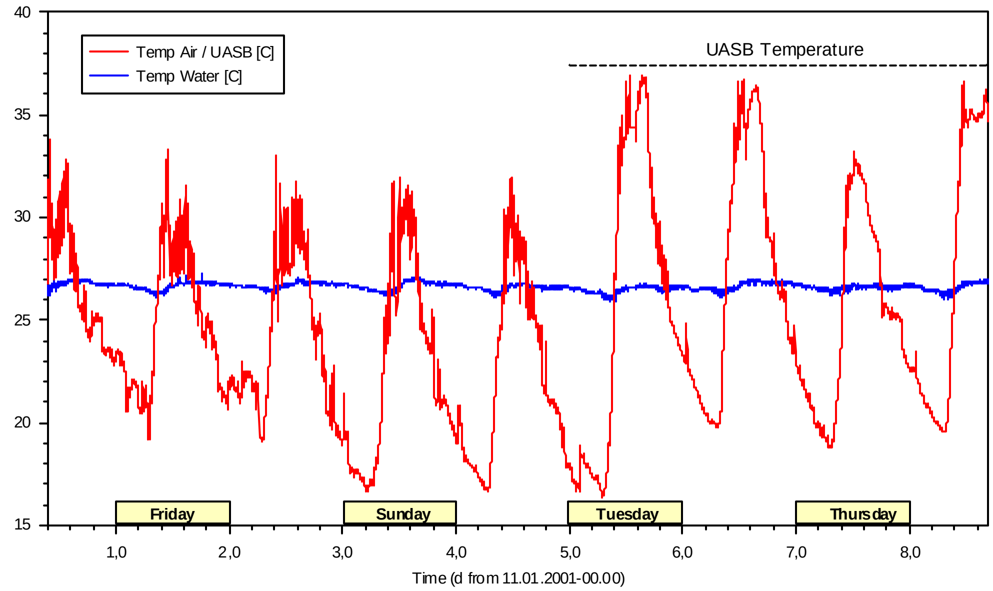


Fig. 11 Temperature at Pumping Station 3

Suspended Solids

Suspended solids vary as expected (Fig. 12), increasing in the morning and drop during the night. The daily pattern is very constant. Detailed observations of the curves during on-line monitoring revealed some strong variations in during the day, which could be attributed to the delivery of cesspool emptiers to the treatment plant (Fig. 13)

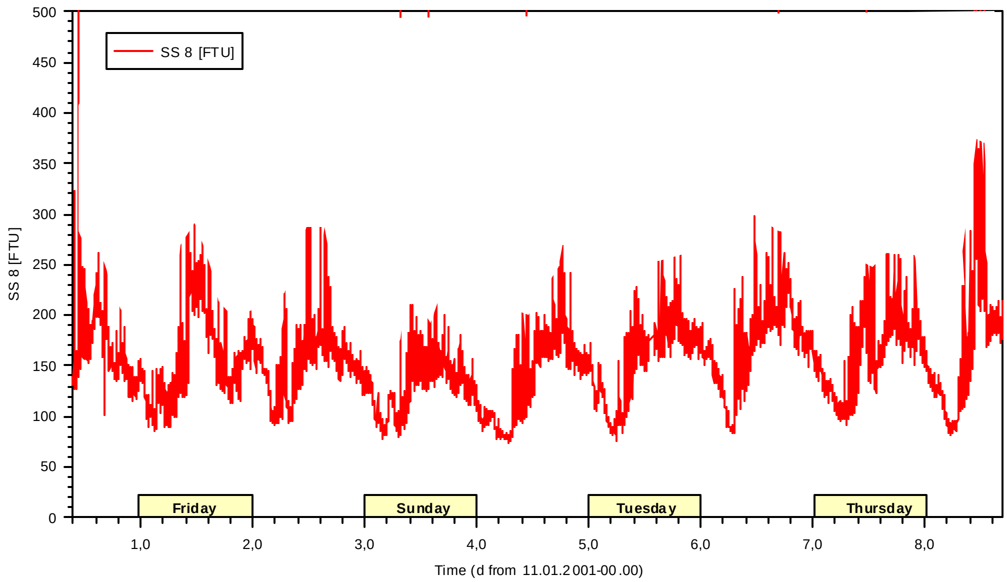


Fig. 12 **Suspended Solids in Pond Influent**

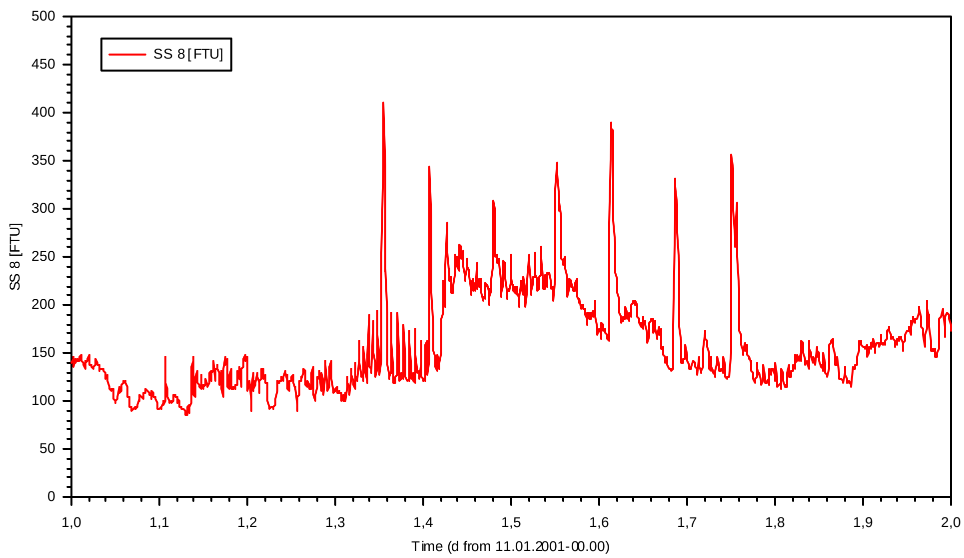


Fig. 13 **Peaks Related to Cesspool Emptiers**

Redox Potential

In the nomenclature a brief description is given of the redox potential. Fig. 14 shows a negative redox potential which is an indication for anoxic and anaerobic conditions in the wastewater. There is a continual and significant drop during the week. The reasons for increasing anaerobic conditions are not understood, however they may have an impact on the treatment process.

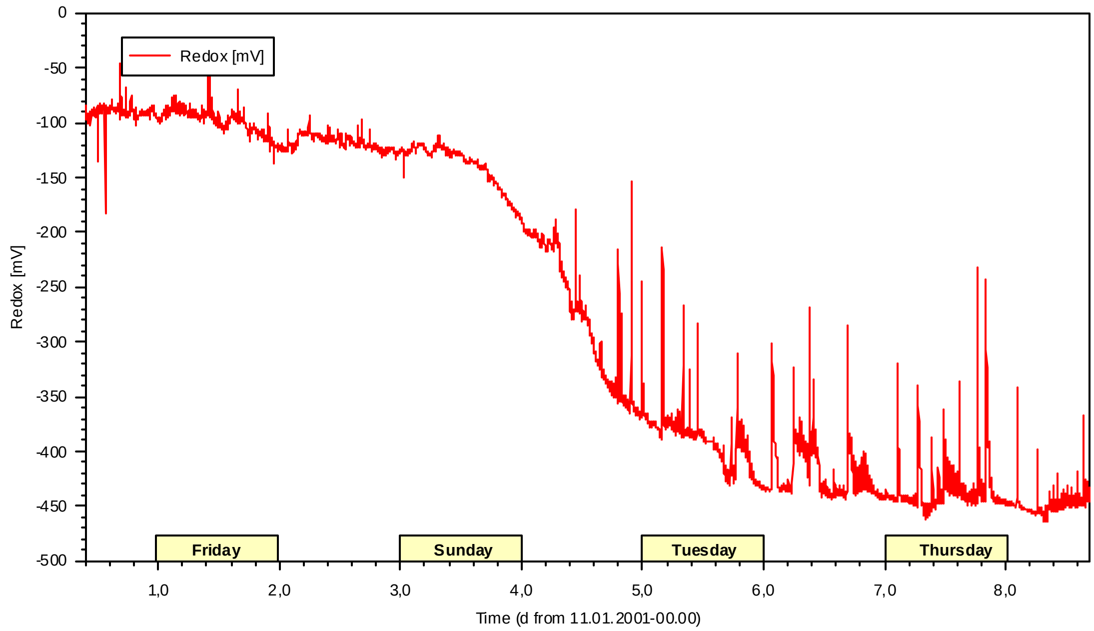


Fig. 14 Redox potential at Pumping Station 3

Hydrogen-Sulphide

During the sampling period there was a relatively continuous odour partly like the one of rotting eggs, which is identified with hydrogen-sulphide. The sulphide concentrations of the four samples are presented in Tab. 1.

	Date	Time	Sulphide in Inflow (mg/L)
PS3	11.01	20:45	0,56
	12.01	2:30	0,84
	13.01	24:00	0,35
	14.01	22:00	0,44

Tab. 1. Hydrogen Sulphide in Influent to Pump Sump 3

Composite Influent Sample Characteristics

Daily composite influent samples were analysed for COD, Total Nitrogen, Ammonia Nitrogen, Total Phosphate and Ortho-Phosphate in order to get an overall picture of the varying characteristics of the inflow. These results are shown in Tab. 2 below.

	COD (mg/L)	TN (mg/L)	NH_4-N (mg/L)	TP (mg/L)	o-P (mg/L)
11.1	626	25.6	16.2	7.0	3.4
12.1	736	28.6	10.8	6.0	1.9
13.1	510	24.3	10.0	3.9	2.2
14.1	263	25.0	8.4	4.1	1.4
15.1	600	15.4	11.0	5.3	3.5
16.1	388	37.4	9.4	8.6	6.6
17.1	576	28.6	8.9	7.7	4.0
18.1	488	32.4	16.2	7.5	4.0

Tab. 2. Chemical Analysis of Composite Influent Samples

Notably the ratio between COD: TN: TP is 100: 5.8: 1,3, which is quite normal for sewage. However there are some variations that point to other sources of wastewater than simply sewage. This is expected, as industrial waste, particularly from the Freeport, is included in the influent.

Summary of Major Findings

The major findings of the investigation of the sump are summarised below:

- The flow rate is around 300 - 600 m^3/h.
- COD ranged from below 200 to nearly1900 mg/L. This not usual for sewage and is an indication of industrial wastewater and/or cesspool discharge.
- Odour represents sometimes a significant environmental aspect particularly during the operation of the old treatment plant.
- The sump cannot be emptied completely as a routine.

Findings at Montego Bay Ponds

The following section of the report outlines the findings from the monitoring and measurements at the sewage treatment ponds.

Flow

The investigating team had to reject the use of the Venturi canal at the ponds for flow measurement. Figure 15 shows the flow variations during one day.

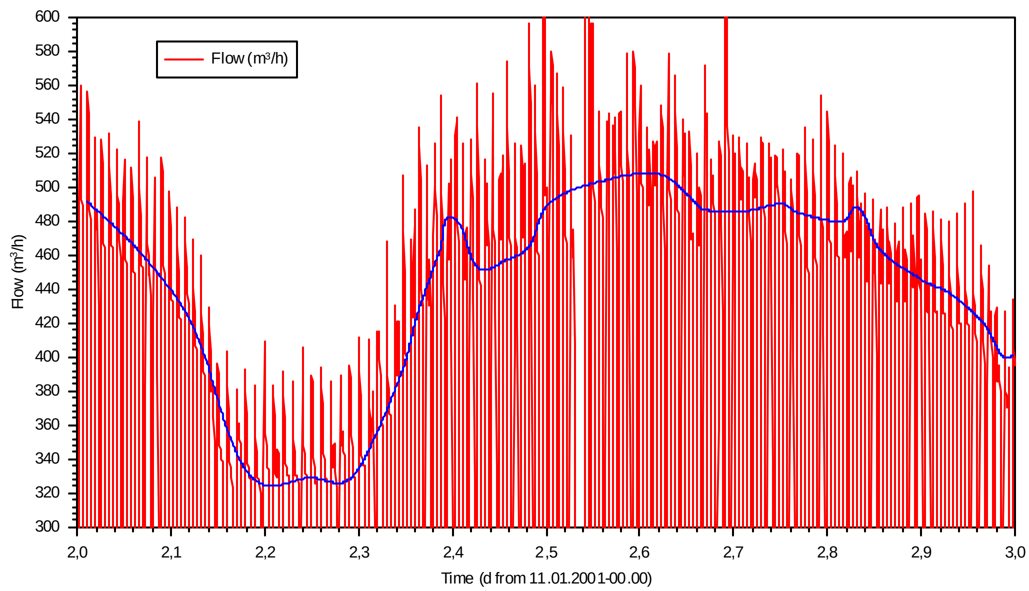


Fig. 15 Flow at Pump Sump 3 (Inflow to Ponds)

The flow drops significantly after midnight to around 320 m^3/h. The flow then rapidly increases to values between 400 and 500 m^3/h.

The screen is situated before the Venturi canal. However, the fact that there exists back flow in the canal is most likely due to the impact of the surge tanks. The result is backing up of water in the grit chamber and Venturi canal causing screenings to be washed away from the screen. Every time the flow stops, the screen is cleaned. During the rainy days no significant flow increase has been observed due to storm water entering the sewer.

The main pump sump #3 is the most appropriate place to measure the flow. However the exact sump area at different levels need to be determined. Sludge accumulation and/or a leaking non-return valve may impact on the measurement.

COD and Nutrients

The COD and nutrient concentrations of the influent to the ponds are shown in Tab. 3.
The table shows that the effluent values for TN are between 10 and 16 mg/L. Most of the N is present as ammonia-N, indicating that the progress in biological treatment is at the very beginning in the ponds. There is also the possibility that the biological nitrogen and phosphorus removal/fixation is inhibited or not given sufficient time to take place. TP varies between 3 and 5 mg/L. The o-P values show stronger variations.

	Pond (No.)	COD (mg/L)	COD-filtered (mg/L)	TN (mg/L)	NH_4-N (mg/L)	NO_3-N (mg/L)	TP (mg/L)	o-P (mg/L)
13.1	1	68	44	13,3	8,9	2,3	3,4	<0,5
13.1	2	49	47	14,5	8,8	2,4	4,5	0,25
13.1	3	47	34	12,2	9,7	2,7	4,0	0,84
16.1	3	63	57	10,6	8,4	1,9	4,5	3,5
18.1	1	67		14,9	6,6	1,4	3,4	1,9
18.1	2	63		13,3	5,0	1,5	3,7	2,1
18.1	3	43		15,3	4,5	1,7	3,7	1,4

Tab. 3. Pond Effluent COD

The COD as well as the settleable matter are significantly lower in the ponds than at pump sump 3. (refer to section 0). The reasons for this could be:

- Infiltration water
- Poor water conservation by users
- Retention of solids in the sumps
- Degradation during conveyance

The COD of the day composite samples is between 290 and 300 mg/L.

Note: COD value in inflow represents a composite of a few composite samples.

<u>Scum</u>

Pond 4 contained a scum layer, which appeared to be mainly grease, oil, suspended matter and algae. Operationally the scum is being removed from the surface on a daily basis.

The algae in pond 6 of the series in operation agglomerates sometimes to small round loose green particles, sometimes to tree shaped loose dark green agglomerates. In pond one, dark green-blue flakes of algae can be seen at the surface. The intensive smell attributed to the die off of algae was not observed during the sampling period.

Profile in Ponds

The first pond in each series was designed to be facultative and the other two in each series were designed to be maturation ponds.

In a facultative system the oxygen level up to 0,8 m depth never reaches zero. Below that level the facultative ponds are predominantly anaerobic. In terms of maturation ponds, they never become anaerobic.

During the investigations in January 2001 November oxygen levels were measured at different depths. In addition the oxygen profile during the night and the day were also observed.
Ponds 4, 5 and 6 are currently being operated. Figs. 16, 18, 19 and 20, show respectively the oxygen, temperature, pH and conductivity profiles at the surface and near the bottom at the outlet of the ponds. In the case of pond 1 generally the oxygen concentrations were extremely low, indicating that it predominantly functions as an anaerobic pond. Conductivity was recorded at around 1.0 mS/cm and the temperature ranged from 24 to 30 C.

For pond 2 the oxygen concentration was also highly variable. Thus indicating that pond two is a facultative pond. A sample of the effluent was taken and oxygen levels were measured continually for 24 hours (see Fig. 17). The observation showed that during the night the oxygen levels decreased, however not to zero. During the daytime the oxygen concentration increased, confirming the presence of algae and demonstrating that the degradation of organics and the oxygen consumption by algae at night is rather low. Conductivity and temperature were similar to those observed in pond 1.

The conditions in pond 3 were similar for all parameters as pond 2. No larger fish has been observed. Small ones were present, suggesting strong variations in water characteristics in the ponds.

Interesting oxygen profiles are present. Based on the strong variations in organic load, they can be considered as expected.

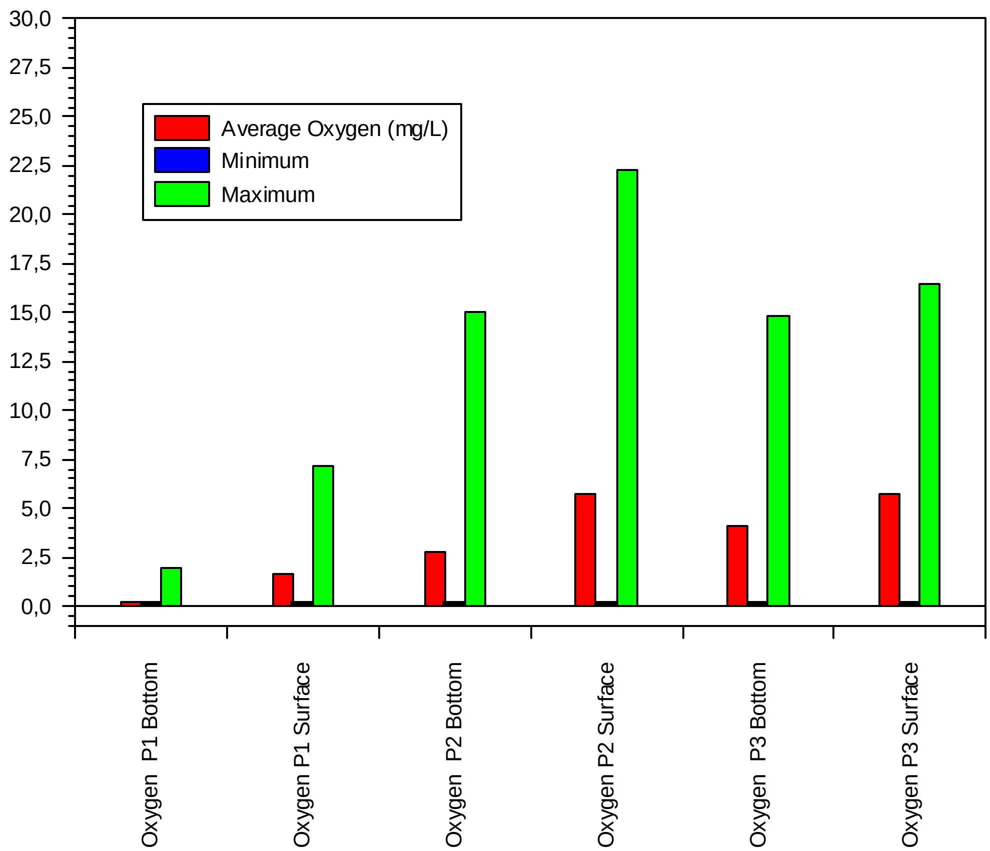


Fig. 16 **Oxygen profiles in the Ponds**

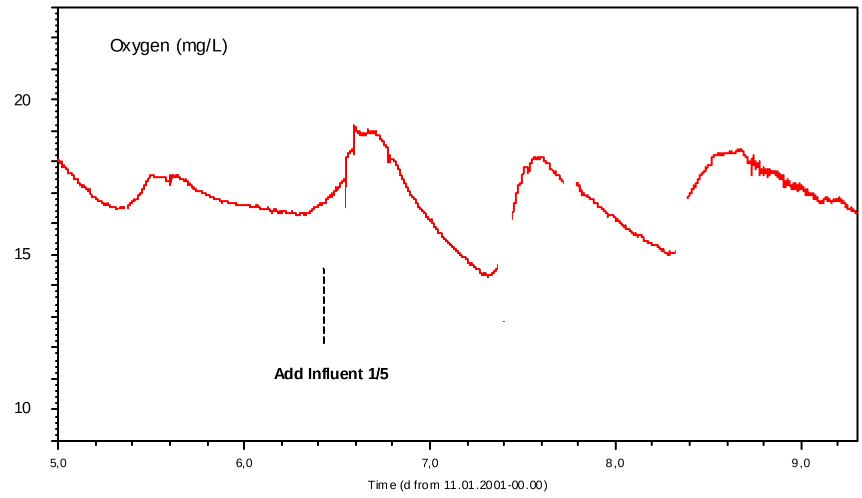


Fig. 17 Temperature of Ponds in Operation

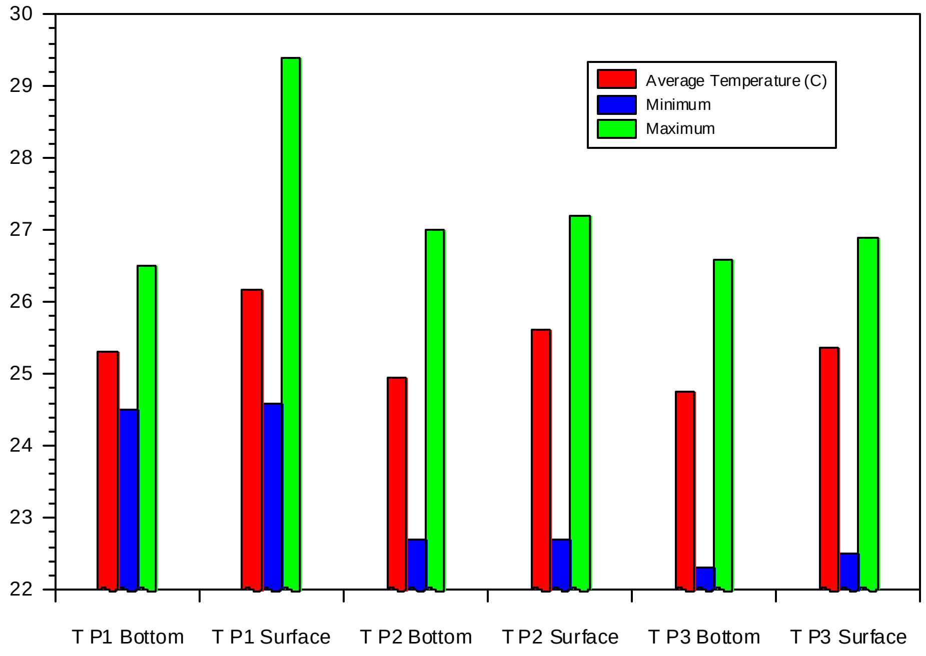


Fig. 18 Temperature profile in the ponds

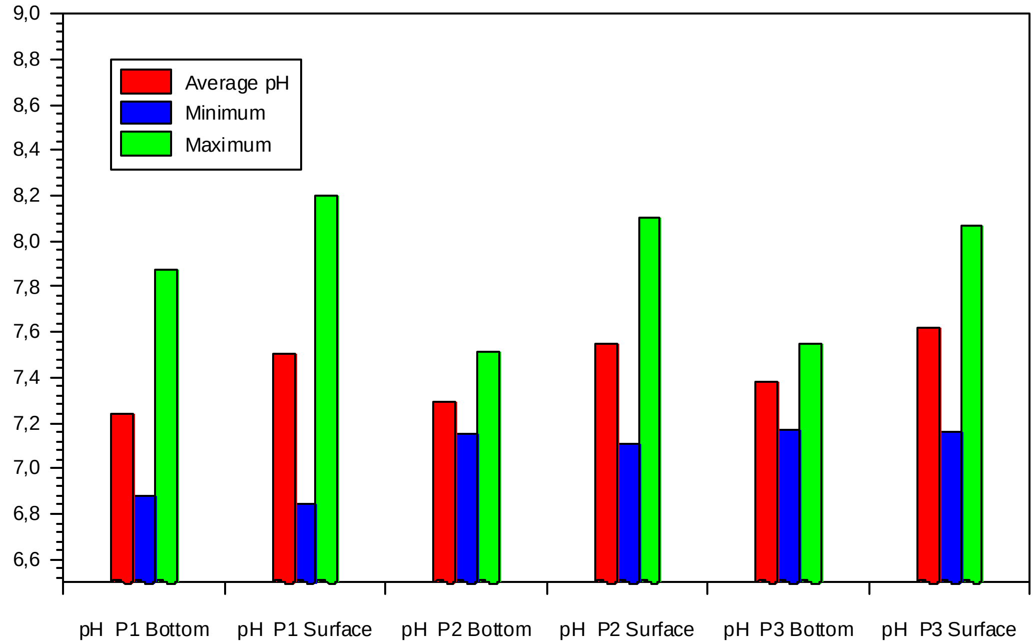


Fig. 19 pH profiles in the ponds

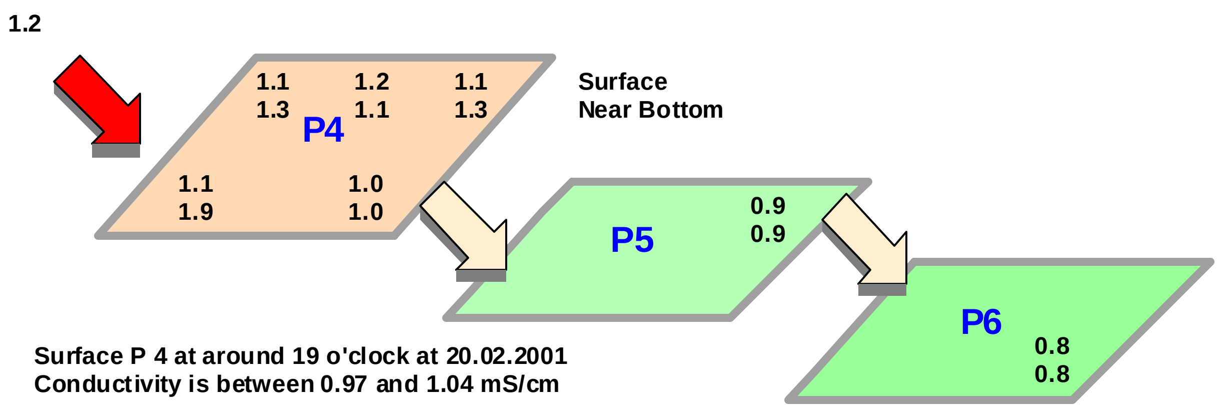


Fig. 20 Conductivity Profile after Salt Entered Pump Sump 3 Saturday Morning at around 6 a.m.

Final Effluent Quality

0 shows the NRCA standards, as listed in the Negril Wastewater Operations Protocol of May 2000, compared to the Montego Bay pond performance. Results indicate that COD, BOD, TSS, pH and TN have met NRCA requirements. DO and FC results are partly met. Conductivity and TP were not met, while the Ammonia figure is unacceptable (not having any standard).

Parameter	Unit	NRCA Standard	Compliance
COD	mg/L	<100	met
BOD	mg/L	<20	met
TSS	mg/L	<30	met
DO	mg/L	>4	partly met
pH		6-9	met
Conductivity	mS/cm	<0.4	not met
TN	mg/L	<10	met
TP	mg/L	<4	not met
FC	MPN/100 ml	<1100	partly met
Ammonia	mg/L	none	not acceptable

Tab. 4. NRCA Standards and Compliance November 2000

Summary of Major Findings

The following summarise the major observations during the monitoring of the Montego Bay sewage treatment ponds:

- The Venturi canal configuration is not suitable for flow measurement.
- Flow into the sump #3 has been used for estimating the flow into the ponds at around 10000 m^3/d.
- Flow rates are currently estimated around 10000 m^3/d
- Pond 4 predominantly anaerobic, pond 5 and 6 are facultative or sometimes maturation ponds.
- Significant odours occurred at the Venturi canal.
- Scum is being removed from the surface.
- The predominant Northeast wind direction tends to enhance short-circuiting.
- Strong variations in terms of organic load, incl. oil, may adversely affect pond performance.
- COD loading rate is approximately 425 kg/(ha.d) for pond string 2 with ponds 4,5 and 6
- The pond effluent does not meet all NRCA standards and would be considered a significant aspect for the EMS.

Inter-calibration

Samples, carefully mixed and then split, were sent on ice to different laboratories for chemical and biological analysis. Laboratories involved were:

- NWC laboratory at Bogue, St. James
- Jamaica Bureau of Standards
- Environmental Solutions Limited
- Environmental, Technical and Analytical Services Limited

Inter-calibration with different laboratories is a difficult and delicate matter. Every laboratory does its best to provide the most accurate and reliable data. Nevertheless, there may be differences in the outcomes. There are however so many different activities which could cause the differences in analytical values.

The individual laboratories carry out analysis themselves, however they may use other labs for certain analysis too.

Three different samples were selected for inter-calibration, including composite influent and grab effluent samples.

Existing Data

Existing data was received from NWC and reviewed by the consulting team. The details the consultants review have been placed in the appendices for reference.

Environmental Aspects

This is intended as initial environmental review to identify environmental aspects, which should form the basis for the development of an environmental management programme.

0 = significant
1 = very significant
2 = slight or moderate

Activity	Aspect	Impact	Quantification of Aspects	Significance
Inflow	Odour Release	▪ Air Pollution ▪ Corrosion	▪ H_2S level ▪ Observation	▪ 1 ▪ 0
Desludging	Solid Waste	▪ Landfill ▪ Agricultural use	▪ Volume, solids ▪ Volume, solids	▪ 0 ▪ 0
Scum Removal	Solid Waste	▪ Landfill	▪ Volume Solids	▪ 1
Treatment	▪ Odour Release ▪ Effluent	▪ Air Pollution ▪ Water Pollution	▪ Smell ▪ Biological (BOD, COD, SS) ▪ Nutrients (N, P) ▪ Pathogens (Fecal Coliform)	▪ 2 ▪ 0 ▪ 2 ▪ 0

Tab. 5. Summary of Environmental Aspects for Ponds

Conclusions

The investigations of the pump sump and the ponds treatment system indicate that there is variability in the overall treatment performance depending on conditions. For example:

- Changes in wind direction result in short circuiting and insufficient treatment.
- High strength waste adversely affects treatment performance
- Inflow drops at the pumps sumps and at the Venturi canal result in odour release

Given the present controlled levels of pond operations, none of these changes can be responded to effectively. The introduction of environmental management systems supported by effective data collection and an interactive training approach (on the job) can result in improvements in pond performance. However, it is fully recognised (see Negril report on assessment on pond treatment capacity) that other changes would need to accompany the introduction of an introduction of an EMS. Indeed these changes should be incorporated in the management plan. It is our recommendation therefore that for Montego Bay the implementation of the EMS should involve a consideration of this report as well as the capacity assessment report.

NWC Data

BOD and Nitrate

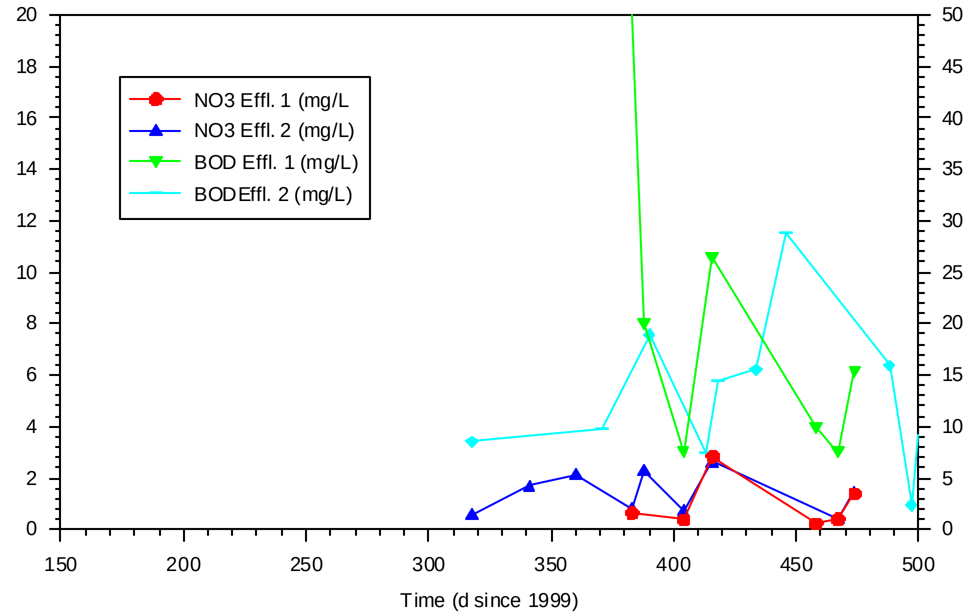


Fig. 5 BOD and Nitrate in the Effluent

PO4 and SS in Influent

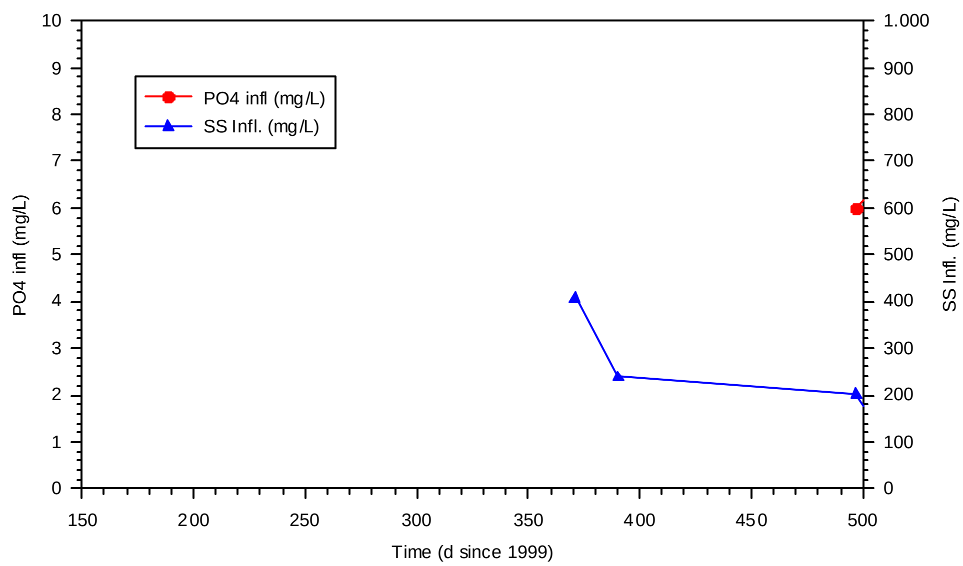


Fig. 6 PO_4 and SS in the Influent

DO

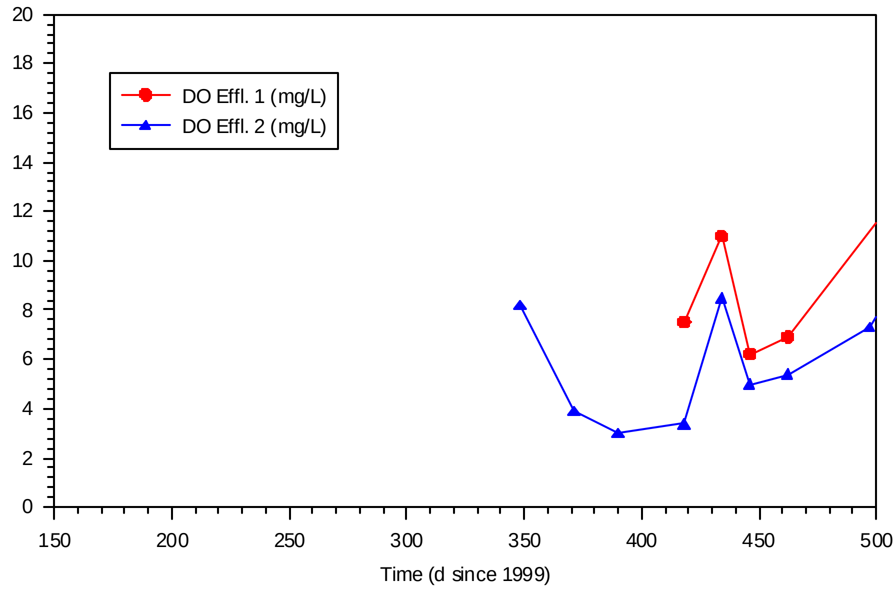


Fig. 7 DO in Effluent

PO_4

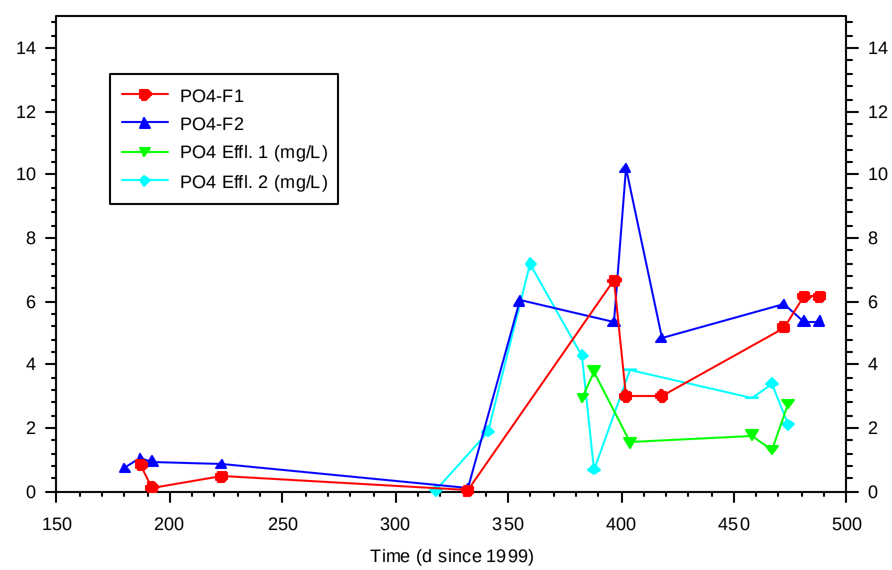
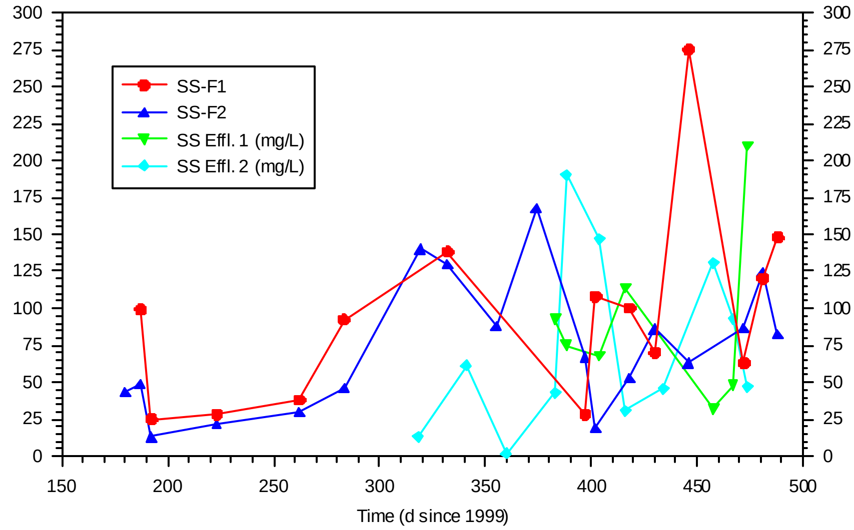


Fig. 8 Phosphate in first Pond in Series and Effluent

SS



Tab. 6. Suspended Solids in first Pond in Series and Effluent

Faecal Coli

No data in the data NWC data compilation are readily available.

OLD TREATMENT PLANT

Pict. 1. Old inflow structure is still in use for a number of incoming sewer lines

Pict. 2. Sedimentation Tank

Pict. 3. Digester

Pict. 4. View inside digester showing corrosion. Trickling filters are in background

Pict. 5. Pumping Station #3 discharges to the ponds

Pict. 6. Water bypasses screen after grit chamber

Pict. 7. Cesspool emptier discharges to the inflow

Pict. 8. View of aeration chamber and grit chamber

Pict. 9. Anaerobic Treatment in settling tank

Pict. 10. Oil in influent

Pict. 11. Easy access to top of surge tank

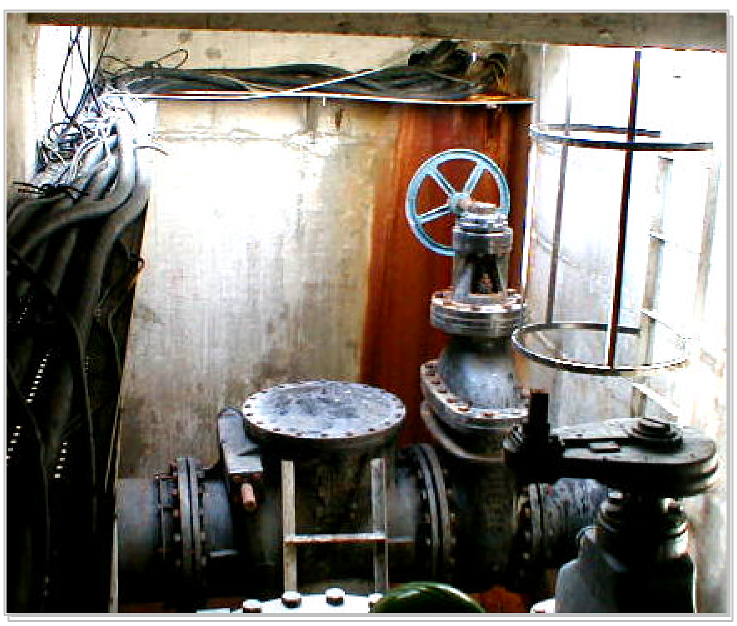
Pict. 12. Difficult access to monitoring equipment of surge tank

PUMP SUMP

Pict. 13. Power Cables to pumps.

Pict. 14. Valve and backflow valve not in use

Pict. 15. Valve requires maintenance



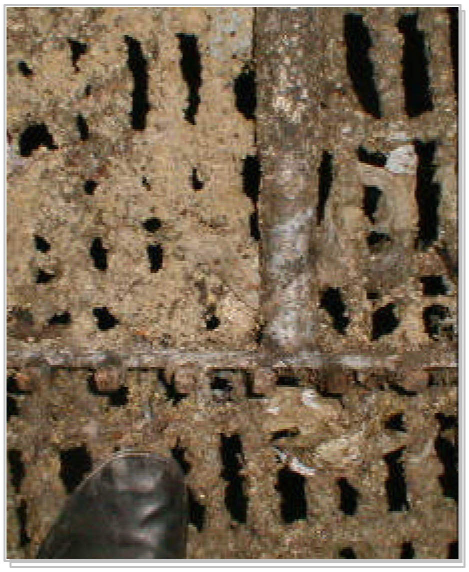
Pict. 16. Overview of valve room

Pict. 17. Outgoing Pressure Pipes

Pict. 18. Pump falling dry at low level

Pict. 19. Installing the Conductivity meter

Pict. 20. Level indications. Three pumps: one not in use; also a connection for a fourth pump



Pict. 21. No trace of recent entry in Pump Sump #3

Pict. 22. Inflow with screen

Pict. 23. Equipment to lift screens from Sump #3

Pict. 24. Setting up Monitoring and Control Unit

Pict. 25. Coarse Screen: Little Screen and Basket has not been used for a long time

Pict. 26. One line for extension (no pump)

Pict. 27. Scum in Pump Sump # 3

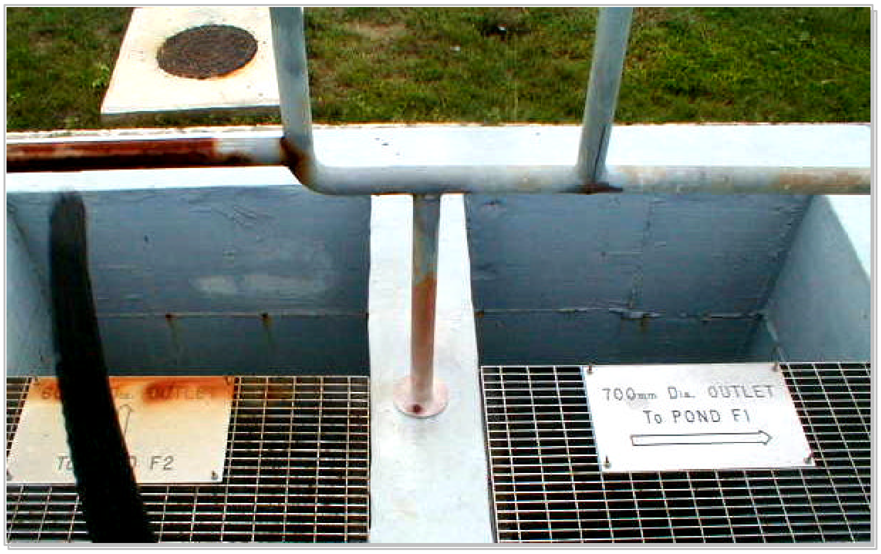
Pict. 28. Difficult access

Pict. 29. Difficult access

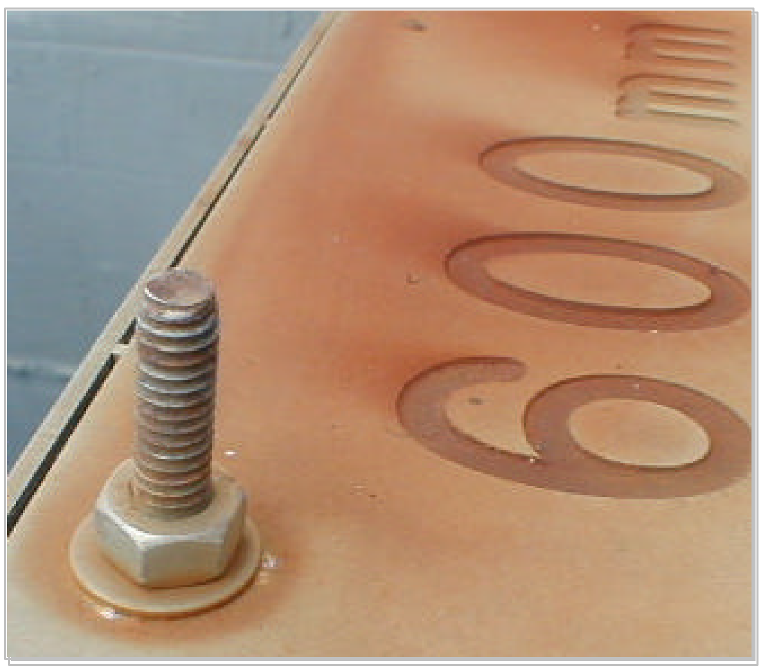
Pict. 30. Sample Collection

Pict. 31. Surge Tanks in Background; Cover of the Pump Sump in middle; Monitoring/Sampling setup in foreground

Pict. 32. Potassium Permanganate on site

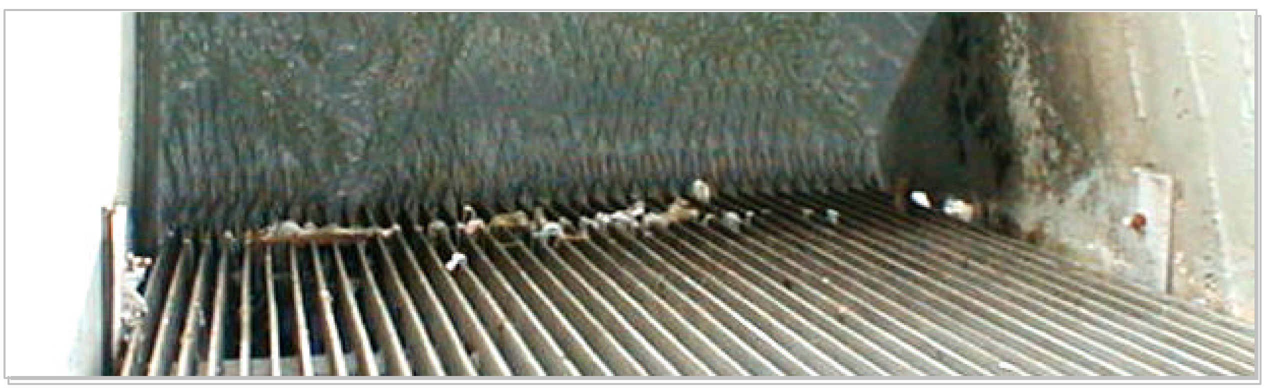


Pict. 33. Outlet of the Venturi Canal



Pict. 34. Safety Hazard

Pict. 35. Screen during Inflow



Pict. 36. Screen during backflow

Pict. 37. Collection of screenings. Good access to the screen

Pict. 38. Backflow of water

Pict. 39. Level Sensor properly installed

Pict. 40. Flow measurement very secure

Pict. 41. Improper construction at the Venturi outflow

Pict. 42. Venturi

Pict. 43. Backing up of water in the Venturi

Pict. 44. Grit chamber valves for cleaning

Pict. 45. No visible outflow

Pict. 46. Corrosion. Pipes blocked

Pict. 47. Distribution of Flow to the Ponds

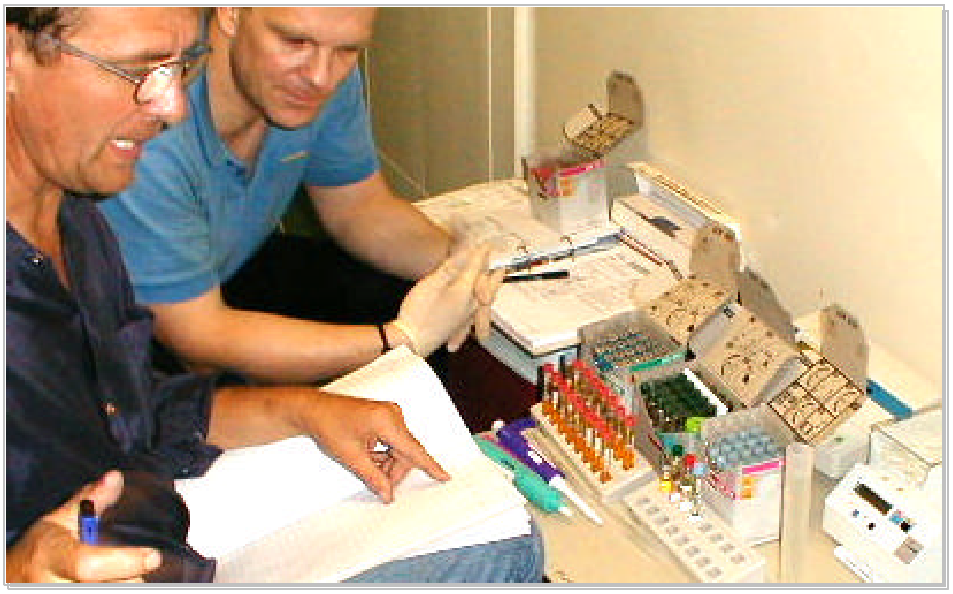
TREATMENT PONDS

Pict. 48. Aerial View of the MoBay Treatment Ponds

Pict. 49. Empty Pond M1.1 because lining has been cut from sides. Repairs to be done soon

Pict. 50. Covers not replaced properly

Pict. 51. two different influents to the Treatment Ponds

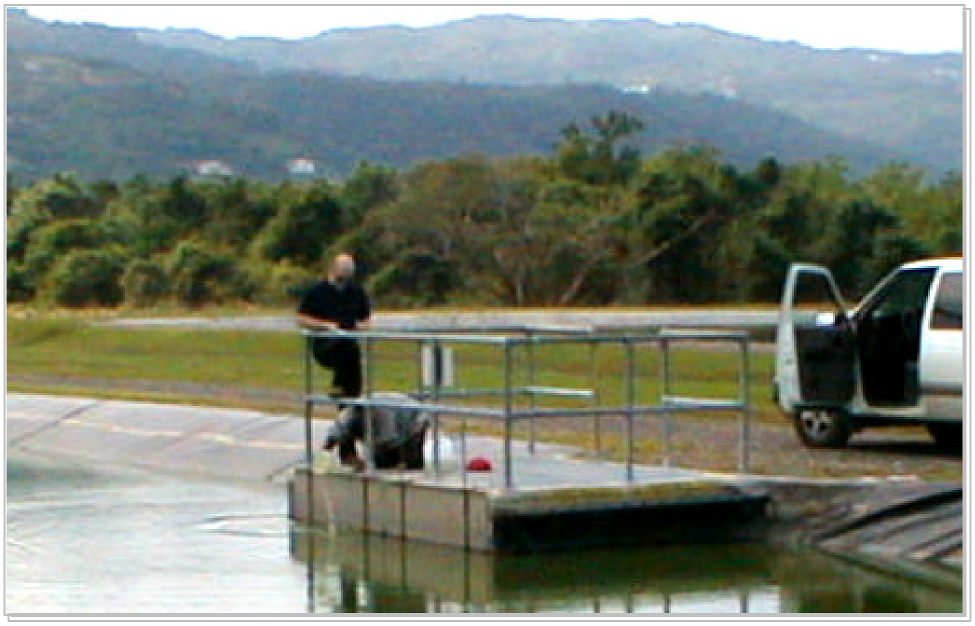


Pict. 52. Chemical Analysis done on-site

Pict. 53. Wave in Pond M1.2

Pict. 54. Toxic looking algae because of its green colour

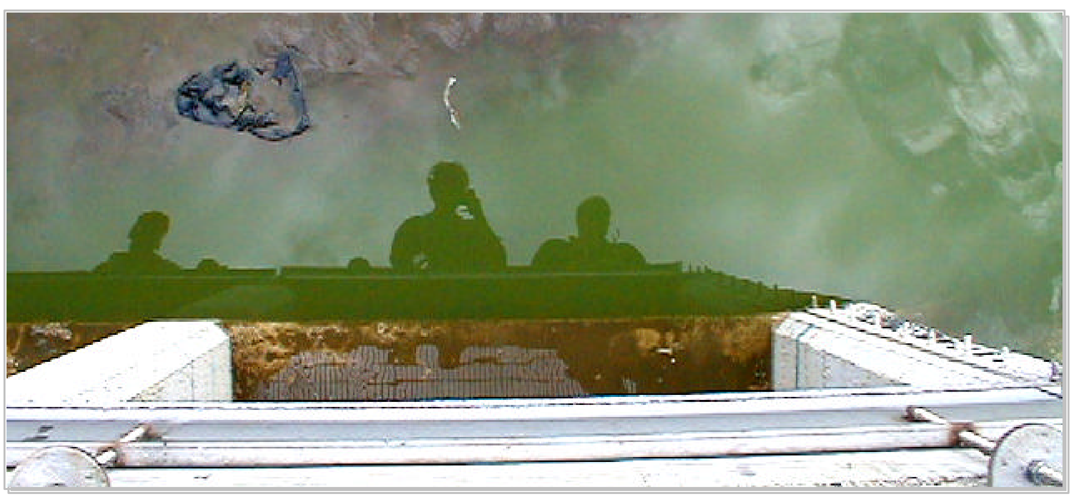
Pict. 55. Algae causing odour nuisance



Pict. 56. Outflow baffled at Pond F2

Pict. 57. Outflow structure at Pond M1.1

Pict. 58. Structure of Inflow to Pond F2



Pict. 59. Outflow of Pond M1.1

CWIP

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