EXECUTIVE SUMMARY

INTRODUCTION

The Water and Sewerage Authority (WASA) proposes to build and operate a wastewater treatment plant for the Malabar catchment area and to refurbish the existing treatment plant in the Maloney catchment in Trinidad. The intention to address wastewater collection, treatment and disposal in these catchments is part of an overall long term plan to address the wastewater needs of the entire region between Sangre Grande and Mount Hope, which is an area of high population density in Trinidad. The relevance and urgency of the project is made more evident with the knowledge that this entire region continues to undergo rapid industrial and commercial development as well as population growth.

Against this background WASA embarked upon a study to develop a Wastewater Master Plan for the East–West Corridor up to the design horizon 2035, and commissioned the "Expansion and Integration of Existing Wastewater Systems in Trinidad along the East – West Corridor and its Environs" study in May 2004. The study was undertaken by Safege Consulting Engineers and encompassed the area from Mount Hope to Sangre Grande in the East-West direction, and from the Northern Range to the Caroni River in the North-South direction. The study recognised the inefficiency of the region's wastewater treatment systems with regard to its capacity and capability, as well as the resulting potential public health and environmental threats presented. The study also recommended the creation of six regional wastewater catchment areas each serviced by a main regional wastewater treatment plant. It is proposed that a regional wastewater treatment system which allows for the integration and expansion of the existing wastewater facilities will lead to improvement of the riverine water quality in the catchment areas and alleviate the public health and environmental risks now being encountered. Integration, which allows for the operation and maintenance of fewer regional plants, presents a more cost-effective and management efficient solution over the current system which involves the operation and maintenance of segregated wastewater plants, scattered throughout the study area.

Subsequent to the master plan study a conceptual design of the six regional catchments to a design horizon of 2035 was developed. Of the six regional wastewater catchment areas identified, the Malabar and Maloney catchments are considered to be of greatest priority for development especially since the the majority of the existing sewerage systems are either abandoned or in a dire state of disrepair and sewage flows are not being efficiently or effectively treated. The Malabar catchment is of particular significance because it drains into the Caroni River upstream of the Caroni Arena Water Treatment Plant (WTP) which provides potable water both north and south of Trinidad.

The project scope involves the establishment of a conventional activated sludge wastewater treatment plant (WWTP) for the Malabar catchment area and the refurbishment and expansion of the existing Maloney Gardens WWTP – the only functional facility in the Maloney catchment area. It also involves the installation of new lift stations, underground pipelines, sewer mains and all associated gravity flow collection works in these two high priority catchment areas. The project includes the decommissioning of five existing WWTPs in the Malabar catchment and five existing WWTPs (all currently operating below desired standards) in the Maloney catchment, as well as the decommissioning of selected lift stations within the catchment service areas, with establishment of new lift stations in areas in which gravity flow is hindered. Existing sewers will be integrated with the new mains constructed.

THE PROJECT SITE

The project site comprises two key areas, Malabar and Maloney, and encompasses approximately 3,835ha. The Malabar project area spans approximately 2,766 ha and is bound by the Northern Range to the North, the Caroni River to the South, the Maloney Catchment to the west and the Valencia/Wallerfield catchment to the east. The region encompasses the following main areas: Arima, Malabar, Santa Rosa, La Horquetta, O'Meara, Maturita, and Cleaver Heights.

Approximately 29% of the population equivalent[1] (pe) has access to sewerage facilities in this region. The plant design will accommodate population projections to the year 2035 and will employ ultra violet light disinfection to meet EMA discharge requirements for inland waters. The conventional activated sludge plant will be located south of the Churchill Roosevelt highway, South-West of the existing Malabar WWTP and will discharge treated effluent into a creek just south of the site which drains into the Mausica River and subsequently into the Caroni River. Waste solids will be dewatered, solar dried and stabilized in greenhouses. This will entail the acquisition of 11.06 ha of land for the plant and sludge beds. Five existing plants in the catchment area will be decommissioned and new and existing sewers will be integrated into a comprehensive gravity fed sewage collection system. Eight new lift stations and the laying of over 175 km of sewerage mains are proposed for the catchment area. Construction of the treatment plant is expected to take 3.5 years while construction of the comprehensive sewerage system is expected to take 4.3 years.

The Maloney project area spans approximately 1069 ha and is bound by the Northern Range to the North, the Church Roosevelt Highway to the South, the Malabar catchment to the east and the Trincity catchment to the West. The region includes the following main areas: La Resource, La Florissante, Santa Monica, Lillian Heights, Maloney Gardens and Lynton Gardens. Approximately 59% of the total population equivalent (pe) of the Maloney catchment currently has access to sewerage facilities. The project proposes the refurbishment and expansion of the existing Maloney Gardens WWTP to accommodate population projections to the year 2035. The plant will be a conventional activated sludge plant with ultra violet (UV) light disinfection capability. Treated effluent will meet EMA discharge requirements for inland waters and will be discharged into the Oropuna River. This will entail the acquisition of 3.6 hectares (ha) or 8.9 acres of land to accommodate the expansion. It will involve the construction of five new lift stations for the gravity fed collection system which will be integrated into the existing sewer system and the laying of over 19 km of new sewerage mains. All five other treatment plants in

[1] Refers to the amount of oxygen-demanding substances whose oxygen consumption during biodegradation equals the average oxygen demand of the waste water produced by one person.

the catchment area will be decommissioned. Tender and construction of the system is expected to span two years and commence in 2010.

An application for a Certificate of Environmental Clearance (CEC) for this development was submitted to the Environmental Management Authority (EMA) in accordance with CEC Rules 2001. The EMA determined that the application required an Environmental Impact Assessment (EIA) study to be conducted to assist in its determination of the application since the project was considered to have the potential for environmental and social impacts. Final Terms of Reference (TOR) dated 3rd August 2006 for the conduct of the EIA in support of WASA's application (CEC 1469/2006), was provided to WASA. The services of Rapid Environmental Assessments (2003) Limited were secured by WASA's primary consultant Earth Tech (AECOM), to conduct an EIA in accordance with the Final TOR issued by the EMA.

The goal of an EIA is to:

- Provide information which allows developers to maximize benefits of the project to themselves, the environment and local and national community;
- Allow regulators to ensure that the positive impacts of the project are maximized and the negative impacts eliminated or minimized to acceptable levels;
- Allow the community and the wider public to have an understanding of the project and its impacts upon them and their socio-economic and physical environment, and to have their views and concerns addressed.

This EIA report consists of a Main Text and Appendices which document a detailed description of the project and the environmental and social setting in which it will be constructed and operated, a list of the environmental and social aspects of the project, as well as an identification of the potential environmental and social impacts of the project. The EIA report also includes mitigation measures which, when employed, will reduce residual impacts to minor or beneficial during the construction and operational phases of the proposed project.

BASELINE BIOPHYSICAL AND SOCIAL ENVIRONMENT

The project is located in a largely residential and commercial area. The area is not the habitat of any endangered or protected species. Topography is gentle to undulating and soils consist of clays and loams. As such soil instability, erosion and drainage do not present as major factors of concern in the project area. The most noteworthy biophysical parameter investigated in the area was that of surface water quality. An analysis of surface water quality of the Malabar and Maloney catchment areas revealed very high levels of total and faecal coliforms, high Biological Oxygen Demand (BOD) and high levels of nutrients - Phosphates, Nitrates, Nitrites and Ammonia - in the samples taken from the Arouca, Oropuna, Mausica, Arima, Guanapo, Caroni and Oropuna Rivers. Fish species recorded from samples taken from the Caroni tributary system represented only 65% of the potential species known for the Caroni river system, a probable indicator that the health of the river system is compromised.

The Social Environment was assessed through reviews of data, reports in the public domain, Central Statistical Office and primary data collection via household surveys. Over 900 households were interviewed in the conduct of the survey. The investigation revealed that respondents have an overall sense of benefit to be derived from the project, both on a personal and community level including factors such as employment generation, cleaner water courses and the reduction of potential harm to aquatic life. On the negative side some were apprehensive regarding the technology involved in chemical treatment of water and the risk to human health. Of particular interest is the general concern regarding poor road surfaces in the project area since implementation of the project will require severe but temporary disruption of roadways, property access and traffic diversions.

POTENTIAL IMPACTS AND MITIGATION

An analysis of the project elements revealed the following potential impacts associated with the proposed project:

- Traffic congestion during construction
- Temporary disruption to sewage disposal
- Minimal increase in air pollutants and noise levels

Some of the beneficial aspects of the proposed project include:

- Increased sewage disposal efficiency
- Improvement in riverine water quality, particularly tributaries of the Caroni River, and water entering the Caroni WTP
- Minor employment opportunities
- Decrease in human health and environmental concerns regarding untreated wastewater

Mitigation strategies against traffic congestion include a traffic management plan which seeks *inter alia* to inform the community of traffic diversions and disruptions, with adequate provisions for detours including signage, minimizing open trenching as much as possible and restoration of damaged pavement/roadways to its original condition as soon as is practically possible.

Dust levels can be mitigated against by application of dust palliative such as wetting of cleared and exposed areas particularly in the dry season, clearing only the minimum area necessary for construction and by restoration of damaged pavements and roadways as soon as is practically possible. Natural re-vegetation will be encouraged as early as practical after the completion of construction. Exhaust fumes will be minimised by enforcing a structured vehicle maintenance plan including scheduled vehicle inspections, engine maintenance and the optimizing of the use of equipment and vehicles.

Noise levels in populated areas will be mitigated against by confining activities to the hours between 7 am and 7 pm. Communication with administrative representatives of nearby institutions e.g. schools prior to construction in the area will be a fundamental component of the construction phase.

In an effort to accentuate the positive project impacts and ensure employment opportunities for community residents, construction contractors should be required to use local labour to the full extent possible. A condition of the use of local labour will be the provision of relevant training by the Contractor(s) to enhance the skills of the local labour force.

The project has a net positive benefit with residual impacts (after mitigation) ranging from minor/insignificant (3) to positive (6). Significant positive impact to human health and the environment through marked improvement of surface water quality to levels which ultimately pose no risk to human health are expected. The project is expected to meet the proponent's objective of providing a cost effective, management efficient solution to the waste water treatment challenges currently facing the catchment area while meeting a sustainable development objective.

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GLOSSARY OF TERMS

Accretionary prism	a wedge-shaped mass of sediment and rock scraped off the top of a downgoing plate and accreted onto the overriding plate at a convergent plate margin
Aerobic	living or occurring only in the presence of oxygen
Aerobic Digester	a chamber which facilitates digestion of matter suspended or dissolved in waste by microorganisms under favourable conditions of oxygenation
Anoxic	areas of water that are depleted of dissolved oxygen
Attenuation	the gradual loss in intensity of any kind of flux through a medium
Azimuth	the angle from a reference vector a reference plane to a second vector in the same plane, pointing toward, (but not necessarily meeting), something of interest
Bioreactor	a fermentation chamber in which living organisms, especially bacteria digest (break down) harmful substances (as in sewage)
Coliform	Coliform bacteria are the commonly-used bacterial indicator of sanitary quality of foods and water
Cutthroat flume	flow measuring device for open channel flow, commonly used in stream gauging, agricultural and sanitary applications
Denitrification	an anaerobic biological process, employed to convert the nitrate-nitrogen in effluent from the activated sludge-nitrification process into nitrogen gas
Effluent	The sewage or industrial liquid waste that is released into natural water by sewage treatment plants, industry, or septic tanks
Erosion control blanket	a preformed protective blanket of plastic fibres, straw or other plant residue designed to protect soil from the impact of precipitation and overland flow, and retain moisture to facilitate establishment of vegetation

Finish grade any surface cut to or built to the elevation indicated for that point. Surface elevation of lawn, driveway or other improved surfaces after completion of grading operations

Force main a pipe that conveys wastewater under pressure from the discharge side of a pump to a point of gravity flow

Headworks A system of screens and grit chambers which remove large objects, sand and gravel from sewage at the point of entry into a wastewater treatment plant

Influent Water, wastewater or other liquid flowing into a reservoir, basin or treatment plant

Inter Tropical Convergence Zone a belt of low pressure girdling the Earth at the equator, formed by the vertical ascent of warm, moist air from the latitudes north and south of the equator

Kick 'Em Jenny an active submarine volcano on the Caribbean Sea floor about 8km north of the island of Grenada

Lift Station Structures (tank or chamber and accompanied pump) installed along the sewerage network at a low point to pump effluent to a point of higher elevation in cases in which the topography prevents downhill gravity flow

Metamorphic rock rock derived from pre-existing rock altered by marked changes in pressure and heat

Parshall flume a calibrated device used to measure the flow of liquids in open conduits

Phylite a metamorphic rock formed from clay-rich sediments which is intermediate between slate and mica schist. It has a silky sheen on undulating cleavage surfaces

Polymer a coagulant added to a wastewater flow to help separate out components, typically solids from liquids.

Population equivalent	refers to the amount of oxygen-demanding substances whose oxygen consumption during biodegradation equals the average oxygen demand of the waste water produced by one person
Primary Treatment	initial sewage treatment which removes materials that can be easily collected, such as larger settleable solids e.g. sand and gravel and floating materials e.g. rags as well as fats, oils and greases (FOG)
Quartzite	hard metamorphic rock (which was originally sandstone) consisting mainly of interlocking quartz crystals
Rip rap	coarsely broken rock used for protection against erosion of embankment or gully
Riverine	of or pertaining to a river or system of inland wetlands
Secondary Clarifier	secondary treatment process designed for gravity removal of suspended matter
Secondary Treatment	stage in sewage treatment designed to degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent
Septage	all sewage matter (liquids and solids) that is pumped out of septic tanks and holding tanks
Sludge	the residual semi-solid material left from industrial, water treatment, or wastewater treatment processes
Sludge digester	Tank in which complex organic substances like sewage sludge is biologically dredged
Strike slip fault	a geologic fault in which surfaces on opposite sides of the fault plane have moved horizontally and parallel to the strike of the fault
Tectonics	the branch of geology studying the folding and faulting, structure and movement of the earth's crust

Tertiary Treatment Final treatment stage designed to raise the effluent quality for discharge to the receiving environment. The process involves nutrient removal as well as disinfection

Thermohaline refers to the part of the large-scale ocean circulation that is driven by global density gradients created by surface heat and freshwater fluxes

Torque measure of how much a force acting on an object causes that object to rotate

Trunk sewer a sewer which receives and transports wastewater from many tributary branches or sewers, serving a large territory, and transports it to a central destination such as a lift station or treatment plant

Vortex grit chamber a chamber in which rotating paddles create a mechanically induced vortex or spiralling flow, which transports it to the centre, settles it and efficiently removes grit from the treatment plant influent stream

Washover pipe large-diameter pipe fitted with an internal grappling device and cutting surfaces on the bottom. It serves as a conduit for drilling fluid

Wet well a chamber or tank in which wastewater is collected, and to which the suction pipe of a pump is attached

ABBREVIATIONS AND ACRONYMS

<	Less than
>	Greater than
^{o}C	Degrees Celsius
#	Number
%	Percent
ADWF	Average Dry Weather Flow
ASTM	American Society for Testing and Materials
BFP	Belt Filter Press
BI	Base Infiltration
BOD	Biological Oxygen Demand
CEC	Certificate of Clearance
CRH	Churchill Roosevelt Highway
d	Day
d/wk	Day per week
DO	Dissolved Oxygen
DWF	Dry Weather Flow
EIA	Environmental Impact Assessment
EMA	Environmental Management Authority
EMP	Environmental Management Plan
EMR	Eastern Main Road
FOG	Fats, Oils and Grease
GPS	Global Positioning System
GORTT	Government of the Republic of Trinidad and Tobago

ha	Hectare (10,000m^2)
HCL	Home Construction Limited
HDC	Housing Development Corporation
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HMI	Human Machine Interface
hr/d	Hour per day
HRT	Hydraulic Retention Time
IES	Illuminating Engineers Society
kg	Kilogram
km	Kilometre
km^2	Square Kilometre
kPa	Kilopascal
kW	Kilo Watt
L	Litre
Lpcd	Litre per Capita per Day
Lpd	Litre per Day
L/s	Litres per second
m	Metre
mg/L	Milligrams per Litre
mL	Millilitre
ML/d	Million litres per Day
MCC	Motor Control Centre
MFO	Market Facts and Opinions

MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
NHA	National Housing Authority
OFR	Over Flow Rate
PDWF	Peak Dry Weather Flow
Pe	Population Equivalent
pH	Negative Logarithm of Hydrogen Ion Concentration
PLC	Programmable Logic Controller
PPWF	Peak Wet Weather Flow
PVC	Polyvinyl Chloride
PWWF	Peak Wet Weather flow
RAS	Return Activated Sludge
RW	Raw Wastewater
SAE	Standard Aeration Efficiency
SND	Simultaneous Nitrification and Denitirfication
SRT	Solids Retention Time
SWD	Side Water Depth
T&TEC	Trinidad and Tobago Electricity Commission
TN	Total Nitrogen
TOR	Terms of Reference
TP	Total Phosphorus
TSS	Total Suspended Solids
TSTT	Telecommunications Services of Trinidad and Tobago
TWAS	Thickened Waste Activated Sludge

USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
UV	Ultraviolet
W1	Potable water
W2	Service water
W3	Treated effluent water
WAS	Waste Activated Sludge
WASA	Water and Sewerage Authority of Trinidad and Tobago
WTP	Water Treatment Plant
WWTP	Waste water Treatment Plant

1 INTRODUCTION

The Water and Sewerage Authority (WASA) of the Ministry of Public Utilities (MOPU) applied to the Environmental Management Authority (EMA) in April, 2006, for a Certificate of Environmental Clearance (CEC) for the establishment and operation of two wastewater treatment plants, one for each of the catchment areas of Maloney and Malabar, inclusive of associated works, laying of sewage mains and decommissioning of existing treatment plants. The EMA adjudged the project to have significant environmental and social impacts and notified WASA that the CEC application could only be entertained after completion of an Environmental Impact Assessment study conducted against specific terms of reference. Final Terms of Reference (TOR) were provided to WASA by the EMA on 3rd August 2006 (Ref: CEC1469/2006) for the conduct of an Environmental Impact Assessment (EIA) study.

1.1 OVERVIEW

The area between Sangre Grande and Mount Hope, Trinidad is commonly referred to as the East–West Corridor, an area of the highest population density for the island of Trinidad. The population density in the area exceeds 22 inhabitants per hectare, thus meeting the United Nations Population Division definition of a high population density area, and is one of the major axes of urban growth for Trinidad with several planned developments which will utilize available land for residential development. In the Study Area, land use is dominated by residential settlement, together with areas of commercial and industrial land use.

In May, 2004 the Water and Sewerage Authority of Trinidad and Tobago (WASA) commissioned the “Expansion and Integration of Existing Wastewater Systems in Trinidad along the East – West Corridor and its Environs”. The major aim of this study was the provision of a Wastewater Master Plan for the East–West Corridor up to the design horizon 2035. The study area encompassed the area from Mount Hope in the West, to Sangre Grande in the East and from the Northern Range in the North to the Caroni River in the South. The study, undertaken by Safege Consulting Engineers, recommended the creation of six regional catchment areas for development of regional wastewater treatment plants. This approach provides a structured long-term solution to address the myriad issues linked to environmental pollution caused by the discharge of untreated wastewater into rivers and streams. Regional wastewater treatment plants allow for the integration and expansion of the existing wastewater facilities and will alleviate public health and environmental risks. Integration, which allows for the operation and maintenance of regional plants, presents a more cost-effective solution over the operation and maintenance of segregated wastewater plants, scattered throughout the study area.

In maximizing the integration of existing independent wastewater systems and gravity flows to the future regional wastewater treatment plants, the six regional wastewater catchments (and associated sub-catchments) identified in the study are:

1. Bamboo sewerage catchment:
   - St Joseph / Tunapuna sub-catchment;
   - Frederick Settlement sub-catchment.
2. Trincity sewerage catchment,
   - Trincity sub-catchment
   - Piarco sub-catchment
3. Maloney sewerage catchment
4. Malabar sewerage catchment
5. Wallerfield catchment
   - Valencia sub-catchment
   - Wallerfield sub-catchment
6. Sangre Grande sewerage catchment

The Master Plan Study was followed by a conceptual design of the six regional catchments to a design horizon of 2035. Population and land use forecasts, per capita effluent flow and load projection and estimated effluent flow and load per customer were employed in the determination of future effluent flows and loads up to design horizon 2035. As part of the studies, the Malabar catchment was ranked as the number one priority for development in large part because the catchment drains to the Caroni River upstream of the Caroni Water Treatment Plant (WTP).

The implementation of the overall project for six regional sewerage catchments will be addressed in two phases. The scope of this document involves the proposed works for the two high priority catchments. :

- Malabar Wastewater Catchment
- Maloney Wastewater Catchment

Two wastewater treatment plants are proposed in this project: one for each of the catchment areas of Malabar and Maloney.

1.1.1 Maloney Wastewater Catchment

The Maloney catchment consists of an area of 1069 hectares situated north of the Churchill Roosevelt Highway and south of the Northern Range with the Malabar catchment to the East and the Trincity catchment to the West. The Maloney Catchment in 2005 was recorded as approximately 23,620 inhabitants while projected population for 2035 is estimated to be 31,420 inhabitants. At present, approximately 59% of the total population equivalent of the Maloney catchment has access to sewerage facilities. The majority of the existing sewerage systems, however, are either abandoned or in a dire state of disrepair. Of the six (6) wastewater treatment plants (WWTPs) listed below, five (5) are abandoned and only the Maloney WWTP is currently operational:

1. La Florissante
2. La Resource
3. Lillian Heights
4. Lynton Gardens
5. Santa Monica
6. Maloney

The project proposes the refurbishment and reuse of the existing Maloney Activated Sludge Wastewater Plant located south of the Churchill Roosevelt Highway with design to meet the 2035 population capacity requirements. The aeration system, recirculation/sludge extraction systems and scrapers will be replaced and new sludge treatment facilities will be constructed. Three modules of 3,750m^3/day are envisaged with treated effluent discharge into the Oropuna River.

Duration of construction is expected to be approximately three years and involves the following key elements:

- Refurbishment and expansion of the existing Maloney Gardens WWTP to meet the needs of 2035 forecasted population estimate of 31,420;
- Acquisition of 3.6 ha of land for the new centralized wastewater treatment plant which includes area for sludge drying beds.
- Laying over 48.5 km of sewerage mains;
- Construction of 5 lift stations;
- Installation of service connections to serve customers;
- Decommissioning of the five abandoned WWTPs and replacement with sewerage pumping stations where gravity flow to the new network cannot be ensured.

1.1.2 Malabar Wastewater Catchment

The Malabar catchment consists of an area of 2,766 hectares and is situated north of the Caroni River and south of the Northern Range with the Maloney catchment to the West and the Valencia/Wallerfield catchment to the East. Resident population of Malabar area in 2005 is recorded as 69,687 inhabitants while projected population for 2035 is estimated to be 108,630 inhabitants. At present, approximately 29% of the total population equivalent of the Malabar catchment has access to sewerage facilities and as with the other catchment areas, the majority of the existing sewerage systems are either abandoned or in a dire state of disrepair.

Six wastewater treatment plants currently in the Malabar catchment are as follows:

1. Arima WWTP
2. Malabar Wastewater Treatment Plant
3. Hermitage Heights
4. Tumpuna Gardens
5. Ascot Gardens
6. Maturita

The project proposes the decommissioning of the existing Arima Wastewater Treatment Plant and the construction of a new conventional activated sludge plant in Malabar, south of the existing Malabar Wastewater Treatment Plant (WWTP). The new plant will consist of two modules with a total capacity of 189,016 m^3/day to treat flow from all existing WWTP's as well as the currently unsewered portions of the catchment. Treated effluent from the plant will be discharged into a creek, which drains into the Mausica, then Caroni Rivers.

The duration of Phase 1 construction is projected to be approximately four years and involves the following key elements:

- Construction of a new wastewater treatment plant to meet the needs of 2035 forecasted population of 108,630.
- Acquisition of 11.06 ha of land for the new centralized wastewater treatment plant, which includes area for the sludge drying beds.
- Laying 175 km of sewerage mains.
- Construction of 8 lift stations.
- Installation of service connections to serve customers.
- Decommissioning of five abandoned WWTPs

Figure 1.1 below shows the location of the project area in Arima.

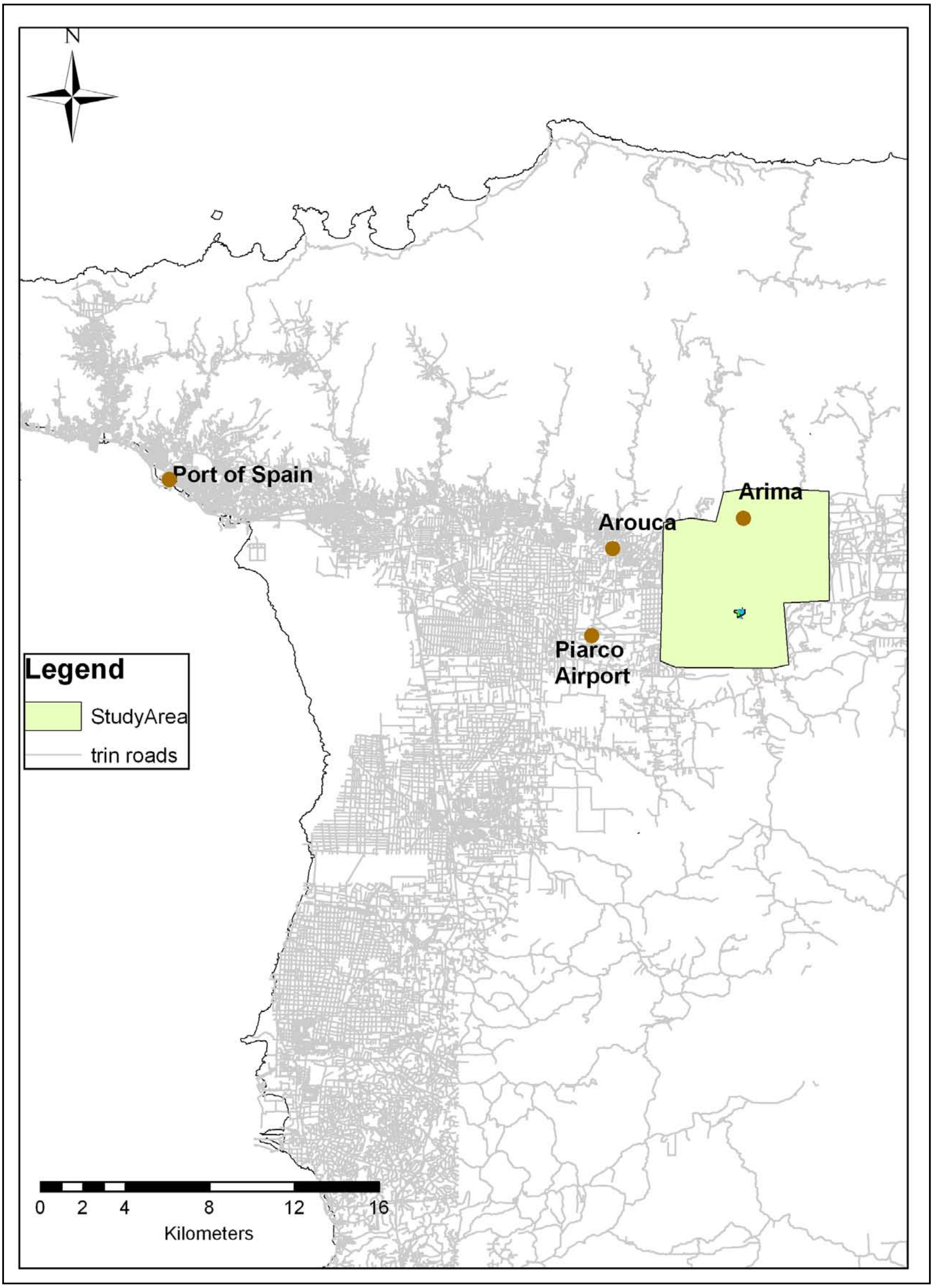


Figure 1.1 Project Area

It is proposed that both the new Malabar WWTP and the refurbished Maloney WWTP be designed to accommodate the population capacity requirements of 2035. Both plants require the establishment of primary, secondary and tertiary pipeline networks. Sludge is to be disposed at landfills or reused in rehabilitating degraded sites e.g. quarries. It is also proposed that approximately 5% of the treated effluent from both treatment plants will be used in irrigation of on-site lawns and other landscaped areas and for washing down purposes.

In accordance with the Certificate of Environmental Clearance (CEC) Rules, 2001 and Activity 42 of the CEC (Designated Activities) Order, 2001, an application for a CEC (CEC 1496/2006) for the establishment of regional wastewater plants at Maloney and Malabar, inclusive of all associated works, laying of sewage mains and decommissioning of existing plants, was submitted by WASA to the Environmental Management Authority (EMA) in April 2006.

Rapid Environmental Assessments (2003) Limited (REAL) was commissioned by WASA's primary consultant EarthTech (Canada) Inc. to conduct the EIA in accordance with the Terms of Reference (Appendix I) issued by the EMA for the study.

1.2 RATIONALE /JUSTIFICATION

The increase in the number of housing developments across the country has created a substantial increase in demand for wastewater facilities. Presented with significant challenges to meet the increased demand, WASA allowed private developers to build wastewater facilities with the hope that they would come under its jurisdiction in the future.

Before 2005 WASA had twelve wastewater facilities under its direct jurisdiction. These are located in Chaguaramas, Port-of-Spain, WASA Head Office, Trincity, Piarco, Santa Rosa, Arima, Penco Lands, Lange Park, San Fernando, Techier and Scarborough. All these systems except for Scarborough (commissioned in 1994) are over twenty years old and subject to frequent breakdowns in light of limited preventative maintenance programmes and minimal funding allocated for repair work. In 2005 WASA adopted 35 wastewater facilities from the National Housing Authority (NHA) for which it is now directly responsible regarding operation and maintenance of the facilities. Over 150 systems which are in varying degrees of disrepair are still outside of the jurisdiction of WASA. As a consequence, many environmental problems result.

The wastewater system in Trinidad and Tobago is largely neglected. This is evident by the following:

- A degraded wastewater system, characterized by poorly functioning or non-functional wastewater treatment plants, lift stations and collection systems
- Limited recurrent expenditure for operations and maintenance
- Very little capital investment
- Institutional fragmentation
- Poor legal and regulatory framework
- Minimum capacity building
- Low and stagnant level of coverage

In its 'Vision 2020 Operational Plan 2007-2010' the Government of the Republic Trinidad and Tobago (GORTT) set fundamental goals regarding the utility sector and the environment as follows:

- The utility sector (water, sewerage and electricity) will be modern, customer oriented and technologically enabled to provide efficient, cost effective, quality services to all citizens.

- The environment will be valued as a national asset and conserved for the benefit of future generation and the wider international community.

In its review of the sector and its ability to meet stated goals the GORTT recognised the following as urgent requirements:

- refurbishment and upgrading of existing sewage treatment plants with a view to enhancing their functionality as well as minimising the negative impact on the environment in terms of contamination of water sources and pollution of water courses

- expanding the centralised sewerage networks

Against this background, specific targets regarding water distribution and sewerage were set for WASA to the year 2010. General targets for sewerage involve increased access to central sewerage services, while specific targets refer to the increase in the percentage of population with access to central sewerage services from 30% in 2006 to 35% in 2010.

In keeping with the GORTT's stated goals and targets for the sector and in an effort to address the inadequacies of the wastewater system in Trinidad and Tobago, WASA has taken steps to identify important projects to be undertaken. A Wastewater Master Plan for the East–West Corridor was prepared by the consultants, Safege, and is now in the process of being executed. Immediate action is necessary, however, to alleviate the potential negative impacts the current wastewater situation has on the environment and human health.

WASA now proposes a project to address the wastewater treatment systems of Maloney and Malabar. The Maloney and Malabar catchments are considered priority for development largely because the catchments drain into the Caroni River, upstream of the Caroni Water Treatment Plant, which is the largest Water Treatment Plant in the Caribbean, providing a potable water supply for 67% of the population of Trinidad and Tobago.

The creation of two regional wastewater treatment facilities for the area is a more cost effective solution over the current system of operation and management of twelve segregated plants. Establishing well operated and maintained regional wastewater plants will significantly contribute towards the protection of water sources from the potential transmission of water-borne diseases. In addition, there will be positive impacts on the agricultural sector since many of the farmers located along the East–West Corridor use the same polluted waters from the rivers and streams for crop irrigation.

It is anticipated that this project will have overall positive social, environmental and economic benefits. Positive impacts of the project include the reduction in public health hazards through the suppression of raw wastewater (RW) discharge into the rivers and the environment. The resulting cleaner environment will facilitate the revival of recreational activities along the watercourses and increased land values as a result of the decommissioning of defective package WWTPs. The proposed project will provide increased opportunities for employment at construction, operation and maintenance phases.

The project is well in keeping with the governments stated goals for the water and sewerage sector and seeks to address urgent requirements identified and contribute toward achieving the targets set.

1.3 CORPORATE PROFILE AND HISTORY

The Water and Sewerage Authority of Trinidad and Tobago (WASA), is the sole organization responsible for the development and control of water resources in Trinidad and Tobago. The authority is also the principal operator of existing water and wastewater systems with responsibility for the management, provision, operation and administration of water and sewerage facilities in the country.

WASA was established in 1965 by the Government of Trinidad and Tobago (GOTT) through the Water and Wastewater Act (Chapter 54:40). It was set up as an independent governmental organization under the Ministry of Settlements and Public Utilities with the following specific responsibilities:

- Provision of the water supply
- Provision of sewage services
- Maintenance and development of the wastewater system and sewage works
- Maintenance and development of waterworks
- Management of the water resources of the Republic

Currently the authority is the largest public utility in the country, operating three impounding reservoirs in Trinidad and four major sources of supply in Tobago. It serves approximately 95% of the population with pipe borne water through private house connections and standpipes. Approximately 30% of the population is served by centralized wastewater systems and another 40% of the population is served by cesspit-tank soil-absorption field systems. The remainder of the population depends on pit latrines.

The existing water supply system dates back to 1853 when the Maraval weir was constructed to serve the city of Port-of-Spain. Today, the Authority operates three (3) impounding reservoirs in Trinidad, a number of intake stations and four (4) major sources of supply in Tobago. The combined production of the water system is 1,032,187 m^3 per day with approximately 95% of the population of Trinidad and Tobago having access to potable water supplied by WASA. Access is provided in a variety of ways and includes in-dwelling connections, private yard pipes and public standpipes. Customers are classified into four broad categories – domestic, industrial, commercial and agricultural – and as metered or un-metered.

The first semblance of an underground wastewater system was constructed in Port-of-Spain in 1861, but the first major works were constructed in 1902 when the Mucurapo Pumping Station was built together with a trunk sewer along Wrightson Road, Port-of-Spain. Between 1902 and 1937, street sewers were added and Woodbrook was completely sewered. The largest wastewater project in 1962 was commissioned when the rest of Port of Spain, the East-West Corridor up to and including Arima, and San Fernando were sewered. Currently there are over 200 wastewater treatment plants with associated lift stations and collection systems in Trinidad and Tobago and approximately 30% of the population of the Republic is serviced by centralized wastewater systems operated by WASA.

The water resources of Trinidad and Tobago are managed by the Water Resources Agency (WRA) a division of WASA. WRA is mandated to effectively manage and control the use of the country's water resources and to promote conservation, development and protection of these resources in a cost-effective manner for sustainable socio-economic growth.

The WRA's databases are utilized to drive activities such as water resources assessments, water resource planning, source identification and quantification. The Agency also provides support services to WASA in respect of its dry season planning, pollution monitoring activities, and the exploration, development and management of new surface water and groundwater sources.

1.4 DEFINITION OF STUDY AREA

1.4.1 The Maloney Catchment

The Maloney catchment area comprises the areas of Maloney, Santa Monica, La Resource, La Florissante, Lillian Heights, Bregon Park and Lynton Gardens. It comprises an area of 1069Ha and is located north of the Churchill Roosevelt Highway (CRH). The WWTP site is located south of the CRH.

The study area was determined by the extent of direct and indirect impacts on the physical, biological and social environments. It includes the catchment areas serviced by each of the proposed treatment plants, the drainage area serviced by the wastewater collection systems and the watercourses which may be influenced by the effluent discharge.

The scope of the study area is bounded by the Churchill Roosevelt Road to the South, Golden Grove Road to the West, and Arima Old Road to the North. The Eastern boundary is west of Andrews Lane, Riverwood Development and Cleaver Road.

1.4.2 The Malabar Catchment

The Malabar Catchment comprises the Borough of Arima and surrounding developments west, east and south of Arima. The total area is approximately 2766ha. The town of Arima has a centralized wastewater collection and treatment system built in the early 1960s as part of the Lockjoint Project. Other main developments include Malabar, La Horquetta, Greenvale, Santa Rosa East and West, Riverwood and Cleaver Heights. Industries within the project area include the O'Meara Industrial Park and a variety of small to medium size commercial businesses. The Catchment Area contains many institutional facilities including the new University of Trinidad and Tobago (UTT), the Arima Regional Hospital, and several government schools. There are also a number of new and proposed housing developments within the catchment area. The Malabar wastewater catchment is located upstream of the Caroni Water Treatment Plant (WTP).

The study area is bounded by the Caroni River to the South, Demerara Road and Arima By-Pass Road to the East, Arima Old Road and Arima By-Pass Road (with all roads feeding into these roads) to the North, and Cleaver Road, Riverwood Development, and Andrews Lane to the West.

1.5 OBJECTIVES

The main objective of this study was to conduct an Environmental Impact Assessment in conformity with the EMA's Terms of Reference in order to obtain a Certificate of Environmental Clearance for the establishment of regional wastewater plants at Maloney and Malabar, inclusive of associated works, laying of sewage mains and decommissioning of existing treatment plants. The sub-objectives are as follows:

- Conduct an environmental and social assessment of the elements of the activities planned for the establishment of the wastewater treatment plants and associated works;
- Determine the extent of environmental and social impacts arising from the proposed activities;
- Prepare a management plan identifying and mitigating against significant negative impacts;
- Prepare monitoring plans to gauge the effectiveness of the adopted mitigation measures;
- Evaluate the cumulative impacts from this proposed development, ongoing and other proposed activities within the project area.

1.6 TERMS OF REFERENCE AND SCOPE OF THE EIA

The Terms of Reference (TOR) for the conduct of this Environmental Impact Assessment (EIA) study were provided to WASA by the Environmental Management Authority (EMA). A copy of the TOR is provided in Appendix I.

Based on the TOR, the scope of works for the project was divided into the following areas:

- Conduct of a literature review (including legislative requirements) of existing information in the public domain related to the proposed establishment of the wastewater treatment plants and associated works, as well as the areas adjacent to the proposed development area.
- Identify data gaps existing in the public domain that are pertinent to describing the biophysical and social environmental baseline that exists within the project affected area.
- Field collection of social and environmental data to fill data gaps and establish baseline conditions.
- Determination of the potential environmental and social impacts of the proposed activity.
- Evaluation of various project alternative and justification of the preferred alternative on the basis of technical, financial, environmental, social and planning requirements.
- Conduct consultations with all relevant stakeholders and members of the general public.
- Development of mitigation measures and strategies to manage any negative residual impacts of the project or maximize beneficial elements of the project.
- Development of a management plan for all phases of the project life.
- Development of a monitoring plan for the different phases of the project.

1.6.1 EIA Methodology

The requirement in the TOR for establishing baseline data has been limited in this EIA to the socio-economic and current environmental conditions in the study area. As described above, the Malabar and Maloney catchment areas encompass some of the more densely populated centres along the East-West corridor comprised of commercial, light industrial, urban and sub-urban centres. Thus the proposed regional wastewater collection, transmission and treatment project was adjudged to be a "Brownfield" development and thus extensive field studies, covering seasonal changes, were not deemed necessary. More to the point, during the dry season 2008, no water flows were observed in many of the lower reaches of the rivers identified as catchments for the wider study area. Thus it was not possible to do two-season sampling of the aquatic environment given the time frame (June to December 2008) for conduct of the EIA by the WASA.

Some baseline data was deemed to be necessary for defining the current status of the following in project affected areas:

- ambient air quality in community receptor locations,
- noise in community receptor locations,
- traffic flows in the immediate areas of influence of the transmission system and treatment plants,
- water quality of main watercourses draining the Malabar and Maloney catchment areas,
- aquatic ecology of the main water courses,
- terrestrial ecology of the undeveloped areas within the project affected sites.

Listed below are the methodologies and QA/QC procedures used in the data collection process. Note that the stand-alone Social Impact Assessment (Appendix III) and Ecology reports (Appendix IV) contain detailed information on the sampling methodologies and QA/QC procedures used for the socio-economic and terrestrial ecology studies conducted.

Noise

Determination of baseline noise levels in the project affected communities and public areas were conducted in strict accordance with the procedures described in the Noise Pollution Rules, 2001. Noise was measured at six locations in the Study Area. All QA/QC procedures described in the rules, including the calibration of the Noise Meter prior to and post monitoring at each location, were complied with. Note that both the Noise Meter and its Calibrator had valid annual factory calibration certificates during the conduct of this study.

Ambient Air Quality

Ambient air quality measurements were made at six locations in the Study Area. The parameter measured was restricted to particulate matter since it was envisaged that dust generated during construction activities would be the major impacting factor associated with the project. Combustion gas emissions from trucks, excavators, backhoes and other mobile sources were not considered to be significant, and as mobile sources, not regulated under the Draft Air Pollution Rules, 2005 (APR05). Note that the air quality data presented in Chapter 5 of this EIA was obtained from data collected by REAL in 2008.

Airmetrics Mini Vol units were used to measure particulate matter in ambient air. Average twenty four hour concentrations were computed and compared to both the APR05 permissible limits and human health criteria promulgated by the World Health Organisation (WHO).

Standard QA/QC procedures were employed in the data collection process and included pre and post-use calibration of the MiniVol units using a magnaheliometer, the use of filter and field blanks and the use of chain of custody forms for transmittal of the post-weighed filters from the field to Airmetrics lab where the post-weights of the filters were determined. Note that Airmetrics provides a filter weighing service in addition to the supply of the filters and MiniVol units and this facility was used in this project.

Riverine Water Quality

Riverine water quality was determined at fifteen locations along the main rivers draining the Malabar and Maloney catchment areas, thirteen along the upper middle and lower reaches of the water courses and two at points of effluent discharge from the existing WWTPs at Maloney and

Mausica. A detailed discussion of the results obtained is presented in Chapter 5 of this EIA document. Note that this data was collected by REAL in 2008. All analyses were performed at a laboratory in Trinidad and at an accredited laboratory in Mississauga, Canada and results compared to the permissible limits pertaining to effluent discharges to inland waterways found in the water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006). Standard QA/QC procedures were employed throughout the sampling and testing, inclusive of the use of field and reagent blanks, spike sample recoveries and chain of custody forms for transmittal of samples from the field sampling location to the Canadian Laboratory. Samples were treated with preservatives where appropriate and were all stored in ice from the time of sampling to the time of testing. Samples were shipped from Trinidad to Canada via FEDEX International Priority shipment, with samples being received by the Lab within three days of sample dispatch from Trinidad. All samples were dispatched within twenty four hours of sample collection.

Terrestrial Ecology

Baseline terrestrial ecology data was collected on vegetative cover species and abundance in both the forested upper reaches of the Malabar/Maloney watersheds and in the grasslands of the plains leading to the Caroni River. Avifauna was also assessed in each of the areas surveyed.

Surveys of vegetative cover species and abundance were conducted along line transects covering the ecotones of the forested areas in the wider study area. The lines were walked and significant tree and underbrush vegetation were noted along each transect line.

In the case of the grasslands which contained a monoculture of plant species, line transects were walked and 1m x 1m quadrats were placed at intervals of 100m along each transect line. The species observed in each quadrat were identified and quantified. In both the forested and grassland areas, samples of any unknown plants observed were taken and identified by the National Herbarium.

Avifauna was counted based on visual observations of species roosting in tress or grasses or of birds feeding on fruit trees, the underbrush or in the grasslands. Species of avifauna were also identified in some cases on bird calls which were heard by field surveyors. All avifaunal surveys were conducted at day-break or at sunset.

1.6.2 Outline of This Report

The EIA study analyses the impacts of the project and assess the value of appropriate mitigation measures which may be applied to ensure that the quality of the environment is not compromised. It examines best available technologies and recommends appropriate management systems and processes for the continuous improvement in environmental performance. The EIA study examines the local statutory approvals required and international protocols governing the proposed activity. Additionally the physical, biological and social environments have been carefully surveyed in accordance with the rules cited in the Environmental Management Act of 2000. Predictive modeling as well as various qualitative and quantitative analyses was used to determine the probable project impacts. Based on these probable impacts mitigation strategies for orderly and progressive development were established. The findings of this EIA have been presented in the following format:

Main Text

Executive Summary. This chapter provides general details of the project in brief, summary of baseline data, impacts and mitigation measures.

Chapter 1 – Introduction. This section introduces the project and describes the scope of work of the EIA report.

Chapter 2 – Policy, Legal and Administrative Framework. This section provides details of the environmental regulations applicable to this project.

Chapter 3 – Project Description. This section describes the proposed site location, gives details of the various components of the proposed wastewater treatment plants and collection and transmission systems and the operations of the entire wastewater management system during the construction and operation phases of the project.

Chapter 4 – Analysis of Alternatives. This section provides details of the various alternatives considered in project location, project design and technology to minimise environmental impacts. Note that the choice of location, and design of the systems were the subject of an earlier evaluation conducted by Safege on behalf of WASA and thus this EIA only evaluates the preferred siting and design options approved for implementation by WASA and the Government of Trinidad and Tobago.

Chapter 5 – Baseline Study of the Physical, Biological and Social Environment. This section presents details of the baseline environmental and social status for the identified environmental components.

Chapter 6 – Key Stakeholder Meetings and Public Consultations. This section provides a summary of the public consultation meetings and includes representative questions and answers from the meetings, and consideration of public feedback.

Chapter 7 – Environmental Impact Analysis. This section discusses the likely environmental and social impacts of the proposed project. Note that the project is not subject to fire hazards or explosion risks thus a semi-quantitative plant and facility risk assessment, employing ARCHIE and other similar software, was **not** deemed to be applicable, nor were they required under the Final Terms of Reference issued by the EMA. A ranking of potential impacts of the proposed project elements is provided in this chapter.

Chapter 8

Chapter 9 – Environmental Management and Monitoring Plans (EMMP). This section presents the EMMP for the project, including measures to be taken to minimize likely residual impacts on the surrounding environment. In addition, the institutional system proposed to monitor and maintain environmental quality is described.

Chapter 10 – References

Appendices

Individual, stand-alone studies and reports complied during the conduct of the EIA are presented in the Appendices. Two of the significant appendices include the stand alone Social Impact Assessment Study report with the results of a house-to-house survey conducted in the Malabar/Maloney study area and a stand alone report on the terrestrial ecology of the wider study area.

GIS

Geographical Information System prepared as required under the TOR. This GIS shows the interrelationship between baseline descriptors of the Study Area in a database which spatially presents the data and analyses conduct during the course of the EIA. The data collected from the Baseline Survey was stored in a personal Geo-database GIS project compatible with ArcView version 3.2. This information has been organized in feature classes formally called themes, with attribute tables joined or when not possible linked, to the station location feature class and an organizational framework for understanding the information.

1.7 LIST OF REPORT PREPARERS AND EIA PROJECT TEAM

Project Team	Organization	Individual Role	Years Experience
Mr Jim Marx	AECOM	Senior Project Engineer/ Client Project Manager	>25
Ms. Natalie Wilson		Project Engineer	>3
Dr Ahmad Khan	Rapid Environmental Assessments (2003) Limited	Local Project Team Study Director	>20
Caryl Neehall		Environmental Management Professional	> 10
Desiree Modeste		Social Scientist	>3
Kamara Ramhit		Environmental Scientist	>3
Fareed Ali		Environmental Technologist	>6
Floyd Lucas (deceased)	Strategic Environmental Services	Senior Ecologist	>10
Carl Ramjohn (deceased)		Terrestrial Ecologist	>10
Ryan Mohammed		Aquatic Biologist	>10
Carol Ramjohn		Senior Environmental Scientist/GIS Mapping	>10

2 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 GENERAL

The wastewater collection, treatment and disposal plants proposed for the Malabar and Maloney areas will be subject to a number of policies, laws and regulations which concentrate on health, safety and environmental management. The policy, legal and regulatory sources are grouped as follows:

- The National Environmental Policy;
- Policies and Practices of WASA;
- Laws, Policies and Rules relating to Health, Safety and the Environment (local and international); and
- Other applicable guidelines.

2.2 THE NATIONAL ENVIRONMENTAL POLICY (2005)

The National Environmental Policy (June 1998) was made under the aegis of Section 18 of the Environmental Management Act #3 of 2000. The National Environmental Policy (2005) is intended to satisfy the requirements of the Environmental Management Act 2000. The goal of this policy is environmentally sustainable development, meaning the balance of economic growth with environmentally sound practices in order to enhance the quality of life and meet the needs of present and future generations.

The policy recognizes the linkages among the human resources, natural systems and development processes and the competition for use of the same resources by different interests. It offers a framework for the management and use of resources to yield sustainable benefits for the population. With respect to industrial activity, the National Environmental Policy seeks to:

- Prevent, reduce or eliminate various forms of pollution to ensure adequate protection of the health and well-being of the environment and consequently, of humans.
- Conserve the biological diversity of the country and the stability and the resilience of ecological systems.
- Integrate environmental considerations in all development planning and decision-making on the use of the country's natural resources.
- Encourage stakeholder participation in solving problems related to multi-user conflicts in coastal areas in keeping with sound integrated coastal zone management principles and philosophies.
- Conserve non-renewable resources such as oil and gas as other minerals to obtain the best possible benefit to all citizens without impairing the value of other resources.
- Ensure that the permitting of any new point-source or non-point source of water pollution will be considered only if cost-effective and reasonable environmental management practices are in place to address such pollution.
- Encourage the use of energy recovery and integration techniques and technologies.
- Encourage the use of environmentally friendly energy sources (e.g. natural gas).
- Develop new and renewable energy sources where feasible (e.g. solar wind) to decrease dependence on fossil fuels and so avoid the pollution generated by burning them.
- Adopt ambient air quality standards consistent with those of the World Health Organization.
- Cooperate with relevant local, regional and international agencies to implement technologies that will reduce, prevent or control man-made

emissions of greenhouse gases including the energy, transport, industry, agriculture, forestry and waste management sectors.

- Encourage the recovery of waste, including recycling, reuse or reclamation, and the use of waste as a source of energy.
- Employers have a general duty to secure health, safety and welfare of persons at work and to provide for the protection to the public from work activities.
- Ensure the health and safety of the population and the environment through measures such as assessment of risks, establishment and effective implementation of pre-emergency contingency plans and development of post-emergency response systems including containment of chemical spills or discharges, and remediation of contaminated sites.
- Raise the consciousness and knowledge of society and promote understanding of the essential linkages between environment and development.
- Encourage co-operation with other countries organizations and agencies at the regional and international levels, in preventing or controlling trans-boundary pollution and achieving optimal use or common natural resources.

2.3 LAWS POLICIES AND RULES RELATING TO THE ENVIRONMENT

2.3.1 The Environmental Management (EM) Act

The Environmental Management Act was first enacted in June 1995. It was passed however, by a simple majority in parliament when many of its provisions had the potential to infringe on the rights and liberties of citizens. Thus, the act was repealed and re-enacted in 2000 with a special majority of parliament so that pieces of subsidiary legislation such as the noise, water, air and solid and hazardous waste standards could be brought into law. The special majority also gave power to parliament to constitute and bring into operation, an environmental court of superior record, called the Environmental Commission.

The objectives of the Environmental Management Act are to:

- Promote and encourage among all persons a better understanding and appreciation of the environment.
- Encourage the integration of environmental concerns into private and public decisions.
- Ensure the establishment of an integrated environmental management system in which the Authority, in consultation with other persons, determines priorities and facilitates co-ordination among governmental entities to effectively harmonize activities designed to protect, enhance and conserve the environment.
- Develop and effectively implement written laws, policies and other programmes for and in relation to:
    - The conservation and wise use of the environment to provide adequately for meeting the needs of present and future generations and enhancing the quality of life
    - The GORTT's commitment to achieve economic growth in accordance with sound environmental practices
    - The GORTT's international obligations
    - The enhancement of legal, regulatory and institutional framework for environmental management

2.3.2 Subsidiary Legislation under the EM Act

The Environmental Management Authority has published five pieces of subsidiary legislation aimed at environmental protection in Trinidad and Tobago:

1. Certificate of Environmental Clearance (CEC) Rules, 2001;
2. Noise Pollution Rules, 2001;
3. Environmentally Sensitive Areas Rules, 2001;
4. Environmentally Sensitive Species Rules, 2001; and
5. Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006)

In addition, the Air Pollution Rule, 2005 has been presented for public comment, but has not yet been enacted. Another rule, the Solid and Hazardous Waste Management Rules, 2005 is currently in preparation.

2.3.2.1 Certificate of Environmental Clearance (CEC) Rules, 2001 (as amended by the Certificate of Environmental Clearance Rules, 2008)

The Certificate of Environmental Clearance Rules 2001, are made pursuant to section 26 (h) of the Environmental Management Act.

Under the Certificate of Environmental Clearance Rules, new developments, expansions of existing developments and decommissioning of facilities (as designated by the Minister) require an application for a Certificate of Environmental Clearance (CEC). The purpose of the CEC is to determine the environmental impact of the proposed activity.

The applicant in support of his application shall supply the following information:

- The purpose and objectives of the activity.
- A description of the site and the areas likely to be affected by the proposed activity.
- The size and scale of the activity including capacity, throughput, land space and covered areas.
- A description of the activity explaining:

  The types of processes and equipment or machinery to be involved;

  The type, quantity and sources of input materials;

  The quantity and destination of any by-products, including any waste;

  The modes of transportation that will be used to carry out the proposed activity and the potential effects of such transportation;

  The volume of intermediate and final products; and

  The frequency or rate of extraction with respect to the use of natural resources;
- The expected life of the activity.
- The proposed schedule of actions from preparatory work to start-up and operation.
- Such maps, plans, diagrams, photographs, charts and other illustrative or graphic material as may facilitate understanding of the information presented and the nature of the site.

The procedure to obtain a CEC can be summarized as follows:

- Submission of an application for a CEC and payment of an application fee.
- Determination by EMA as to whether an Environmental Impact Assessment is required.
- Once it is required, preparation of a Draft Terms of Reference by the EMA.
- Discretionary public consultations by the project proponent and submittal of comments on the Draft Terms of Reference.
- Preparation of Final Terms of Reference by EMA and payment of statutory fee.
- Submission of Environmental Impact Assessment to EMA.
- Publication of Environmental Impact Assessment for public comments.
- If sufficient public interest, discretionary hearing.
- If necessary, further information sought by EMA.
- Grant or refusal of grant of CEC.

WASA submitted an application for a Certificate of Environmental Clearance (CEC) in April 2006 and final Terms of Reference (TOR) dated 3rd August 2006 for the conduct of the EIA in support of WASA's application (CEC 1469/2006), was provided to WASA.

2.3.2.2 Noise Pollution Control Rules, 2001

Under the Environmental Management Act, 2000, the Environmental Management Authority has issued Noise Pollution Rules, 2001 which are in effect. These rules recognize the following noise zones:

Zone I – Industrial Areas,

Zone II – Environmentally Sensitive Areas, and

Zone III – The General Area

Under Section 2 of the Noise Pollution Rules 2001, Zone I (Industrial Areas) is defined as areas 'expressly approved for industry by a competent governmental entity'. Zone II (Environmentally Sensitive Areas) means a portion of the environment so designated under Section 41 of the Act and Zone III (General Areas) means all of Trinidad and Tobago except environmentally sensitive areas and industrial areas.

The Rules prescribe standards, which apply to areas within the noise zones. As a measure of noise, the Sound Pressure Levels (SPLs) are measured. In accordance with the Terms of Reference sound pressure levels and vibrations data collected will cover daily seasonal and normal activities at the relevant treatment sites and affected communities. The applicable zone for this project is generally Zone III (The General Area) since the project scope covers broad areas in Arima and surrounding communities as well as Maloney and associated communities. The proposed project area does not include areas which apply to Zone II – Environmentally Sensitive Areas. The following describes prescribed standards as documented in the First Schedule of the Noise Pollution Rules, 2001, for Zones I and III.

ZONE I – Industrial Area

Anytime – The sound pressure level shall not exceed the following:

- Equivalent continuous sound pressure level of 75dBA.
- Instantaneous unweighted peak sound pressure level of 130dB (peak).

The O'Meara Industrial Park within the Malabar region falls within Zone I. Equipment and machinery attributed to the installation and operation of the proposed wastewater treatment collection system and plant are not expected to produce sound pressure levels in exceedance of prescribed standards.

ZONE III – General Area

Daytime limits – between the hours of 8.00 a.m. and 8.00 p.m. sound pressure level shall not exceed the following:

- Equivalent continuous sound pressure level of 5dBA above background sound pressure.
- Instantaneous unweighted peak sound pressure level of 120dB (peak).

Notwithstanding the above, no person shall emit or cause to be emitted any sound that causes the sound pressure level when measured as the equivalent continuous sound pressure level to exceed 80dBA.

Night-time limits – between the hours of 8.00 a.m. and 8.00 p.m. sound pressure level shall not exceed the following:

- Equivalent continuous sound pressure level of 5dBA above background sound pressure.
- Instantaneous unweighted peak sound pressure level of 115 dB (peak).

Notwithstanding the above, no person shall emit or cause to be emitted any sound that causes the sound pressure level when measured as the equivalent continuous sound pressure level to exceed 65dBA.

Section 7 of the Rules identifies those activities which are exempt from the prescribed standards. Of these, the following sub-sections are relevant to this proposed project.

7(f) sound associated with the installation of public utilities in a public place between the hours of 7.00 a.m. and 11.00 p.m.

7 (k) construction activities when conducted on a construction site between the hours of 7:00 a.m. and 7:00 p.m. of the same day.

Additionally, Section 9 of the Rules describes the procedures for the application of a Noise Variation. The relevant sub-sections are as follows:

9 (1) Subject to sub-rule (3) where a person proposes to conduct an activity or an event that will cause sound in excess of the prescribed standards, that person shall submit an application to the Authority for a variation.

(4) Notwithstanding anything to the contrary in these rules, where a person emits a sound in a noise zone within the prescribed standards for that noise zone but which results in the creation of a sound in excess of the prescribed standards in an adjoining noise zone, the Authority may notify that person to submit an application for a variation.

The proposed project which involves the installation of public utilities, falls mainly within the category of general area and is exempt from prescribed standards between the hours of 7.00 a.m. and 11.00 p.m. Further to this, equipment and machinery attributed to the installation and operation of the proposed wastewater treatment collection system and plant is not expected to produce sound pressure levels in exceedance of prescribed standards.

2.3.2.3 Environmentally Sensitive Areas, 2001

Under the Environmental Management Act, 2000, there are provisions for the designation of 'Environmentally Sensitive Areas' (ESAs). According to these rules the EMA may, by Notice, designate any area as "environmentally sensitive" which satisfies the requirements of the Rules. To date, sites designated as ESAs are – the Matura National Park (2004), the Nariva Swamp (2006) and Aripo Savannas (2007). None of these areas is in the vicinity of the Malabar - Maloney project area.

2.3.2.4 Environmentally Sensitive Species, 2001

Under the Environmental Management Act, 2000, there are also provisions for the designation of 'Environmentally Sensitive Species' (ESS). These rules, which came into force simultaneously with the Environmentally Sensitive Areas Rules (ESA Rules), state that the EMA may, by Notice, designate an animal or plant "environmentally sensitive" which satisfies specific guidelines within the Rules. To date three species have been defined as an Environmentally Sensitive Species, these are the West Indian Manatee (*Trichechus manatus*), the Pawi *(Pipile pipile)* and the White-tailed Sabrewing *(Campylopterus ensipennis*). The Manatee is limited to the Nariva Swamp Trinidad and the Pawi can be found in the eastern part of the Northern Range (concentrated in the forests around Aripo and Toco), and in the Trinity Hills Reserve of the Southern Range.

The Sabrewing Hummingbird is limited to Tobago. None of these species is found in the proposed project area.

2.3.2.5 Water Pollution Rules, 2001(as amended by the Water Pollution Rules, 2006)

Under the Environmental Management Act, 2000, the EMA has issued Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006) which are in effect. These rules identify substances considered to be water pollutants and also identify the EMA as the authority responsible for the maintenance of a Water Polluters Register consisting of registered facilities which are sources of releases of water pollutants. Substances considered to be pollutants include *inter alia* Dissolved Oxygen Content (DOC), five-day Biological Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), total suspended solids, chlorine, phosphorus and faecal coliforms. The rules define water as any surface water, sea, groundwater, wetlands or marine areas within the environment and also identify permissible levels of water pollutants for inland surface water, coastal nearshore water, marine offshore water as well as environmentally sensitive areas and groundwater.

Under these rules any entity intending to discharge a water pollutant likely to cause harm to human health or to the environment is required to submit a source application to the EMA for a renewable registration certificate, prior to commencement of such discharge. The registration certificate is generally valid for a period of three years. Factors considered by the Authority in determining the conditions of the permit include the volumetric release rates and quality of effluents including conditions and concentrations of constituents, characteristics and uses of receiving waters, location of point source and best available practicable technology.

Under the First Schedule of the Rules, parameters/substances and the quantities or concentrations at which they are defined as a pollutant are identified. Under the Second Schedule of the Rules, parameters or substances and the permissible levels of quantities or concentrations for various receiving environments are identified. The parameter is considered to be a pollutant beyond these levels. The Second Schedule of the Rules is given in Table 2-1 below.

Baseline studies of water quality will be conducted at key locations within the proposed project area. Water quality parameters for analyses include pH, temperature, dissolved oxygen, total suspended solids (TSS), chemical oxygen demand, biochemical oxygen demand, nitrates, phosphates, coliforms and contaminants i.e. heavy metals and hydrocarbons.

Table 2-1 Permissible Levels of Water Pollutants for Various Receiving Environments

SECOND SCHEDULE – PERMISSIBLE LEVLS					
No.	Water Pollutants	Receiving Environment			
	Parameters or Substances	Inland Surface Water	Coastal Nearshore	Marine Offshore	Environmentally Sensitive Areas &/or Groundwater
		Levels or conditions (mg/L) / (°C) / (pH units) / coliforms – counts per 100ml / NIAA- no increase above ambient / NATE no acute toxic effects / NSD-No Solid Debris			
1.	Temperature NIAA	35	40	45	NIAA
2.	Dissolved Oxygen	>4	>4	>4	>4
3.	Hydrogen ion (pH)	6-9	6-9	6-9	6-9
4.	Five day Biological Oxygen Demand (BOD5 at 20°C)	30	50	100	10
5.	Chemical Oxygen Demand (COD)	250	250	250	60
6.	Total Suspended Solids (TSS)	50	150	200	15
7.	Total Oil and Grease (TO&G) or n-Hexane Extractable\Material (HEM)	10	15	100	No release
8.	Ammoniacal Nitrogen (as NH3-N)	10	10	10	0.1
9.	Total Phosphorus (as P)	5	5	5	0.1
10.	Sulphide (as H_2S)	1	1	1	0.2

SECOND SCHEDULE – PERMISSIBLE LEVLS					
No.	Water Pollutants	Receiving Environment			
	Parameters or Substances	Inland Surface Water	Coastal Nearshore	Marine Offshore	Environmentally Sensitive Areas &/or Groundwater
		Levels or conditions (mg/L) / (°C) / (pH units) / coliforms – counts per 100ml / NIAA- no increase above ambient / NATE no acute toxic effects / NSD-No Solid Debris			
11.	Chloride (as Cl^-) 250	250	NIAA	NIAA	NIAA
12.	Total Residual Chlorine (as Cl_2)	1	1	2	0.2
13.	Dissolved Hexavalent Chromium ($Cr^{6=}$)	0.1	0.1	0.1	0.01
14.	Total Chromium (Cr)	0.5	0.5	0.5	0.1
15.	Dissolved Iron (Fe)	3.5	3.5	3.5	1.0
16.	Total Petroleum Hydrocarbons (TPH)	25	40	80	No release
17.	Total Nickel (Ni)	0.5	0.5	0.5	0.5
18.	Total Copper (Cu)	0.5	0.5	0.5	0.01
19.	Total Zinc (Zn)	2	2	2	0.1
20.	Total Arsenic (As)	0.1	0.1	0.1	0.01
21.	Total Cadmium (Cd)	0.1	0.1	0.1	0.01
22.	Total Mercury (Hg)	0.01	0.01	0.01	0.005
23.	Total Lead (Pb)	0.1	0.1	0.1	0.05
24.	Total Cyanide (as CN^-)	0.1	0.1	0.1	0.01
25.	Phenolic Compounds (as phenol)	0.5	0.5	0.5	0.1
26.	Radioactivity	NIAA	NIAA	NIAA	NIAA
27.	Toxicity	NATE	NATE	NATE	NATE
28.	Faecal Coliforms	400	400	400	100
29.	Solid Waste	NSD	NSD	NSD	NSD

2.3.2.6 Air pollution Rules, 2005 (Draft)

Under the Environmental Management Act 2000, the EMA put out draft air pollution rules in 2005 for public comment. These rules are still in draft and have not yet been enacted. The rules identify maximum permissible limits beyond which substances are considered to be air pollutants and also propose that source emitters be registered with the EMA. A list of activities which require registration as a source emitter is included in the draft rules. Permissible levels for particulates, non-metallic inorganic compounds, metallic compounds and organic substances for both point and non-point sources, beyond which the substance is considered to be a pollutant, are identified.

Baseline studies of ambient air quality of the area around the sites proposed for the wastewater treatment plants and impacted communities is proposed with a view to determine the potential impact of vehicular and equipment emissions during all proposed site activities.

2.3.3 Other National Laws and Regulations

Prior to the enactment of the Environmental Management Act, Trinidad and Tobago relied on a progression of specific administrative and penal laws to protect certain resources and manage specific elements of the environment. A complete listing of these pieces of legislation can be found in the Environmental Code, prepared by the EMA in 1998. There are also several laws, which are not primarily concerned with protecting natural resources or environmental health, but include clauses to ensure that activities are conducted without any destruction to the environment or impact to worker health and safety. This section identifies the more relevant pieces of legislation referring to or applicable to aspects of project.

2.3.3.1 Liquid Effluent Standard

The Trinidad and Tobago Bureau of Standards has promulgated a compulsory standard (TTS 417:1993) - Trinidad and Tobago Specification for the Liquid Effluent from Domestic Wastewater Treatment Plants into the Environment. The Standard specifies the maximum permissible levels of the 5-day Biochemical Oxygen Demand (BOD_5), Suspended Solids, pH, Total Residual Chlorine and Faecal Coliforms, for liquid effluent from domestic wastewater treatment plants into various points of the environment. It specifies that direct discharge into groundwater is not permitted. The standard also provides the reference to the methods of test to assess compliance with the specified maximum permissible levels. The standard does not provide details on the methods of domestic wastewater treatment nor on the design, operation or maintenance of domestic wastewater treatment plants necessary to ensure and maintain effluent at the specified levels.

Baseline studies of water quality will be conducted at key locations within the proposed project area. Water quality parameters for analyses will include pH, temperature, dissolved oxygen, total suspended solids (TSS), chemical oxygen demand, biochemical oxygen demand, nitrates, phosphates, coliforms and contaminants i.e. heavy metals and hydrocarbons.

Table 2-2 lists the maximum permissible levels of key parameters for the liquid effluent from domestic wastewater treatment plants as specified by the standard.

Table 2-2 Maximum Permissible Levels of Key Parameters for Liquid Effluent from Domestic Wastewater Treatment Plants

Points of Discharge of Effluent	5-day Bio-chemical Oxygen Demand BOD_5 (mg/l)	Suspended Solids (mg/l)	pH	Faecal Coliforms (counts per 100 ml)	Total Residual Chlorine (mg/l)
Inland surface waters	25	30	6-9	4000	0.1
Inshore areas of sea	25	30	6-9	4000	0.1
Offshore areas of sea	175	175	6-9	4000	0.1
Environmentally sensitive areas	25	30	6-9	400	0.0
1) Recreational Waters 2) Irrigation Waters 3) Waters that are sources of food or potable water 4) Other waters that impact on human health	25	30	6-9	400	0.0

2.3.3.2 Occupational Health and Safety Act, 2004

The Occupational Safety and Health Act, 2004 is a comprehensive law governing all aspects of health and safety in the workplace. It was passed by parliament in 2004 and proclaimed in 2006 and is now officially the law of T&T. The Act represents the first major change in the legislative framework for occupational safety and health since the Factories Ordinance, the Employment of Women (Night Work) Act, and the Factories (Boilers) Regulations. The Act increases the responsibilities of the company and its management with respect to ensuring a safe and healthy work environment. WASA will implement an Occupational Health and Safety Management System which is in compliance with the requirements of the OSHA Act thereby ensuring compliance with the law at the start of plant operations.

2.3.4 Institutional Framework for Enforcement of Environmental Legislation

2.3.4.1 The Environmental Management Authority

Pursuant to Section 6 of the Environmental Management Act, a corporate body known as the Environmental Management Authority hereinafter referred to as "the EMA", was established.

The general functions of the EMA are to:

- Make recommendations for a National Environmental Policy;
- Develop and implement policies and programmes for the effective management and wise use of the environment, consistent with the objectives of this Act;

- Co-ordinate environmental management functions performed by persons in Trinidad and Tobago;
- Make recommendations for the rationalization of all governmental entities performing environmental functions;
- Promote educational and public awareness programmes on the environment;
- Develop and establish national environmental standards and criteria;
- Monitor compliance with the standards, criteria and programmes relating to the environment;
- Take all appropriate actions for the prevention and control of pollution and conservation of the environment;
- Establish and co-ordinate institutional linkages locally, regionally and internationally;
- Perform such other functions as are prescribed; and
- Undertake anything incidental or conductive to the performance of any of the foregoing functions.

2.3.4.2 The Environmental Commission

Pursuant to Section 81 of the Environmental Management Act, the Environmental Commission was established. In 2000, the President of Trinidad and Tobago appointed the members of the Environmental Commission for a period of three years.

The Environmental Management Act concedes that the Environmental Commission shall be a superior court of record and has jurisdiction to hear and determine:

- Appeals from decisions or actions of the Authority as specifically authorized under this Act and appeals from a decision by the Authority under Section 36 to refuse to issue a Certificate of Environmental Clearance or to grant such a certificate with conditions;
- Applications for deferment of decisions or deferment of designations;
- Administrative civil assessments;
- Complaints brought by persons by virtue of the direct private party action provision.

2.3.4.3 The Town and County Planning Division

The Town and County Planning Act makes provisions for the orderly and progressive development of land in both urban and rural areas and require that Planning Permission ought to be obtained for conducting any development of land or the granting of permission to develop land. The Town and Country Planning Act Chapter 35:01 (formerly the Town and Country Planning Ordinance No. 29 of 1960) came into effect on August 1, 1969.

The Minister responsible for The Town and Country Planning Division (TCPD) has the authority to grant permission for the conduct of any development of land. The TCPD is the agency responsible on behalf of the Minister, for processing the applications required for permission to develop land.

TCPD's Environmental Role

With the implementation of the CEC rules, the role of the TCPD in environmental management changed radically. Prior to that, the TCPD managed the EIA process for development projects on-land. Now, the TCPD participates in two roles with regard to the EIA Process:

- The law requires that, for all projects which require Planning Permission, the CEC Application must be submitted to the TCPD. The role of the TCPD in this instance is simply to forward the application to the EMA within 5 working days of receipt.

- The TCPD may be consulted by EIA practitioners when EIAs are being prepared or by the EMA when EIAs are being reviewed; on matters under their purview (that is, matters related specifically to land use zoning, etc.).

A two-tier system of planning permission exists in Trinidad and Tobago, administered by the TCPD. This consists of:

- Outline Planning Permission and
- Planning Permission.

Outline Planning Permission

Outline Planning Permission is based on land use and planning grounds. In essence, this level of permission seeks to ensure that the proposed development is compatible with the intended land use in the area, as defined in national, regional or local area plans.

Planning Permission

The grant of Planning Permission is only one of the requirements to be satisfied before the start of construction. Another is Final/Building Approval from the respective Regional Corporation of the Ministry of Local Government. The grant of Outline Planning comes with conditions to be satisfied in the application for Planning Permission (commonly but erroneously referred to as “Final Planning Permission”). This latter stage deals with engineering and architectural details of the development, and the application is expected to include design and layout drawings to provide these details.

2.3.4.4 Municipal Corporations

The Municipal Corporations Act, 1990 (Act #21 of 1990) created a legal and regulatory framework in which development planning and approval fell to local governing bodies, i.e. Regional Corporations and City Corporations. The provisions of the Act for development planning approval is restricted to the certification of compliance of structures, erected or expanded, with building regulations. In this regard, the Regional or City Corporations are entitled to inspect and approve all design drawings for buildings, water reticulation systems, wastewater treatment systems and on site solid waste disposal facilities. In order to fulfill this mandate under law, staff of the respective Regional and City Corporations include as a minimum, a Chief Engineer, a Medical Officer of Health and a Chief Public Health Inspector. In the case of this wastewater collection and treatment project the responsible local government body is the Arima Borough Corporation and the Tunapuna/Piarco Regional Corporation.

2.4 LEGISLATION, POLICIES AND PRACTICES OF PROJECT SPONSORS

2.4.1 The Water and Sewerage Act

Water and Sewerage Act of 1965 Chapter 54:40 was created to provide for the development and control of water and sewerage facilities and related matters of sanitation in Trinidad and Tobago. It establishes WASA as the Authority responsible for maintaining and developing waterworks and for administering the supply of water as well as promoting the conservation, protection and proper use of the nation's water resources. Under the Act the Authority is also made responsible for all sewerage, sanitation and works and fittings in buildings as well as construction and operation of sewerage works.
The Authority is responsible for the following:

- Maintaining and developing the existing sewerage system and other related property
- Maintaining and developing all sewerage works
- Construction and development of further sewerage works as necessary
- Administration of sewerage services and provision of the nation's sewerage facilities

Under the Act, WASA also has the authority to conduct the following:

- Construct underground drainage sewers in any street, street sewers, collecting sewers and house sewers as necessary for conveyance and disposal of sewage
- Lay down, install, erect and construct all works, pumps, machinery, appliances and accessories as required for proper conveyance and disposal of sewage
- Employ contractors with responsibility for construction works indicated above

The Act also grants to WASA the authority to divide Trinidad and Tobago into separate sewerage areas as necessary for the following purposes:

- Conducting further construction works on existing sewers
- Developing the sewer system
- Operating sewerage works

In the execution of its works the Authority also has the power to lay sewers in any street and to break open roadways and footpaths of any street and any sewer or drain under the roadways and upon completion of the works, reinstate and repair the roadway. Adequate arrangements for the control of traffic must me put in place during these activities.

Under Part V of the Act the Authority is given power via a Compulsory Purchase Order subject to confirmation by the relevant Minister, to compulsorily purchase land or to acquire water rights for any of the purposes of its water and sewerage works or proposed water and sewerage works. This aspect of the legislation is particularly relevant since land acquisition is required for this project.

2.4.2 Sludge Disposal Standards USEPA CFR 503

WASA adheres to the sludge disposal standards as outlined by the United States Environmental Protection Agency (USEPA). The USEPA standard (Part 503 - Standards for the Use or Disposal of Sewage Sludge), defines sludge and establishes standards for its pollutant content as well as handling procedures. These are described hereunder. Table 2-3 and Table 2-4 describe metal content ceiling concentrations and cumulative loading rates respectively, while Table 2-5 and Table 2-6 describe the metal pollutant concentrations and annual loading rates respectively.

Sludge Definition

Sewage sludge is defined as solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

The person who prepares bulk sewage sludge that is applied to agricultural land, forest, a public contact site, or a reclamation site shall provide the person who applies the bulk sewage sludge written notification of the concentration of total nitrogen (as N on a dry weight basis) in the bulk sewage sludge.

Table 2-3 Ceiling Concentrations

Pollutant	Ceiling Concentrations (mg/kg)[1]
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7500

[1]Dry weight basis

Table 2-4 Cumulative Pollutant Loading Rates

Pollutant	Cumulative Pollutant Loading Rate (kg/ha)
Arsenic	41

Pollutant	Cumulative Pollutant Loading Rate (kg/ha)
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

Table 2-5 Pollutant Concentrations

Pollutant	Ceiling Concentrations (mg/kg)[1]
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

[1]Dry weight basis

Table 2-6 Annual Pollutant Loading rates

Pollutant	Annual Pollutant Loading Rate (kg/ha/365-day period)
Arsenic	2.0
Cadmium	1.9
Copper	75
Lead	15

Pollutant	Annual Pollutant Loading Rate (kg/ha/365-day period)
Mercury	0.85
Nickel	21
Selenium	5.0
Zinc	140

The USEPA Standards for sewerage handing are itemized below:

503.14 (a) Bulk sewage sludge shall not be applied to the land if it is likely to adversely affect a threatened or endangered species listed in the Endangered Species Act or it is designated critical habitat.

503.14 (b) Bulk sewage sludge shall not be applied to agricultural land, forest, a public contact site, or a reclamation site that is flooded, frozen, or snow-covered so that the bulk sewage sludge enters a wetland or other waters…

503.14 (c) Bulk sewage sludge shall not be applied to agricultural land, forest, or a reclamation site that is 10m or less from waters.

503.14 (e) Either a label shall be affixed to the bag or other container in which sewage sludge that is sold or given away for application to the land, or an information sheet shall be provided to the person who receives sewage sludge sold or given away in another container for application to the land. The label or information sheet shall contain the following information:

1. The name and address of the person who prepared the sewage sludge that is sold or given away in a bag or other container for application to the land.

2. A statement that application of the sewage sludge to the land is prohibited except in accordance with the instructions on the label or information sheet.

3. The annual whole sludge application rate for the sewage sludge that does not cause any of the annual pollutant rates in Table 4 to be exceeded.

2.4.3 Health, Safety and Environment Policies

In the decommissioning of 12 existing wastewater treatment plants and the establishment and operation of the Maloney and Malabar treatment plants, the Water and Sewerage Authority proposes to manage and operate using the best available technology to ensure that the environment is protected, and to guarantee the health and safety of all employees and the welfare of the surrounding communities. The project is committed to abide by the highest health, safety and environmental standards, rules. A copy of WASA's HSEQ Policy Statement is provided at the end of this chapter.

2.5 RELEVANT APPROVAL AGENCIES

The relevant approval agencies for the proposed Malabar Maloney Waste Water Treatment Project include:

- Environmental Management Authority
- Town and Country Planning Division
- Water and Sewerage Authority
- Electrical Inspectorate
- Ministry of Agriculture, Land and Marine Resources
- Arima Borough Corporation
- Tunapuna/Piarco Regional Corporation
- Ministry of Works and Transport

- Drainage Division
- Ministry of Health
- Ministry of Labour

2.5.1 Outline of Required Approvals

Based on the information available an outline of the required approvals for the proposed project is summarized in Table 2-7.

Table 2-7 Approval Outline

Required Approval	Approval Agency
Certificate of Environmental Clearance Environmental Impact Assessment	• Environmental Management Authority
Design of Building and Plant Structures/ Adherence to electrical codes	• Arima Borough Corporation - Arima Borough Council (process water applications and building plans) • Town and Country Planning • Electrical Inspectorate Unit
Potable Water Supply and Treatment and Disposal of Sanitary Waste Provision for Carrying out Random Test	• Water and Sewerage Authority
Surface Water Drainage	• Drainage Division – Ministry of Works and Transport
Discharge Point	• Environmental Management Authority • Town and Country Planning
Safety and Health of Workers	• Ministry of Labour – Occupational Safety and Health Division • Local Health Authority
Disposal and Control of Non-Toxic, Non-Hazardous Garbage and other Solid	• Solid Waste Management Company of Trinidad and Tobago Limited

Required Approval	Approval Agency
Waste	• Environmental Management Authority
Treatment and Disposal of effluent from sewage treatment facility	• Environmental Management Authority
Monitoring Program	• Environmental Management Authority
Plant Operation	• Industrial Inspection Supervisor/ Water and Sewerage Authority
Approval of Planning Permission	• Town and Country Planning Division

2.6 WASA'S POLICIES – ENVIRONMENTAL, HEALTH AND SAFETY

The Water and Sewerage Authority is committed to the constructive use and conservation of the environment. It seeks to provide its customers with safe, reliable and responsive utility service at reasonable rates. The Authority is committed to conduct its operations in an environmentally sensitive and responsible manner by adhering to principles which include *inter alia*:

- Organisation Priority - To recognize environmental management as within the highest corporate priority and as a key determinant in sustainable development; WASA seeks to establish policies, programs and practices in conducting its operations in an environmentally sound manner.

- Environmental Assessment - To assess the environmental impacts before implementing any new project and before decommissioning any facility or leaving/abandonment a site.

- Precautionary Approach - To minimize any significant adverse impacts of new projects by use of new technologies and design.

- Consumption reduction - To minimize the consumption of natural resources.

- Adoption by Interested Parties - To promote the adoption of these principles by our customers, consultants and suppliers as well as developers.

- Pollution Prevention - To prevent pollution by employing management systems and procedures specifically designed to prevent activities and/or conditions that pose a threat to human health, safety or the environment. To minimize risk and protect employees and the communities in which it operates. To set and review environmental objectives and targets which will minimize the toxicity and waste levels generated. To seek to ensure the safe treatment and disposal of waste generated and promote the use of environmentally safe materials and technologies.

- Employee Education - To educate, train and motivate employees to conduct their activities in an environmentally responsible manner.

- Emergency Preparedness - To develop and maintain, where significant hazards exist, emergency preparedness plans.

- Compliance - We will comply with all applicable laws, regulations and guidelines. We will employ appropriate resources to implement proactive programs and procedures to assure compliance. Adherence to Environmental Standards will be a key ingredient in training and incentives to employees.

- Continuous Improvement - We are committed to continual improvement and will continuously seek opportunities to improve our adherence to these principles; we will periodically reward progress and set new targets, and will communicate and reinforce this policy throughout the organization.

2.6.1 Safety and Health Policy

WASA'S SAFETY AND HEALTH POLICY STATEMENT

The Board of Commissioners and Management of the Water and Sewerage Authority is committed to ensuring the safety, health and welfare of its employees, trainees, contractors, visitors and members of the general public who may be affected by its operations. Our commitment extends to providing a work environment where safety and health are factored into every task and based on the principle that all injuries and occupational illnesses can be prevented.

On this premise, the Authority shall not in any way sacrifice nor compromise the safety and health of the employees or any other person, nor the security of any structure or property in the due performance of its duties as a service provider. It shall strive continuously to develop and sustain a positive safety culture by accepting that high standards of safety, health and environment management are achievable as part of a long term strategy formulated by the Authority.

The Authority will establish strict policies and procedures which must be observed and followed by all individuals to ensure safety of people and property in work-related activities and it is the principal responsibility of management at all levels to ensure conformity with these standards and guidelines. The Chief Executive Officer shall be responsible for the implementation of this policy.

In pursuit of the policy the Executive Management commits itself to:

- Demonstrate leadership and commitment to the safety, health and welfare of employees.

- Provide adequate/appropriate resources for the management of the safety, health and welfare of employees.
- Establish a Joint Health and Safety Committee (JHSC) comprising representatives of management and trade unions to co-manage the safety, health and welfare of employees.
- Comply with national safety and health laws, regulations and standards.
- Develop aggressive inspection programmes and execute company-wide safety and health audits to identify compliance gaps and to assess the effectiveness of the Authority's Safety and Health Management System.
- Execute timely and effective remedial works affecting safety and health.
- Develop relevant training programmes in support of this policy.
- Develop communication and consultation procedures aimed at gaining support of all employees and stakeholders to foster a positive safety culture
- Assess all safety and health risks in the organization and develop appropriate controls, and monitoring systems.
- Achieve hazard and risk control systems through the adoption and/or adaptation of modern designs and effective purchasing policies.
- Ensure that all employees trained in recognition/evaluation/control of hazards
- Ensure that contractors, consultants and others who provide services on the Authority's behalf comply with all safety and health standards/guidelines.

- Co-operate with government and non-governmental organizations, industrial groups and others involved in safety, health and environmental issues.

The success of this policy hinges on the involvement and full co-operation of all employees who are expected to adhere to safe work practices, safety standards and guidelines. Additionally, employees must report all accidents, incidents and near misses to their supervisors/managers and refrain from misuse, damage or interference with any item/s provided for the purpose of occupational safety and health.

This policy shall be reviewed and revised as required to ensure its relevance and effectiveness. Management shall provide the necessary resources to the Joint Health and Safety Committee to facilitate these reviews.

3 PROJECT DESCRIPTION

3.1 SCOPE AND OBJECTIVE

The objective of this chapter is to outline and, where possible, provide detailed information on the proposed project written in accordance with the EIA TOR for CEC#1469/2006. Following a description of the site layout, the project description addresses details of the collection and treatment of the waste water, labour requirements, activities associated with pre-construction (i.e. enabling works), and construction phase activities. The project description also addresses those activities that will occur during the operational life of the treatment plant. Non-routine (i.e. accidental) events are then discussed, followed by the decommissioning stage.

The chapter results in an ‘environmental aspects register’ of operations that will be undertaken as part of construction and operation activities that have the potential to cause positive and negative environmental and social effects. These environmental aspects will continue to feature throughout the remainder of the report.

Urbanization in the Maloney, Malabar and Arima areas, coupled with inadequately treated wastewater, has degraded the quality of the surface water, adversely affecting the surrounding environment and posing a hazard to human health. In 2005, the resident population was 69,687 in Malabar and 23,620 in Maloney. Population equivalent projections estimate 108,630 inhabitants by the design year 2035 for the Malabar Catchment and 31,420 for the Maloney Catchment. The Malabar catchment comprises an area of 2,766 ha, while the Maloney catchment is 1,069 ha. There are several industries within the project area including the O’Meara Industrial Park and a variety of small to medium size commercial businesses. The Catchment Area contains many institutional facilities including the new University of Trinidad and Tobago (UTT), the Arima Regional Hospital, and several government schools.

The elements of the Project are:

- Laying of trunk and lateral sewers (estimated 19.4 km for Maloney and 175 km for Malabar)
- Construction of five (5) lift stations for Maloney and eight (8) lift stations for Malabar
- Acquisition of land for a new centralized WWTP in Malabar
- Construction of a new WWTP in Malabar, to be sited on 11.06ha of land.
- Expansion of the Maloney Gardens activated sludge WWTP requiring acquisition of 3.6ha of land.

The two WWTPs will remove from service five existing plants in the Malabar catchment and five existing plants in the Maloney catchment. The existing Ascot Gardens WWTP will remain functioning; however the new Malabar WWTP has been sized for this flow if the collection system is changed in the future. The following facilities will be eliminated:

- Arima trickling filter plant
- Existing Malabar activated sludge plant
- Maturita package activated sludge plant
- Hermitage Heights package activated sludge plant
- La Florissante WWTP
- La Resource WWTP
- Lillian Heights WWTP
- Lynton Heights WWTP
- Santa Monica WWTP
- Tumpuna Gardens sewage lagoon
- Malabar Lift Station

- Santa Rosa Springs Lift Station
- Darceuil Lift Station
- Carib Homes Lift Station

The project would meet service demands, paying due consideration to public health issues, and the quality of inland waters. The main goals of this project are to protect public health and safeguard the environment, and to achieve the most effective operation of the treatment plant.

The boundaries of the Malabar Catchment are Demerara Road to the east, Cleaver Road and Andrews Lane to the west, Arima By-Pass Road and Old Arima Road to the north and the Caroni River to the south. The boundaries of the Maloney Catchment are Cleaver Road and Andrews Lane to the east, Golden Grove Road to the west, Arima By-Pass Road and Old Arima Road to the north and the Churchill Roosevelt Highway to the south.

3.1.1 Population

The projected service population values from 2005 progressing to 2035 for the entire project area are summarized in Table 3-1.

Table 3-1 Service Population for Project Catchment

Regional Sewerage Catchment	2005[1]	2015[2]	2020[1]	2035[2]
	pe	pe	pe	pe
Arima & Malabar	25,800	66,900	87,470	108,630
Maloney	17300		26080	31,420

Note:
1. Safege (2005) Report
2. Linear Interpolation between 2005 and 2020

3.1.2 Design Effluent Criteria

The design effluent criteria are based on reliably satisfying the standards stipulated in the Environmental Management Act, Water Pollution Rules 2001 for Inland Surface Water Discharges. The design effluent criteria for Malabar WWTP are summarized in Table 3-2 below.

Table 3-2 Malabar WWTP Effluent Criteria

Effluent Design Parameter	Units	WWTP Value	Liquid Effluent from Domestic WWTPs into inland Surface Waters TTS 417:1993 Permissible levels	Water Pollution Rules 2001 for Inland Surface Water Permissible Levels	Reference Notes
Chemical Oxygen Demand (COD)	mg/L	250	-	250	1,3
Biological Oxygen Demand (BOD_5)	mg/L	20	25	30	1,3
Total Suspended Solids (TSS)	mg/L	20	30	50	1,3

Effluent Design Parameter	Units	WWTP Value	Liquid Effluent from Domestic WWTPs into inland Surface Waters TTS 417:1993 Permissible levels	Water Pollution Rules 2001 for Inland Surface Water Permissible Levels	Reference Notes
Total Oil and Grease	mg/L	10	-	10	1,3
Ammoniacal Nitrogen (NH_3-N)	mg/L	10	-	10	1,3
Total Nitrogen (TN)	mg/L	10	-	-	2,3
Total Phosphorus (TP)	mg/L	5	-	5	1,3
Total Residual Chlorine	mg/L	1	0.1*	1	1,3
Dissolved Oxygen (DO)	mg/L	>4	-	>4	1,3
Faecal Coliforms	No./100 mL	100	4000	400	1,4
pH	units	6-9	6-9	6-9	1

*The Authority responsible for monitoring compliance with this standard shall have the discretionary power to relax or make more stringent the specified levels of total residual chlorine, according to any special environmental conditions in the vicinity of the point of discharge

Notes:
1. Based on Inland Surface Water Discharge Regulations (Republic of Trinidad and Tobago, 2006)
2. Added to the effluent limits to minimize nitrate discharges that eventually reach the Caroni River upstream of a major water treatment plant
3. Compliance basis is arithmetic average of daily values for a calendar month
4. Compliance bases is geometric mean of daily values for a calendar month

3.2 MALABAR SITE DESCRIPTION AND PROPOSED PROJECT

3.2.1 Existing Sewered Areas

3.2.1.1 Arima Sewerage System

The Arima sub-catchment is approximately 1,200 ha. The area includes a 270 ha area served by a centralized wastewater collection, treatment and disposal system owned and operated by WASA. The system was constructed in the 1960s (Lockjoint Project). There are approximately 9,000 population equivalents (pe) within the Arima sewerage system and of these approximately 58 % is reported to be connected to the system. The Arima wastewater treatment plant (WWTP) is a trickling filter plant with upstream grit removal and primary clarification. The final effluent is discharged to the Mausica River. There are five existing lift stations connected to the system. There are a number of residential areas within the subcatchment that are served by individual on-lot septic tank/soak-away systems. Overall, approximately 68 % of the Arima sub-catchment, by area, is served by on-lot systems.

3.2.1.2 Surrounding Sewered Areas

The largest sewered areas outside of Arima are the Malabar residential developments, Santa Rosa developments, the La Horquetta development, and O'Meara Industrial Estate.

The Malabar developments cover an area of approximately 125 ha. They were built by the National Housing Authority (NHA) (now Housing Development Corporation, HDC) in the 1970s (upper Malabar) and 1980s (lower Malabar). New developments in lower Malabar are currently under construction. The population equivalent is approximately 3,000 and there is an estimated 4.5 km of sewer network.

The wastewater from the three Santa Rosa developments is conveyed to the existing Malabar WWTP. The Santa Rosa Heights (East) development is sewered and wastewater flows to the Santa Rosa Heights lift station where it is pumped across the Arima River to a gravity pipeline along the north bank of the CRH that conveys it to the existing Malabar WWTP. The new Santa Rosa (West) “the Crossings” development is sewered by gravity and wastewater is conveyed to the existing Malabar WWTP via the same gravity pipeline along the north bank of the CRH. The Santa Rosa Springs development is sewered and wastewater flows to a lift station where it is pumped to the Lower Malabar Housing Development collection system and onward to the existing Malabar WWTP. These developments cover an area of approximately 120 ha.

The La Horquetta development located south of the CRH covers an area of 140 ha and has an existing population equivalent of approximately 12,950. There are a reported 25 km of gravity sewers in the area that convey flow to the La Horquetta lift station where it is pumped directly to the existing Malabar WWTP. Wastewater from the O’Meara Industrial Park also flows to the existing Malabar WWTP.

There are a number of other private and government developments within the project area that are sewered but do not have functioning lift stations and/or WWTPs. Wastewater from these areas is currently by-passing treatment and discharging into surrounding rivers, creeks or drains.

3.2.2 New Developments

There are a number of new and proposed developments that are either under construction or in the final planning stage. A list of known new developments is shown in Table 3-3.

Table 3-3 New and Proposed Developments

Development	Name of Developer	Lot Count	Existing /Under Construction (UC)/Proposed	Sewered/ Unsewered	Subcatchment
Sarita Park	Soogdeo Bachan	40	Existing	Sewered	Arima Proper
Cleaver Heights	HDC	538	UC	Sewered	Cleaver Road /Andrew Lane
Greenvale Park	HDC	1200	UC	Sewered	La Horquetta /Greenvale
HCL Development	HCL	2000	Proposed	Unknown	La Horquetta /Greenvale Malabar
La Croix	Farm	10	Existing	Sewered	Malabar Development
Malabar 1	HDC	130	UC	Sewered	Malabar
Malabar 2	HDC	350	Existing	Sewered	Malabar
Malabar 3	HDC	97	UC	Sewered	Malabar
Royal Palm Development	Malabar Farm Development	29	UC	Sewered	Malabar
Almond Boulevard	Malabar Farm	50	Existing	Sewered	Mausica /Olton Road
Elliot Netto Development	Elliot Netto Development	25	Proposed	Sewered	Mausica /Olton Road
Kenneth Netto Development (Darwell Gardens Ext.)	Kenneth Netto Development	45	Proposed	Sewered	Mausica /Olton Road
Riverwood (Olton Road Housing Development/ Eastol Lands)	NIPDEC	283	UC	Sewered	Mausica /Olton Road
Samaroo Village (LSA)	LSA	29	Existing	Sewered	Mausica /Olton Road
Syjdra Court	Syjdra Holding Co.Ltd.	19	Existing	Unsewered	Mausica /Olton Road
'A River Runs Thru'	UDeCoTT	80	UC	Unsewered	Mt. Pleasant /Maturita
La Residencia	R & D Holdings	27	UC	Sewered	Mt. Pleasant /Maturita
Windsor Heights	Executive	100	UC	Unsewered	Mt. Pleasant /Maturita

Development	Name of Developer	Lot Count	Existing /Under Construction (UC)/Proposed	Sewered/ Unsewered	Subcatchment
	Company				
Ascot Gardens	Royal Property Development	140	Existing	Sewered	Peytonville/Carapo
Race Course Road (LSA)	LSA	687	Existing	Sewered	Peytonville / Carapo
The Crossings'	HCL	900	UC	Sewered	Santa Rosa East / West
Ackbarali Trace (LSA)	LSA	80	Existing	Sewered	Upper Malabar/Tumpuna Road
Mandalay Gardens	Acreage Investment Ltd.	196	Proposed	Sewered	Upper Malabar/ Tumpuna Road
Saint's Gardens	Malabar Farm Development	42	UC	Unsewered	Upper Malabar/Tumpuna Road
O'Meara Road Development	UDeCoTT	30	Proposed	Sewered	Upper O'Meara Road
Buena Vista Gardens #1	Blackthorn Investments Ltd.	49	Existing	Unsewered	Upper Pinto Gill's View Upper Pinto
Buena Vista Gardens#2	Blackthorn Investments Ltd.	57	UC	Unsewered	Road /Gill's View Upper Pinto
Victorian Villas	Home Land Development	8	UC	Unsewered	Road /Gill's View

These developments will be connected to the proposed collection system for treatment at the new Malabar WWTP. Wastewater flows from these areas have been incorporated into the 2035 design flow and load projections.

3.2.3 Malabar Scope of Works

The collection system design for the Malabar Wastewater Treatment Project includes installation of new trunk sewers for conveying wastewater to the new wastewater treatment plant, new local sewers to capture flow from properties that do not currently have sewer service, and integration of new and existing sewers into a single comprehensive wastewater collection system. The new WWTP will replace the existing Malabar WWTP, Arima WWTP, and several smaller plants previously installed by developers. The new plant will be located south of the Churchill Roosevelt Highway.

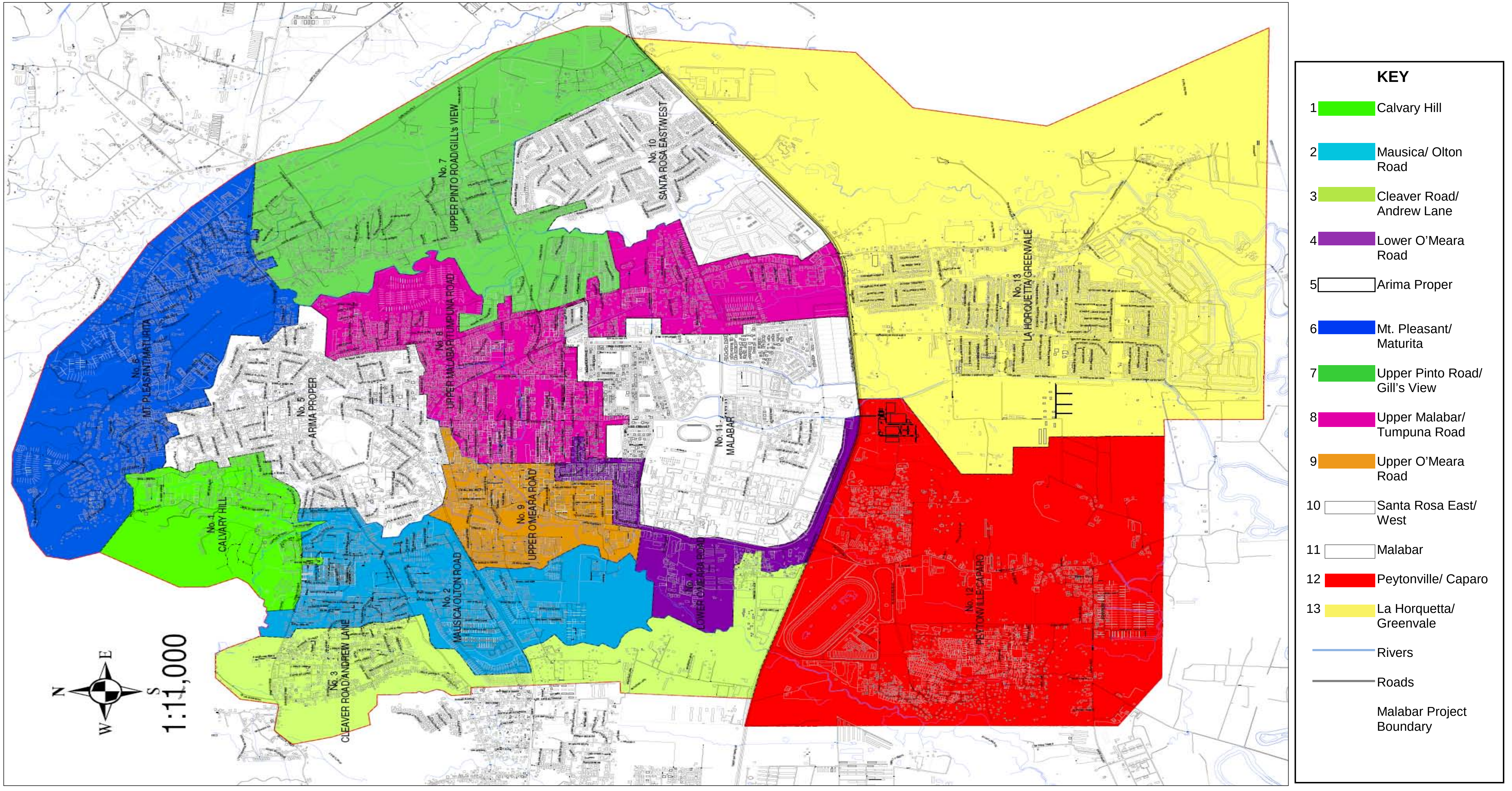


Figure 3.1 Malabar Sanitary Sewer Subcatchments

The project area has been divided into thirteen subcatchments as shown on Figure 3.1 boundaries are defined based on the natural topography and drainage of the areas as well as physical boundaries. A brief description of each subcatchment is as follows:

3.2.3.1 Calvary Hill

The Calvary Hill subcatchment is located in the north western area of the project boundary. It includes the areas west of King Street, including Belle Vue Circular Road, Mausica Lands, and Paul Mitchell Street. The southern boundary is Arima Old Road, and the western boundary is the western project boundary. There is one existing lift station.

3.2.3.2 Mausica/ Olton Road

This subcatchment northern boundary meets the south boundary for Calvary Hill. The housing developments of Almond Boulevard, Carib Homes, Riverwood, Syjdra Court, Elliot Netto Development, Darwel Gardens, Kenneth Netto, and Samaroo Village are found in the Mausica/ Olton Road subcatchment. There is one existing WWTP, one lift station proposed by developers, and one lift station proposed for design.

3.2.3.3 Cleaver Road/ Andrews Lane

This subcatchment forms the western catchment boundary north of the CRH. The Cleaver Heights development is located within the Cleaver Road/ Andrew Lane subcatchment. This subcatchment has no existing or proposed lift stations.

3.2.3.4 Lower O'Meara Road

This subcatchment includes the sewered areas on Subero Street, including North Star Avenue and Hatters Crescent, South to Nutones Boulevard. The subcatchment runs south to the CRH, and includes the road which runs through the south of the O'Meara Industrial Estate. The Malabar Housing Development is located within the Lower O'Meara Road subcatchment. There is one existing lift station and one proposed lift station in this subcatchment.

3.2.3.5 Arima Proper

Arima Proper includes the existing sewered areas in the Arima area. The Soogdeo Bachan (Sarita Gardens) housing development is located within the Arima Proper subcatchment. There are also ten schools located within the sub-catchment. There are no existing lift stations in the Arima Proper sub-catchment, and none proposed.

3.2.3.6 Mt. Pleasant/ Maturita

The Mt. Pleasant/ Maturita sub-catchment encompasses the northwest portion of the catchment boundary. Orange Flats located west of the Arima River, is included, as well as the following housing developments: A River Runs Through, Windsor Heights, Maturita, Dundee Village, and La Residencia. There is one existing lift station in this sub-catchment, and one proposed.

3.2.3.7 Upper Pinto Road/ Gills View

This sub-catchment boundary to the north mainly follows the Eastern Main Road from the Arima River to the eastern catchment boundary. Within the Upper Pinto Road/ Gill's View sub-catchment the following housing developments are found: Zone 8, Pinto Road Development, Buena Vista Gardens 1 & 2, Hermitage Heights and Tumpuna Heights. There are three existing WWTPs in the Upper Pinto/ Gills View sub-catchment. There is one proposed lift station.

3.2.3.8 Upper Malabar/ Tumpuna Road

The Upper Malabar/ Tumpuna sub-catchment has three sections which are joined together by Tumpuna Road. Within the Upper Malabar/ Tumpuna Road sub-catchment the following housing developments are found: Fiddler's Dream, Buena Vista 3, Saint's Gardens, Ackbarali Trace, and Santa Rosa Springs. The Arima Presbyterian Primary School is located within this sub-catchment. The sub-catchment has two existing lift stations, and none proposed.

3.2.3.9 Upper O'Meara Road

The Upper O'Meara Road sub-catchment includes Church Street North, Edna Street, and the area west of the existing Arima WWTP in its western boundary. There are the housing developments of Charles Gardens, O'Meara Road Development, and El Rancho within the Upper O'Meara sub-catchment. The Malabar RC Primary School is located within this sub-catchment. This sub-catchment includes no existing of proposed lift stations.

3.2.3.10 Santa Rosa East/ West

This sub-catchment includes the housing developments of Santa Rosa Crossings, and Santa Rosa Heights. The northern boundary follows the Santa Rosa Heights subdivision along Pomegranate Avenue, with the western boundary along Mathura Road south to the CRH. The Santa Rosa Government Primary School is found in the Santa Rosa East/ West sub-catchment. There is one existing lift station.

3.2.3.11 Malabar

The Malabar sub-catchment boundary to the south includes the O'Meara Industrial Estate, minus the southernmost road to the south, as well as the area south to the CRH from the creek west of the existing Malabar WWTP to the border of the western edge of the Upper Malabar/ Tumpuna Road subdivision. The western boundary follows O'Meara Road. Within the Malabar sub-catchment, the housing developments of La Croix, Malabar Housing Development, and Malabar 1, 2 & 3 are located, as well as three schools. This sub-catchment includes one existing WWTP.

3.2.3.12 Peytonville/ Carapo

This sub-catchment is located south of the CRH, from the western project boundary, south to the southern project boundary. The Peytonville/ Carapo sub-catchment includes the Race Course Road and Ascot Gardens housing developments. This sub-catchment includes one existing WWTP. It includes a proposed lift station by developers and the proposed Malabar WWTP.

3.2.3.13 La Horquetta/ Greenvale

The La Horquetta/ Greenvale sub-catchment includes the southern and eastern project boundaries, south of the CRH. HCL housing developments are located within this sub-catchment as well as two schools. There is one existing and one proposed lift station by developers.

3.2.4 Malabar Subcatchment Population

The projected population equivalent (pe) figures to year 2035 for each proposed sub-catchment within the project area are summarized in Table 3-4.

Table 3-4 Projected Population Equivalents in Subcatchment Areas

Subcatchment Name	PE
Calvary Hill	1,605
Mausica/ Olton Road	6,242
Cleaver Road/ Andrews Lane	6,848
Lower O'Meara Road	1,494
Arima Proper	9,039
Mt. Pleasant/ Maturita	6,495
Upper Pinto Road/ Gills View	7,187
Upper Malabar/ Tumpuna Road	8,812
Upper O'Meara Road	657
Santa Rosa East/ West	6,823
Malabar	14,653
Peytonville/ Carapo	10,380
La Horquetta/ Greenvale	28,395
Total	108,630

The total projected population equivalent of 108,630 includes all existing and known future developments within the project area as well as an estimate of the distribution of future residential developments based on available land space.

3.2.5 Malabar Design Flows

3.2.5.1 Base Wastewater Unit Flow

The average wastewater unit flow of 280 Lpcd will be used for design. This unit flow is made up of residential, light industrial and commercial contributions.

3.2.5.2 Base Infiltration (BI)

The existing collection systems will remain as part of the overall integrated sewer network. The new trunk sewers and collection pipe work will be designed to carry unavoidable amounts of infiltration or seepage from the existing pipe networks - through pipe joints, broken pipe, cracks or openings in manholes. To account for the age of the existing system a base infiltration rate of 155 Lpcd will be adopted for design purposes.

3.2.5.3 Dry Weather Unit Flow

A value of 435 Lpcd has been adopted for Malabar. For the purposes of designing the collection system it is assumed that the unit flow will remain relatively constant at 435 Lpcd up to the 2035 design year.

3.2.5.4 Wet Weather Flow

Based on wet weather flow data from Beetham WWTP and Arima, a wet weather peaking factor of four is used to calculate the design peak flows for the collection system. Using the recommended average dry weather unit flow of 435 Lpcd this translates to a peak wet weather unit flow of 1,740 Lpcd. The peaking factor may be reduced by 2035, if WASA enacts and enforces developmental guidelines to restrict rainfall inflow into the systems. The 2035 design peak wet weather flow for the collection system is therefore:

$$108{,}650 \text{ PE} \times 1{,}740 \text{ Lpcd} = 189 \text{ ML/d}$$

A summary of the average and peak flows used for the design is shown in Table 3-5.

Table 3-5 Design Flows for the New Malabar WWTP

Design Parameter	Units	Value
Design Year	-	2035
Design Year Population Equivalent	-	108,630
Average Unit Flow	Lpcd	370
Average Dry Weather Flow (ADWF)	ML/d	40
Peak Dry Weather Unit Flow	Lpcd	740
Peak Dry Weather Flow (PDWF)	ML/d	80
PDWF/ADWF Ratio		2.0
Average Wet Weather Unit Flow	Lpcd	1,013
Average Wet Weather Flow (AWWF)	ML/d	110
AWWF/ADWF Ratio		2.75
Peak Wet Weather unit flow	Lpcd	1,740
Peak Wet Weather Flow (PWWF)	ML/d	189
PWWF/ADWF Ratio	-	4.725

Note: ML/d – Million Litres per Day, Lpcd – Litres per Capita per day

3.2.6 Malabar Design Loadings

The design loading data for the new Malabar WWTP are summarized in Table 3-5.

Table 3-6: Design Loads for Malabar WWTP

Parameter	Units	Value
Design Year		2035
Serviced Population Equivalent		108,630
Unit loads		
Average BOD	kg/c/d	0.065
Average COD	kg/c/d	0.143[1]
Average TSS	kg/c/d	0.090
Average TN	kg/c/d	0.013
Average TP	kg/c/d	0.0017
Total Loads		
BOD		
Average	kg/d	7,061
Maximum month	kg/d	8,261[2]
COD		
Average	kg/d	15,534
Maximum month	kg/d	18,175[2]
TSS		
Average	kg/d	9,777
Maximum month	kg/d	12,612[3]
TN		
Average	kg/d	1,412
Maximum month	kg/d	1,582[4]
TP		
Average	kg/d	185
Maximum month	kg/d	218[5]
Average Concentrations		
BOD	mg/L	177
COD	mg/L	390
TSS	mg/L	244
TN	mg/L	35
TP	mg/L	4.6

Note: mg/L – milligram per Litre, kg/d – Kilogram per day, kg/c/d – Kilogram per capita per day

Note:
1. Based on a COD/BOD ratio of 2.2.
2. BOD and COD maximum month to average ratio of 1.17 derived from Beetham data.
3. TSS maximum month to average ratio of 1.29 derived from Beetham data.
4. TN maximum month to average ratio of 1.29 derived from Beetham ammonia data.
5. TP maximum month to average ratio of 1.18 derived from Beetham data

3.2.7 Malabar Wastewater Treatment Plant

The WWTP will be sized to treat the year 2035 design flow expectations. The influent pump station and screenings and grit removal facilities (headworks) will be capable of handling the design peak wet weather flow (PWWF) of 189 ML/d. The plant will also be sized to treat an average flow of 40ML/d and peak flow of 110 ML/d through secondary treatment. The excess PWWF flow that cannot be treated immediately through secondary treatment will be stored in a storm water storage tank until secondary treatment capacity is available. Treated effluent will be discharged to a creek located south of the proposed site, which eventually drains into the Mausica, then Caroni River. Waste solids from the activated sludge secondary treatment process will be dewatered, solar dried and stabilized in green houses. After drying it will be hauled offsite and disposed at landfills.

The process flow diagram for the new Malabar WWTP is shown on Figure 3.2.

The treatment scheme for the wastewater includes the following unit processes:

- Influent Pumping
- Septage Receiving Station
- Fine Screening
- Grit Removal
- Storm Water Storage
- Activated Sludge Aeration (Bioreactors)
- Secondary Clarification
- Return Activated Sludge (RAS) Pumping
- Disinfection

The treatment scheme for waste solids from the activated sludge system includes the following unit processes:

- Waste Activated Sludge (WAS) Pumping
- WAS Dewatering
- Solar Drying

Figure 3.3 depicts how the different unit processes would be in proximity and spatial arrangement to each other. Figure 3.4. shows the underground site utilities.

Two water utility systems will be provided as follows:

- Potable Water (W1 and W2) Storage and Pumping Station
- Disinfected Secondary Effluent Water (W3) Pumping Station

Operations and laboratory functions will be housed in an Administration Building. Workshops and offices for mechanical, electrical, and instrumentation maintenance will be located in a Utility Building.

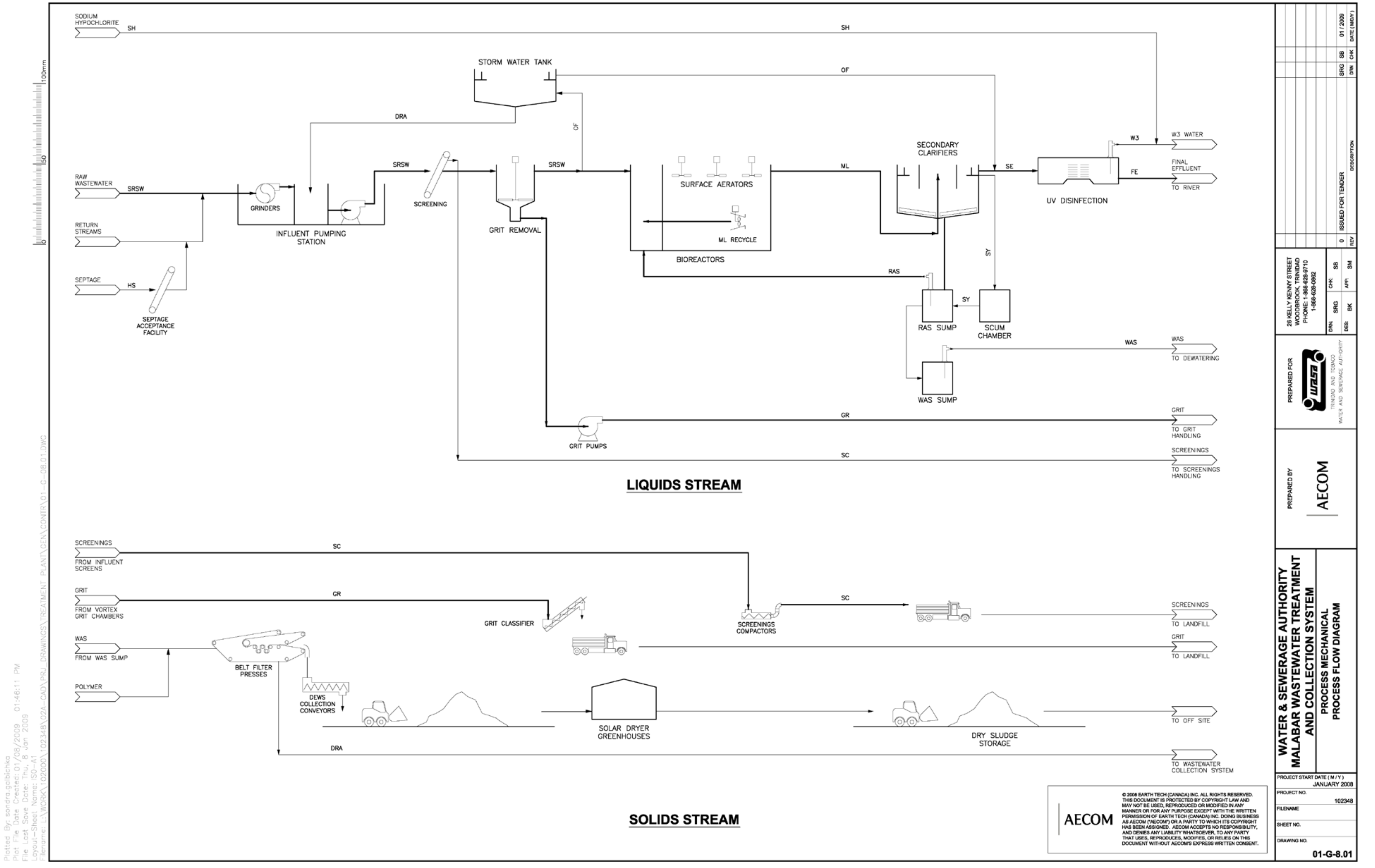


Figure 3.2 Process Flow Diagram of the Malabar WWTP

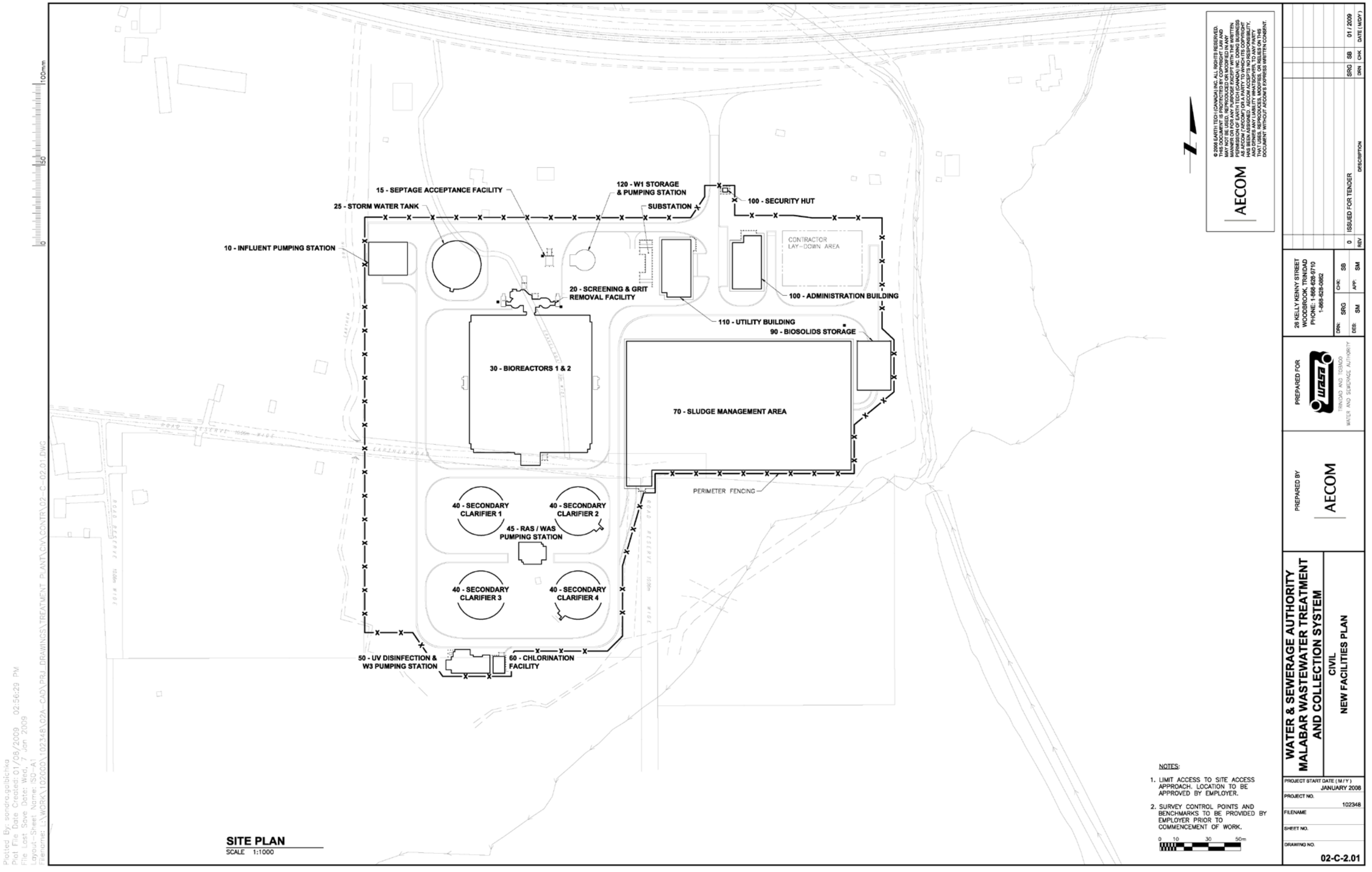


Figure 3.3 Malabar New Facilities Plan

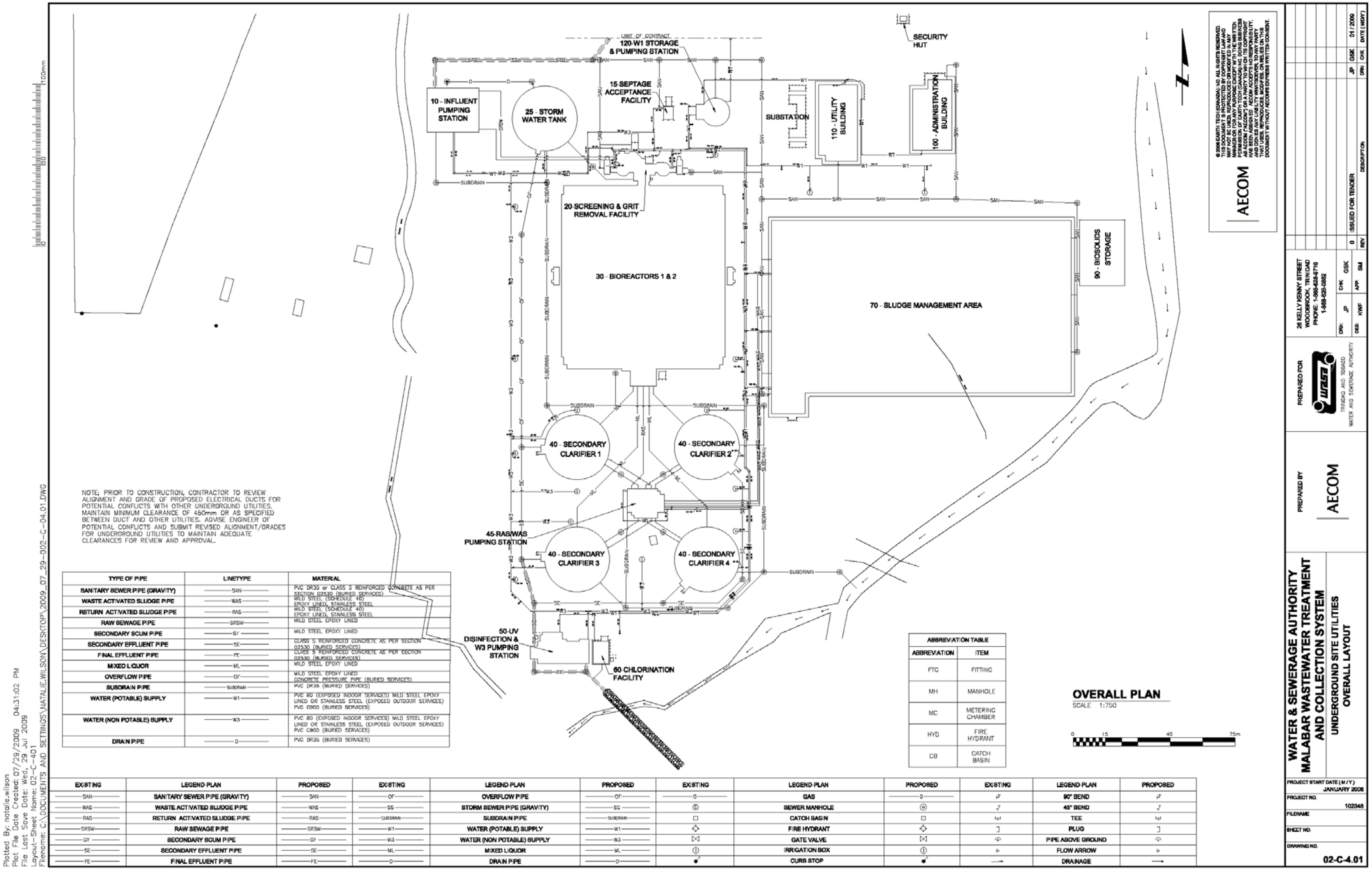


Figure 3.4 Malabar Underground Site Utilities

3.2.7.1 Influent Pump Station

The incoming raw wastewater pipe will be split into two channels that direct flow into the pumping station. Each of the incoming channels will convey the flow into one side of a two cell wet well. An in-channel grinder will be provided in each channel to reduce the size of incoming debris and protect the downstream pumps. A series of dry pit

submersible pumps, mounted in a drywell, pump raw wastewater from the wet wells to the screening system. The wet well and dry well are at an elevation of approximately 16 m above sea level and the final discharge of the plant is approximately 20 m above sea level. Pumps are required to lift the wastewater to an elevation sufficient to allow it to flow by gravity alone through the entire plant, to the outfall.

Three 150 kilowatt (kW) pumps are installed for each wet well (total of six pumps) each rated at 550 L/s (Litres per second). The entire peak flow can be accommodated with two pumps out of service as standby pumps. Flow into a wastewater treatment plant is not constant, but varies with the time of day and season. Therefore, each pump will be equipped with a variable speed drive so that it can match its output as closely as possible to the actual rate of inflow. An ultrasonic level sensor and a controller will maintain a relatively constant water level about the normal water level in the wet well, by controlling the pump speed.

3.2.7.2 Septage Receiving

The septage receiving station will be located adjacent to the raw wastewater pumping station. This station will be for those who remove sewage from soakaways and septic tanks, and need to dispose of it at a WWTP. The hauler connects to the discharge pipe and transfers septage into the package septage plant. The septage acceptance plant consists of a rock trap and a 6 mm screen. The screenings will be washed and dropped into a dumpster for off-site disposal. A simple and uncomplicated septage receiving station is proposed; it does not have a flow meter, control valve or card reader for monitoring of haulers.

3.2.7.3 Fine Screens

Two outdoor influent screens will be mounted above ground level. Each will have a capacity of 190 ML/d. The screens will be band screens with 6 mm openings. A wiper removes screenings from the screen and drops the screenings into its dedicated compactor mounted below the discharge point of the screen. Each of the two compactors reduces the moisture content of the material, raising the solids concentration from approximately 15 to 40 %. The compactor consists of a screw conveyor that drives the material into a converging cone section. As the material is 'squeezed' into the cone, water is ejected and is drained to the influent channel. Compacted screenings discharge into a dumpster. The dewatered screenings are hauled off-site for disposal. Compressed air will be provided to supply air to a coarse bubble aeration system in the channels ahead of the screens to minimize settlement of grit under low flow conditions.

3.2.7.4 Grit Removal

The screened wastewater will be conveyed in channels to the grit removal area. Grit will be removed by two mechanically induced vortex grit removal chambers. These chambers are designed to remove greater than 80 % of the silt, sand, and other inert material greater than 0.25 mm in size. The de-gritted effluent continues to the bioreactor, while the collected grit is dewatered in a cyclone classifier to approximately 75 % solids content and stored for offsite disposal. Three facilities associated with the Grit Removal are as follows:

- **Vortex Grit Removal Chambers** - Vortex grit chambers exploit the difference in density between inorganic (grit) and organic solids to separate the two materials and preferentially remove the grit from the process stream.
- **Grit Pump -** Grit slurry is removed from the bottom of each grit chamber by a recessed impeller solids- handling centrifugal pump.
- **Grit Classifier** - Grit slurry is pumped from the vortex chambers to two grit classifier and dewatering systems. Each system consists of cyclones (one per connected pump), a clarifier tank, and dewatering screw conveyor.

3.2.7.5 Storm Water Storage

The storm water storage facility will provide a degree of storage during excessive wet weather periods. In addition, during a storm event of long duration, the facility will act as a primary clarifier and reduce suspended solids, fats, oils and grease, etc., before being discharged to the disinfection system and outfall. Clarification of excess wet weather flow is preferred for protection of downstream UV (ultraviolet) lamps and to minimize pollutant loads to the Caroni River. Once the storm event has subsided, the contents of the storage facility would be returned to the headworks by gravity. It is not envisaged that a scraper mechanism will be necessary for the storm tank.

The biological treatment system is designed for a maximum flow of 110 ML/d, which corresponds to a peak flow to DWF ratio of 2.75. Flow in excess of 110 ML/d is diverted to a storm tank. This storm tank has the same diameter as the secondary clarifiers, and would operate as a highly loaded primary clarifier when operating at peak flow of 79 ML/d (189 ML/d minus 110 ML/d).

A series of water sprays/nozzles around the tank periphery will be used to wash solids to the central draw-off where it will flow back to the influent pump station by gravity and through the treatment plant.

An analysis of wet weather flows to the New Beetham WWTP was performed to determine what volume should be provided for the Malabar storm water storage tank. Based on the worst storm on record, a minimum volume of 1,760 m^3 would be needed to contain the excess flow. To provide an additional level of protection, and to simplify construction, the storm water storage tank will be the same size as the secondary clarifiers. The 29 m diameter by 6 m deep tank will provide a storage capacity of approximately 3,960 m, which is 2.25 times the estimated minimum volume required.

3.2.7.6 Bioreactor

The bioreactor comprises two equally sized parallel aeration basins. With a total volume of about 24,500 m^3, the hydraulic retention time (HRT) at the Average Dry Weather Flow (ADWF) of 40 ML/d is 14.5 hours. System solids retention time (SRT) will be controlled at a minimum of 10 days. Combined with a minimum mixed liquor temperature of 26°C, the 14.5 hour HRT and 10 day SRT are expected to achieve and maintain nitrification year round. Mixed liquor suspended solids (MLSS) will be maintained at about 3,100 mg/L, and the mixed liquor volatile suspended solids (MLVSS) concentration will be about 1,500 mg/L.

A portion of each bioreactor will be mixed and not aerated to promote denitrification reactions. The anoxic volume comprises 30 percent of the total bioreactor capacity, and is provided for by three anoxic cells per bioreactor. Each anoxic cell has a volume of 1,225 m^3. Simultaneous nitrification-denitrification (SND) in zones aerated with surface aerators, is expected to reduce effluent nitrate concentrations. Mixed liquor recycle pumping is provided to increase the level of denitrification, and meet the 10 mg/L TN limit.

3.2.7.7 Secondary Clarifiers

Mixed liquor from the bioreactor is split through four cutthroat flumes to four secondary clarifiers. The clarifiers separate the mixed liquor into Return Activated Sludge (RAS), which settles to the clarifier floor and is returned to the bioreactor, and secondary effluent, which proceeds to disinfection and final discharge. They are each equipped with a full width suction header mechanism that removes the settled sludge to a common wet well for withdrawal by the return activated sludge pumps. Each of the four clarifiers is 29 m in diameter, with a 6.0 m side water depth (SWD). The total surface area is 2,642 m^2. The overflow rate (OFR) under ADWF conditions is 0.6 m/h. Under peak flow conditions the OFR is 1.7 m/h.

3.2.7.8 UV (Ultraviolet) Disinfection

Disinfection reduces levels of pathogens in the final effluent to meet discharge regulations stipulated by the Environmental Management Authority of less than 100 faecal coliform/100 mL.

The disinfection system consists of a low pressure, high intensity UV disinfection system. The UV system will be sized to disinfect up to 110 ML/d (peak secondary treatment flow) plant to 100 N/100 mL faecal coliform. However, the UV disinfection system will be designed to hydraulically pass 189 ML/d. Once flow through the UV disinfection facility exceeds 110ML/d, there will be a degree of disinfection, but the effectiveness will be reduced if the quality of the effluent deteriorates significantly

Flows into the WWTP in excess of 110 ML/d will be diverted to the storm water storage tank with a capacity of 3,960 m^3, sufficient to contain excess flow (79 ML/d) for a duration of 1.2 h. Stored wastewater will be returned to the treatment works once the storm subsides. Flow in excess of 110 ML/d, in duration beyond the capacity of the storm water tank, will receive primary clarification in the storm water storage tank, and then pass through UV disinfection. This approach to disinfection is common in other jurisdictions and eliminates the expense (both capital and operational) of providing a very large UV disinfection system that will only be used to its full capacity for a few hours each year.

The disinfected secondary effluent flow discharges from the UV facility through a channel that enters a Parshall flume. This flume measures the flow out of the WWTP, and controls upstream water levels, and sends a signal to the UV system controls. The flume discharges into a chamber, which then directs flow into a conduit that conveys the treated effluent to the receiving stream.

3.2.7.9 Flow Measurement and Wet Weather Bypass

Two Parshall flumes will be provided downstream of the grit removal system. These flumes will measure the flow to the bioreactors. The flow signals from the flumes will be used to control actuated gates upstream of the flumes. When the total flow to the plant exceeds 110 ML/d, the actuated weir gate will modulate to limit the flow through the flumes to 110 ML/d. Bypassed flows will be directed to the storm water storage tank. The only wet weather bypass is through the storm water storage tank, which provides a minimum of primary clarification for all flows in excess of the tank's storage capacity. Wastewater that overflows the storm water storage tank also passes through the UV disinfection system before exiting the WWTP.

3.2.7.10 Secondary Sludge Pumping

Return Activated Sludge (RAS) Pumps

The RAS pumps convey the RAS, via a common header to the RAS splitter box. This box directs the RAS flow to the two bioreactor modules.

The total maximum RAS flow is set at 1.5 times ADWF, or 60 ML/d. The three 75 hp (56 kW) pumps are each rated for 350 L/s at about 9 m of head. Centrifugal screw impeller pumps will be used for RAS pumping. These pumps are capable of handling any solids likely to be present in the RAS from the secondary clarifiers. Further, their steep operating curves permit maintenance of a relatively constant flow rate under small variations in pumping head. A vertical shaft mixer is provided to prevent the solids from settling in the RAS wet well.

Waste Activated Sludge (WAS) Pumps

Waste activated sludge (WAS) is removed via a WAS wet well. A penetration between the WAS wet well and the RAS wet well allows RAS to flow into the WAS tank when the WAS pumps are running. The WAS and scum in the WAS tank are kept in suspension by mixers.

WAS will be conveyed from the WAS tank to the belt filter presses using three interconnected variable speed WAS pumps.

3.2.7.11 Sludge Dewatering

WAS will be pumped from the WAS tank to the three belt filter presses (BFP) (2 duty, 1 standby). In the belt filter press the solids content is increased from approximately 0.5 to 1.0 % solids to between 15 to 20 % solids. The belt filter presses are three-belt units consisting of one gravity belt followed by two pressure belts. The gravity and pressure sections are operated independently to optimize the thickening and dewatering functions within a single unit. The gravity section thickens the dilute WAS by removing a majority of the water by gravity. The thickened WAS (TWAS) then feeds the pressure section where the two belts are routed through a serpentine path between a series of rollers. As the sludge travels along the dewatering path, pressure is increased, expelling water from the material. On their return travel, the three belts are washed by a flow of clean water.

3.2.7.12 Sludge Drying

Dewatered cake will be transported by front-end loader to a series of solar dryers. The solar dryers will be of the covered greenhouse-type. At the discharge end, the product will have a solids content of approximately 65 %. The dried product is expected to comply with Class B requirements of the USEPA Part 503 Regulations. This allows for land application with certain restrictions on setbacks. For the design conditions, a total of five greenhouse halls are required. However, as requested by WASA, additional greenhouse capacity has been provided for by the inclusion of one additional greenhouse. Dried sludge will be disposed of at landfills.

3.2.7.13 Design Summary

Table 3-7 summarizes the design criteria, unit process capacities, and equipment details for the new Malabar WWTP. The design is in accordance with Manual of Practice 8, Design of Municipal Wastewater Treatment Plants, published by the Water Environment

Federation, Alexandria, Virginia, USA. Equipment selection is based on manufacturers' published data and correspondence with their technical support personnel.

Table 3-7: Malabar Wastewater Treatment Plant Design Data

Item	Units	Value
Raw Wastewater Characteristics		
Flow		
ADWF	ML/d	40
AWWF	ML/d	110
PWWF	ML/d	189
Total Loads		
BOD		
Average	kg/d	7,061
Maximum month	kg/d	8,261
COD		
Average	kg/d	15,534
Maximum month	kg/d	18,175
TSS		
Average	kg/d	9,777
Maximum month	kg/d	12,612
TN		
Average	kg/d	1,412
Maximum month	kg/d	1,582
TP		
Average	kg/d	185
Maximum month	kg/d	218
Final Effluent		
Monthly Arithmetic Average		
COD	mg/L	250
BOD	mg/L	20
TSS	mg/L	20
Total Oil & Grease	mg/L	10
TN	mg/L	10
TP	mg/L	5
DO	mg/L	4
pH		6 to 9
Monthly Geometric Mean	mg/L	20
Faecal Colifoms	N/100 mL	100
Raw Wastewater Pumps		
Number		6
Capacity	L/s	550
Head	M	23
Power	kW	175
Septage Acceptance Plant		
Number		1
Capacity	L/s	10
Screen Size	Mm	6
Power	kW	5

Item	Units	Value
Screening		
Number		2
Opening Size	Mm	6
Capacity per screen	ML/d	190
Dimensions		
Width, m	M	1.25
SWD, m	M	3.35
Screenings Quantities (wet)		
Average	kg/d	2,700
Maximum	kg/d	27,000
Compactors		
Number		2
Capacity	m^3/hr	1.8
Compacted Screenings Quantities (wet)		
Average	kg/d	1,000
Maximum	kg/d	10,000
Grit Removal		
Type		Vortex
Number		2
Capacity	ML/d	95
Dimensions		
Diameter	m	5.49
Depth	m	7.55
Grit Pumps		
Number		2
Capacity per pump	m^3/h	57
Power	kW	6
Classifiers		
Number		2
Capacity	m^3/h	0.3
Dewatered Grit Quantities		
Dry Solids		
Average	Tonnes/d	1.6
Maximum	Tonnes/d	16
Volume		
Average	m^3/d	1.3
Maximum	m^3/d	13
Storm Water Storage Tank		
Peak Flow	ML/d	79
Peak Overflow Rate (OFR)	m/d	120
Number		1
Dimensions		
Diameter	m	29
SWD	m	6
Volume	m^3	3,960
Bioreactors		
Peak Flow	ML/d	110
Basic Design Parameters[1]		
SRT	d	10
HRT	d	14.5
MLSS	Mg/L	3,100

Item	Units	Value
Number of Bioreactors		2
Volume per Bioreactor	m^3	24,500
Anoxic Cells		
Number per Bioreactor		3
Volume per cell	m^3	1,225
Aerobic Cells		
Number per Bioreactor		7
Volume Aerobic Cells	m^3	1,225
Passes per Tank		2
Dimensions		
Pass Width	m	16.5
Pass Length	m	82.5
SWD	m	4.5
Anoxic Cell Mixers		
Number per cell		1
Power Per Mixer	kW	7.5
Mixed Liquor Recycle Pumps		
Number per cell		4
Flow, each	ML/d	20
Power, each	kW	10
Mechanical Aeration		
Type		Low Speed Surface
Field Oxygen Demand		
Average per basin	kgO_2 /d	5,140
Maximum per basin	kgO_2/d	7,970
Standard Oxygen Demand		
Average per basin	kgO_2/d	8,630
Maximum per basin	kgO_2/d	13,300
Standard Aeration Efficiency (SAE)	kgO_2/kWh	1.8
Number of Aerators per Bioreactor		7
Total Number		14
Aerators		
Aerobic Cell		1
Number		1
Power each	kW	75
Aerobic Cell 2 & 3		
Number		2
Power each	kW	56
Aerobic Cell 4 & 5		
Number		2
Power each	kW	45
Aerobic Cell 6 & 7		
Number		2
Power each	kW	30
Clarifiers		
Basic Design Parameters		
SSVI at Peak Flow	mL/g	75
Overflow Rate (OFR)		
Average	m/h	0.6
Maximum	m/h	1.7

Item	Units	Value
Solids Loading Rate (SLR)		
Average	$kg/m^2/h$	3.1
Maximum	$kg/m^2/h$	8.4
Number		6
Dimensions		
Diameter	m	29
SWD	m	6
UV Disinfection		
Peak process capacity	ML/d	110
Peak hydraulic capacity	ML/d	189
No of channels		2
Banks per channel		1
Lamps per bank		144
UV reduction equivalent dosage	mWs/cm^2	35
UV transmittance	%	55
Power	kW	104
Return Activated Sludge (RAS) Pumps		
Number		3
Capacity	L/s	350
Total Dynamic Head	m	9
Power	kW	56
Waste Activated Sludge (WAS) Pumps		
Number		3
Capacity	L/s	30
Total Dynamic Head	M	14
Power	kW	11
Waste Sludge Characteristics		
Solid Loads		
Average	kg TSS/d	7,710
Maximum	kg TSS/d	9540
Concentration	%	0.5 to 1.0
Maximum Flow	m^3/d	1,285
Belt Filter Presses		
Number		
Total		3
Duty		2
Standby		1
Weekly operation	d/week	5
Daily operation	h/d	8
Solids loads		
Average	kg/d	10,800
Maximum	kg/d	13,360
Solids concentration		
Inlet	%	0.5-1.0
Outlet	%	15-20
Belt width each unit	M	3
Solids loading	kg/m/h	280
Hydraulic loading	$m^3/m/h$	35
Minimum solids capture	%	95

Item	Units	Value
Belt Drives		
Number of drives per unit		3
Power	kW	2.2
Belt washwater		
Flow per unit	L/s	2.5
Pressure	kPa	800
High pressure booster pump		
Number of pumps		3
Flow per unit	L/s	7.5
Head	M	82
Power	kW	11
Compressed Air		
Flow per unit	Nm^3/h	1
Pressure	kPa	1,000
Compressor		
Number of compressors		2
Capacity	Nm^3/h	10
Pressure	kPa	1,000
Power	kW	2.2
Filtrate flow per unit	L/s	38
Cake Conveyors		
Number of units		2
Minimum Width	mm	600
Speed	m/min	23
Peak capacity each	m^3/hr	15
Power	kW	3.7
Polymer System		
Number of make-up systems		1
Number of storage tanks		1
Polymer dosage		
Average	kg/t	8
Maximum	kg/t	15
Hourly polymer load		
Average	kg/h	11
Maximum	kg/h	25
Weekly dry polymer loader requirement		
Average	kg/week	430
Weekly	kg/week	1,000
Polymer concentration		
After make-up	% w/w	0.5
After addition of carrier water	% w/w	0.1
Volume of mixing tank (each)	L	6,000
Volume of storage tank	L	10,000
Aging time in mixing tank at 0.5 % w/w	min	60
Polymer dosing pumps		
Number of pumps		3
Capacity (each)	L/min	25
Design head	M	50
Power	kW	0.75

Item	Units	Value
Dry Polymer Screw Feeder		
Power	kW	0.37
Dry Polymer Blower		
Power	kW	1.86
Mixer		
Power	kW	3.73
Solar Dryer		
Annual feed solids (dry)	dry tonnes/ year	2,800
Average feed solids content	% DS	16
Annual feed solids (wet)	tonnes/year	17,500
Average product solids content	% DS	65
Average product solids	tonnes/year	4,300
tonnes/day		12
Number of drying halls		6
Length of hall	m	116
Width of each hall	m	12
Tillers		
Drive Motors each	kW	0.8
Drum rotational motor	kW	5.5
Drum lifting motor	kW	0.9
Dried Product Storage		
Average storage	d	30
Storage mass	tonnes	350
Bulk density	kg/m^3	800
Storage volume	m^3	440
Length	m	20
Width	m	10
Product height	m	3
W1 Water Supply Pumps		
Number		3
Capacity	m^3/h	12
Total Dynamic Head	m	50
Power	kW	7
Storage Reservoir	m^3	450
W3 Water Supply Pumps		
Number		2
Capacity	m^3/h	110
Total Dynamic Head	m	80
Power	kW	30

Notes: SRT – Solids retention time

HRT – Hydraulic retention time

MLSS – mixed liquor suspended solids

3.2.8 Malabar Collection System

The proposed Malabar wastewater collection system is shown schematically on Figure 3.5 page 3-37 and details of Figure 3.5 are shown in a four page layout in Appendix VIII. The proposed sewer network can be broken down into four pipe classifications: sewers less than 600 mm diameter, sewers greater than 600 mm diameter, service connections, and force mains. A summary of the proposed sewer pipe lengths per sub-catchment is shown in Table 3.8.

Table 3-8 Pipe Length per Subcatchment

ID	Subcatchment Area	Sewer < 600mm (m)	Sewer ≥ 600mm (m)	Service Connection (m)	Force Main (m)
01-Ch	Calvary Hill	7,194		1,265	93
02-Mo	Mausica/Olton Road	12,507	471	4,620	0
03-Ca	Cleaver Road /Andrew Lane	11,608	1,144	5,295	0
04-Lor	Lower O'Meara Road	2,054	2,631	1405	476
06-Mm	Mt. Pleasant /Maturita	18,023	0	5835	981
07-Upr	Upper Pinto Road /Gill'sView	19,715	2,445	6230	675
08-Umt	Upper Malabar /Tumpuna Road	17,410	2,523	6235	0
09-Uor	Upper O'Meara Road	12,981	435	5065	471
11-Mal			1110		0
12-Pc	Peytonville/Carapo	13,093	293	51	1,352
13-Lg	La Horquetta /Greenvale	8,180	1,760		
Total		122,767	12,812	36,001	4,048

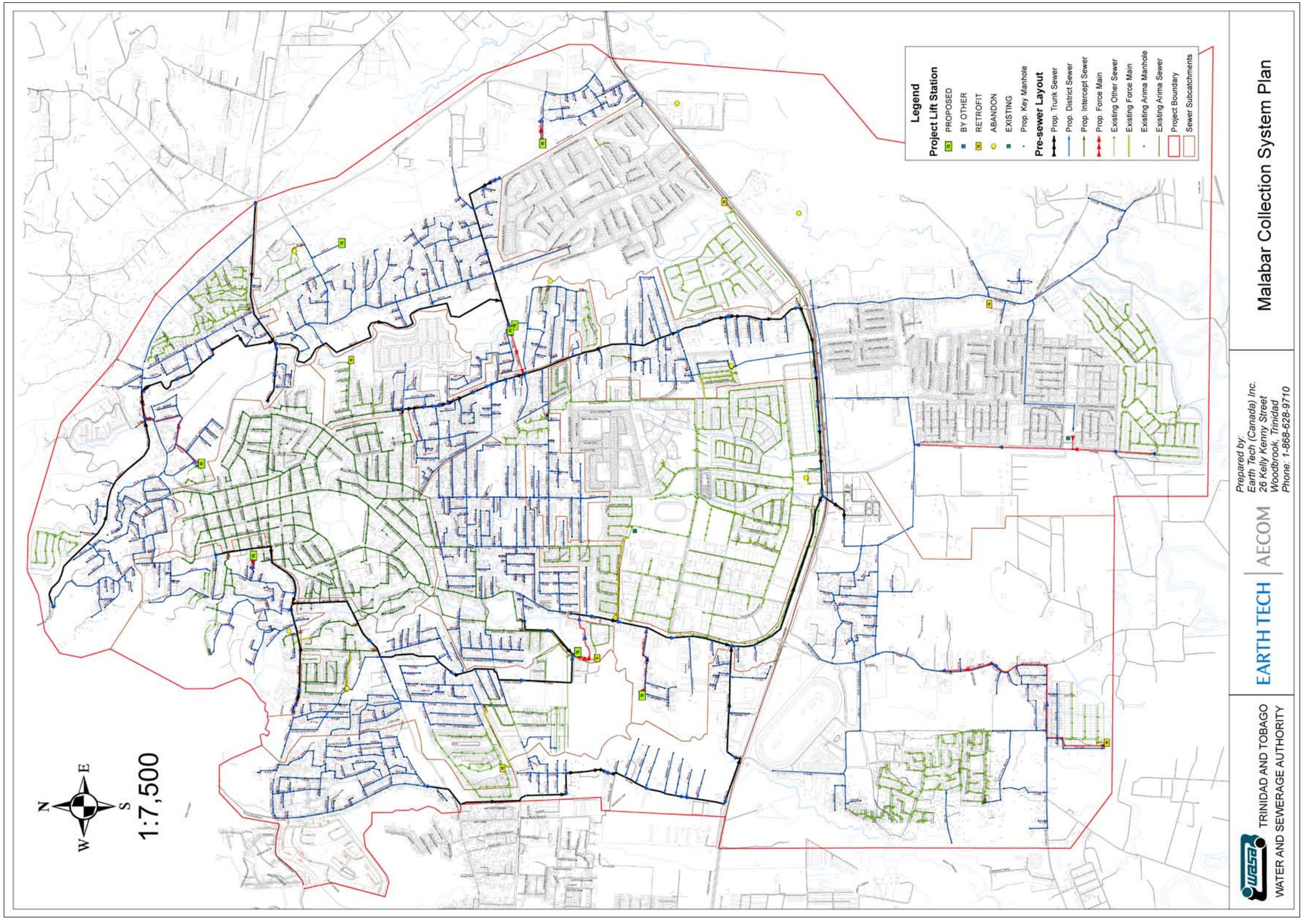


Figure 3.5 Malabar Proposed Sanitary Collection System Plan

3.2.9 Malabar Lift Stations

In the Malabar catchment area, there will be eight new lift stations required to convey the wastewater to the Malabar WWTP. The existing WWTP at Ascot Gardens will remain in operation; however the Malabar WWTP has been sized to accommodate this flow in the future, if the collection system is extended south of the CRH. A summary of all existing and proposed lift stations is shown in Table 3.8.

The new lift stations have been categorized by flow into three types. Type I is low flow, Type II medium flow, and Type III is high flow. Three type I, three type II, and two type III lift stations will be constructed. The remaining lift stations in Table 3-8 are either existing, are to be constructed by others, or will be decommissioned. Appendix VIII has examples of civil process mechanical, and structural drawings for Type I, II, and III lift stations.

Table 3-9 Summary of Lift station Information

Lift station Name	PE	ADWF (m^3/hr)	PWWF (m^3/hr)	Lift station Type	Comments
Arima	16,408	297	1,190	III	Lift station to be built at existing WWTP
Gills View	14,879	270	1,079	III	New lift station/
Gills View Booster	1122	22	88	II	New lift station
O'Conner Drive	357	7	26	II	New lift station
Dundee	4137	75	300	II	New lift station
Sanchez	35	0.63	2.5	I	New lift station
Jump Street	35	0.63	2.5	I	New lift station
Street 07-12	35	0.63	2.5	I	New lift station
La Horquetta	18,792	341	1,362	Existing	
Ascot Gardens	5,500	100	399	Existing	Existing WWTP, modify to Lift station in future
Santa Rosa Heights	3,675	67	266	Existing	
El Rancho	60	1	4	Existing	
Fiddlers Dream	175	3	13	Existing	
Greenvale Park	4,330	79	314	Unknown	Lift station to be constructed by others

Lift station Name	PE	ADWF (m^3/hr)	PWWF (m^3/hr)	Lift station Type	Comments
Race Course Road	3,427	62	249	Unknown	Lift station to be constructed by others
Riverwood	616	11	45	Unknown	Lift station to be constructed by others
A River Runs Through	280	5	20	Unknown	Lift station to be constructed by others
Ail	144	3	10	Unknown	Private Lift station

3.2.10 Labour Requirements

3.2.10.1 Malabar Staff Facilities

The WWTP on-site staff is categorized as follows:

Managerial	3
Administrative support	2
Operations	6
Laboratory	2
Maintenance	5
Total	18

Additional staff will be required for maintenance of the collection system and lift stations. It is anticipated two crews of one crew chief and two labourers will suffice. However, the collection system maintenance staff will not be located at the treatment plant.

This brings the total staff required to twenty four employees.

3.2.11 Malabar Pre Construction Activities

3.2.11.1 Land Acquistion

A preliminary review of land ownership at the site for the new Malabar WWTP was conducted in 2005. At that time, all parcels were state lands identified for agricultural use. Most of the parcels had been leased, but all leases had expired and no renewals were found in the records. WASA is pursuing transfer of these lands for the purpose of constructing the new WWTP.

While the majority of the new sewers will be constructed in public roadways, several sewer alignments had to be located off-road. For these alignments it will be necessary for the construction contractor to obtain construction easements, and for WASA to obtain permanent easements for maintenance purposes. All easement requirements were provided to WASA and they are in the process of securing the required easement.

3.2.11.2 Clearing

The 11 Ha plant site is located south of the CRH, west of the La Horquetta housing subdivision, and east of Peytonville. The south and west portions of the site are currently being cultivated for melons, pumpkin and papaya. The north east portion of the site which at one time may have also been cultivated is untended and taken over by bush. Site clearing will involve removing the undeveloped bush as well as removal and disposal of unwanted material.

3.3 MALONEY SITE DESCRIPTION AND PROPOSED PROJECT

3.3.1 Maloney Scope of Works

The Maloney scope of works includes rehabilitation and expansion of a WWTP on 3.6 Ha (8.9 acres) of land, construction of 5 lift stations, as well as installation of 48.5 km collection system piping. The upgraded Maloney WWTP will utilize some of the structures at the existing Maloney Gardens WWTP, and expand upon these.

3.3.2 Existing Sewered Areas

The Maloney Wastewater Catchment is situated to the east of the Trincity Wastewater Catchment and to the west of the Malabar Wastewater Catchment. The catchment is approximately 1,069 Ha in size and is currently serviced by six (6) wastewater treatment plants, these are as follows:

- Maloney Extended Aeration WWTP; operational
- La Florissante Extended Aeration WWTP; abandoned
- La Resource Extended Aeration WWTP; abandoned
- Lillian Heights Extended Aeration WWTP; abandoned
- Lynton Gardens Extended Aeration WWTP; abandoned
- Santa Monica Extended Aeration WWTP; abandoned

Maloney Extended Aeration WWTP located at Maloney Gardens is the largest of the systems in the Maloney subcatchment. This system, built by NHA, has 4,354 m of sewerage mains. In 2004 the WWTP had significant upgrades including construction of a biological reactor. The effluent of the Maloney WWTP discharges into the Oropuna River.

3.3.3 Maloney Design Flows and Loads

The Design Flow for the Maloney Wastewater Treatment Plant will be designed based on future flows shown in **Error! Reference source not found.** below.

Table 3-10 Maloney Design Flows

Parameter	Design Flow
Dry Weather Daily Flow (m^3/d)	8,691
Peak Wet Weather Flow (PWWF, m^3/d)	15,643

The influent design parameters of the wastewater are expected to be as shown in Table 3-11, with the effluent design objectives shown in Table 3.12.

Table 3-11 Maloney Influent Design Parameters

Parameter	Concentration
BOD_5	536 mg/L
TSS	49 mg/L
TKN	12 mg/L
P	6 mg/L

Table 3-12 Maloney Effluent Design Parameters

Parameter	Concentration
BOD_5	15 mg/L
TSS	15 mg/L
TKN	10 mg/L
P	5 mg/L

3.3.4 Maloney Wastewater Treatment Plant

The refurbished Maloney Wastewater Treatment Plant is to be situated on 3.6 Ha (8.9 acres) of agricultural land which borders the existing Wastewater Treatment Plant. The expanded site is located south of the Churchill Roosevelt Highway and the main treatment process to be used is activated sludge (low load). The plant is designed to have a process train of:

- Mechanical fine screen
- Vortex grit chamber
- Aeration tank
- Clarifier
- UV Treatment
- Sludge Thickener
- Sludge Digester
- Sludge Drying Beds

Figure 3.6 illustrates the process flow of the new Maloney Wastewater Treatment Plant and Figure 3.7 depicts the site plan of the Maloney Wastewater Treatment Plant.

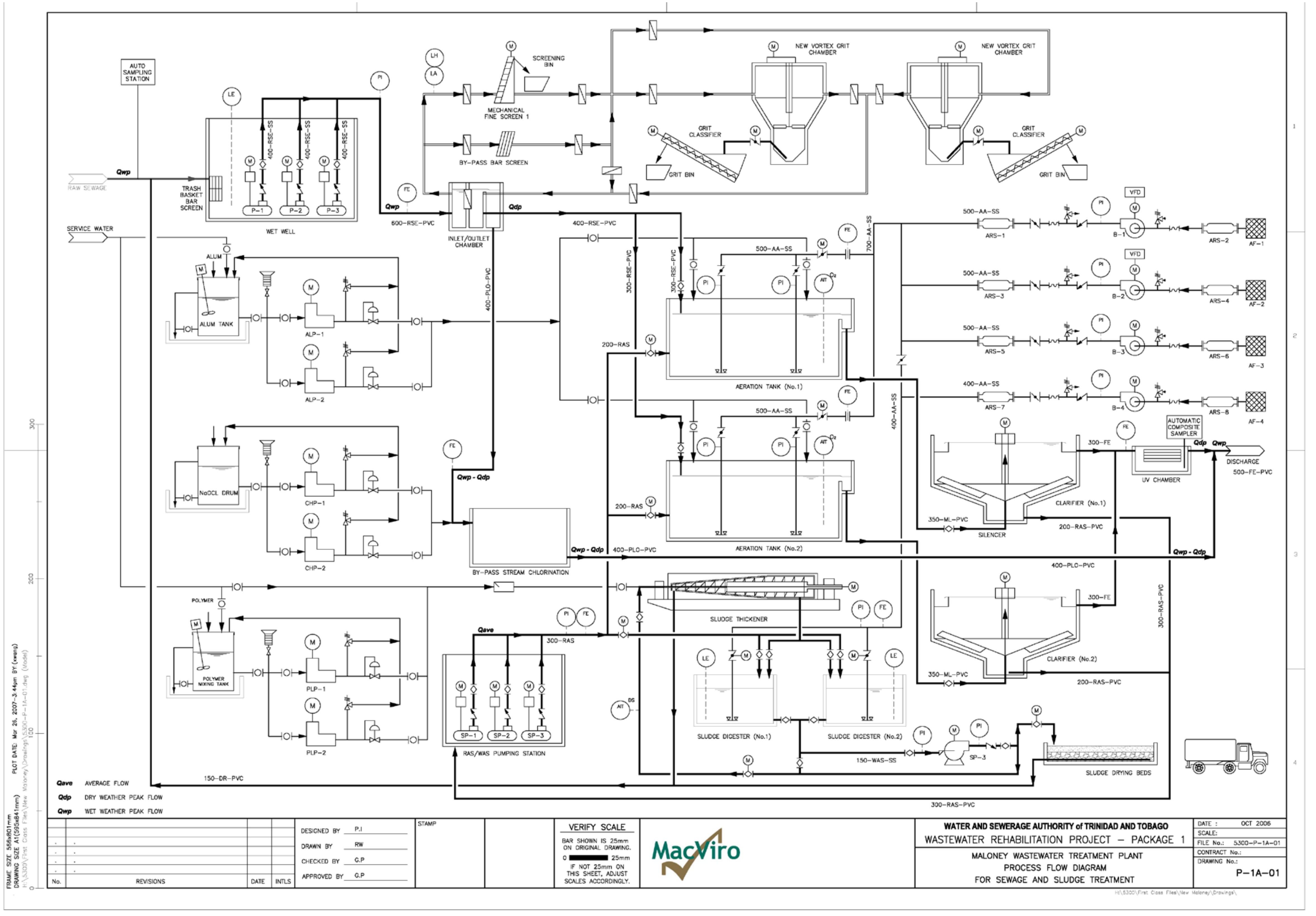


Figure 3.6 Process Flow Diagram of the New Maloney Wastewater Treatment Plant

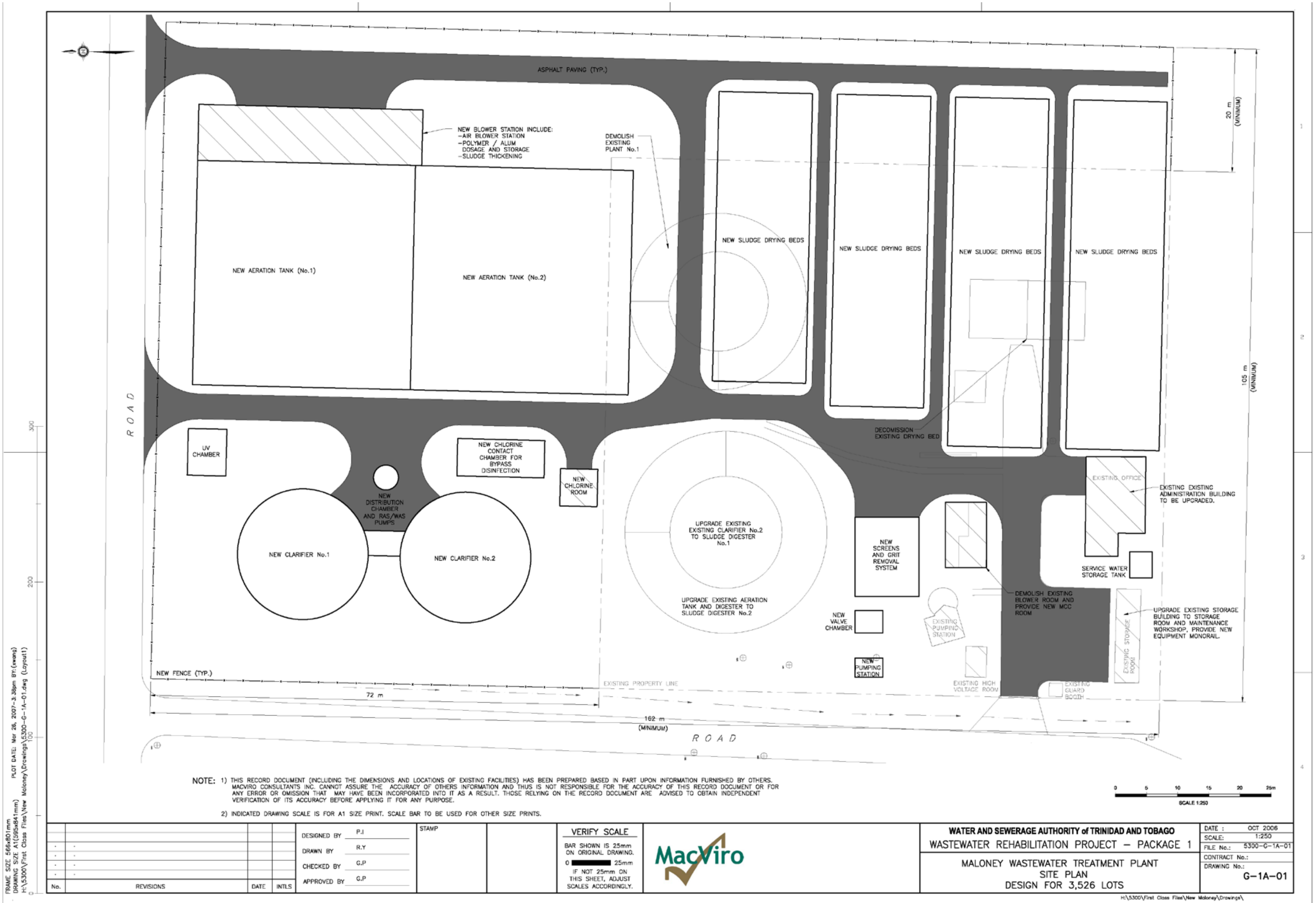


Figure 3.7 Site Plan of the New Maloney Wastewater Treatment Plant

3.3.4.1 Design Recommendations for Rehabilitation

The existing Maloney WWTP will be rehabilitated and expanded to handle the 2035 design flows, and treat to the discharge requirements. The design recommendations entail:

- Three new raw sewerage pumps with variable frequency drives (VFD)
- One new wet well
- One new mechanical fine screen
- Two new vortex grit chambers
- Two new aeration tanks with nitrification
- Two new secondary clarifiers
- Retrofitting existing aeration tanks to sludge digestion tanks
- Three New blowers , 2 with VFD's for aeration tanks, 1 with constant speed for sludge digestion
- One new sludge thickening system
- One new MCC
- One new Ultra-Violet disinfection system
- One new chlorine contact chamber for by-pass disinfection
- One new standby generator
- Upgrading of the chlorine dosing system (using sodium hypochlorite)
- Four new sludge drying beds
- Extension of existing access roads to the headworks, sludge drying beds and secondary treatment
- Rehabilitation of existing buildings
- Provision for a plant wide flushing water system.

3.3.5 Treatment Processes

WASA contracted for design consultancy services for preparation of Design/ Build (DB) Tender Documents for the rehabilitation and expansion of the Maloney WWTP. As such, a detailed design of the unit processes and support facilities was not prepared. Sufficient information was prepared to obtain competitive bids for the work to meet specified performance requirements. With the DB project delivery method, detailed design is the responsibility of the contractor.

The following sections provide an overview of the WWTP facilities proposed to be refurbished, modified, or constructed new.

3.3.5.1 Raw Sewage Lift Station

Raw sewage pumps are designed to accommodate wet weather peak flow (WWPF). The design includes three pumps, with two duty at peak flow, and 1 on standby. During dry weather flow, one pump will handle the flow.

The minimum TDH of the pumps is 16.3 m and each pump is 605 m^3/h. When the pumps have lifted the raw sewage, the flow is by gravity through the preliminary, secondary, and tertiary treatment.

As the duty pump has to cover a wide range of flow based on the design peaking factor, variable frequency drives (VFDs) are used. A Raw Sewage Lift Station will be provided with wet pump well and dry valve chamber, including but not limited to the following:

- Three submersible sewage pumps with lifting guide rail and device, two duty, one standby with constant drives.

- Three 400 mm check valves
- Three 400 mm plug valves with manual actuator
- One trash screen with lifting guide rail and device
- One gantry crane to install/ remove raw sewage pumps and trash basket
- One aluminum ladder
- One aluminum grating platform
- Four lockable check plate access haches
- One lockable aluminum grating access hatch

3.3.5.2 Preliminary Treatment

Similar to the raw sewage pumps, preliminary treatment shall be designed to accommodate WWPF. This treatment will include the following equipment:

- One 6 mm opening size mechanical fine screen with local control station in NEMA4X enclosure with Local-Remote-Manual selector switch, Down-Off-Up selector switch and emergency stop pushbutton with lock-out.
- One 20 mm opening size manual bar screen included as a standby to the manual bar screen.
- One ultrasonic level differential transmitter with two sensors, one at either side of the fine screen.
- One overflow weir for mechanical fine screen bypass.
- Two grit vortex systems completed with grit pump, centerless screw grit classifiers and local control station in NEMA4 enclosure.
- One effluent splitter chamber with WWPF overflow weir to intercept DWPF to followed secondary effluent.
- Eight channel gates, to be installed in the channels.

3.3.5.3 Secondary Treatment

The design of secondary treatment will accommodate the design flow as documented above. The new design allows for redundancy at all times, allowing one treatment train to be off for maintenance while the remaining treatment trains are adequately sized to accommodate all design flow and influent characteristics, and meeting effluent targets. Secondary treatment will include aeration and secondary clarification.

3.3.5.3.1 Aeration

A new aeration tank, with a minimum of two cells, is designed to handle a DWPF with RAS. Table 3-13 describes the aeration tank design criteria.

Table 3-13 Maloney WWTP Aeration Tank Design Criteria

Type	Rectangular Shape, Plug Flow
Minimum Required Volume	11,423 m^3
Effective Water Depth	4.5 m
Max. Organic Loading Rate	0.24 kg BOD/ m^3d
Actual Oxygen Requirement (AOR)	5,403 kg O_2/d

The fine bubble diffuser systems to be installed. Aeration system will include:

- Two butterfly valves with electric actuators for modulation of air flow.
- Two air flow meters with measuring element and transmitter.
- Six stainless steel downcomer piples with a manual butterfly valve.
- One fine-bubble aeration system with manifold, headers and supports.
- Two dissolved oxygen monitoring systems.

Existing aeration tanks will be retrofitted with coarse bubble diffusers to be sludge digestion tanks.

3.3.5.3.2 Secondary Clarification

The clarifiers will be designed to handle DWPF with RAS. The existing clarifiers will be re-furbished with new internal components as following.

- Two mechanism rotary bridge sludge collection and scum skimming system for redial flow secondary settling tanks with dimension of 21.0 m diameter and 4.0 m side water depth.

3.3.5.4 Tertiary Treatment – UV Disinfection

The design includes UV disinfection of plant effluent, to ensure a high quality effluent meeting the design objectives, and staying under the effluent non-compliance limits at all times. The effluent UV disinfection system includes:

- Four package ultraviolet disinfection systems, designed for peak flow rate of 5300 m^3/d, consisting of stainless steel with transition connections, control panel with intensity monitor and cleaning rake.
- One magnetic flow meter.

3.3.5.5 Phosphorus Removal – Alum Dosing and Storage System

To remove phosphorus from wastewater, alum will be dosed into the aeration tank. In order to provide flexible operations, alum is also able to be dosed to the influent split chamber upstream of the aeration tank as well as the effluent split chamber downstream of the aeration tank.

The new alum feed and storage system for phosphorus removal, pre-piped on a PVC backer board is designed for a peak flow rate of 19,740 m^3/d at Pure Alum ($Al_2(SO_4)_3$) dosage rate of 30 kg/h and includes:

- Two chemical metering pumps with capacity of 68 L/h Alum Solution (8% Al_2O_3 Alum strength) (one duty, one standby)
- One 1000 L Alum day tank with high and low level switches

- Fifteen days dry Alum powder indoor storage area.
- One back pressure valve
- Two pressure relief valves
- One pressure gauge
- One calibration column
- Associated PVC and isolation valves.

3.3.5.6 Bypass WWPF – Chlorine Disinfection

The plant bypass, in the event of wet weather peak flow shall be disinfected using sodium hypochlorite, which presents a much safer alternative to chlorine gas. Adequate disinfection shall be ensured through dosing the recommended 8 mg/L (10 State Standards). The chlorine contact tanks are designed to achieve a minimum 15 min. contact time (10 State Standards) at the bypass flows (the WWFF superfluous above DWPF). Existing chlorine contact chambers are adequate in achieving disinfection.

One new sodium hypochlorite feed system designed for peak flow rate of 19,740 m^3/d at dosage rate of 8 mg/L free chlorine will be pre-assembled on a PVC backboard, including:

- Two chemical metering pumps with degassing heads (one duty, one standby)
- One pressure relief valve
- One calibration cylinder
- One set of PVC ball valves and fittings
- One chemical storage tank made of polyethelene with 30 days storage capacity
- One chlorine leak detection set with alarm system
- Several respirators and mask for emergency chlorine leak

3.3.5.7 Air Blower Station

The air blower station will include four blowers. Three shall have variable frequency drives that each meet the capacity of one aeration tank (two duty, one standby).The fourth blower will operate on a fixed speed to aerate the sludge digestion tanks. The standby VFD blower will also operate as standby to the fixed speed blower. Using this design, a 100% level of redundancy is provided at all times for the sludge digester, and 50 % redundancy for the aeration tanks. The blower station includes:

- Three air blowers with VFD drive, each with a capacity of 181 Nm^3/min.
- One air blower with capacity of 102 NM^3/min
- Four manual butterfly valves
- Four check valves
- Four intake filters
- Four intake and discharge silencers
- Four discharge PRV and blower overload and overhead protection systems.
- One air flow monitoring system with pressure and temperature monitoring capabilities.

3.3.5.8 RAS/ WAS Pumping Station

The RAS ratio for RAS pumps will be designed for 100 % DWAF. The TDH of the pumps are sized so that the RAS will flow by gravity without any pumping through the secondary treatment, and WAS will flow to the digester by gravity.

A RAS/WAS pumping station will be provided with a wet pump well and dry valve chamber, including:

- Three submersible return sludge pumps, one duty and one standby.
- Three 200 mm plug valves with electric on/off actuator for RAS control.

- One 150 mm plug valves with electric on/off actuator for WAS control.
- One magnetic flow meter to be installed on the RAS line.

3.3.5.9 Sludge Thickening

Sludge thickening is proposed to reduce the required sludge digestion volume. The sludge thickening is designed for continuous operation towards a specific target sludge concentration. WAS will flow from the clarifier through the thickener, to the sludge digestion tank, and continue to be recycled from the sludge digestion tank through the thickener until the specified concentration is achieved. The sludge thickening design criteria are shown in Table 3-14.

Table 3-14 Maloney WWTP Sludge Thickening Design Criteria.

Type	Drum Thickener
Influent Sludge Concentration	<1%
Effluent Sludge Concentration	2% to 4%
Sludge Loading	1,367 kg DS/d

The sludge thickening system will include:

- One sludge thickener
- One polymer storage and preparation system
- One polymer dosing and mixing system
- One sludge feeding and recycle pumps
- One water flushing system
- One control station

3.3.5.10 Sludge Digestion

Adequate sludge digestion is designed to ensure the desired quantity of biosolids. The design includes a 45 day on-site sludge digestion and storage facility. Sludge digestion tanks will be retrofitted with coarse bubble diffusers for aerobic digestion.

The existing aeration tanks and sludge digester will be re-furnished with new internal components. The existing coarse bubble aeration system will be removed and replaced.

Digester #1 will have a total volume of 1,020 m^3. The aeration system will require airflow of 31m^3/min and the following equipment:

- One 250 mm butterfly valve with electric actuator for airflow modulation.
- One airflow meter (common for both digesters), with measuring element and transmitter
- Four 150 mm stainless steel downcomer pipes with a manual butterfly valve and Vanstone flanges at the top.
- One coarse bubble aeration system, with 84 wide band coarse-bubble diffusers. 304 stainless steel downcomers, manifold and headers, and supports.

Digester # 2 will have a total volume of 2,380 m^3. The aeration system will require airflow of 71 m^3/min including:

- One 350 mm butterfly valve (common to both digesters) with an electric actuator for modulation of air flow.
- Eight 150 mm stainless steel downcomer pipes with a manual butterfly valve and Vanstone flanges.
- One coarse-bubble aeration system with 168 wide band coarse-bubble diffusers. 304 stainless steel downcomers, manifold and headers, and supports.

3.3.5.11 Sludge Drying

The biosolids will be dried in sludge drying beds. For the plant's nominal capacity; an area of 2,281 m^2 is required, and for future flow, a total area of 3,105m^2 is required. The bed will consist of a minimum of 200 mm thickness sand layer (size range of 0.8 mm to 1.5 mm), 150 mm thickness pea gravel layer (size range 3 mm to 6 mm), 300 mm thickness gravel layer (size range 10 mm to 20 mm). The bed will be sealed by 150 mm thickness concrete slab. The underdrain will utilise 150 mm perforated PVC pipe, and should not be spaced more than 6 m. 100 mm perforated PVC lateral drains are to be connected to the underdrain in symmetry to collect the filtrate.

3.3.6 Maloney Collection System

The proposed Maloney wastewater collection system comprises 48.5 km of sewerage pipeline, broken into Trunk, District, and Tertiary network lengths. A summary of the proposed network pipe lengths is shown in Table 3-15: Maloney Catchment Sewer Pipeline Lengths Per Category.

Table 3-15: Maloney Catchment Sewer Pipeline Lengths Per Category

Network Type	Pipe Diameter (mm)	Length (m)
Primary	400-800	5,600
Secondary	300	13,820
Tertiary	200	29,160
Total		48,580

Figure 3.8 illustrates the proposed force mains, gravity mains and lift stations to be installed in the Maloney Sewerage Catchment.

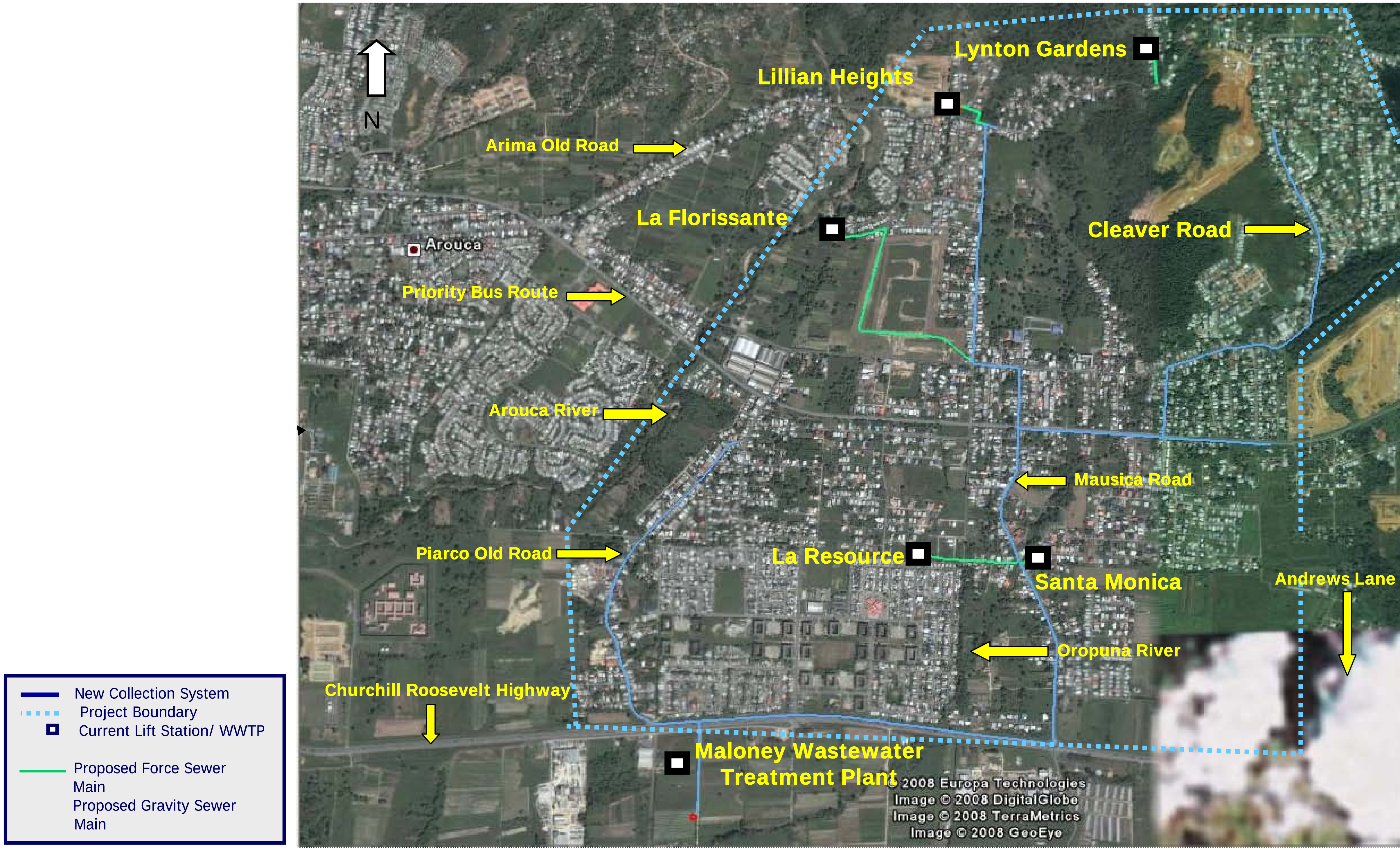


Figure 3.8 Google Earth Image of Maloney Sewerage Catchment with Pump Stations, Force and Gravity Mains

3.3.6.1 Maloney Sewer Catchment Lift Stations

There will be five lift stations constructed within the Maloney catchment, these would be classified into the following categories:

- Type I Q < 20 l/s
- Type II 20 l/s < Q < 150 l/s

Table 3-16 gives the breakdown of each proposed lift station and its respective category with its dry weather and wet weather flow rates. Appendix VIII has examples of civil, process mechanical, and structural drawings for Type I, and II, lift stations.

Table 3-16 New Lift Stations in the Maloney Sewerage Catchment

Lift stations	Category	Average Dry Weather Flow (m^3/hr)	Peak Wet Weather Flow (m^3/hr)
La Florissante	Type II	36	179
La Resource	Type I	10	49
Lillian Heights	Type II	40	243
Lynton Gardens	Type I	2	12
Santa Monica	Type I	6	36

3.3.7 Maloney Pre Construction Activities

3.3.7.1 Land Acquisition

The land required for expansion of the Maloney WWTP has been identified, but since final design of the project have not been completed, land acquisition activities have not been initiated. However, the needed land appears to be vacant and should be available for the expansion project.

Likewise, the collection system has only undergone conceptual design as part of the master Plan for the East-West Corridor (Safege). For this reason, the need for easements has not been determined.

3.3.7.2 Clearing

The plant site is located south of the CRH and east of the Piarco Old Road. Site clearing, will involve removing the undeveloped bush, as well as removal and disposal of unwanted material and subsequent grading.

3.4 CONSTRUCTION ACTIVITIES

3.4.1 Sewer location and Alignment

Generally sanitary sewers are in locations accessible to each property facing a roadway. Sanitary sewers will be installed along roadways where possible, and generally be located at an offset of 1.5 m from centreline of roadway. It is common practice to locate sewers and other utilities offset from the centerline of the roadway so that when maintenance such as sewer cleaning is conducted, one lane of traffic can be maintained. However, the final location will likely be dictated by other factors such as location of other utilities and road width. In cases where sanitary sewers cannot be located along roadways, a sewer easement will be required. The requirement for easements will be minimized to the degree possible by keeping sewers within the road right of way as much as possible, however for properties in low lying areas and not located near roadways, an easement is unavoidable. Manholes must be located in accessible areas of the roadway or easement for maintenance purposes.

3.4.2 Crossing Clearance to Sewers

It is essential that all pipeline crossings be inventoried as they affect both the alignment and profile of the sewer network. The plan-profile drawings will show the existing utilities and new sewers that cross will be located at the required separations to meet utility requirements. The National Gas Company's (NGC) natural gas pipelines are of particular importance and require a minimum separation of 0.9 m where crossings have been identified. When crossing over or under watermains of 450 mm in diameter or less, a minimum clearance of 0.15 m is required. This is the minimum to be used only when spatial constraints exist. In normal situations, a minimum of 0.3 m of clearance will be provided. Watermains larger than 450 mm diameter require a minimum clearance of 0.6 m. A minimum clearance of 0.23 m is required for storm sewers/ drains. Also, the minimum horizontal separation recommended between watermains and sewers is 2.5 m. Appendix VIII contains a construction standard detail for watermain pipe crossing. For buried power lines (T&TEC), a minimum spacing of 0.5 m will be maintained and for telecommunication lines (TSTT) a minimum spacing of 0.3 m will be maintained.

3.4.3 Manhole Location

Manholes will be located as follows:

- At the top end of all terminal sewers.
- At all junctions.
- Every change of grade.
- Every change of pipe size.
- Every change of line or grade that exceeds ½ the maximum joint deflection recommended by the manufacturer, or where the radius of an approved curvilinear sewer alignment is less than 30 m.

- The maximum distance between manholes does not exceed 100 m, .for sewer cleaning purposes.

All manhole lids are to be secured in place. Manholes in low lying areas or those with the potential for surface flooding are to be sealed, and raised above the top water level of the river.

3.4.4 Pipe Bedding, Backfill and Reinstatement

Locally sourced granular bedding material is recommended for sewer pipe and manhole installation as it will be readily available and at a reasonable cost. Sewer pipe should be placed on a minimum of 150 mm of bedding sand with 300 mm of cover above the pipe crown.

For sewer above the water table sand bedding will be used. For sewers below the water table a free draining granular bedding material will be used. A variety of backfill materials will be specified, depending class of roadway, location of water table and type of pipe material. It is anticipated that excavated material can be used as common backfill for sewers off roadways and as select backfill under roadways if it meets the specification requirements for material composition, strength, compactability and gradation. This is to be determined through testing by the contractor. The backfill material must be compacted in 300 mm layers using mechanical compaction equipment to meet compaction specifications stipulated in the contract documents. For all roadways compaction is to be 95% of modified proctor in accordance with ASTM D698. Key standard details for trench backfill in wet and dry conditions are included in Appendix VIII.

Road reinstatement is to be done after trenches have been backfilled. Most roadways in the project area are asphalt surface. The thickness of asphalt, base course and sub-base materials will depend on the classification of roadways based on vehicular traffic. Class 1 roadways are main roadways and include CRH, O'Meara, Road, Tumpuna Road, Pinto Road, EMR, PBR, Arima Bypass Road, and Mausica Road.. Class 2 roadways are secondary paved roads. Class 3 roadways are gravel roads. Key standard details for road reinstatement are included in Appendix VIII.

3.4.5 Sewer Installation Techniques

Generally most sewers are expected to be open cut. Various techniques have been evaluated for installation of the sewer lines. Factors affecting the installation methods include:

- Traffic disruption and disruption to the general public and adjacent property owners,
- Interference with existing utilities,
- Soil conditions, and
- Cost

Soil conditions that impact sewer construction methods and cost include existence of rock, groundwater levels, and variability in soil conditions. The existing buried infrastructure also has a major impact on both the selection of technique and the risks associated with its use. The most common installation method for sanitary sewer piping is conventional open cut trenching. It is usually the most economical alternative when installing pipe at shallow depths, especially in suburban or rural areas. In developed urban areas the extent of disruption and impact to the area from construction activities is more significant with open cut trenching.

Where sewers are deeper, stability of side slopes can pose a problem depending on soil conditions. Trench cages and shoring must be used to protect workers and reduce slope destabilization. Where installation is below the water table, trench dewatering is required which can add significantly to cost. Existing utility crossings need to be accommodated and repaired if damaged. The selection of the alignment is extremely important to minimize conflicts with existing utilities, minimize disruption and reduce restoration costs. In highly developed areas with existing underground infrastructure present, trenchless installation techniques are often justified. The capital cost of trenchless techniques including pipe jacking, microtunnelling, and horizontal directional drilling (HDD) are significantly higher than conventional open cut trenching but can often be justified by owners when the direct and indirect social costs of disruption to the public are considered.

Traffic and business disruption is a key issue in the Arima Malabar area. Therefore installation techniques that minimize surface disturbances and minimize disruptions in traffic along major roadways require further evaluation. Trenchless techniques will be considered when there are restrictions to the use of open cut for a number of reasons such as subsurface conditions, groundwater, river crossings, major road crossings, heavily trafficked streets, high surface reinstatement costs, etc. One trenchless application is crossing the CRH from the existing Malabar plant to the new plant.

It will be the construction contractor's responsibility to determine construction means and methods. Traffic control will need to be taken into consideration. For the Malabar project, the contractor's responsibility for traffic control is covered in the technical specifications, specifically Section 01570 – Traffic Control.

Sewer service connections from the sewer lines to the property lines will be made to the construction standard detail seen in Appendix VIII.

3.4.5.1 Horizontal Directional Drilling

Horizontal directional drilling can be used for the installation of water pipes, or telephone cables, or pressure line sewers. A pilot hole is drilled from the surface followed by a washover pipe to a receiving pit. The drill bit can be steered in the direction of the receiving pit. A reamer then travels back along the washover pipe followed by the required piping. Typically, polyethylene or specific types of PVC are utilized for directional drilling.

Horizontal directional drilling offers advantages in terms of minimal surface disruption which means low restoration costs. It is considered to be an environmentally friendly means of pipe installation. The steering capabilities means the drill head can be manoeuvred around obstacles such as large boulders. Additionally, construction times tend to be shorter compared with trenching. However, specialized equipment and trained operators are required and it is more costly than conventional trenching. Also, for gravity sewer installations where maintaining tight slope tolerances are critical, horizontal directional drilling may not be appropriate. Typically, High Density Polyethylene HDPE or specific types of PVC are utilized for directional drilling. Pipe design is normally limited by axial forces during pullback.

3.4.5.2 Microtunnelling and Pipejacking

Micro tunnelling and pipejacking will be used on the CRH crossing to the new WWTPs. Microtunnelling and pipejacking are used in locations where minimum surface disruption is required, in the path of an obstruction such as a highway, river, or at depths which make trenching an unattractive alternative. The term microtunnelling is commonly referred to pipe sizes ranging up to 900 mm diameter and pipejacking is used for pipes larger than 1000 mm. However both involve the use of a remote controlled boring machine with a cutter at the head. The pipe immediately follows the boring machine as it proceeds along the intended alignment. A laser guidance system is used to monitor the progress of the boring machine and to maintain a high level of accuracy. The boring machine can be controlled from the ground surface or the drive shafts. The operator may control steering; cutter head rotation, pressure and torque; auger control station; slurry pressures and flow volume; and jacking pressures. Spoils are removed either by auger, slurry conversion or vacuum extraction through the new pipeline.

The cost of microtunnelling/ pipejacking can be two to three times the cost of conventional open cut trenching. The cost premium has to be weighed against the value the owner places on disruption to the public. It must be recognized that although microtunnelling/ pipejacking can be less disruptive it does not eliminate traffic disruption and inconvenience to the public.

The drive and reception shafts range in size from 3 to 6 meters in diameter and the surface footprint required for equipment and slurry tanks is substantial. In addition unexpected obstructions such as large boulders, roots or man-made structures can obstruct the boring machine and result in a very costly and disruptive rescue of the machine.

3.4.6 Site Grading and Drainage

In all instances, surface runoff will be directed away from buildings to the site perimeter where it will be collected in a series of box drains and ditches that connect to the drainage channels in the area. Internal drainage swales/ditches will be designed as required to carry runoff to the appropriate drainage channel. All roadways will be crowned and elevated as required above existing ground to provide positive drainage to adjacent ditches to ensure the pavement structure remains in an unsaturated condition. Roadway profiles will be coordinated with building elevations at delivery points to maintain the appropriate elevation of vehicles in relation to the facility they are accessing. Roadway profiles will also be coordinated with piping layouts to ensure adequate clearance between pavement structures, ditch inverts and pipes.

3.4.7 Erosion Control

Erosion control measures will be considered along sections of sewer adjacent to river and stream beds and where the sewer crosses a river, stream and major drain. Erosion control blankets, rip rap, and concrete encasement will be utilized to ensure erosion of pipe support materials does not occur during the rainy season. Erosion control during construction and other environmental protection requirements are covered in the project technical specifications, specifically Section 01565 – Environmental and Aesthetic Protection.

3.5 CONSTRUCTION PHASES

3.5.1 Malabar Wastewater Catchment

The Malabar project will be constructed in phases to accommodate operation of existing facilities, and minimize disruption in the community, while achieving a cash flow that will be easier to fund in the current financial situation. The primary objective is to achieve maximum benefit during the first phase of construction by building the new WWTP and connecting most of the sewered areas to the new plant. Three phases are planned as described below:

Phase 1

Phase 1 involves the complete construction of the Malabar Wastewater Treatment Plant as well as 9 km of new sewer, two lift stations and independent and associated works such as property connections in the following sub-catchments, continuing for 2- 2 ½ years after commencement of works (Figure 3.9).

- **Lower O'Meara Road** Works comprise gravity sewers and appurtenant structures, and O'Connor Drive lift station and force main.

- **Malabar Area** Works comprise gravity sewers, and appurtenant structures, including microtunnelling beneath the Churchill Roosevelt Highway.
- **Arima** Works comprise Arima lift station and force main.

At the completion of Phase 1, it is expected that 55 % of all properties in the catchment will be connected, which would be approximately 46,200 pe.

Phase 2

Phase 2 involves the commencement of works inclusive of 40 km of new sewer and property connections, and one lift station in the following sub-catchments following completion of Phase 1. Works are to be completed 1 year -after commencement of Phase 2. (Figure 3.10)

- **Calvary Hill** Works comprise gravity sewers, Sanchez Street Lift Station and forcemain, and appurtenant structures.
- **Mausica/ Olton Road** Works comprise gravity sewers and appurtenant structures.
- **Cleaver Road/ Andrew Lane** Works comprise gravity sewers and appurtenant structures.
- **Upper O'Meara Road** Works comprise gravity sewers and appurtenant structures.

At the completion of Phase 2, it is expected that 73 % of all properties in the catchment will be connected. This adds approximately 15,400 pe.

Phase 3

Phase 3 construction commences in the following sub-catchments following completion of Phase 2. Completion of works would be 1 ½ years after commencement of Phase 3 and include 68 km of new sewer, four lift stations and property connections. (Figure 3.11)

- **Mount Pleasant/Maturita** Works comprise gravity sewers and appurtenant structures, and Dundee lift station and force main.
- **Upper Pinto Road/Gills View** Works comprise gravity sewers and appurtenant structures, the two Gills View lift stations, Jump Street Lift Station, Street 07-12 Lift Station and associated force mains.
- **Upper Malabar/Tumpuna Road** Works comprise gravity sewers and appurtenant structures.

At the completion of Phase 3, all properties north of the CRH will be connected. This adds approximately 22,500 pe.

Existing facilities will be maintained in service until the new Malabar wastewater treatment plant is constructed and ready to receive wastewater for treatment. Temporary bulkheads or other watertight isolation methods will be provided to ensure wastewater continues to flow to existing treatment facilities until the new WWTP is available to receive flow.

Due to potential health hazards, existing wastewater conveyance shall be maintained during construction of new facilities. Temporary pumping equal to the capacity of facilities before the commencement of construction will be provided.

Figure 3.9, Figure 3.10 and Figure 3.11 depict the various phases of the Malabar regional catchment.

3.5.2 Maloney Wastewater Catchment

The Maloney Wastewater Catchment, being much smaller than Malabar, will not be phased. However, it will be constructed under two separate contracts. The first contract will be for the refurbishment and expansion of the WWTP. It is expected that this work will be done using the Design/ Build project delivery method. The second contract will be for the collection system expansion including new sewers, lift stations and force mains. The two contracts will be coordinated so the WWTP work is completed before additional flows are directed to the site.

The estimated time for completion of the WWTP upgrade is two years. The estimated time of completion for construction of the gravity sewer system, lift stations, and force mains is 1.5 years so the WWTP project will need to be started first.

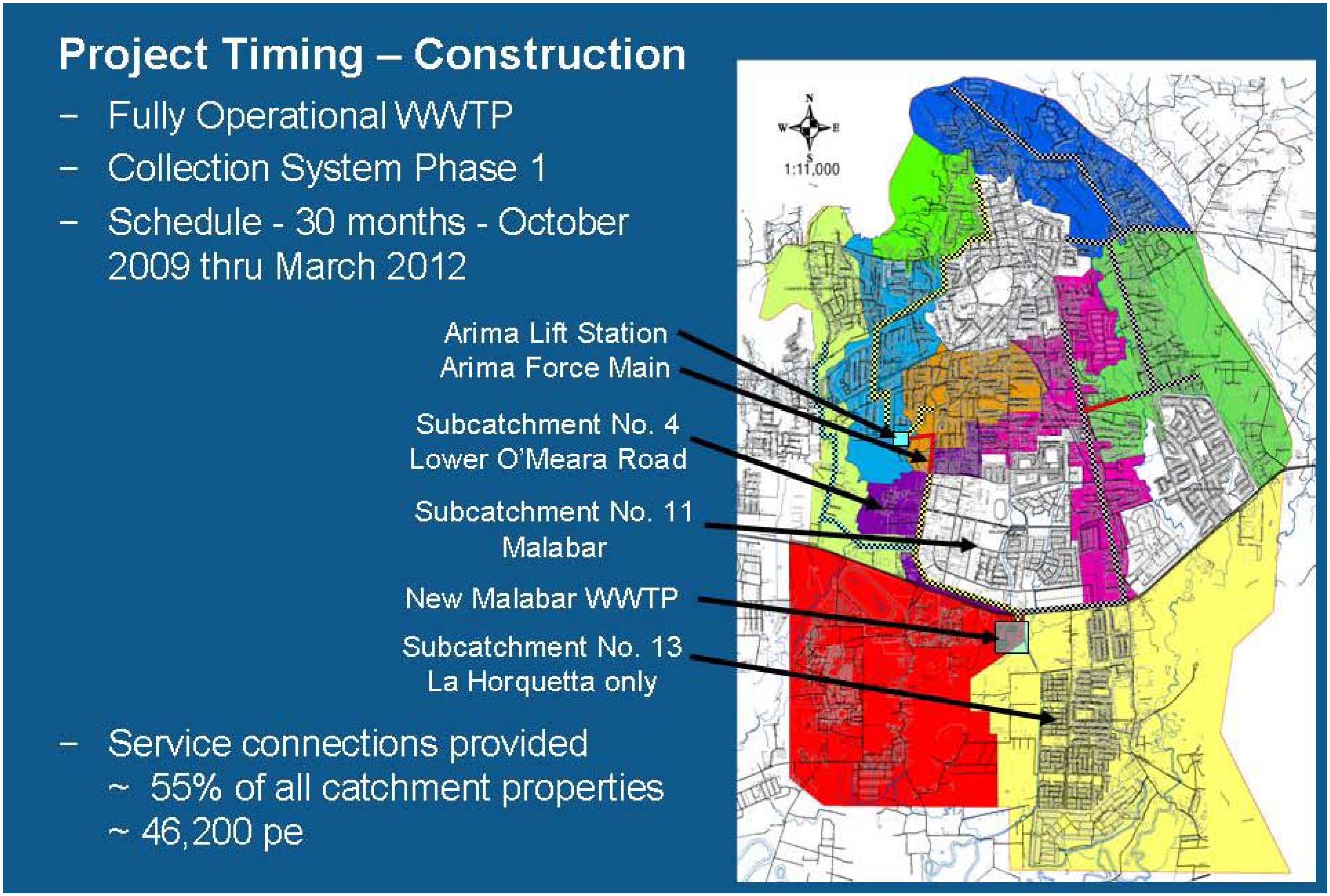


Figure 3.9 Phase 1 Construction Works

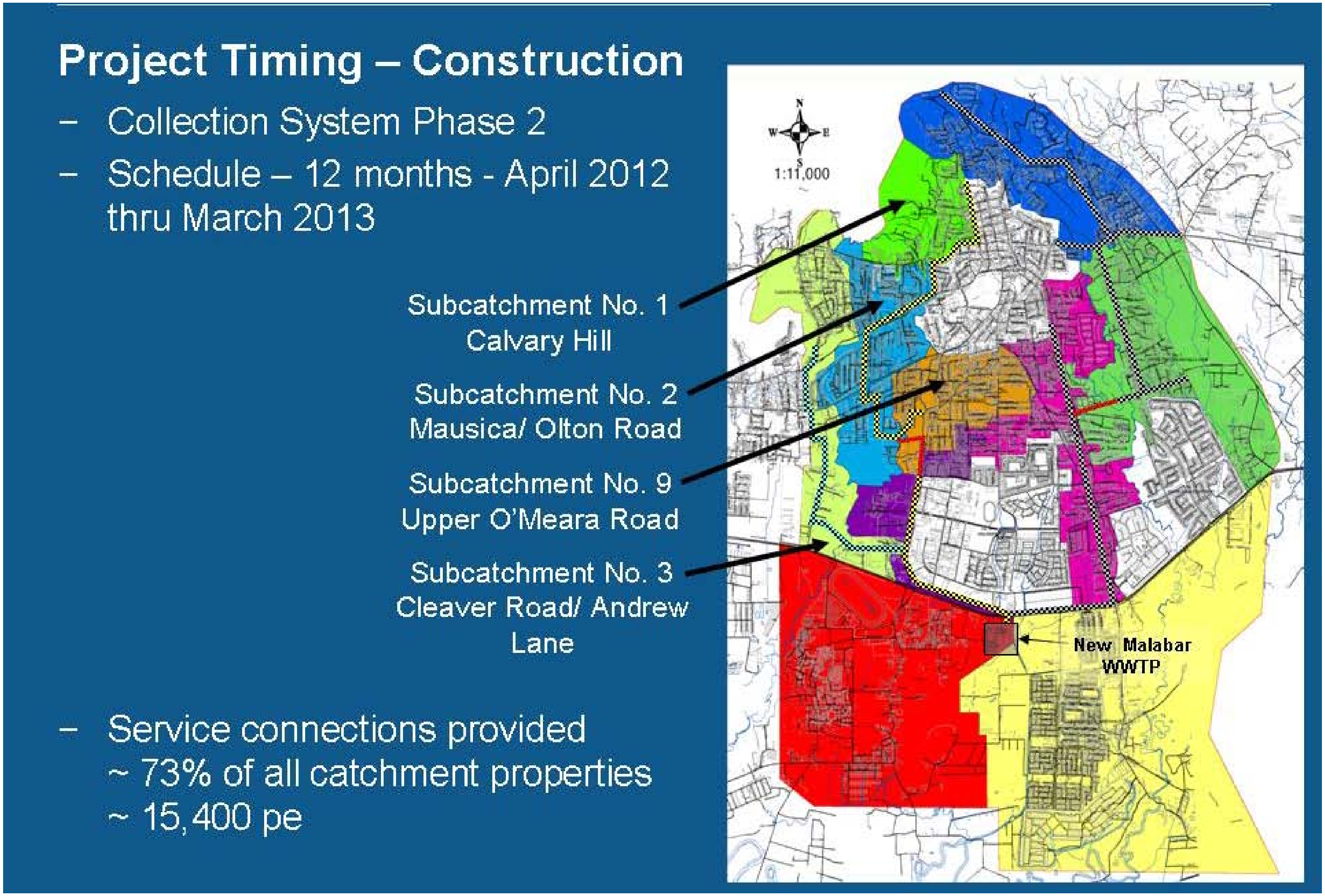


Figure 3.10 Phase 2 Construction Works

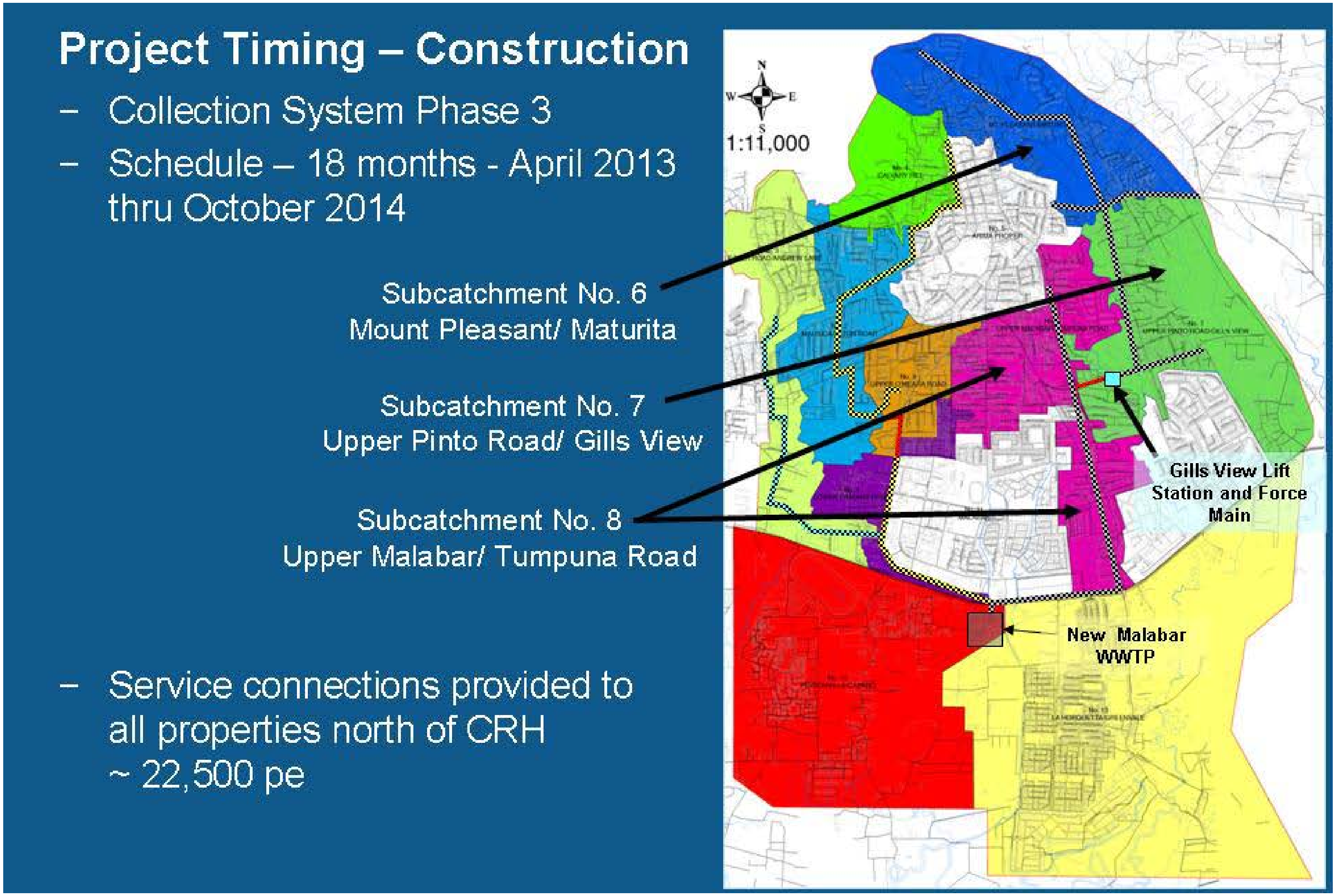


Figure 3.11 Phase 3 Construction Works

3.6 DEMOLITION AND DECOMMISSION OF EXISTING FACILITIES

The establishment of a comprehensive wastewater collection system leading to a single WWTP involves the decommissioning and demolition of several wastewater treatment plants and lift stations in the project area. All operating facilities will remain in service until the new facilities are constructed and placed in service. Demolition procedures are specified in technical specification Section 02411 – Demolition. The following activities are involved in the process and will be employed in both the Malabar and the Maloney project areas:

- Removal and salvage of electrical, instrumentation and associated devices, ventilation and air conditioning, plumbing and process and other mechanical equipment and piping as necessary.
- Rerouting and/or terminating utilities.
- Shutting off, capping and abandoning utilities and underground piping.
- Demolition and removal of structures
- Backfilling and securing wet wells, below grade tanks and open pits

Figure 3.12 shows the decommissioning plan for the existing Malabar WWTP. Other WWTPs and lift stations to be removed, demolished or backfilled in the Malabar project area are as follows:

1. Hermitage Heights
2. Maturita WWTP
3. Tumpuna Gardens Wastewater Treatment Lagoons
4. Carib Homes Lift Station
5. Darceuil Lift Station

6. Existing Dundee Lift Station

7. Malabar Lift Station

8. Santa Rosa Springs Lift Station

3.6.1 Hermitage Heights WWTP

Facilities to be demolished at Hermitage Heights WWTP include three steel tanks, the electrical building, process piping, wet well and sewer pipe(s) leading to the wet well.

Photograph 3.1: Hermitage Heights WWTP

3.6.2 Maturita WWTP

Facilities to be demolished at Maturita WWTP include, the bioreactor concrete structure, the electrical building with wet well, the discharge pipe and the sewer pipe(s) leading to wet well. The site fencing will remain.

Photograph 3.2: Maturita WWTP

3.6.3 Tumpuna Gardens Wastewater Treatment Lagoons

At Tumpuna Gardens WWTP the concrete lagoon structure (approx 60 m x 40 m), pump building and underground influent and discharge piping will be demolished.

Photograph 3.3: Tumpuna Gardens Wastewater Treatment Lagoons

3.6.4 Carib Homes Lift Station

Facilities to be demolished at Carib Homes Lift Station include the valve chamber, electrical controls and wiring, wet well, sewer pipe(s) leading to wet well and the overflow pipe. Fencing is to remain.

Photograph 3.4: Carib Homes Lift Station

3.6.5 Darceuil Lift Station

At the Darceuil Lift Station/ the building, electrical controls and wiring, wet well, sewer pipe(s) leading to wet well and the overflow pipe are to be demolished. The fencing is to remain on site.

Photograph 3.5: Darceuil Lift Station

3.6.6 Dundee Lift Station

The wet well, valve chamber, overflow pipe and sewer pipes leading to the wet well will be demolished. The electrical/ control building however is to be reused for the new lift station to be constructed on the same site.

Photograph 3.6: Dundee Lift Station

3.6.7 Malabar Lift Station

Photograph 3.7: Malabar Lift Station

Underground influent and discharge piping, the electrical building, wet well, electrical controls and wiring will be demolished at the Malabar. Fencing will remain in place.

3.6.8 Santa Rosa Springs Lift Station

At this lift station the underground influent and discharge piping, two buildings on site, the wet well and electrical controls and wiring will be demolished.

Photo 3.8: Santa Rosa Springs Lift Station

3.6.9 Demolition Process

Prior to demolition, removal or abandonment all earmarked structures will be released by WASA and all electrical, VAC, process and plumbing services will be rerouted or shut off outside of the demolition area. Items identified for salvage will be delivered to a storage facility. All other existing facilities intended to remain in-place which may be affected by the demolition process will be surveyed and recorded both before and after the demolition process. If necessary, any affected facility will be restored to its original condition. All existing facilities, utilities and equipment intended to remain will be maintained in service and protected from damage.

- Roadways, streets, walks and other facilities occupied or used by WASA and the public will not be closed or obstructed without permission from the relevant authorities.

- Relevant utility authorities will be notified prior to razing operations to allow for disconnection, removal or relocation of equipment serving existing facilities if necessary.

- Salvaged material and equipment to be retained shall be transported to a designated storage site. Materials to be salvaged include pumps, motors, standby generators, valves, hoists, fittings, and aluminum sheeting

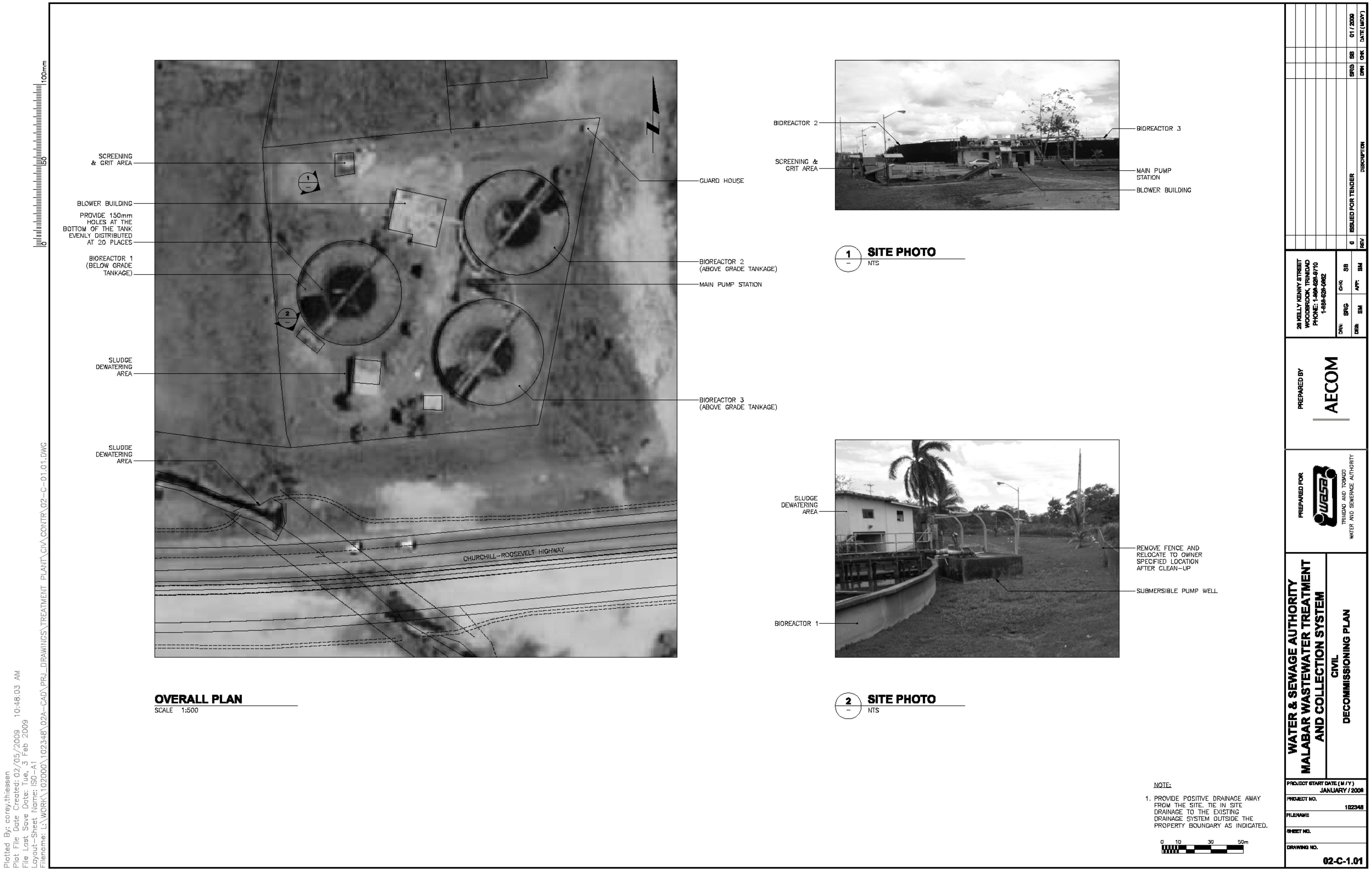


Figure 3.12 Existing Malabar WWTP Civil Decommissioning Plan

3.6.10 Demolition Operations

Demolition involves the removal of existing structures to a point below specified finish grade.

- All affected tankage and miscellaneous structures will be emptied and wastewater disposed of in an environmentally friendly manner. Organic sludge will be removed and hauled to the new WWTP. Sand or grit material from the tanks will be disposed of at the nearest landfill site in accordance with relevant regulations.

- Existing structures including superstructure, foundation, footings, piles, utility drains and other piping 450 mm below finished grade in landscaped areas, and 1 m below finished grade in pavement areas will be demolished. Structures within the influence zone of new structures will be completely demolished.

- Drainage of demolished structures will be provided by cutting openings in floors of structures remaining in-place. Holes shall be 150 mm diameter minimum, spaced at 6.0 m centres maximum (minimum of 2m each in confined areas). Remaining structures will be backfilled

- Utility drains and other piping will be plugged or capped and the final area graded to prevent ponding.

3.6.11 Removal Operations

These operations involve the removal of portions of existing structures or utilities to both above and below finish grade as required.

- Existing concrete, steel and masonry will be removed as required. Smooth, straight joint or cut line and cuts parallel with walls or floors will be employed. Cut and patch will be done in accordance with Contract specifications.

- Utilities and piping will be removed and plugged/ sealed permanently with steel cap, concrete plug or other approved method.
- Abandoned utilities and underground piping within influence zone of proposed underground piping and proposed structures will be removed
- Temporary shoring and bracing will be provided in order to transfer loads of existing remaining construction from construction being removed where necessary.

3.6.12 Abandonment Operations

Abandonment is the removal of existing utilities from service, and involves full disconnection from other portions that are to remain in service. Portions of the utility that are being abandoned are removed from the influence zones of structures, manholes or underground piping, and piping ends are plugged or capped as necessary.

- Relevant underground utilities and piping will be selected for abandonment.
- Compatible caps for pressurized type piping will be provided. Thrust blocks for caps (unless piping has fully restrained joints) will be provided.
- Gravity type piping will be fitted with concrete plugs. Plugs will be thrust block standard concrete a minimum of 0.6 m thick.

3.6.13 Disposal

- Sludge, debris, and other undesirable and unsalvageable material resulting from demolition operations will be disposed of to the nearest landfill site.
- Wastewater will be disposed of to the wastewater treatment plant.

- All hazardous waste must be disposed of in accordance with the regulation and code requirements.

3.7 ANCILLARY PROCESS REQUIREMENTS

3.7.1 Plant Water Systems

W1 Water System: W1 water is potable water supplied from WASA's water distribution system and intended for normal domestic services within the plant. The W1 system is isolated from the main system via a backflow preventer to prevent any potential contamination. W1 water is used throughout the plant for washrooms, sinks, and other domestic consumption. A booster pump station and storage tank will be provided to ensure a reliable supply of potable water to the plant.

W2 Water System: W2 water is potable water supplied from WASA's water distribution system; but intended exclusively for process use (such as pump seals and polymer make-up water). To isolate the W2 system from the W1 system, a backflow preventer is required at the junction. W2 water is not connected to any device that might be construed as suitable for human consumption.

W3 Water System: W3 water is reclaimed from the treatment plant effluent, and is used for landscape watering, tank flushing, and line purging. All outlets will be marked with warning signs discouraging consumption. However, there is some risk of exposure to humans, so it is disinfected prior to use. Disinfection also prevents the growth of bacteria in the distribution system. Water is withdrawn downstream of the UV disinfection facility and conveyed to the W3 water pumps and a strainer. The pressurized W3 water is distributed through a dedicated reticulation system through the plant. A hypochlorite dosing system will provide a chlorine residual throughout the system. The pump will be controlled to maintain a relatively constant pressure (551 kPa) in the distribution system.

Fire Water System: Fire water will be drawn from the potable water tank and distributed around the site via a fire pump and a jockey pump.

Instrument and Service Air: Several control devices in the process and mechanical systems require a supply of clean, dry instrument air. In addition, a service air supply is provided to allow use of pneumatic tools and for line purging. For this plant, only a small instrument air supply will be provided. The system will consist of two compressors (duty and standby) and an air dryer capable of lowering the dew point.

Flow Control Gates: Flow control gates isolate channels and tanks and control levels or flows. The following gates will be installed at the new Malabar WWTP Flow control gates for the Maloney WWTP will be determine during the design/ build process.

Wet Well Entry Gates. Two manual gates, one per wet well, are used for isolation of the wet wells.

Wet Well Isolation Gate. One gate to isolate one wet well from the other wet well is provided.

Screens Channel Isolation Gates. Four manual isolation gates are provided: one for each inlet channel, and one for each outlet channel.

Grit Chamber Gates: Four sets of manual gates are used to isolate the two grit chambers. One gate is provided for the influent and one for the effluent of each chamber, for a total of four. Two manually operated slide gate are placed in the main channel feeding each pair of grit chambers, for a total of two, to allow for bypassing of a grit removal system.

Storm Water Bypass Gate. One actuated slide gate in the bioreactor feed channel modulates to controls and limit the flow to the bioreactors to 110 ML/d.

Bioreactor Inlet Gates: Three manual slide gates are installed in the inlet openings of each anoxic cell, for a total of six.

Bioreactor Outlet Gates: Three manually adjusted weir slide gates are installed in the outlet openings of each bioreactor, for a total of six.

Bioreactor Bypass Gates. One manual bypass slide gate is installed on each bioreactor for a total of two.

Secondary Clarifier Inlet Gates: A manually actuated slide gate is installed at the head of each flume feeding the secondary clarifiers, for a total of four.

Secondary Clarifier Outlet Gates: A manually actuated slide gate is installed on the discharge to the discharge box on the exterior of each clarifier, for a total of four.

RAS Pumping Station Gate: One automatic actuated gate is installed between the RAS wet-well and the WAS wet-well.

Scum Chamber Gates: One manual weir gate is installed in each scum chamber, for a total of two.

UV Disinfection Inlet Gates: A manually operated slide gate is installed at the upstream end of each UV disinfection channel, for a total of two.

UV Channel Level Control Gates: An automatic actuated weir gate is installed in the downstream end of each channel to maintain a constant water level over the lamps, for a total of two.

UV Bypass Gate: One manual slide gate is provided for bypassing of the UV system.

Process Piping: Piping will be sized to ensure economic transfer of material and to reduce the risk of plugging where solids transport is involved. Above ground pipe and equipment connections will be flanged where greater than 65 mm. Threaded connections will be used for smaller pipes/equipment. Where temporary connections are to be made to service piping or flushing/purging points, the connections will be bayonet quick connect type. Most pipe to pipe connections will be grooved joint. Below ground connections will depend on the type of pipe.

Piping material specifications will be generally as described below.

- Liquid Piping, Equal to or greater than 350 mm, below ground: Steel pipe, tape wrapped and mortar lined for corrosion protection; or concrete cylinder pipe.
- Liquid and Sludge Piping, greater than 200 mm and less than 350 mm: Steel pipe, tape wrapped and mortar lined for corrosion protection or ductile iron, polyethylene sheathed and mortar lined.
- Liquid and Sludge Piping, less than 350 mm, below ground: Steel pipe, tape wrapped and mortar lined for corrosion protection; ductile iron, polyethylene sheathed and mortar lined; or PVC.
- Liquid Piping, below structures: Steel pipe, concrete encased and mortar lined.
- Sludge Piping, below structures: Steel pipe, concrete encased and epoxy coated.
- Liquid and Sludge Piping, submersed: Steel pipe, coal tar epoxy lined and coated.
- Liquid and Sludge Piping, above ground: Steel pipe, coal tar epoxy lined and painted on the exterior.
- Low Pressure Air and Gas Piping, above ground and submerged: Light gauge stainless steel.
- Water Services, below ground: PVC or HDPE.
- Water Services, above ground: Copper.
- Compressed Air Services, above ground: Stainless steel for instrument air; copper for service air.

- Process Equipment Coatings

- Process equipment will be coated with materials appropriate for the environment in which they are installed. Coatings will be low maintenance and corrosion resistant as necessary. Submerged equipment is coated with coal tar epoxy or two component epoxy coatings.

- Exterior mounted equipment receives industrial grade enamel coating. Interior equipment is coated with urethane or epoxy.

3.8 MALABAR AND MALONEY UNDERGROUND UTILITIES

The network of underground pipes will be extensive. It will include the trunk sewer entering the plant from the collection system to the Influent Pumping Station. From that point underground piping will be required between the Influent Pumping Station, Storm Water Storage Tank and the Screening and Grit Removal Facility.

Underground utilities are again needed once the effluent leaves the Bioreactors and are piped to the Secondary Clarifiers. All the effluent and RAS piping will run in the same area and will be larger diameter pipes; so a detailed coordination effort will be carried-out to avoid conflicts.

A pipe will also be designed from the UV Disinfection and W3 Pumping Station to the Storm Water Storage Tank for wash-down purposes, and running parallel to that will be an overflow pipe from the Storm Water Storage Tank to the end of the plant.

Potable water pipes will be designed to run to the Administration and Utility Building as well as the Sludge Dewatering Facility. Also, a lawn sprinkling system will be installed that will utilize the plant effluent.

Power Supply

The Malabar WWTP electrical system is shown to be serviced from two primary overhead cables from the Trinidad and Tobago Electricity Company (T&TEC). These lines connect to a ring service located in the area of the WWTP. Two lines provide transmission reliability. In the event that one supply line is lost, the plant will continue to be serviced from the other line. A similar system would be provided for the Maloney WWTP.

Standby Power

Suitable emergency standby generators will be located in the area to provide emergency power to the total facility in the event of power loss through the utility connections. Two generator sets will be provided for at the Malabar WWTP. The capacity of the two units is sufficient to start and operate the entire plant during a power outage. A single standby generator will be provided for the small Maloney WWTP. Automatic transfer switches will be provided to switch between power sources.

Power Distribution

The distribution of power will supply various plant loads. The buses feed a normal and emergency board via transformers that step down the voltage from T&TEC kV service to 480 volts (V). The transformers for operation power will have a secondary voltage of 480 V.

Motor Control Centers (MCCs) throughout the facility will provide the suitable operating power for the plant operation. The MCCs will be connected to the stand-by generators to maintain full operation of the facility.

Lighting

Lighting is provided within the buildings and on the site, following IES standards (Illuminating Engineers Society) for illumination. Fluorescent fixtures are used for internal building spaces while high pressure sodium lamps are used for process areas and for external lighting. Lighting can be serviced from the MCCs at 120/240 V single phase. However, on the emergency system MCC, 480 V emergency lighting is provided.

Plumbing

Domestic water piping systems and service air piping systems will be provided for five buildings at the Malabar WWTP: the Administration Building, Utility Building, UV Disinfection Building, Influent Pumping Station and the Sludge Dewatering Building. Similar requirements will be met at the Maloney WWTP as determined during the design/ build process. Services to each comprise the following:

Administration and Utility Buildings

- Potable water (W1)
- Instrument air (IA)
- Fire protection hose reels supply

Grit Removal

- Seal water (W2)
- Service (Agitation) air (SA)
- Treated effluent water (W3)

Bioreactor/ Clarifier

- Treated effluent water (W3)

U.V. Disinfection Building

- Potable water (W1)
- Treated effluent water (W3)

Influent Pumping Station

- Potable water (W1)
- Treated effluent water (W3)

Sludge Dewatering Building

- Potable water (W1)
- Service water (W2)
- Treated effluent water (W3)

Potable Water - Building Distribution

For the Malabar WWTP, potable water will be supplied to the building distribution systems from a central storage tank, fed by the WASA system, with a packaged water booster system with multiple variable speed pumps, manifolding and automatic pressure controls (water system W1). Each building connected to the W1 system will incorporate the required pressure regulating valves, isolation valves and back flow preventers. A similar but smaller potable water system will be provided for the Maloney WWTP.

3.9 MALABAR AND MALONEY OPERATIONAL ACTIVITIES

3.9.1 Treatment Plant Process Control

Both WWTPs will be using the activated sludge process to convert colloidal and soluble contaminants into settleable solids that can be removed in gravity settling basins. This conversion is achieved by bacteria that use carbonaceous compounds for food and produce more biomass. This process is controlled by making sure the bacteria have the right balance of food and oxygen to perform effectively. When operated properly, the process produces excess biomass that must be removed from the process and stabilized.

Operators will monitor the treatment processes using permanently installed field instruments and portable measuring devices. Based on operating data, dissolved oxygen levels will be adjusted and the inventory of biomass in the reactors will be maintained at appropriate levels.

At Malabar, waste activated sludge (WAS) removed from the activated process will be dewatered using belt filter presses (BFPs) and the sludge cake formed will be dried in solar dryers in the form of greenhouses located on the plant site. Operators will need to make up batches of chemicals used to condition the sludge ahead of the BFPs and monitor the operation of the BFPs while they are running.

At Maloney, WAS will be aerobically digested and then transferred to uncovered sludge drying beds for further moisture reduction. Another option for processing WAS from the Maloney plant will be to haul the liquid sludge to Malabar for dewatering and drying in the solar dryers.

Operational activities will also include routine equipment checks, and monitoring the following treatment processes that are not typically controlled, but need to be running effectively to keep the overall treatment system operating optimally:

- Fine screening
- Grit removal
- UV disinfection
- Solar drying

Both treatment plants will be equipped with laboratory facilities equipped to conduct process control tests for chemical oxygen demand (COD), total suspended solids (TSS), and nitrogen compounds.

3.9.2 Instrumentation and Control

The following description is for the new Malabar WWTP. A similar, but less intricate system will be provided for the Maloney WWTP.

In a fully automatic operation, all controlled variables and set points are controlled by a computerized system, complete with all necessary ancillaries needed to modulate, open/close, or start/stop process functions. The plant will be staffed 24 hours per day, seven days per week (24/7) with at least one operating crew on duty at all times. This level of attendance reduces the value associated with full automation so fully automatic operation is not required.

Semi-automatic operation with provision for operator intervention will be provided. In a semi-automatic system, set point adjustment becomes the responsibility of the operators and some of the open-close and start/stop functions are manual. For instance, setting the effluent weir on the bioreactor basins will not be automated. The duty crew will be trained and directed to make the necessary process modifications to optimize the treatment system on an ongoing basis.

Field instruments will be wired to a series of marshalling panels mounted in the electrical rooms. The main marshalling panel locations will be in the utility building control room and the sludge dewatering building electrical room. Adjacent control centres will receive the wiring from the marshalling panels into programmable logic controllers (PLCs). All control functions and monitoring of digital input and output will be through these PLC centres.

The control centres communicate through an Ethernet network connection, which further connects to a series of human-machine interface (HMI) devices and an archive computer. One

HMI will be located at each control centre and in the control/operations room in the Administration Building.

3.9.3 Waste Management

Measures that could be taken to minimize pollution caused by construction or its related activities are:

- Provide temporary sanitary facilities for workers.
- Provide regular servicing of temporary sanitary facility by septage truck, with disposal to a proper disposal facility.
- Install silt control fences along sewer trench construction, and around stockpiled materials.
- Require the contractor to provide a Construction Environmental Management Plan to address the collection and proper disposal of all unsuitable construction materials or refuse.
- Recycle all excavated materials where suitable.
- Provide a designated landfill site for disposal of surplus construction materials and/or contaminated soils, and monitor the usage of the site by the contractor.
- Restrict the burning of removed vegetated materials to designated areas only.

Residual materials physically removed from the wastewater during treatment (screenings and grit) will be washed and dewatered before sending to landfill for disposal. The dried biomass, commonly known as biosolids, are suitable for agricultural land application, daily cover for landfill operations, and landscaping.

3.10 MALABAR AND MALONEY NON-ROUTINE EVENTS

A range of possible accidental (non-routine) events could arise as part of the construction and operations phases of the works. These may comprise the following:

- Liquid spills, including fuel, chemicals and paints and solvents (construction and operations phases);
- Failure of unloading arm of cranes handling cargo, which may result in the spill of handled cargo;
- Accidents, including collisions with other vehicles / equipment and other occupational-related incidents (construction and operation phases); and
- Fire and explosion (construction and operation phases).

3.11 MALABAR AND MALONEY DECOMMISSIONING PHASE

The project is designed for 2035 flows. Future conditions which may affect the decommissioning decision are largely based on unknown factors; therefore, details of facility closure and decommissioning presented herein are limited. A decommissioning plan and separate impact assessment would be conducted in the future in the event that the plant or components of its infrastructure are to be decommissioned.

Decommissioning of the wastewater treatment plant and its associated facilities would be executed in a manner consistent with relevant legislations and regulations at that time. This process would involve interaction with the jurisdictional regulatory agencies of Trinidad and Tobago. WASA will develop a detailed plan for site closure when that information is better understood.

The end use objective will affect the type of decommissioning undertaken. This may include:

- Alternate use
- Abandon in place
- Demolition and removal (i.e. the removal of buildings, equipment, and installed features)
- A combination thereof

Elements of the decommissioning plan will include:

- Evaluation of decommissioning alternatives
- Sequencing of activities
- A strategy to identify and remediate disturbed areas
- Details of the demolition and removal activities to be undertaken
- Restoration and revegetation

For safety of personnel and the environment, decommissioning activities will be implemented after operations have ceased and equipment has been properly deactivated. The Government of Trinidad and Tobago (GOTT) will be notified when decommissioning is scheduled. A revised plan will be prepared and provided to the GOTT when decommissioning is more imminent, but no less than 12 months before closure is planned.

At this time, decommissioning and demolition of no longer needed facilities will be accomplished by the construction contractors. Lift stations and small package-type WWTPs will be demolished by the collection system contractor. The existing Malabar WWTP will be demolished by the WWTP construction contractor. The Arima WWTP will be decommissioned but not demolished. This site is owned by WASA and will remain until a new use is identified. A portion of the facility could be used for locating the sewer maintenance personnel and their equipment, but this has not been decided.

3.12 MALABAR AND MALONEY ENVIRONMENTAL REGISTER

An environmental aspect is an element of an organization's project activity, product or service that can interact with the environment. This section is intended to register all significant environmental aspects that may have an adverse or beneficial impact, wholly or partially on the socio-environmental surrounding resulting from the project's activities. It is considered that the information provided previously in the Chapter is of sufficient detail to allow for this register to be made. This register of aspects will continue to feature in this report, as it will be used to focus our impact evaluation, mitigation measures and environmental management plan.

Table 3-17 Environmental Aspects Register

Phase	Project Component	Environmental Aspect
General Project Activities	Use of equipment and machinery	• Maintenance and repair • Refuelling • Operating
	Use of vehicles	• Driving / commuting • Maintenance and repair • Refuelling • Loading / unloading
	Procurement	• Procurement of products, supplies and construction/raw materials
	Use of labour	• Refer to Social Impact Assessment for further information.
	Storage	• Storage of hazardous materials • Storage of raw materials (non-hazardous)
Construction	Pre-construction/ Enabling works	• Procurement and storage of construction materials • Procurement of labour • Vegetation clearance • Earthworks (including stockpiling and grading) • Upgrading of access routes (including grading and surfacing)

Phase	Project Component	Environmental Aspect
		• Installation of perimeter fence around construction base camp • Transportation (personnel, equipment, machinery, supplies) • Use of construction equipment and machinery
	Installation of Utilities	• Installation of temporary sanitation facilities • Installation of telecommunications systems • Installation and use of power / energy systems • Installation and use of lighting • Construction of drainage system • Storage and disposal of construction debris and waste • Use of chemicals, coatings and paint
	General Construction Ground excavation/ Pipe installation/ External works	• Piling • Backfilling • Compaction • Grading and surfacing • Alteration of grade and drainage patterns • Waste management • Water supply management
Operations	Process activities – Wastewater Treatment operations and general operations	• Wastewater treatment and effluent release to catchments • Use of energy • Use of labour • Cleaning and maintenance • Transportation of supplies and personnel • Storage of materials • Waste management
Non-routine events	Use of vehicles	• Fire/explosion • Vehicle collision
Decommissioning	General Decommissioning	• It is anticipated that a Decommissioning Management Plan will register the environmental aspects relating to this phase prior to commencement of works

4 ANALYSIS OF ALTERNATIVES

4.1 SCOPE AND OBJECTIVE

The objective of an analysis of alternatives is to describe reasonable alternatives to any project beginning with an assessment of the project siting options, through to an analysis of the technical and design consideration and ending with an assessment of a no action alternative, which can achieve similar project objectives. For this project, the overriding project goal is to reduce the pollution loading from the discharge of untreated or partially treated sewage from homes, commercial, instructional and industrial entities on the Malabar and Maloney Catchment areas. The goal of the project is to be realised through a few key project objectives:

1) Connection of all point sources of discharge of grey water from homes, commercial, institutional and industrial entities in the Malabar/Maloney catchment areas to a centralized sewer collection, transmission and treatment system.

2) Establishment of an interconnected network of trunk lines and lift stations that will serve as an integrated grey water transmission system.

3) Upgrade of the WWTP at Maloney and construction of a new municipal WWTP at Malabar. The two wastewater treatment plants will have the capacity to effectively handle all of the grey water treatment needs of the Malabar/Maloney catchment areas while using modern secondary treatment technology to consistently produce an effluent quality that meets the standards for discharge to inland water courses in Trinidad and Tobago.

Section 2.6 of the Final Terms of Reference for the conduct of the EIA for this project, issued to WASA by the EMA on 26th July 2006, lists the factors that may be taken into account in addressing the feasibility of alternatives. These include:

(1) Site suitability,

(2) Type of collection system

(3) Type of treatment system

(4) Conceptual design and layout of the proposed wastewater treatment plant

(5) Construction techniques and phasing

(6) Alternatives to proposed land use

(7) Treatment and disposal of sludge

(8) No action alternative

In 2005, the consulting consortium of Safege Consulting Engineers (France) and ADeB Consultants Ltd. (T&T) developed a Master Plan for the expansion and integration of existing wastewater systems in Trinidad along the east-west corridor and its environs[2]. This Master Plan enabled the development of sewerage alternatives and the identification of the preferred alternatives for the Government of Trinidad and Tobago's first phase (2005 – 2020) and second phase (2021-2050) investment periods in modernizing the wastewater management sector. The Master Plan document identified the following elements of a new integrated wastewater management system for six regional sewerage catchments along the east-west corridor:

1) The identification of distinct regional sewerage catchments (of which Malabar and Maloney are two)

2) The determination of effluent flows and loads up to design horizon 2035 for each regional sewerage catchment.

3) The determination of base flows and dilution capabilities of the receiving water courses in each of the six regional sewerage catchments

[2] Final Master Plan Report – Expansion and Integration of Existing Wastewater Systems in Trinidad Along The East West Corridor And Its Environs. Report prepared by Safege Consulting Engineers in Association with ADeB Consultants Ltd. April 2005.

4) The development of sewerage alternatives
5) The preliminary impact assessment of sewerage alternatives
6) The preliminary financial assessment of sewerage alternatives
7) The multi-criteria analysis of sewerage alternatives
8) A summary of total investment costs per phase and for each regional sewerage catchment
9) Tariff and affordability factors
10) The prioritization of sewerage works
11) Institutional recommendations
12) A Conceptual Design Phase.

The Master Plan document covered comprehensive analysis of various technical, siting, financial and other considerations in developing a final conceptual design plan for the Malabar and Maloney Regional Sewerage Catchments.

The final development plan for Malabar involves the decommissioning of the existing Arima WWTP and the routing of the wastewater currently handled at this plant to a new activated sludge WWTP to be built at Malabar.

The final development plan for Maloney is the installation of a lift station and force main from La Florissant to the existing site of the WWTP at Maloney which will be refurbished and expended to treat the future flows.

This final conceptual design plan (See Chapter 3) was approved by WASA in 2006 and thus the analysis of alternatives required under Section 2.6 of the Final TOR for the conduct of this EIA is constrained by the EIA consultants being presented with an approved plan that already addressed the following:

1) Site suitability,
2) Type of collection system
3) Type of treatment system
4) Conceptual design and layout of the proposed wastewater treatment plant
5) Construction techniques and phasing
6) Sludge Management

The decision made by the client on the six key elements of final conceptual design presents the EIA consultants with several constraints which limit the alternatives to be considered. For the WWTPs, various treatment processes have been considered, taking account the reliability of the technology, the expected characteristics of the wastewater, the capacity of the WWTPs and other site conditions. The proposed processes have been selected for their ease of operation, reliability, and ability to meet the required effluent standards. A copy of the Executive Summary of the Safege et al report is provided in Appendix VI of this EIA. The reader can find an analysis of the alternatives of the above five project elements in this Appendix.

For the purposes of addressing the requirements of Section 2.6 of the EMA's Final TOR, the following alternatives to land availability, use, site selection and planning, as well as environmental considerations are discussed together with the 'No Action Alternative'.

4.2 ALERNATIVES CONSIDERED

4.2.1 Land Availability, Land Uses, and Site Selection Planning

The Study Area of the Malabar and Maloney regional wastewater catchments are largely urban in nature with few areas of available land where a wastewater treatment plant can be sited (for the new Malabar Wastewater Plant) and limited areas for expansion of the existing Maloney Wastewater Treatment Plant. The proposed new wastewater plant and up-grade of the existing plant are in areas which are not currently under dense housing and thus would not produce nuisance factors during construction and operation.

There are no established communities in the area of the potential plants, so there is no risk of conflicts with an existing community. Depending upon the specific location selected for the plant, there would be the potential for conflict with the land use plans and zoning of Government Ministries (such as Town and Country Planning Division and the Ministry of Agriculture, Land and Marine Resources).

This was the case with an alternative site considered for the new Malabar WWTP. A site at the southern end of the catchment, just north of the Caroni River was identified as a suitable site based on engineering considerations. However, a site visit identified the land as being actively farmed. Because this site was considered to be more productive than the original location south of the CRH, the decision was made to locate the new WWTP on the original site. This was not the case with the Maloney WWTP, which will be refurbished and expanded, rather than constructed as a new greenfield project.

The area within the proposed Malabar Wastewater Treatment Plant and the area for upgrade of the Maloney Wastewater Treatment Plant are located in agricultural land. Construction of the plants would remove an area of land under agricultural production. Locating the plants in these areas poses a significant but unavoidable impact. The sites were selected in order to facilitate the use of the proposed gravity flow system of untreated sewage which minimizes costs, as much as possible, to the proposed plants.

4.2.2 WWTP Design and Treatment Technology

As with the proposed project, a wastewater plant would expect to be designed to accommodate many years of growth in the participating communities. Such a design may provide capacity sufficient for a population in excess of that currently identified in the communities' general plans.

Waste Discharge Requirements and similar regulations would apply to any alternative. Such regulations provide adequate protection to water quality. The designs of the proposed plants were considered based on the level of treatment required, availability of resources and the methods of treatment which have been most effective in Trinidad to meet or surpass the regulatory requirements.

The activated sludge treatment process selected for Malabar is essentially the same process used at the New Beetham WWTP that has been in operation since 2005 treating wastewater collected in Port of Spain and surrounding areas. The New Beetham WWTP consistently meets all regulatory limits. The Malabar plant will include one modification to enhance nitrate nitrogen removal. Reducing effluent nitrates will improve the water quality entering the Caroni River upstream of the Caroni Arena WTP.

A similar activated sludge system is planned for the Maloney WWTP expansion.

Engineering alternatives have the potential to alter conditions to a greater degree than the project. Alternatives are possible for some components of the project (such as activated sludge use in agriculture and landscaping or alternatively disposal at landfills). These alternatives however are considered minor in the wider project proposal, and are dealt with in the scheme of industrial 'best practice'.

4.3 ENVIRONMENTAL CONSIDERATIONS

For each of the regional wastewater catchments, Safege et al considered the environmental impacts stemming from the implementation of the Master Plan. It was anticipated that the implementation of the integrated sewerage system in the Malabar and Maloney regional catchment areas will translate into dramatic improvements in river water quality. The new and refurbished treatment plants at Malabar and Maloney will be designed to produce socially and environmentally acceptable products that can be applied to agricultural land as a soil amendment having some fertilizer value.

Other positive and negative aspects of the project include:

1) Positive Impacts:

   a. Reduction in public health hazards from the suppression of raw wastewater discharges into rivers and environment.

   b. Improvement in environmental quality and reduction of degradation effects on ecological systems from cleaner watercourses.

   c. Cleaner environment enabling the revival of recreational activities along the watercourses.

   d. Increased land values as defective package WWTPs are decommissioned.

   e. Opportunities for employment during construction, operation and maintenance phases of the project.

2) Negative Impacts:

   a. Nuisances stemming from the implementation of the works

   b. Sludge disposal

   c. Reduction of base flows of some tributaries to the Caroni River as a result of the decommissioning of independent package plants and other point sources of discharge situated in the tributary catchments.

4.4 NO ACTION ALTERNATIVE

With or Without the Project

An alternative to the proposed project is 'No Action' in which the proposed project is not undertaken. The proposed development is part of a larger Wastewater Master Plan which has identified the need for improved sewage treatment along the East-West Corridor. Implications of the 'No Action' alternative are that the problems that have been identified in the Study Area and the wider national community will continue.

The problem of non-functional wastewater treatment plants (WWTPs) servicing private housing development has been a persistent wastewater and surface water management issue in Trinidad for several decades. The identification of these small private WWTPs and the inefficient treatment of sewage resulting in the pollution of watercourses, have been assessed over the last decade with many of the privately owned WWTPs identified as non-functional (Rodriguez-Atwell 2000). Organic pollution of the south-flowing tributaries of the Caroni River (which include the present Study Area) has been documented with the concomitant decrease in aquatic diversity (Phillip 1998, Kenny 1995, Rostant 2005).

Without the proposed project, urbanization, and population growth will result in increasing volumes of untreated domestic and small quantities of industrial wastewater being discharged into the rivers and drains and a consequent deterioration in surface water quality. The pollution of surface water would continue to affect and threaten drinking water safety and thus the health of urban and rural residents. The area's ecosystem, and particularly aquatic life, will be significantly degraded. The downstream water quality in the Caroni River will be negatively affected seeing that the rivers in the Study Area are located upstream of the raw water intake for the Caroni Area Water Treatment Plant. The quality of life and the standard of living of residents of the project area will deteriorate. Implementation of the proposed project will significantly reduce the direct discharge of untreated wastewater, thereby contributing to the long-term goal of cleaning up the Caroni River and improving related ecological, physical, and health conditions.

5 BASELINE STUDY OF THE PHYSICAL, BIOLOGICAL AND SOCIAL ENVIRONMENT

5.1 CLIMATE

Climate and meteorology are major factors affecting dispersion of effluent and emissions. As such, assessment of existing climatic conditions is important in terms of identifying baseline conditions within which the proposed project will be operating. The following climatic factors are considered below:

- Wind speed and direction
- Rainfall
- Temperature
- Humidity
- Extreme climate

5.1.1 Wind Speed and Direction

Wind speed and direction significantly affect the route and rate of dispersion of potential gaseous and particulate pollutants, as well as the attenuation characteristics of noise emissions. Henry in 1990 summarized winds in the region and indicated that the Northeast Trade Winds blow over Trinidad during the period November to July, which covers most of the year. During the period October through to June, the wind direction is stable from East to East-Northeast. This is particularly true during January and April when the Inter Tropical Convergence Zone (ITCZ) moves farthest south and the Northeast Trade Winds prevail. In the period August to October, the wind changes to the South East Trade Wind.

During the dry season, (January to May) the prevailing wind occurred from an easterly direction 36% of the time, at Piarco. In the wet season, the prevailing wind from the easterly direction occurred 20% of the time at Piarco. Wind speeds recorded at Piarco were generally higher during the dry season based on data from 1995 to 2004. Wind speeds were recorded as being between 19 km/hr and 30 km/hr during the dry season, and between 9 km/hr and 17 km/hr during the wet season. Wind speeds are in excess of 8km/hr approximately 97 % of the time, in the dry season and in excess of 24 km/hr approximately 70% of the time, in the wet season.

Reference data from Ecoengineering Consultants Limited indicated that calm conditions were noted at Piarco, a quarter of the time during the dry season, and one third of the time during the wet season. Non predictable tornadoes sometimes form over Central Trinidad and they are associated with unstable weather. Wind roses for the period 1995 to 2004 are presented in Figure 5.1.

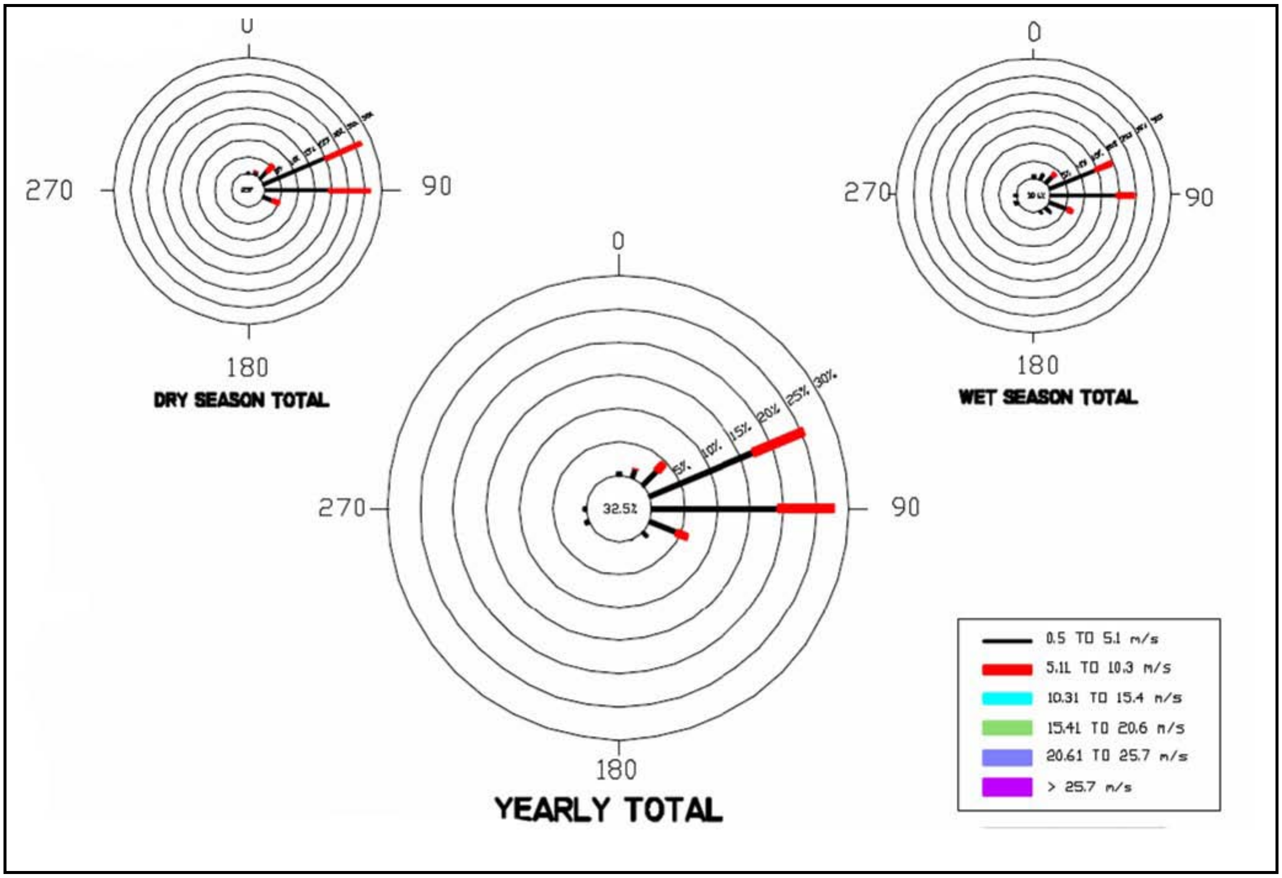


Figure 5.1 Wind Roses 1995-2004

5.1.2 Rainfall

Despite its comparatively small size (4,828 km^2), Trinidad experiences significant spatial variation in rainfall distribution patterns, with annual averages varying from 3800 mm in the northeast, to 1200 mm in the extremes of the northwest and southwest peninsulas. The climate of the area is described as tropical with a pronounced dry season from January to May and a wet season from June to December. The occurrence of the wet season coincides with the passage of the (ITCZ). Clear skies with hot days prevail for a short dry spell in the wet season during September to October. This phenomenon is referred to as the "*Petit Careme*" The ITCZ is the region over the Equator in which the Northeast and Southeast Trade Winds converge and rise, precipitating rain upon cooling. The variation over Trinidad is linked with the topography which gives rise to relief rain when air rises over the higher grounds. Relative Humidity of the prevailing trade winds is greater than 70%. This can also give rise to isolated showers due to a drop in atmospheric pressure, low night time temperatures and low pressure systems. Average rainfall for Trinidad is shown in Figure 5.2.

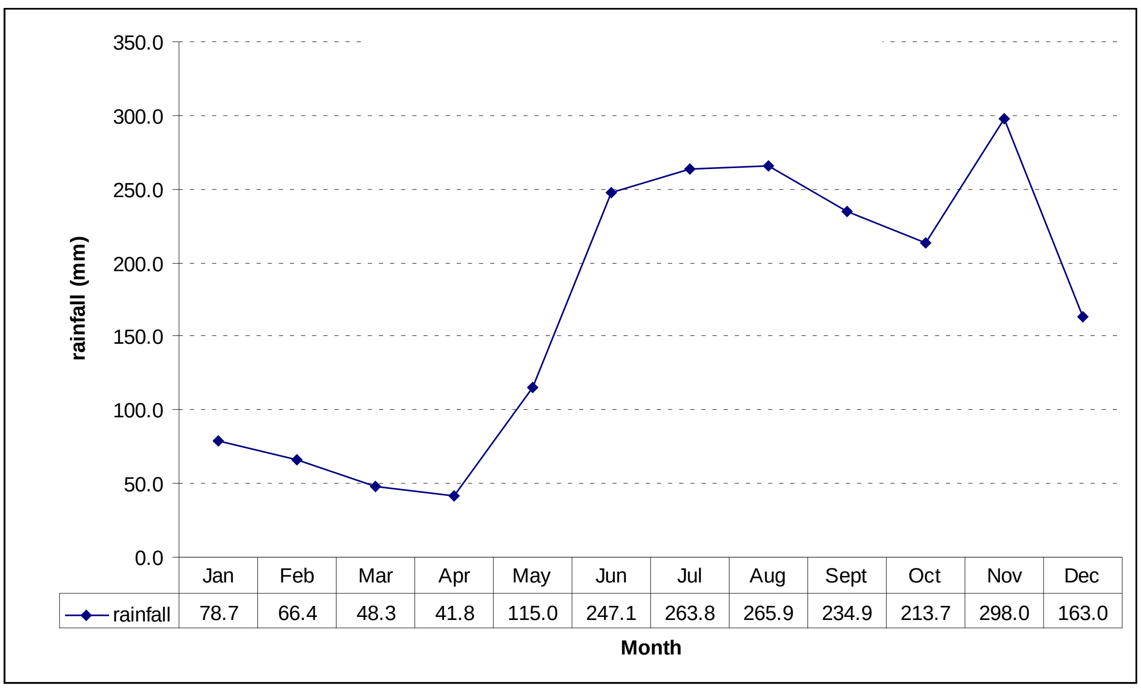


Figure 5.2 Average Rainfall Trinidad (mm) (Data Source: Water Resources Agency)

Rainfall volume and intensity (in association with land cover and surface characteristics) determine rates of surface run-off, and significantly affect the suspension, transport and dilution or degradation of water pollutants (in addition to atmospheric wash-out effects for air pollutants). Flooding is usually associated with higher-than-average rainfall, and occurs when surface run-off exceeds river channel capacities. Figure 5.3 depicts rainfall frequency duration curves.

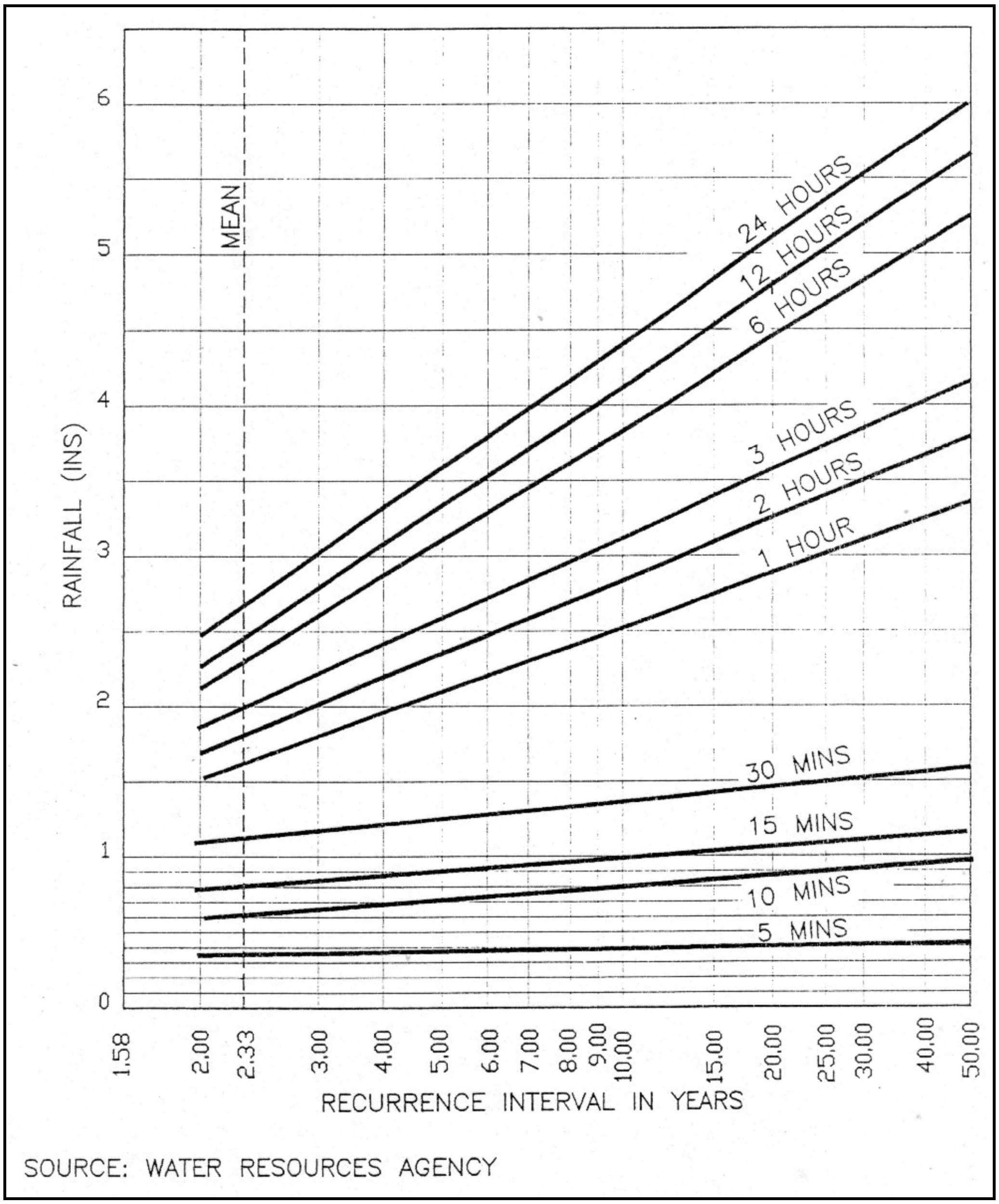


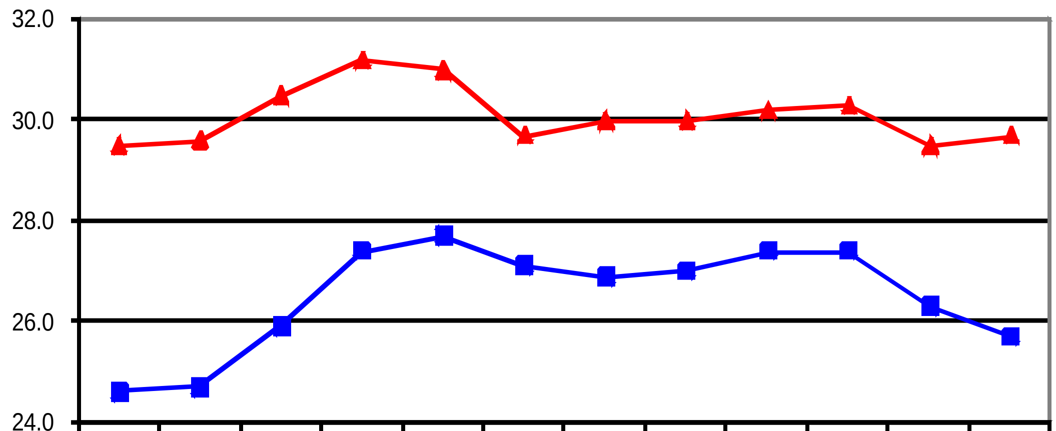
Figure 5.3 Rainfall Frequency-Duration Curves

Generally rainfall data for the period 1961-1990 from the National Meteorological Service at Piarco revealed that Trinidad experiences a mean annual rainfall of 1870 mm. In the pronounced dry season monthly averages vary with March being the driest month (34 mm). During the dry season mean monthly rainfall values are less than 75 mm, with the exception of December (156 mm) and May (116 mm) which are transitions of the dry and wet seasons. All other months exceed 200 mm mean monthly rainfall. According to 30 year means the rainiest month of the year is July (266 mm). Following the temporary return to drier conditions in late September to early October, there is a secondary rainfall peak in November (228 mm)

The El Nino Southern Oscillation (ENSO) is a warm current that occurs every 2-7 years in the Eastern Tropical Pacific. The effects are drier wet seasons and wetter dry seasons and suppressed hurricane activity which leads to widespread dryness. In general the Gulf of Paria is located south of the hurricane belt. However tropical cyclones may pass further south. On average, ten tropical storms form in the Atlantic during the period June to November. Other statistical analysis shows that return period for hurricanes is 34.7 yrs and for storms is 13.1 yrs. Extreme category 3 hurricanes (Flora-1963) have a return of 3 yrs. Further details on the incidence of hurricanes are provided in Section 5.2.2.

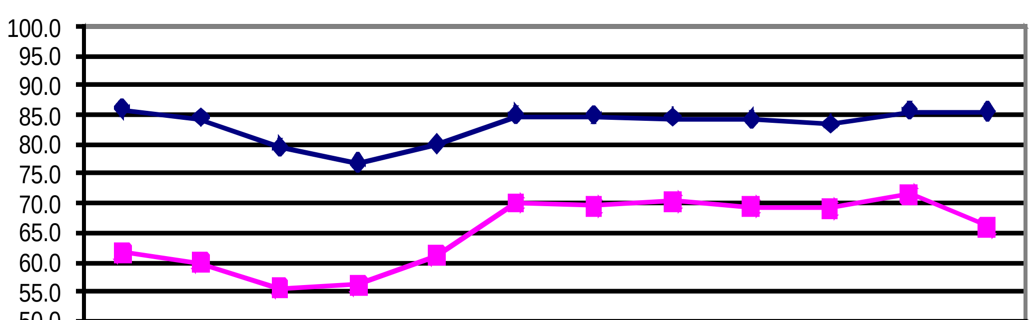
5.1.3 Air Temperature & Relative Humidity

The annual variation in temperature is relatively small in Trinidad, because of its small landmass and proximity to the equator (~10º N). According to long-term data for Piarco, 24-hr average temperatures are lowest in January (24.6°C) and peak in May (26.9°C). Maximum daily temperatures frequently exceed 34°C, and the average diurnal (day-night) range is about 8-13°C. Average air temperature and relative humidity are summarized in Figure 5.4 and Figure 5.5.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
08:00 AM	24.6	24.7	25.9	27.4	27.7	27.1	26.9	27.0	27.4	27.4	26.3	25.7
02:00 PM	29.5	29.6	30.5	31.2	31.0	29.7	30.0	30.0	30.2	30.3	29.5	29.7

Figure 5.4 Air Temperature (°C) Trinidad



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
08:00 AM	85.9	84.4	79.4	76.7	79.9	84.9	84.8	84.5	84.1	83.3	85.6	85.4
02:00 PM	61.6	59.9	55.4	56.0	61.1	70.1	69.5	70.3	69.4	69.2	71.6	66.0

(Data Source: Meteorological Services Division)

Figure 5.5 Relative Humidity (%) Trinidad

In the Gulf of Paria, a constant temperature ranging between 23°C and 33°C for most of the year has been documented. The highest and lowest ambient air temperatures in Trinidad occur during the dry season (Piarco Meteorological Station, 2004). In the period 1994 to 2004, the lowest temperature of 26.7°C occurred in February and the hottest month is September with a recorded average of 28.5°C. Tidal cycles have little impact on sea temperature although slightly higher temperatures are observed at high water. Sea surface temperature tends to peak in August with lowest recorded in February.

The mean maximum and minimum Relative Humidity was obtained from Piarco for the period 1995 to 2004. The highest Relative Humidity was recorded for the month of November (82%) which preceded the end of the wet season. The lowest average Relative Humidity was recorded for the month of March (73%) following the driest month of the year. Relative humidity variation over Trinidad is small and the data from Piarco is representative of the entire island. Relative Humidity often reaches 100% in the early night as temperature decreases and cooler air distills more moisture. It is clear that Relative Humidity is acceptably slightly lower in the dry season. During the El Nino cycle additional dryness is experienced as hurricanes are suppressed.

5.2 NATURAL HAZARDS

5.2.1 Tsunami Hazards

In the open ocean or near shore zones, crustal deformation during earthquakes, submarine volcanic eruptions from Kick 'Em Jenny or near shore tanker explosion, (although of low probability) can result in displacement of water. The primary potential for tsunami threats are large local plateboundary earthquakes, submarine slides, or a mega thrust on the Lesser Antilles sub-duction zone to the north, amplified by potential submarine slides in the Tobago-Barbados accretionary prism. Essentially the entire Eastern Caribbean arc will have to rupture if tectonically possible. At the same time no land mass has been identified to cause a slide of the required magnitude that will trigger a tsunami. Given a subduction of 2 cm/yr with a seismic efficiency of possibly 0.7, soliciting for a 10m slip would require strain accumulation of over 700 years.

5.2.2 Hurricanes

Generally, Trinidad lies south of the Atlantic Hurricane Track, although occasionally a tropical cyclone may pass further south than usual. The Atlantic Hurricane Season extends from June 1 to November 30, during which time an average of 10 tropical storms are formed annually (Daniel and Maharaj 1987). Trinidad is in the path of hurricanes and may well experience extreme Tropical storms with sustained winds between 63 kmh^{-1} and 118 kmh^{-1}, with a return period of 100 years, especially considering the prospect of future climate change due to global warming (Meteorological Services 2000). Maharaj (1990), using statistics over the period 1886 to 1990, estimated return periods for hurricanes in the region of 34.7 years and for hurricanes and/or storms a return period of 13.1 years. From 1974 to 2004, 17 cyclones have passed 'close' to Trinidad and Tobago where 'close' is defined as passing through the geographical area bounded by latitude 10EN to 12EN and Longitude 60EW to 62EW. Most of these cyclones affected Tobago and northeastern Trinidad and only seven cyclones (one hurricane and five tropical storms) have made landfall. Only two tropical cyclones, Fran and Alma, were recorded as having passed over Trinidad via the southeastern coast. Hurricane Flora (in 1963) was the only recorded tropical cyclone, which passed over this area to attain hurricane intensity. It was previously predicated, that hurricanes within the category 3 intensity such as Flora have a return period of 200 years (Maharaj 1990). However, in September 2004, Hurricane Ivan, which was classified as a Category 5 Hurricane, caused extensive damage in Tobago and devastated Grenada. In Trinidad, the direct damage was less extensive with only some roofs being blown off buildings in the northeastern tip of Trinidad. The island experienced severe flooding as a result of heavy rainfall associated with the passage of Ivan. Areas affected included St. Helena, Piarco, Caparo and Kelly Village. In July 2005, Trinidad and Tobago experienced the effects of Hurricane Emily which passed north of the islands. There were torrential rains and high winds, followed by flooding in low-lying areas in north and central Trinidad. A list of the tropical storms and hurricanes affecting Trinidad and Tobago between the years 1974 – 2004 are presented in Table 5-1 below.

Table 5-1 Tropical Cyclones Affecting Trinidad and Tobago (1974-2004)

Name	Date Of Passage	Classification	Area of Centre Passage
ALMA	1974 Aug. 14	Tropical Storm	Southern Trinidad+
GRETA	1978 Aug. 10	Tropical Storm	70 km N of Tobago
CORA	1978 Sept. 13	Tropical Storm	30 km WNW of Port of Spain
DANIELLE	1986 Sept. 8	Tropical Storm	90 km NE of Tobago
JOAN	Oct.14 1988	Tropical Storm	70 km N of Tobago
FRAN	1990 Aug. 13-14	Tropical Storm	Between Northern and Central Ranges, Trinidad+
BRET	1993 Aug. 9	Tropical Storm	Between Trinidad and Tobago
IRIS	1995 Aug.	Tropical Storm	North of Tobago
LENNY	Nov 13-23 1999	Hurricane	North of Tobago
JOYCE	Oct. 1 2000	Tropical Storm	Tobago+
CHANTAL	Aug. 16 2001	Tropical Storm	Northern Tobago
JERRY	Oct. 7 2001	Tropical Storm	Northeast of Tobago
ISIDORE	Sept 14-27 2002	Tropical Storm	West of Trinidad
LILI	Sept 21 2002	Tropical Storm	Northeast Tobago
FRANCES	Aug. 24 2004	Tropical Storm	Northern Tobago
IVAN	Sept. 7 2004	Hurricane	Tobago+

(Source: Meteorological Office Piarco) +Cyclones Making Landfall

It has been hypothesized that the heightened Atlantic major hurricane activity between 1995-2004 is a consequence of the multidecadal fluctuations in the Atlantic Ocean thermohaline circulation (THC) which is directly related to North Atlantic sea surface temperature anomalies. When the Atlantic Ocean thermohaline circulation is running strong, the ITCZ becomes stronger. The stronger the ITCZ becomes, the more favourable are conditions for the development of major hurricanes in the central Atlantic. Since 1995, the THC has been flowing more strongly, and there has been a concomitant increase in major hurricanes in the tropical Atlantic.

5.2.3 Earthquakes

Another hazard, which may affect the area, is the possibility of earthquakes. Earthquakes require assessments of precise predictability and careful application of design codes for determining and managing probable seismic risk. Current codes are based on spectral ground acceleration to derive seismic design parameters. Satellite images, seismic data, reference literature, geology and geotechnical assessment are used to estimate location, source, magnitude, and recurrence of earthquake events. Research has revealed that several earthquakes have caused severe damage in the Caribbean archipelago in post-Columbian times (Antigua-1974, Trinidad-1977, Jamaica-1993, Tobago-1997, Carriacou- 1997).

Geographically, Trinidad is located to the south of the main trend of the Lesser Antilles arc in the Eastern Caribbean. The island however, is tectonically within the boundary zone between the Caribbean and South American Plates. Trinidad lies close to the (hinge) junction of the plates, and interactions at such localities are generally characterized by moderately intense and extremely complicated seismic activity (Morgan 1993). Off eastern Venezuela and Trinidad, during the late Tertiary geological processes were controlled by tectonics associated with interactions along the boundary between the Caribbean and South American Plates. Major east-west oriented, right lateral strike-slip fault zones have partitioned the compressional strains. The degree of tectonic strain and the severity of uplift on Venezuela and Trinidad diminish from north to south (Sheppard *et al* 1998).

Much of the seismic activity near Trinidad & Tobago is focussed off the west and north coasts. Seismicity off the west coast is related to the El Pilar fault system, which runs east-west through northern Venezuela and is believed to terminate along the southern base of the of the Northern Range of Trinidad (extending off the northeast coast).

Another fault system far south of the project site is the Los Bajos Fault, which traverses the Cedros Peninsula. The Los Bajos fault has been described (Wilson 1958), as a right-hand strike-slip displacement, crossing the southwest peninsula along an average azimuth of 112º from Point Ligoure on the west coast to Point Negra on the south coast. Note that, according to Speed (1985), the present deformation front of the active (South American) foreland thrust and fold belt appears to be just south of Trinidad.

The Seismic Research Unit (SRU) at UWI continuously monitors seismic activity in Trinidad. The SRU headquarters at St. Augustine collects, processes and analyses data from 32 remote seismograph stations along the Eastern Caribbean islands, and monitors the distribution and frequency of earthquakes and volcanic activity, to specify levels of hazard and risk associated with each country.

As discussed by Shepherd & Prockter (1993), standard methods of seismic hazard assessment require that earthquake zones be defined from combination of seismicity data, surface geological observations and knowledge of regional tectonics. The rate of activity of each source zone is then used together with assumed rates of attenuation of the parameters of strong ground motion to estimate, in a probabilistic way, the levels of ground motion. The Trinidad Hazard & Response Map, (NEMA, 1996) classified Trinidad's southwest peninsula as an "earthquake-prone area". Long-term seismic data (1964-94) for Trinidad are summarized in Table 5.2.

Table 5-2 Long-Term Earthquake Statistics - Trinidad

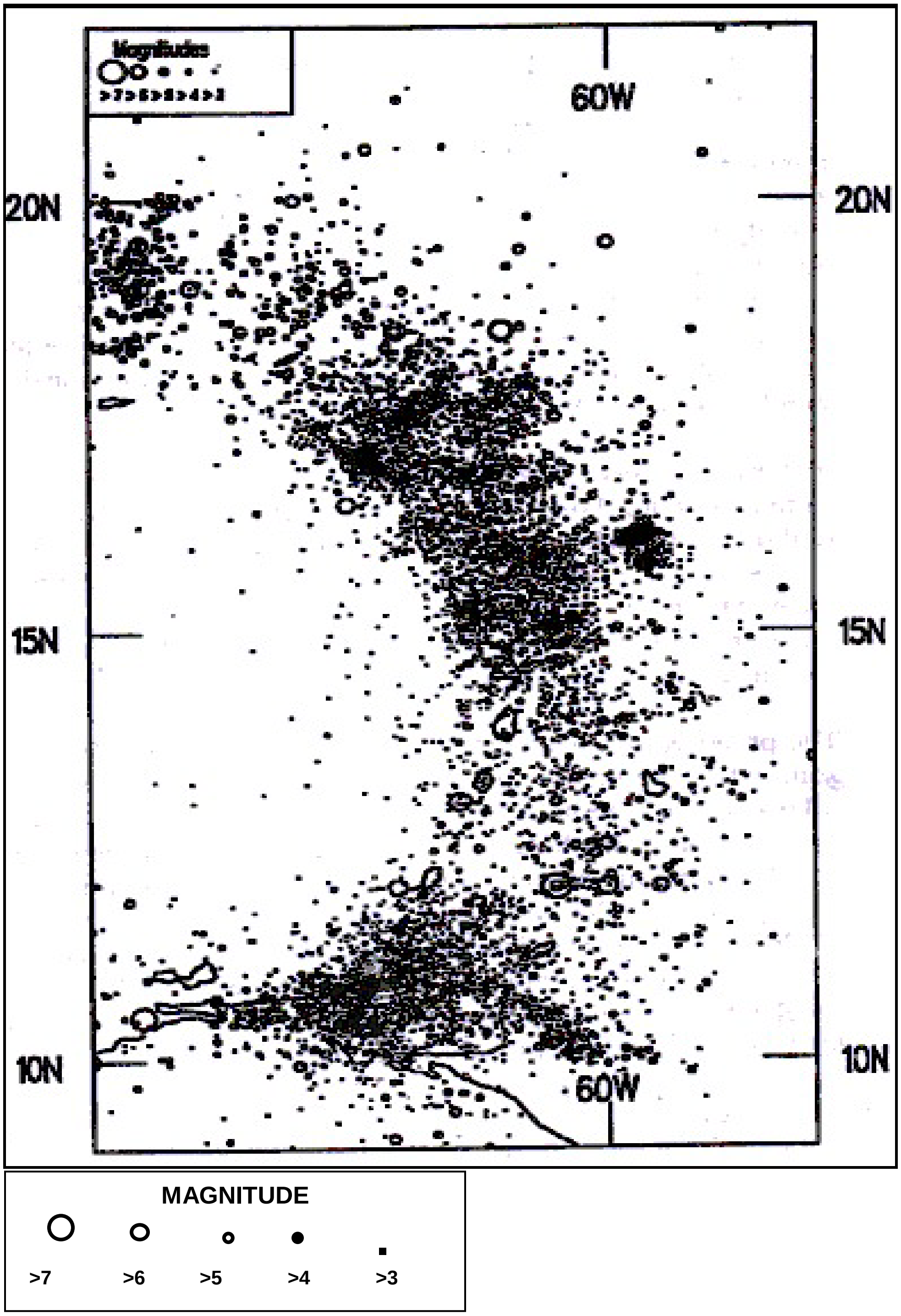
Magnitude Range (Richter Scale)	No. Of Events In 30-yr Period	Annual Rate of Occurrence (Statistical Average)
4.0 – 4.9	188	6.27
5.0 – 5.9	39	1.30
6.0 –6.9	2	0.07

(Source: Seismic Research Unit)

Shephard et al (1993) list the Caribbean as seismically active with records dominating the period from 1990 to 1992 (Figure 5.6). Earthquakes occur in the 35km thick crust in Trinidad (

Figure 5.7). However in the Eastern Caribbean it can vary from 10-200km as the subduced plate remains rigid. Prior to 1982, most earthquakes were concentrated in a zone north of the NE/SE trend near the Paria Peninsula and the others occurred in the Gulf of Paria in a NW/SE trend (

Figure 5.7). In 1988, east Trinidad, noted for low magnitude earthquakes experienced a 6.2 magnitude followed by after-shocks for years. The most recent seismic event with a magnitude greater than 5 occurred in September 2006, on the north coast. The event was of magnitude 5.8 and resulted in at least 46 aftershocks, the strongest of which had a magnitude 5.3. To date there have been numerous reports of minor damage in Trinidad and at least three injuries in south Trinidad resulting from the event.



(Diagram for illustrative purposes only. Not to scale)

Figure 5.6 Regional Seismicity for the Eastern Caribbean 1990-1992 (Shepherd 1993)

One of the major hazards associated with earthquakes is liquefaction. This is the temporary transformation of water-saturated granular material from a solid to a functionally liquefied state, resulting in the development of conditions in which buildings/infrastructure sink or settle, in relation to the ground surface. In Trinidad, liquefaction is most likely to occur in areas characterized by water-saturated, clay-free sediments that are relatively unconsolidated (e.g., reclaimed land in coastal areas). As such, this is unlikely to occur at the project sites. Based on available information, for the purposes of the study area, earthquakes of significant magnitude (M>6) are risks of potentially high consequence, but low probability.

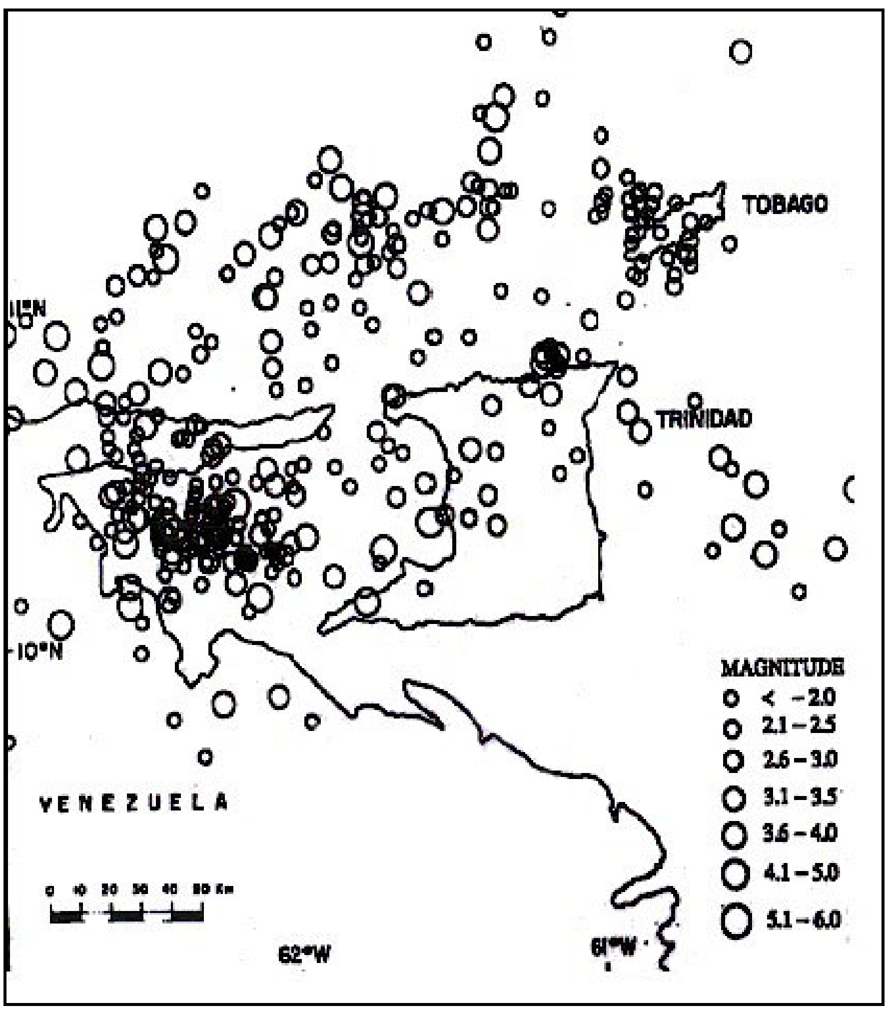


Figure 5.7 Distribution of Shallow Earthquakes (depth <34km) in the Trinidad-Paria Peninsula Area - August 1977 to September 1988 (Shepherd et al 1992)

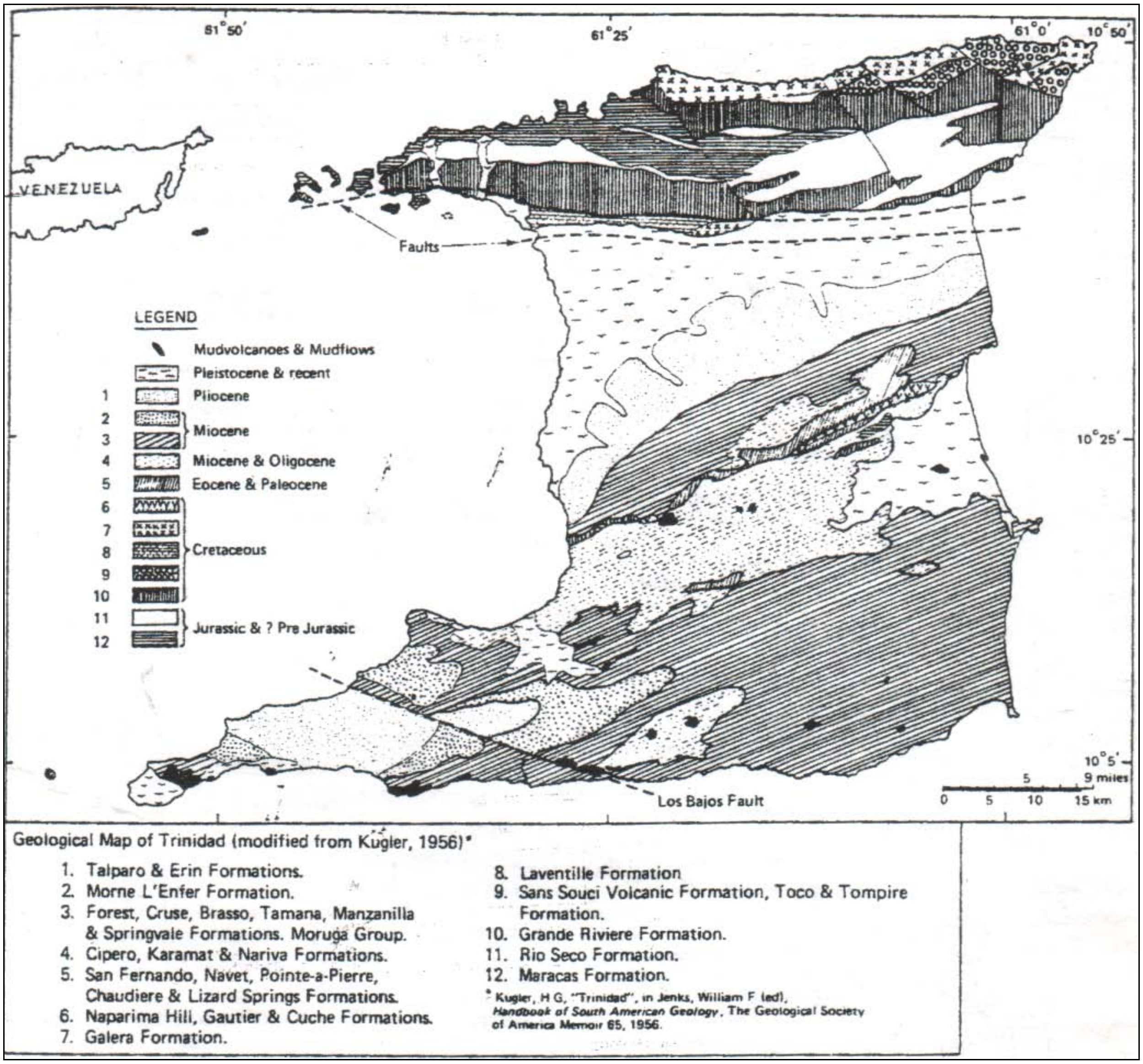
5.3 GENERALIZED GEOLOGY

5.3.1 Stratigraphy & Structure

On a geological time scale, Trinidad is considered to date to the Mesozoic era, very little of it having formed earlier than the Cretaceous period. The geology of the island has been described as showing significant diversity, in terms of stratigraphy (rock types) and associated structural complexity of formations (Barr 1981).

Geographically, Trinidad is located to the south of the main trend of the Lesser Antilles arc in the Eastern Caribbean. Tectonically however, it is within the boundary zone between the Caribbean and South American Plates, located on the continental shelf of South America. Trinidad lies close to the (hinge) junction of the plates, and interactions at such localities are generally characterized by moderately intense and extremely complicated seismic activity (Morgan 1993). The present deformation front of the active (South American) foreland thrust and fold belt is believed to be located on the Venezuelan mainland, to the south of Trinidad (Speed 1985).

Off Trinidad and eastern Venezuela, during the late Tertiary, geological processes were controlled by tectonics associated with interactions along the boundary between the Caribbean and South American Plates. Major east-west oriented, right lateral strike-slip fault zones have partitioned the compressional strains. The degree of tectonic strain and the severity of uplift on Venezuela and Trinidad diminish from north to south (Sheppard *et al*. 1998). The geological formations (stratigraphy and structure) in the oil-producing areas of southwest Trinidad are mapped on Figure 5.8



(Source: Barr 1981)

Figure 5.8 Map Showing Generalized Geology of Trinidad

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At the end of the Cretaceous period (approximately 100 million years ago), earth movements produced folds in submarine areas where rivers flowing out of the Guiana Highlands deposited thick bands of sediments. These folds produced three separate islands, which are now the Northern, Central and Southern Ranges. Sands, clays and some limestone were deposited in the shallow seas between these islands during the Tertiary Period (50 to 25 million years ago). Subsequently these areas were uplifted above water level. In the Recent Period (<10000 years ago) Trinidad broke off from the South American continent and the island has been subjected to further uplifting (<10 000 years) as evident by the presence of river terraces, the result of lifted flood plains.

Table 5-3 Summary of Geological Formations & Rock Types, Northern Range, Trinidad

Geological Age	Geological Formations	Average Thickness	Rock Type
Pleistocene 1×10^6 yr	Terraces, River Gravels	~15m (Up to 100 ft)	Sands, gravels, alluviums
Pliocene 12×10^6 yr	Talparo	~910 m (3000 ft)	Mainly clays with several prominent sand layers
Miocene 25×10^6 yr	Springvale	~450 m (1500 ft)	Mainly silt and clays with minor sands
	Manzanilla	~910 m (3000 ft)	Mainly sands in upper part, dominantly silts and clays below.
	Brasso	~610 m (2000 ft)	Mainly calcareous clay and silts, minor sands and thin limestone layers
Cretaceous 130×10^6 yr	Caribbean Series	~6100 m (20000 ft)	A large group includes the thick series of low grade metamorphic rocks of the Northern Range, mainly slatey phyllites with subordinate limestone quartzites and grits

(Source: Barr 1981)

5.3.2 Site Specific Geology

5.3.2.1 Bedrock

The geology of the study area comprises bedrock from the Cretaceous period. This group includes Grande Riviere Formation, Laventille Formation, Galera Formation, and (from the Jurassic Period) the Rio Seco Formation (to the east representing very little of the Study Area). The northern lowlands are occupied by geologically younger formations of soft sands and clays, with superficial gravel terraces, river and swamp alluvium. The most southerly areas and much of the lowlands comprise material from more recent formations of the Pleistocene.

5.4 TOPOGRAPHY AND DRAINAGE

The topography of the study area is gently sloping in the northern part and undulating to flat in the southern areas. The study site effectively starts in the foothills of the Northern Range to the Northern Lowlands (of the Caroni Plain). Several tributaries of the Caroni Drainage traverse the wider study area. Due to the relatively flat nature of the area and proximity to the Caroni River, the rivers within the Study Area are generally considered the lower catchment areas (before draining to the Caroni River). These tributaries (from west to east) are the Arouca, Oropuna, Mausica, Arima and Guanapo Rivers with the Guanapo catchment spatially separate from the Maloney and Malabar sub-catchments (as determined by WASA for management of wastewater).

Due to the high urban nature of the Malabar and Maloney catchments, there is a well defined system of surface drains and drainage channels that often lead to the nearby river systems.

5.5 SOIL

For the present study a soil investigation for the Maloney and Malabar Wastewater Catchment was commissioned and conducted by GEOTECH Associates Limited.

A total of forty nine test pits were excavated at the project site to determine the subsoil profile for founding the sewer line network. The fieldwork was carried out during the period May 23rd to August 14th, 2008. The test pits were excavated using a mechanical backhoe. The soil profiles were observed and recorded by a senior technician. Bulk samples were retrieved for the soil profiles encountered in each test pit. The test pits were excavated to depths ranging from 2.7 m to 3.1 m. Test Pit No. 13 was terminated at a depth of 1.8 m due to presence of water at the depth of termination. Test Pit No. 18 was terminated at a depth of 2.0 m due to the presence of boulders. The specific depth of termination of each test pit along with its site location is summarized in Table 5-4 below.

Table 5-4 Site Specific Location and Depth of Termination of Test Pits

Test Pit No	Location	Depth (m)
1	Arima Blanchisseuse Road	3.1
2	Arima Blanchisseuse Road	3.1
3	Calvary Branch*	3.1
4	Dominic Avenue	2.0
5	Mausica Street	3.1
6	Arima Old Road to the West of Victory Street*	3.1
7	Arima Old Road in the West of Ridgeland Park	3.1
8	Barbara Street*	3.0
9	Eastern Main Road to the East of Sawmill Road*	2.9
10	To the West of Olton Road along the PBR	2.4
11	Mendez Trace	3.1
12	Reid Lane*	2.7

Test Pit No	Location	Depth (m)
13	Reid Lane Extension*	1.8
15	Honey Bee Development*	3.1
16	To the West of Marie street along the EMR*	3.1
17	Intersection of Demerara Road and EMR	2.7
18	Valley View	2.0
19	To the West of the intersection of Mt. Zion Road and Punnette Avenue	3.1
20	Ivy Lane	3.1
21	Train Line Road	3.1
22	Westbound of Train Line Road across Pinto Road	3.1
23	Walter Street to the East of Tumpuna Road*	3.1
24	Gills View	3.1
25	Malabar Branch Road	3.1
26	Ackbaralli Street East*	1.5
27	Pine Road, Tumpuna Gardens*	3.1
28	Pinto Road	3.1
29	21 Jump Street	3.1
30	North of Andrews Lane	2.7
31	After Bridge by Racetrack off the CRH	2.7
32	To the West of Connor Drive	3.1
33	At lumber warehouse	3.1
34	East of the Intersection of O'Meara Road and the CRH	3.1
35	Industrial estate of the CRH	2.7
36	Peytonville Road	3.1
37	Opposite the O'Meara Cemetery	3.1
38	At the Malabar Farm Signage	3.1
39	Opposite standpipe along Peytonville Road	3.1
40	Carapo Road	3.1
41	East of Race Course Road	2.7
42	North of Cocorite Trace*	3.1
43	Tumpuna Road*	3.1
44	West of the Intersection of De Freitas Boulevard and the CRH	3.1

Test Pit No	Location	Depth (m)
45	By bus shed on De Freitas Boulevard	3.1
46	Intersection of Ladybird Street and Tumpuna Road.*	3.1
47	North of the Intersection of Carlisle Avenue and Eustace Bernard Drive	3.1
48	Corner of Hadaway Boulevard and Tecoma Street	2.7
49	Bandoo Avenue	3.1
50	Manuel Congo Road *	3.1

*** -** Denotes that the Test Pit was done adjacent to the roadway.

A review of the Agricultural Soils map of Trinidad indicate the sub soils encountered along study areas as determined from the test pits consist of clays and clay loam. The map indicates the following soil types along the length of the study area:

- Soil Unit 55 – Piarco fsl. The lithology of this soil unit comprises sand and clay and has imperfect drainage.

- Soil Unit 59 – Long Stretch scl. This soil unit consists of sandy clay loam and the drainage is also imperfect.

- Soil Unit 123 – Guanapo scl. This soil unit is characterised by sandy clay loams and has the lithology of mica, sand gravel. The drainage property of this soil unit is one of free drainage.

- Soil Unit 153 – Cleaver gscl. This soil unit consists of gravelly sandy clay loam. The lithology comprises of loamy hill wash and it has imperfect drainage.

The detailed soil conditions encountered within Test Pits are shown on the Test Pit logs. (Appendix V). A summarized account of the salient features is presented below. The soil profile encountered in the test pits is considered as a single soil unit (1) consisting of cohesionless and/or cohesive material which was competent in nature. The competent cohesive deposits consisted of the very stiff to hard clayey silt and silty clay. The competent cohesionless deposits consisted of dense to very dense clayey silty sand, sand and gravel with boulders, sandy silt, silty sand, silty gravel and sand. The grain size distribution tests carried out on the cohesive fine grained samples yielded materials the following proportions. (Enclosure Nos. 30 to 41 in Appendix V):

- Gravel – 0 – 25.1 %
- Sand – 11.0 – 51.2 %
- Silt – 19.3 – 52.3 %
- Clay – 10.8 – 65.9 %

The grain size distribution tests carried out on the cohesionless coarse grained samples yielded materials the following proportions. (Enclosure Nos. 30 to 41 in Appendix V).

- Gravel – 0 – 69.8 %
- Sand – 11.9 – 66.5 %
- Silt – 4.0 – 57.7 %
- Clay – 3.8 – 41.6 %

The natural moisture content of this unit ranged between 3.4 and 24.4%. The samples (fine grained) tested within this unit can be classified using the Unified Soil Classification System (USCS) as CL, CL-ML and ML-OL. They are therefore described as inorganic and organic silts, clays and silty or clayey sands with low to slight plasticity. A surficial layer of fill material occurs from the ground surface in to depths ranging from 0.6 m to 2.0 m. This fill layer occurs in Test Pit Nos. 21, 24, 25, 33, 34, 36, 37 and 40.

In Test Pit Nos. 24, 33, 34, 36 and 37, the fill layer consists of silty clays and sands with broken bottles, plastic and vegetation roots and boulders. The moisture contents measured within these layers ranged between 13.1% and 25.7%.

In Test Pit No. 21, 25 and 40, the fill layer consists of loose clayey sand, sand with gravel, and silty sand with fine to large boulders, rubble and pit run. The grain size distribution shows that this layer consisted of materials in the following proportions:

- Gravel – 2.5 – 53.3 %
- Sand – 15.7 – 60.1 %
- Silt – 4.0 – 39.0 %
- Clay – 7.1 – 38.3 %

The natural moisture contents measured within the loose layers ranged between 5.9 and 20.3%. Layers of loose to medium dense silty sand, clayey sandy silt and sand and gravel occur in Test Pit Nos. 1, 2, 17, 25,32, 33, 38, 45, 47 and 49. An isolated layer of soft silty clay was encountered in Test Pit No. 13 between 0.9 and 1.8m below ground surface.

5.6 FLORA

5.6.1 Overview

Terrestrial plants were selected as suitable biological descriptors for this project because they are responsible for primary production of organic matter (and availability of inorganic nutrients) in the ecosystem. Vegetation communities are usually the first biotic components to be affected by development actions, in that the spatial “footprint” of infrastructure often requires clearing of on-site communities; as such, they may be viewed as representing impact initiating points from which ecological "cascading effects" occur in the wider habitat. Even in perceptibly undisturbed areas, they are susceptible to modifications in the eco-hydrology, especially where there are localized changes in soil/groundwater regimes or deposition of sediments during fluctuations in surface water levels. Living plants are immobile, which gives them an appropriate spatial-scale for study. The typical longevity of tree species results in their important role in maintaining ecosystem structure and stability, and suggests an appropriate temporal-scale for detecting environmental changes in the surroundings of development sites.

The ecological and societal significance of tropical forests and associated ecosystems is related to their natural resource support, as they provide economic timber supplies, food sources, watershed and soil protection, critical habitat for dependent flora and fauna, and opportunities for recreation. They are also important for atmospheric resources as they recycle moisture (via evapotranspiration) and control carbon dioxide levels (via photosynthesis and soil-ecosystem processes). The quality of vegetation structure is also important to the micro-climatic environment, the life-support capacity, and the efficiency of subsidiary natural cycling processes at the understorey level, particularly soil quality maintenance (including capacity for carbon sequestration). This is of particular relevance where remnant patches of forest occur along the margins of tropical agriculture in the riparian zone.

The selection of vegetation sampling points was approached by a combination of spatial data collection for ecological scoping, literature review and preliminary site reconnaissance. This was achieved by accessing synoptic land information for the study area, primarily through the acquisition, review and interpretation of existing topographic maps, aerial photographs and other maps to assist in providing geographical focus to the vegetation surveys, in relation to the present land-use patterns (which may influence the ecological integrity of the on-site systems) as well as natural factors affecting the ecosystem type such as landforms and hydrology.

During September 2008, surveys of vegetation resources were conducted at selected (representative) locations, to assist in classifying land-cover quality at the proposed ROW and surroundings of the ROW. At each survey point, a site-walk was used to describe the vegetation communities, via visual observation (with the aid of high-resolution 7 x 42 binoculars). Representative photographs were also taken, to assist in verifying classifications and improving interpretations. Site characterizations were based on qualitative field assessments of the vegetation structure, in conjunction with taxonomic inventories of the floral species encountered at each sampling point.

The important plant species, both native and cultivated, were noted and identified in the field (in most cases). In cases of uncertainty, foliar specimens of unidentified species were sampled for identification at the National Herbarium. Based on this process, broad categories of land-use/land-cover were derived to classify the vegetation sub-units specific to the site, in a spatial/ecological sense.

The study area originally supported Evergreen Season Forest (Beard, 1946). The area was cleared for agriculture, and later largely converted to residential, commercial or industrial land use. All remaining vegetation has been subject to extensive anthropogenic modification. Using Ellis and Ramankutty's (2008) anthropogenic biome classification, the Malabar catchment would fall into the urban biome (based on a population density above 2,500 inhabitants per km^2) while the Maloney catchment would be classified in the dense settlement biome.

5.6.2 Major vegetation types

The area supports a mixture of active and abandoned cultivation and pasture, interspersed with and graduating into areas of anthropogenic savannahs, open woodlands, small forest patches (either relict patches, spontaneous regeneration or planted woodlands) and small patches of riparian woodland. Rural land-use in Trinidad forms a continuum from row-crop cultivation to uncultivated land. Agricultural crops, especially tree crops and other perennials, are often harvested from land that is not otherwise subject to cultivation. It is, therefore, of limited value to attempt to draw a hard line between cultivated and uncultivated lands. Photograph 5.1 depicts representative vegetation of the study area.

5.6.2.1 Fire savannahs

Fire-maintained grasslands are widespread in the humid tropics. Repeated cycles of fire kill understorey vegetation and increase fuel loads, leading to more severe fires in subsequent years. Common species include the grasses *Panicum maximum*, *Paspalum fasiculatum* and in places relict *Saccharum officinarum* (Sugar cane). In wetter areas such as roadside drainage ditches, *Hymenache amplexicuale* and *Leersia hexandra* are frequently present. Fire savannahs are species-poor and have limited value as habitat for native animal species. They are used as unimproved pasture for cattle and other livestock.

5.6.2.2 Tree plantations

Small areas of tree plantation are present within the study area. These include stands dominated by *Pinus caribaea* var. *hondurensis*, a non-native species that was introduced for timber production. Also present in the study area is *Acacia mangium*, another non-native tree which is used for the rehabilitation of degraded land. The presence of trees on the landscape improves the habitat quality through the provision of structural diversity and physical shelter. Beyond that, many of these species offer little benefit to wildlife.

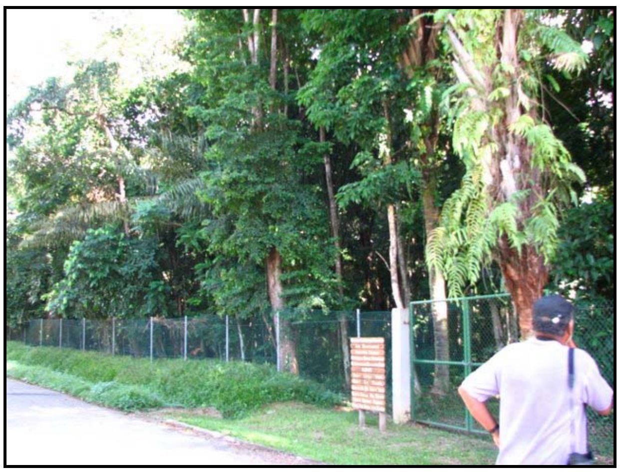
5.6.2.3 Cultivated land

As is common in Trinidad, there is a continuum between cultivated land and uncultivated land. Within the area this ranged from row-crop cultivation to scattered fruit trees in otherwise uncultivated land.

Vegetation in the Study Area

{a} Grassland south of CRH close to proposed Malabar WWTP site

{b} Agricultural activity south of CRH close to proposed Malabar WWTP site



{c} Cleaver Woods Forested Area

{d} Planted Pine Plantation (close to Caroni River)

{e} Grassland adjacent to Arima River

{f} Roadside vegetation south of CRH and close to Caroni River

Photograph 5.1: Representative Vegetation in the Study Area, Present Survey 2008

5.6.2.4 Forest patches

Small patches of heavily disturbed secondary forest and woodland persist in the area. These include patches of trees surrounded by agricultural land or fire savannah, and degraded remnants of riparian woodland. Many of the trees present in these forest patches are fast-growing early successional species such as *Cecropia peltata* or long-lived pioneers like *Hura crepitans*. When compared to their surroundings, these areas have relatively high habitat value for wildlife. They also provide connectivity across the landscape, thus facilitating the movement of animal species that may serve as pollinators and seed dispersers. Many of these species are potentially valuable food species for wildlife, most including such species as *Ficus maxima* and *Cordia collococca*.

One forested area that has greater diversity of tree species is the Cleaver Woods Park where commercial and non-commercial tree species have been planted and maintained by the Forestry Division of the MALMR. This area has several species such as *Tabebuia chrysantha* (Black Poui) *Tabebuia serratifolia* (Poui), *Clathrotropis brachypetala* (Blackheart), *Amaioua corymbosa* and *Genipa americana* (Genip).

5.7 AVIFAUNA

5.7.1 Avifauna Species Distribution and Diversity

Approximately 70% of the species recorded can be considered as open area, aggressive species that can utilise a variety of habitat types. The prevalent species included Great Kiskadee (*Pitangus sulphuratus*), Palm Tanager (*Thraupis palmarum*), Smooth-billed Ani (*Crotophaga ani*), and Tropical Kingbird (*Tyrannus melancholicus*). All of these species can be considered quite common. This group includes the common, aggressive avifaunal species that thrive in all human-derived environments and most can be found in urban and residential environments where they exploit gardens, ‘green areas’ (for fruit) and housing (where insects can be gleaned from structures).

No forest species were recorded in the survey but several species that can utilize secondary forest and cultivated areas (with trees) were observed in the study. Species such as the Rufous-breasted Wren (*Thryothorus rutilus*) and Rufous-browed Peppershrike (*Cyclarhis gujanensis*) are the more resilient members of forest communities that can survive in secondary forest and impacted areas with tree cover.

Almost all the other species can be considered as “generalists” that are able to utilize different habitats for their requirements. Generalists tend to be very aggressive species that can utilize marginal habitat.

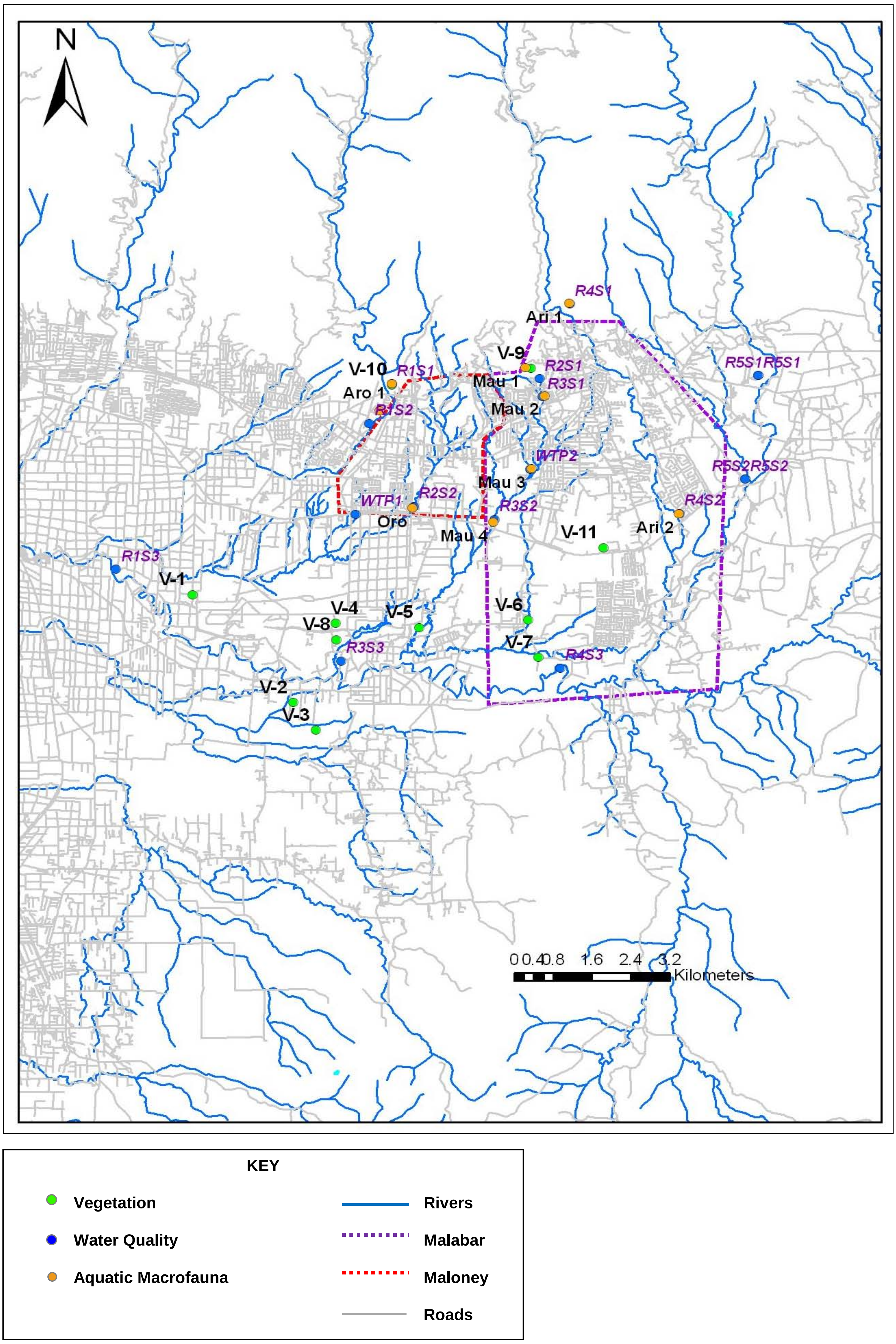


Figure 5.9: Sampling Locations – Water Quality, Vegetation and Aquatic Macrofauna.

5.7.2 Present Survey

Among the faunal components of ecosystems, avifauna has the greatest power of dispersal within and between habitats, through their ability to fly. The ability of birds to move and survive in suitable habitat is determined by internal factors such as competition between species for resources (e.g. nesting and roosting sites) and predation, and external factors such as the size of forest areas (i.e. degree of fragmentation), the ratio of 'edge' to 'interior' habitat, and the interaction with external components of ecosystems (such as predators and potential competitors that may enter different habitat types). As a result, there will be interactions of human-derived ecosystems (such as housing and agriculture) with adjacent ecotypes.

The large base of published information on avifauna for Trinidad & Tobago and northern South America makes them suitable indicators of ecosystem change. Birds have particular requirements from their environment such as food sources, roosting sites, nesting sites, nesting materials, and other elements of habitat and ecosystem support necessary during their life-cycles. Therefore, the impacts to avifauna with environmental modifications (such as increased habitat fragmentation) are determined by utilisation of the area for these purposes. For example, species with specialised requirements from habitats will potentially experience greater negative impacts with habitat change.

During the present survey, avifauna was surveyed in the project site and surrounding areas using the Point Count Method, which samples fauna within a specified distance around a pre-determined sample point. Fixed-radius Point Counts of 25 m (Hutto *et al.* 1986) and 5-minute durations were conducted throughout the study site. The point-counts were conducted during the peak hours of terrestrial bird activity (6:00 am to 9:00 am). The rationale was to ensure that a high proportion of the birds present were detected, and that variation between points as a result of heat and bird inactivity was kept to a minimum. Birds were detected and identified in the field, both visually (with the aid of high resolution 7 x 42 binoculars) and aurally (through detection of species-specific vocalisations). Point Counts were conducted in areas of mangrove and marsh that may be impacted by the proposed development. Identification of species was aided, where necessary, by consulting published field guides for Trinidad and Venezuela (Kenefick *et al*. 2007, ffrench 1991, Hilty 2003, Meyer de Schaunsee & Phelps 1978).

Table 5-5 : Avian Sampling points (UTM co-ordinates)

Point	Easting	Northing
1	679942	1171948
2	682013	1169581
3	682481	1168978
4	682892	1171316
5	684615	1171226
6	686861	1171388
7	687073	1170569
8	682901	1170960
9	686913	1176909
10	684054	1176546
11	688405	1172980
12	688295	1173005
13	686055	1175824

Avian Communities

In the general study area and its surroundings, a total of **31** avifaunal species were encountered. Vegetatively, the habitats here consisted of fire maintained savannahs (including former sugarcane plantation), tree plantations, cultivated land, lastro and small areas of secondary forest.

Some parts of the study site were under high-density human settlement. These were not surveyed for vegetation or avifauna since there was very little native vegetation in these areas, and thus avifauna was severely limited.

Table 5-6 : Avifaunal Species Encountered in Study Area

Common Name	Species Name	Habitat Occurrence	Status
Bananaquit	*Coereba flaveola*	SF, M	VC
Bare-eyed Thrush	*Turdus nudigensis*	SF, U	VC
Barred Antshrike	*Thamnophilus doliatus*	SF	C
Black Vulture	*Coragyps atratus*	C, SF	A
Blue-black Grassquit	*Volatinia jacarina*	GR	A
Blue-gray Tanager	*Thraupis episcopus*	SF, C	VC
Copper-rumped Hummingbird	*Amazilia tobaci*	SF	VC
Carib Grackle	*Quiscalus lugubris*	G, SC, U	A
Cattle Egret	*Bubulcus ibis*	GR	A
Common Black Hawk	*Buteogallus anthracinus*	W	SF
Common Ground Dove	*Columbina passerina*	GR	L
Crested Oropendola	*Psarocolius decumanus insularis*	SF	SC
Great Kiskadee	*Pitangus sulphuratus*	SF, GR, U	A
Housewren	*Troglodytes musculus albicans*	SF, U	U
Orange-winged Parrot	*Amazona amazonica*	SF	A
Palm Tanager	*Thraupis palmarum*	SF, U	A
Pied Water-Tyrant	*Fluvicola pica*	GR	C
Ruddy Ground Dove	*Columbina talpacoti*	SF, GR, U	C, W
Rufous-breasted Wren	*Thryothorus rutilus*	SF	C
Rufous-browed Peppershrike	*Cyclarhis gujanensis*	SF	C
Saffron Finch	*Siscalis flaveola*	L	GR
Shiny Cowbird	*Molothrus bonariensis*	U, GR, SC	C, W
Smooth-bill Ani	*Crotophaga ani*	GR	VC
Snowy Egret	*Egretta thula*	C	A
Southern Lapwing	*Vanellus chilensis cayennensis*	GR	A
Southern Rough-winged Swallow	*Stelgidopteryx ruficollis aequalis*	SF	A
Tropical Kingbird	*Tyrannus melancholicus*	SF, SC, GR	A
Tropical Mockingbird	*Mimus gilvus*	SF, SC, GR, U	VC
Wattled Jacana	*Jacana jacana*	GR	C, L
White-lined Tanager	*Tachyphonus rufus*	SF	VC
Yellow Oriole	*Icterus nigrogularis*	SC, U	C
Yellow-hooded Caracara	*MIlvago chimachima*	SC, GR	C
Yellow-hooded Blackbird	*Agelaius icterocephalus*	GR	VC

Key: **Avifauna Habitat Occurrence**	*Key:* **Avifauna Status**	
GR – Grassland	A – Abundant	R – Rare
SC – Scrub	C – Common	V – Visitor
SF – Secondary Forest	M - Migrant	VC – Very Common
U – Urban, residential, cultivated	NM – Northern Migrant	W – Widespread
	NV – Northern Visitor	L – Localised

Fire Savannahs

Much of the area under study consisted of fire-maintained savannahs of some sort, including abandoned sugar cane cultivation. These areas tend to attract avifaunal species specialising on seed-eating, including Blue-back Grassquit, Ruddy and Common Ground Doves, and the Saffron Finch. This last species is of localised distribution in Trinidad since it has become popular in the cage-bird trade with the decimation of the more popular species. Savannah areas such as these would once have supported song bird species such as the Large-billed Seed Finch and the Grey Seedeater but these species have been largely extirpated locally by the cage bird trade. None of these rare species were recorded during these surveys.

In some parts of the study area the savannahs were cattle pastures, here avifaunal species included Cattle Egret, Southern Lapwings. These pasture areas were often somewhat marshy in parts, leading to a few wet land species such as Pied Water-Tyrant and Wattled Jacana (Photograph 5.2) being recorded.

Open areas such as these with few trees tend to attract so called overhead species such as the Black Vulture, swallows and the Yellow-hooded Caracara.

Tree Plantations

Pine plantations in Trinidad are notorious for low species diversity (Hayes and Samad, 1998) since they have little in the way of feeding resources for most avifauna species. The patches in the study area however were very small and could have provided roosting areas for aggressive and forest-edge specialists such as Great Kiskadee, Tropical Kingbirds and Blue-gray Tanagers.

Cultivated Land/Residential

Parts of the study area were under crop cultivation or low density human settlement. In these areas aggressive species, adapted to co-existing with humans dominated, typical of there were

Bananaquit, Tanagers, Bare-eyed Thrush, Tropical Mockingbird and House Wren. Additionally frugivorous and nectar-feeding species, such as Copper-rumped Hummingbird (Photograph 5.2), Crested Oropendola, and Yellow Oriole, were common in gardens and areas with crops.

Secondary Forest Patches

Small patches of disturbed secondary forest were scattered in the study area and surroundings, many of the tree species in these patches were early successional species. While they do not support the most sensitive forest interior species of avifauna these habitats tend to attract many avifaunal species, both the more aggressive, human associated species, from surrounding residential areas, and the forest edge specialists.

Species recorded here included many of the species found in the cultivated areas as well as Barred Antshrike, Common Black Hawk, Orange-winged Parrot, Rufous-browed Peppershrike and Rufous breasted Wren.

<table>
<tr><th colspan="2">Avifauna of the Study Area</th></tr>
<tr><td></td><td></td></tr>
<tr><td>(a)Wattled Jacana adult and juvenile</td><td>(b)Copper-rumped Hummingbird</td></tr>
</table>

Photograph 5.2: Avifauna observed in Study Area

5.8 ICHTHYOFAUNA

5.8.1 Overview

The study area includes four north Caroni drainages - the Arouca, Oropuna, Mausica and Arima Rivers. All four rivers originate in the Northern Range and enter the main Caroni River. Dissolved oxygen and pH decreased moving downstream, while conductivity and temperature increased. Twenty-three fish species were recorded (Table 5-7 and Appendix IV), which amounts to 65% of the potential species pool in the Caroni system. Two species – *Poecelia reticulata* and *Aequidens pulcher* – were found at all sampling sites while *Astyanax bimaculatus* was present in seven of nine sample points. The only non-native species, *Oreochromis* sp. was a new record for the Caroni drainage.

The ichthyofaunal community was diverse. This reflects the diversity of microhabitat found within these streams and is indicative of fair stream condition, notwithstanding the obvious presence in the catchment areas of dredging, deforestation, quarry and urban runoff (grey water, sewage, offal), water extraction (for human consumption and irrigation). Notably absent species included *Corynopoma riisei* and *Hemigrammus unilineatus*, which tend to be found in very slow, turbid, soft-bottomed streams on the floodplains, habitats that were present in only one of the sampling sites. Absence of their particular habitat requirements at sampling sites also explains the absence of *Gymnotus carapo*, *Steindachnerina argentea*, *Polycentrus schomburgkii* and *Hoplosternum littorale*. However, a site on the Caroni River revealed several of the species that were notably absent from the tributaries which were *Hemigrammus unilineatus*, *Steindachnerina argentea*, and *Odontostilbe pulcher*. In addition to these species a juvenile Tarpon (or Grande E'caille) was captured in seining on the Caroni River, which was not surprising in a large river system as the juveniles of this species will travel far upstream for feeding.

Table 5-7 Aquatic Species Present in the Four Sampled Drainages

Family	Species	Arouca River	Oropuna River	Mausica River	Arima River	Caroni River
Characidae	*Astyanax bimaculatus*	x	x	x	x	x
	Hemibrycon taeniurus	x		x		
	Hemigrammus unilineatus					x
	Odontostilbe pulcher					x
	Roeboides dayi	x		x	x	x
	Steindachnerina argentea					
Erythrinidae	*Hoplias malabaricus*			x	x	
Poeciliidae	*Poecilia reticulata**	x	x	x	x	
Rivulidae	*Rivulus hartii*			x	x	
Cichlidae	*Aequidens pulcher*	x	x	x	x	
	Cichlasoma taenia	x				x
	Crenicichla frenata	x		x		
	Oreochromis sp.		x	x		

Family	Species	Arouca River	Oropuna River	Mausica River	Arima River	Caroni River
Callichthyidae	*Corydoras aeneus*	x		x	x	
Heptapteridae	*Rhamdia quelen*	x		x	x	
Loricariidae	*Ancistrus trinitatis*	x				
	Hypostomus robinii	x		x	x	
Synbranchidae	*Synbranchus marmoratus*	x				

Sample Sites for Aquatic Macrofauna

{a} Arima River (upstream site)

{b} Arima River (downstream site)

{c}Arouca River

{d}Oropuna River Upstream

Sample Sites for Aquatic Macrofauna

{e}Arouca River

{f} Small Tributary into Arima River

{g}Mausica River

{h}Oropuna River (downstream)

{i} Mausica River (downsteam site)

{j}Mausica River site (adjacent to Arima WWTP)

Sample Sites for Aquatic Macrofauna

{k} Caroni River site

{l}'Jumbie' Teta

Photograph 5.3: Sample Sites for Aquatic Macrofauna in Watercourses in Study Area - Present Survey 2008

5.9 HERPETOFAUNAL SPECIES DISTRIBUTION AND DIVERSITY

There have been few studies that look at herpetofauna (amphibians and reptiles) of Trinidad that both document species occurrence and provide distributional data (e.g., Murphy 1997, Boos 2001). The herpetofauna distribution data for Trinidad and Tobago have been compiled by Murphy (1997) based on historical and current museum collection in local and international institutions, publications by local and international authors and collections by the author over several years. At the national level this study represents coverage of the major habitat types.

During the course of biotic surveys amphibians and reptiles were recorded in the study areas. In several river sites tadpoles of the toad, *Bufo marinus* (Crapaud) were observed in areas.

5.10 NOISE

5.10.1 Applicable Standards for Ambient Noise Levels

Under the Noise Pollution Control Rules 2001, the study area falls under two zones of prescribed standards by the Environmental Management Authority. These zones are Zone III for General Areas and Zone I for Industrial areas.

5.10.1.1 Zone III – General Areas

<u>During the Day 8:00 am to 8:00 pm</u>

The sound pressure levels should not exceed the following:

- The sound pressure level when measured as equivalent continuous sound pressure level (Leq) shall not be more than 5 dBA above the background sound pressure level.
- An instantaneous unweighted peak sound pressure level (Lpeak) of 120 dBA.

Notwithstanding the above, no person shall emit or cause to be emitted any sound that causes the sound pressure level when measured as the equivalent continuous sound pressure level to exceed 80 dBA.

<u>During the night 8:00pm to 8:00 am</u>

The sound pressure levels should not exceed the following:

- The sound pressure level when measured as equivalent continuous sound pressure level shall not be more than 5 dBA above the background sound pressure level.

- An instantaneous unweighted peak sound pressure level (Lpeak) of 115 dBA.

Notwithstanding the above, no person shall emit or cause to be emitted any sound that causes the sound pressure level when measured as the equivalent continuous sound pressure level to exceed 65 dBA.

5.10.1.2 For Industrial areas-Zone 1

The sound pressure levels should not exceed the following:

- An equivalent continuous sound pressure level (Leq) of 75 dBA.
- An instantaneous unweighted peak sound pressure level (Lpeak) of 130 dBA.

5.10.2 Baseline Noise Recorded

The study area for noise is defined as the Malabar and Maloney catchments. A baseline noise monitoring exercise was carried out in accordance with the **Noise Pollution Control and Abatement Rules 2001**, and was conducted by REAL to obtain sound measurements for both day and night conditions in the residential communities that would be affected by the proposed construction and operation of the two wastewater treatment plants and sewerage works. The main parameters of interest were **LEQ average and PEAK.** Monitoring of the stated parameters was conducted at each of the following six predetermined locations and in triplicate during both day-time and night-time hours.

Baseline noise monitoring was conducted at six locations over the period 26^{th} – 28^{th} November, 2008. The locations were:

- Site 1 - Pinto Road

- Site 2 - La Chance Trace, off O'Meara Road
- Site 3 - La Florissante Phase 3, Arima Old Road
- Site 4 - Cocorite Trace, Tumpuna Road
- Site 5- Sel Duncan Avenue, La Horquetta
- Site 6 - Jacana Avenue, Maloney Housing Development

These selected sites represent the major communities in the project area of the Maloney and Malabar sub-catchments. All sites were situated just off the major roads within the catchments and subject to the influence of noise emitters such as cars and other vehicles as well as routine residential noise. No unusual events were noted at any of the monitoring locations over the duration of the monitoring period. The Maloney site was off the major road passing through the housing development (close to the Maloney Police Station) and would have received less traffic in comparison to the major road in the Maloney area.

The results obtained showed small variations between night-time and day-time noise in areas in the different communities. Noise levels recorded were all within the stipulated limits for Zone III as defined in the Noise Pollution Rules, 2001. The O'Meara Road site had the highest LEQ Average and PEAK of all locations monitored for both night-time and day-time. This was not unexpected since the O'Meara Road location is adjacent to the O'Meara Industrial Estate and the background noise from this industrial site may have been a significant influence at Site 2. However, it must be pointed out that while higher levels of noise were recorded in comparison to the other sites, the levels obtained are still within the ranges specified for General/Residential Areas (Zone 3) specified by the EMA. On the other end of the spectrum, the lowest noise levels for both night-time and day-time were recorded at Site 3 (Arima Old Road).

Table 5-8 Ambient Noise Monitoring Results

Site Code	Location & GPS Coordinates	Date	Time	SPL Recorded		Computed Night-Time Noise[3]		Computed Day-Time Noise[4]	
				L_{eq}	L_{peak}	Ave L_{eq}	L_{Peak}	Ave L_{eq}	L_{Peak}
Site 1	Pinto Road N 10° 37.038' W 61° 15.880'	Nov 27th 2008	0030 - 0100	46.0	86.6	52.8	94.7	64.2	101.3
			0115 - 0145	54.7	102.4				
			0200 - 0230	57.6	95.2				
			0830 – 0900	64.3	102.6				
			0915 – 0945	69.3	102.5				
			1000 - 1030	59.1	98.7				
Site 2	O'Meara Road N 10° 37.615' W 61° 17.345'	Nov 27th 2008	0300 - 0330	63.2	96.9	63.8	102.6	64.5	111.2
			0345 - 0415	63.7	102.2				
			0430 - 0500	64.5	108.6				
			1130 – 1200	64.3	109.3				
			1215 – 1245	64.6	111.5				
			1300 - 1330	64.6	112.8				

[3] SPL recorded between the hours of 8pm and 8am used in computation of night-time noise

[4] SPL recorded between the hours of 8am and 8pm used in computation of day-time noise

Table 5-9 Ambient Noise Monitoring Results

Site Code	Location & GPS Coordinates	Date	Time	SPL Recorded		Computed Night-Time Noise[5]		Computed Day-Time Noise[6]	
				L_{eq}	L_{peak}	Ave L_{eq}	L_{Peak}	Ave L_{eq}	L_{Peak}
Site 3	Arima Old Road N 10° 38.178' W 61° 19.120'	Nov 26th 2008	2215 - 2245	49.1	102.3	50.0	90.3	52.4	88.7
			2300 - 2330	49.6	96.3				
			2315 - 2345	51.2	72.4				
		Nov 27th 2008	1400 – 1430	53.1	98.0				
			1445 – 1515	52.5	85.4				
			1530 - 1600	51.7	82.8				
Site 4	Tumpuna Road N 10° 36.879' W 61° 16.344'	Nov 27th 2008	2130 – 2200	53.5	88.0	53.0	90.3	53.9	97.8
			2215 – 2245	53.4	91.5				
			2300 - 2330	52.0	91.4				
		Nov 28th 2008	1000 – 1030	54.1	96.3				
			1045 – 1115	53.7	102.7				
			1130 – 1200	53.9	94.4				
Site 5	La Horquetta N 10° 35.809' W 61° 16.662'	Nov 28th 2008	0000 – 0030	56.3	87.2	55.5	92.7	57.9	101.9
			0045 – 0115	53.5	88.0				
			0130 – 0200	56.8	102.8				
			1300 – 1330	56.7	99.9				
			1345 – 1415	58.3	102.8				
			1430 – 1500	58.6	103.0				

[5] SPL recorded between the hours of 8pm and 8am used in computation of night-time noise

[6] SPL recorded between the hours of 8am and 8pm used in computation of day-time noise

Site 6	Maloney N 10° 36.888' W 61° 19.210'	Nov 28th 2008	0230 – 0300	60.4	96.4	60.8	101.6	61.7	106.2
			0315 – 0345	60.6	103.6				
			0400 – 0430	61.4	104.9				
			1530 – 1600	61.3	105.9				
			1615-1645	61.7	107.1				
			1700 - 1730	62.0	105.5				
Noise Pollution Rules, 2001 – Standards – Zone III						5 dBA above background or no more than 65 dBA	115 dB	5 dBA above background or no more than 80 dBA	120 dB

5.11 AMBIENT AIR QUALITY

The study area for ambient air quality is defined as the two catchments of Malabar and Maloney. The major environmental parameters considered for monitoring were:

- Particulate Matter (PM_{10})
- Total Suspended Particulates (TSP)

Monitoring of the stated parameters was conducted at each of the six predetermined locations (which were at the same locations for the noise monitoring) over a 24 hour period. Six Minivol instruments were used, three for each parameter under study. Three locations were monitored at a time, spanning a period of two consecutive days. Results for the ambient air quality monitoring performed are presented in Table 5-10 below.

All locations monitored showed particulate matter concentrations, in both the TSP and PM10 fractions, well below applicable standards. The lowest PM10 and TSP concentrations were noted at the O'Meara Road site while the highest concentrations of both TSP and PM10 were recorded at the La Horquetta site. The source of particulate matter at all locations can attributed to re-suspension of road side dust and its dispersion by wind during the course of a normal twenty-four hour period. No stationary sources of emission of particulate matter were observed in any of the locations monitored.

Table 5-10 Data Summary for Ambient Air Quality Monitoring Study, conducted for WASA Maloney/Malabar Project

Site	Date Sampled	Location	Particulate Matter Concentration (ug/m^3)	
			PM_{10}	TSP
1	Nov 27th 2008	Pinto Road N 10° 37.038' W 61° 15.880'	19	35
2	Nov 27th 2008	O'Meara Road N 10° 37.615' W 61° 17.345'	7	8
3	Nov 27th 2008	Arima Old Road N 10° 38.178' W 61° 19.120'	26	28
4	Nov 28th 2009	Tumpuna Road N 10° 36.879' W 61° 16.344'	17	24
5	Nov 28th 2009	La Horquetta N 10° 35.809' W 61° 16.662'	35	79
6	Nov 28th 2009	Maloney N 10° 36.888' W 61° 19.210'	35	58
Draft APR09			75	150
WHO Guidelines			N/A	120

5.12 WATER QUALITY

Riverine water sampling was conducted on 30th June, 2008, and 7th July, 2008. Thirteen riverine sample sites and two WWTP effluent samples were taken (See Figure 5.7). The rivers sampled included the Arouca, Oropuna, Mausica, Arima, Guanapo and Caroni Rivers. Sampling locations on each river were established, wherever practical, at an upstream location at the start of the catchment, midway along the watercourse and at a downstream location just before the rivers merge or enter the Caroni River. The Maloney and Arima WWTP effluent was also sampled. These effluents are discharged to the Mausica and Arima Rivers respectively and thus the downstream monitoring points of these two rivers would be affected by the presence of these two effluent streams in the water column. The results from the field measurements and laboratory analyses are presented in Table 5-11 to Table 5-16 below. Photograph 5.4 depicts sample sites at water courses within the study area.

All analyses were performed in accordance with the relevant test methods set out in the Standard Methods for the Examination of Water and Wastewater and results obtained compared against the permissible limits stipulated for inland watercourses in the Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006). Samples that were perishable (BOD_5 and Bacteria) were performed by a local laboratory (EcoTox Limited) while the majority of tests were conducted either in-situ or at an accredited laboratory in Mississauga, Canada (ENTECH Labs Inc.).

Standard test procedures were followed for all analyses conducted with several quality control measures implemented for each parameter investigated. Replicate analyses were done for all samples. Blanks, spikes and standard reference materials were included during tests to validate the accuracy and precision of the analytical results obtained.

Table 5-11 Analyses of River Water Samples from Arouca River

Parameter mg/L	R1S1	R1S2	R1S3*	WPR01 1st Schedule[7]
Total Suspended Solids (TSS)	5.0	4.0	13.0	15
Biological Oxygen Demand (5-Day)	11.0	10.0	12.0	10
Chemical Oxygen Demand (COD)	113.27	57.50	108.25	60
Total Sulphates	125.2	98.4	121.5	No Limit
Total Oil and Grease (TO&G)	1.16	0.59	<0.10	10
Available Phosphorous	0.91	1.02	0.62	No Limit
Total Phosphorous	1.52	1.29	1.40	0.1
Nitrite (NO_2-N)	1.4	3.2	4.9	No Limit
Nitrate (NO_3-N)	2.9	2.1	11.8	No Limit
Ammoniacal Nitrogen (NH_3-N)	1.6	4.1	3.6	0.01
Total Coliform MPN/100mls	≥1600.0	≥1600.0	9000.0	No Limit
Total Faecal Coliform MPN/100mls	≥1600.0	≥1600.0	700.0	100

* NB: The most accessible point where the river enters the Caroni River

[7] The First Schedule of the Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006) defines the maximum allowable concentration of a specified parameter that can be found or discharged into a riverine system without it being considered a pollutant. This limit is used in the context of the evaluation of the water quality results obtained from the field surveys to determined whether a riverine system is polluted or not by a specified parameter.

Table 5-12 Analyses of River Water Samples from Oropuna

Parameter mg/L	R2S1	R2S2	WPR06 1st Schedule
Total Suspended Solids (TSS)	18.5	154.0	15
Biological Oxygen Demand (5-Day)	12.0	9.0	10
Chemical Oxygen Demand (COD)	22.88	59.42	60
Total Sulphates	108.9	77.6	No Limit
Total Oil and Grease (TO&G)	0.12	9.80	10
Available Phosphorous	1.22	1.04	No Limit
Total Phosphorous	2.14	3.01	0.1
Nitrite (NO_2-N)	2.1	1.8	No Limit
Nitrate (NO_3-N)	3.2	2.4	No Limit
Ammoniacal Nitrogen (NH_3-N)	2.1	3.8	0.01
Total Coliform MPN/100mls	≥1600.0	≥1600.0	No Limit
Total Faecal Coliform MPN/100mls	≥1600.0	≥1600.0	100

Table 5-13 Analyses of River Water Samples from Mausica

Parameter mg/L	R3S1	R3S2	R3S3*	WPR06 1st Schedule
Total Suspended Solids (TSS)	17.00	238.50	51.0	15
Biological Oxygen Demand (5-Day)	9.0	21.0	10.0	10
Chemical Oxygen Demand (COD)	15.58	714.23	182.03	60
Total Sulphates	117.0	102.8	107.9	No Limit
Total Oil and Grease (TO&G)	0.73	34.78	1.34	10
Available Phosphorous	0.80	3.92	1.44	No Limit
Total Phosphorous	1.50	6.22	3.10	0.1
Nitrite (NO_2-N)	1.6	8.4	6.4	No Limit
Nitrate (NO_3-N)	1.9	11.6	13.3	No Limit
Ammoniacal Nitrogen (NH_3-N)	1.9	0.9	4.9	0.01
Total Coliform MPN/100mls	≥1600.0	≥1600.0	≥1600.0	No Limit
Total Faecal Coliform MPN/100mls	≥1600.0	≥1600.0	2200.0	100

* NB: The most accessible point where the river enters the Caroni River

Table 5-14 Analyses of River Water Samples from Arima

Parameter mg/L	R4S1	R4S2	R4S3*	WPR06 1st Schedule
Total Suspended Solids (TSS)	3.0	3.0	29.0	15
Biological Oxygen Demand (5-Day)	12.0	11.0	11.0	10
Chemical Oxygen Demand (COD)	28.52	31.51	42.00	60
Total Sulphates	117.6	111.7	95.4	No Limit
Total Oil and Grease (TO&G)	0.74	0.60	1.30	10
Available Phosphorous	0.85	2.1	0.85	No Limit
Total Phosphorous	1.74	3.18	1.74	0.1
Nitrite (NO_2-N)	2.8	0.8	3.8	No Limit
Nitrate (NO_3-N)	2.4	1.4	11.1	No Limit
Ammoniacal Nitrogen (NH_3-N)	1.9	1.9	3.8	0.01
Total Coliform MPN/100mls	≥1600.0	≥1600.0	3500.0	No Limit
Total Faecal Coliform MPN/100mls	900.0	≥1600.0	900.0	100

* NB: The most accessible point where the river enters the Caroni River

Table 5-15 Analyses of River Water Samples from Guanapo

Parameter mg/L	R5S1	R5S2	WPR06 1st Schedule
Total Suspended Solids (TSS)	4.0	18.00	15
Biological Oxygen Demand (5-Day)	11.0	9.0	10
Chemical Oxygen Demand (COD)	36.20	85.62	60
Total Sulphates	204.5	88.3	No Limit
Total Oil and Grease (TO&G)	0.39	25.41	10
Available Phosphorous	0.66	1.80	No Limit
Total Phosphorous	2.04	3.85	0.1
Nitrite (NO_2-N)	1.1	1.1	No Limit
Nitrate (NO_3-N)	1.8	2.9	No Limit
Ammoniacal Nitrogen (NH_3-N)	1.8	2.1	0.01
Total Coliform MPN/100mls	≥1600.0	≥1600.0	No Limit
Total Faecal Coliform MPN/100mls	1600.0	≥1600.0	100

Table 5-16 Analyses of Wastewater Treatment Plant Effluents

Parameter mg/L	WTP01 Maloney	WTP02 Arima	WPR06 2nd Schedule [8]
Total Suspended Solids (TSS)	105.50	51.50	50
Biological Oxygen Demand (5-Day)	36.0	28.0	30
Chemical Oxygen Demand (COD)	187.31	32.31	250
Total Sulphates	75.1	88.2	No Limit
Total Oil and Grease (TO&G)	37.36	3.93	10
Available Phosphorous	6.91	11.06	No Limit
Total Phosphorous	10.20	15.85	5
Nitrite (NO_2-N)	16.4	20.4	No Limit
Nitrate (NO_3-N)	22.6	31.4	No Limit
Ammoniacal Nitrogen (NH_3-N)	32.8	26.1	10
Total Coliform MPN/100mls	≥1600.0	≥1600.0	No Limit
Total Faecal Coliform MPN/100mls	≥1600.0	≥1600.0	400

[8] The effluent from the WWTps are defined of end of pipe discharges and are thus compared with the permissible levels for the release of contaminants from point source discharges as prescribed in the Second Schedule of the Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006). Note that the comparison is made with the levels prescribed for inland surface water.

All methods were derived from Standard Methods for the Examination of Water and Wastewater, 20th Edition. The relative standard deviation (RSD) was less than 10.0 % for all analyses conducted and demonstrates that excellent precision was achieved. Standard reference materials and spiked solutions were used with 90 –100% recovery obtained during testing.

The results from the water quality survey show elevated levels of the nutrients (Total Phosphorus, Available Nitrite, Available Nitrate and Ammonia) which were not unexpected in urban catchments where much of the 'grey water' and surface drains are routed to nearby river systems. The elevated nutrients levels in the areas sampled will often lead to low levels of dissolved oxygen but due to the nature of Northern Range streams, mixing of air and water in riffle areas will maintain levels of dissolved oxygen to maintain aquatic life. There were very high levels of Total Coliforms and Total Faecal Coliforms at all sites which can only suggest that raw sewage is entering these systems. The Caroni River site (with R1S3 and R3S3 upstream and R4S3 downstream of the Caroni Arena Water Treatment Plant raw water intake) had lower levels of coliforms, which may be attributed to a dilution factor of fewer urban tributaries upstream of the sample sites.

A metal scan of the Caroni River sites performed by ENTECH (a Division of Agri-Services Lab Inc.) showed elevated levels of Aluminium, Iron, Manganese and Zinc at the sites in comparison to the statistically expected values. (Table 5-17). The method of sample analysis used was Inductively Coupled Plasma (ICP) Spectroscopy and this produced a metal scan of some fifteen elements. The results are presented in comparison with the permissible limits which define a water pollutants as prescribed by the First Schedule of the Water Pollution Rules, 2001 (as amended by the Water Pollution Rules, 2006). The results show that the Caroni River sites are contaminated with Zinc (and in one case Vanadium) at concentrations that define this element as a pollutant but is not contaminated with any other trace metal. The presence of Zinc in riverine water is most likely due to the abundant use of zinc sheeting as roofing material in Trinidad and

Tobago and the leaching of zinc from this sheeting by rainfall which eventually ends up in the river systems in the country.

Table 5-17 Metal Scan Analysis of Water at Caroni River Sites

Parameter	MDL µg/L	WPR, 2006 Permissible Limits (First schedule)	CONTROL SAMPLE		Recovery %	SAMPLE DATA (µg/L)			
			Expected µg/L	Found µg/L		Blank	R1-S3	R3-S3	R4-S3
Aluminium	50	None Declared	954	970	102	<50	381	938	2235
Antimony	0.5	None Declared	28.0	27.0	96	<0.5	<0.5	<0.5	<0.5
Arsenic	0.5	10 ug/L	258	253	98	<0.5	<0.5	1.0	1.8
Cadmium	0.5	10 ug/L	20.6	21.0	102	<0.5	<0.5	<0.5	<0.5
Chromium	5.0	100 ug/L	62.0	67.0	108	<5	<5	<5	5.4
Cobalt	0.5	None Declared	150	158	105	<0.5	<0.5	1.2	4.3
Copper	1.0	10 ug/L	995	1011	102	<1	3.0	4.2	9.3
Iron	50	None Declared	633	653	103	<50	1289	4378	9848
Lead	1.0	50 ug/L	70.4	71.0	101	<1	2.1	2.0	4.7
Mercury	0.02	5 ug/L	4.49	4.18	93	<0.02	0.06	0.06	0.06
Nickel	10	500 ug/L	400	401	100	<10	<10	<10	<10
Selenium	0.5	None Declared	19.0	18.8	99	<0.5	<0.5	0.5	<0.5
Silver	1.2	None Declared	67.6	61.0	90	<1.2	<1.2	<1.2	<1.2
Vanadium	5.0	None Declared	333	355	107	<5	<5	<5	9
Zinc	10	100 ug/L	1840	1902	103	<10	10	17	31

Sample sites for water quality in Study Area - Present Survey 2008

{a} R1S1 Arouca River (upstream site)

{b} R2S1 Oropuna River (upstream site)

{c} R4S1 Arima River (upstream site)

{d}R5S1 Guanapo River (upstream site)

{e}R5S2 Guanapo River (downstream site)

{f}R4S2 Arima River (downstream site)

Sample sites for water quality in Study Area - Present Survey 2008

{g}R3S2 Mausica River (downstream site)

{h}R2S2 Oropuna River (downstream site)

{i} WTP1 Maloney WWTP

{j}WTP2 Arima WWTP (effluent into Mausica River)

{k} R3S1 Mausica River (upstream site)

{l}R1S2 Arouca River (downstream site)

Sample sites for water quality in Study Area - Present Survey 2008

{m} R4S3 Caroni River (downstream of Arima and Guanapo confluence with main river)

{n} R3S3 Caroni River (downstream of Mausica confluence with main river)

{o} R1S3 Caroni River (downstream of Arouca River confluence and Caroni Arena Water Treatment Plant raw water intake)

{p} YSI Sonde at Arouca River (R1S2)

Photograph 5.4: Water Quality Sample Sites in water courses in Study Area - Present Survey 2008

5.13 BASELINE DESCRIPTION OF THE SOCIO-ECONOMIC ENVIRONMENT

This section provides a description, as well as an assessment of the socio-economic and human environment in the Malabar Catchment Area and Maloney Catchment Area by carefully examining three main areas. These include the demographic conditions, the prevailing socio-economic conditions such as education, employment and health as well as some cultural aspirations of the community. Information is summarised in the following section. The entire report which discusses the potential impact so the human and socio-economic environment is presented in Appendix II.

5.13.1 Objectives

For the purpose of this Social Impact Assessment (SIA) the objectives were as follows:

- Description of the socio-economic and human environments of the study area.
- Assessment of the potential impacts of the project activities – pre construction and construction - on the human environments.
- Development of a Management Plan and Monitoring Plan.

5.13.2 Methodology

The specific activities of the SIA were as follows:

Activity 1: Collection of data and information to describe the human and socio-economic resources that may be affected by the establishment of the Wastewater Treatment Plants and associated works in Malabar and Maloney Catchment Areas.

- Task 1: Review of all available information for the study area
- Task 2: Identification of data gaps

Activity 2: Identification and assessment of likely impacts.

- Task 1: Identification and assessment of the likely impacts during each of the project phases (e.g. pre-construction, construction, operational phase).

Activity 3: Stakeholder participation.

- Task 1: Identification of stakeholder groups and key issues
- Task 2: Organization and facilitation of flow of information between WASA, REAL (2003) and identified stakeholders (meetings, public consultations).

Activity 4: Development of Management Plan and Monitoring Plan.

- Task 1: Identification of mitigation measures
- Task 2: Identification of parameters to be monitored, frequency of monitoring and reporting procedures.

Both quantitative and qualitative approaches were used to gather information. The study also utilized both primary and secondary methods of data collection. Public Consultations, both qualitative and participatory, were also used as a means of getting qualitative feedback from residents about their attitudes, expectations and also concerns on the project. This helped in shaping the final product of the Environmental Impact Assessment (EIA).

LIMITATIONS

A number of limitations were encountered in gathering information for the SIA. Firstly, some of the primary data, from the Central Statistical Office (CSO) were outdated since full censuses are conducted only every 10 years and the next census is scheduled for the year 2010. Therefore information on communities or developments which were established after the 2000 Census would not have been available.

In addition to the information being outdated in some of the reports, some of the CSO reports were also unadjusted for non-responses and undercount. A total of 89.8% of all households responded to the census. In some cases a tabulated population was used to inform the SIA study.

The study area is comprised of over thirteen communities, however some information specific to the individual communities was unavailable. In order to overcome this deficiency, information for the entire administrative areas of Arima Borough and Tunapuna/Piarco Region of which the communities in the study area are a part, was utilized. It must be taken into consideration however, that although communities in that same administrative area share commonalities, they are not always homogenous. The differences that may exist among them may be significant enough to set them apart from each other.

The use of the household surveys was one way of overcoming some of the limitations mentioned above. However the interviewers experienced some issues of safety and security. Security was provided by EarthTech AECOM to accompany the interviewers into the communities in order to conduct the household survey efficiently.

In spite of the challenges encountered, with the use of both a quantitative and qualitative approach, as well as the primary and secondary methods of data collection, sufficient information was collected to sufficiently inform the SIA and the EIA.

5.13.3 Location of the Study Area

The study area for this report is comprised of the communities in the catchment areas of Malabar and Maloney. These communities are located mainly in the Borough of Arima with a few situated in the Tunapuna/Piarco Region. Information was gathered for the individual communities in the study area, and in instances in which information specific to the communities was not available, information for the administrative area of Arima Borough and the Regional Corporation of Tunapuna/Piarco as a whole was used.

The Malabar Catchment comprises the Borough of Arima and surrounding developments. The total area is approximately 2766 ha and the Malabar facility will be sited on 11.06 ha of land. The Malabar Catchment contains several developments to the west, east and south of Arima. Some of the main developments include La Horquetta, Greenvale, Santa Rosa East/West, Riverwood and Cleaver Heights. There are also several industries within the project area including the O'Meara Industrial Park and a variety of small to medium sized commercial businesses. The catchment area contains institutional facilities such as the University of Trinidad and Tobago (UTT), the Arima Regional Hospital and several government schools.

The Maloney Catchment area, which comprises an area of 1069 ha, is located north of the Churchill Roosevelt Highway and the facility for this area will require 3.6 ha of land.

5.13.4 Land Use

Within the Maloney and Malabar Sub-catchments the dominant land use is that of residential development. Within this dense residential area is the O'Meara Industrial Estate where mainly light industrial activities and warehousing are situated. South of the Churchill Roosevelt Highway and north of the Caroni River are areas of agricultural activity. These areas of agriculture can be accessed from the Mausica and Tumpuna Roads (south of the Churchill Roosevelt Highway) and are a mixture of Government leases and agricultural activities on 'vacant' land. Just south of the Maloney Housing area is a large tract of contiguous agricultural lands which are under Government leases. This area has a well-established network of agricultural roads and is actively farmed with a variety of short-term crops. Further south, most of the lands adjacent to the Caroni River in close proximity to the older Piarco Arirport was under sugar-cane production with abandoned sugar-cane still present on these lands (but not actively managed).

5.13.5 Roads

The Maloney and Malabar Sub-catchments are within a dense area of residential development with a well-developed road network. The area lies within and around the two major roads for the East West Corridor: the Churchill Roosevelt Highway and the Eastern Main Road (with both in and East-West direction). There is a well-defined series of paved secondary roads that are important routes within the area such as Maloney, Mausica, O'Meara, Tumpuna, Pinto Roads (running north to south and connecting the Churchill Roosevelt Highway and Eastern Main Road) and the Arima Old Road (running East-West and situated north of the Eastern Main Road). Within most of the urban areas are tertiary roads that service these areas of dense housing. The major secondary roads of the project area run south of the Churchill Roosevelt Highway and have tertiary roads running from them, leading to smaller rural communities or agricultural roads (where Government leased agricultural lands are present). The one exception to this trend is the La Horquetta Development (a dense residential development) which is situated west of the Tumpuna Road (south of the Churchill Roosevelt Highway) and part of the Malabar catchment.

5.13.6 Recreational Activities/Facilities

Within the Malabar and Maloney catchments are several national recreational and sporting facilities. The Maloney Cultural and Sporting Complex has one of the community basketball courts currently used for games in the national basketball competition. The Larry Gomes Stadium and the Arima Velodrome are two of the larger stadia infrastructure for Trinidad, with the former predominantly dedicated to football (for Colleges', Super League and Professional matches) and the latter to cricket games (at the club level). Just south of the Churchill Roosevelt Highway is the Santa Rosa Racing Track, the only active horse-racing track, where horse-racing events in Trinidad (and Tobago) have been centralised since the 1990's.

The combined area of the two sub-catchments are resident to just under twenty Steel Pan 'sides' or groups. These Pan 'sides' are an important aspect of recreation in the area, with activities concentrated around the annual National Carnival celebrations and Arima Borough Celebrations (where activities normally associated with Carnival abound). These Pan 'sides' are classed as 'Traditional' or 'Conventional' with the latter containing the larger better known bands such as Arima Angel Harps (Medium band Finalist in the National Panorama Finals 2008) and Arima All Stars (Finalists in the 2005 PanTrinbago 'Pan in the 21st Century' and 'Pan down Memory Lane' Competition).

5.13.7 Public Buildings and other Institutions

Many of management of Local Government functions are conducted by the Arima Borough Council, which is based at the Arima Town Hall. The present Town Hall, situated on Sorzano Street, was built in 1949. Housed within it is the office of the Mayor and on the second floor the meeting chamber of the Arima Borough Council. On the last Thursday of every month, at 1:30pm, the Council holds its Statutory Meeting which is open to attendance by the members of the public.

Arima is one of the Judicial Districts (of 12 such Judicial Districts in Trinidad) and has a Magistrates' Court that has daily sittings. Areas of the Project area which fall under the jurisdiction of the Tunapuna-Piarco Regional Corporation are serviced by the Tunapuna Magistrates' Court (another Judicial District) housed in Tunapuna-Piarco Administrative Complex with the Tunapuna-Piarco Regional Authority Headquarters adjacent to the Administrative Complex.

5.13.8 Population Demographics

The population demographics for the area of study are defined in terms of catchments. It is comprised of communities in the main catchment areas of Malabar and Maloney. The Malabar Catchment area is comprised mainly of the Arima Borough, which according to the 2000 Housing and Population Census (Community Register) has a population of 32,278. Other communities and development that are part of the Malabar Catchment belong to the Regional Corporation of Tunapuna/Piarco, which according to the 2000 Housing and Population Census (Community Register) Census has a total population of 203,975. However, approximately

24.1% of the population in this Tunapuna/Piarco Region belong to the area of study i.e. approximately 49,244 persons.

5.13.8.1 General Description

The communities examined for this report comprise the communities in the catchment and subcatchment areas and surrounding communities. They include Calvary Hill, Mausica/Olton Road, Cleaver Road/Andrews Lane, Lower O'Meara Road, Arima Proper, Mt. Pleasant/Maturita, Upper Pinto Road/Gills View, Upper Malabar/Tumpuna Road, Upper O'Meara Road, Santa Rosa East/West, Malabar, Peytonville/Carapo, La Horquetta/Greenvale, and Maloney (Maloney Gardens). In instances where information for the individual communities was not available, information for the Arima Borough as a whole or data regarding the Tunapuna/Piarco Region was used.

5.13.8.2 Age Distribution[9]

An examination of the data shows that the study areas which belong to Arima Borough and the Tunapuna/Piarco Region have a predominantly juvenile (young) population, with the largest group of persons belonging to the age group 15-29. This pattern is consistent in the Arima Borough, the Tunapuna Region and on a national level.

5.13.8.3 Ethnicity

Trinidad and Tobago is predominantly composed of Indians (40.0%), closely followed by Africans (37.5%) and the 'Mixed' population (20.5%). There is also a number of other groups, however they are in the minority. Within the Arima Borough, the pattern of ethnic groups is not reflective of the national composition. Instead, the 'Mixed' population (45.6%) comprises the largest group in the area followed by African (34.8%), while Indian comprises 17.9%. In the Tunapuna/Piarco Region, there is also a shift from the national pattern. The largest ethnic group

[9] CSO defines gender as males and females

comprises African (37.1%), followed by the Indian (35.3%) and then the 'Mixed' population (25.5%).

5.13.8.4 Religion

Roman Catholics comprise the dominant group in both the Arima Borough (50.0%) and the Tunapuna/Piarco Region (31.9%). Pentecostals (9.3%) comprise the second largest group in the Arima Borough followed by Anglicans (6.1%). Within the Tunapuna/Piarco Region, the second largest religious group was composed of Hindus (Sanatanists/Other) (20.2%) followed by Anglicans (8.3%) and Pentecostals (7.8%).

5.14 SOCIO – ECONOMIC INDICATORS

This section examines the socio-economic conditions that prevail in the Borough of Arima and Tunapuna/Piarco Region, by looking at the quality of social capital that it possesses: education, housing conditions, employment, income, health, poverty and crime. It is important to reiterate that the study area is made up of the Malabar Catchment Area and Maloney Catchment Area, which are geographically located in the Arima Borough and some areas in the Tunapuna/Piarco Region.

5.14.1 Education:

Arima Borough

With reference to education, statistics for the year 2000 show that in the administrative area of Arima Borough, out of a figure of 28,260 responses, 30.4% of the persons who responded were attending school. This included nursery schools (8.4%), primary schools (42.8%), secondary schools (32.5%), trade/vocational (1.5%), University (2.9%) and several others. Most of the students were full-time (88.2%).

In terms of 'highest level of education', the majority of the respondents within that area had attained a secondary level of education (48.3%), while (36.2%) of the respondents had only attained primary level. A few of the respondents had attained tertiary/university level of education (4.0%).

Tunapuna/Piarco Region

Similar patterns to those found in the Borough of Arima also existed in the Tunapuna/Piarco region. Out of 170,625 respondents, 30.2% in the Tunapuna/Piarco Region were attending school. In the Tunapuna/Piarco region, the number of persons attending school full-time was similar to Arima Borough (88.3%). The type of schools that the respondents were attending ranged from Nursery (7.2%), Primary (43.0%), Secondary (31.9%), and University/tertiary (5.0%).

5.14.2 Economic Activity

Arima Borough

The majority of persons in the Arima Borough who received some form of secondary education but were not successful in examinations were still able to find jobs. In spite of the low level of educational achievement, 53.5% of the respondents had a job for the 'past week' i.e. the week before the census. In relation to individuals who had jobs for the past 12 months, the figure was very close to that of the 'past week' (52.9%).

Tunapuna/Piarco Region

Within the Tunapuna/Piarco Region, responses showed that out of 128,442 individuals, 54.7% had a job in the week prior to the census (past week), even though 1.9% of those individuals who had a job did not work. Some individuals who did not have jobs, were seeking employment (3.6%). A significant number of the population however, (40.7%) who did not have a job were not looking for one and the reasons for this varied. Many were at school, some others were retired, disabled, pensioners, temporarily ill, awaiting results, claimed there were no vacancies, discouraged or just did not want to work. With respect to economic activity during the past 12 months' statistical data, 53.7% out of a response of 128,442 worked.

5.14.3 Employment and Occupations

The Arima Borough and the Tunapuna/Piarco Region share a similar pattern in terms of the occupational grouping of individuals within the two areas. The main type of employment that exists in both areas is elementary. In the Arima Borough, 17.1% of the individuals are worked in an elementary position, and 17.9% of the individuals from Tunapuna/Piarco were involved in the same area of occupation. Service and sales were the second highest occupational grouping that in which individuals from both Arima Borough (16.4%) and Tunapuna/Piarco (15.0%) were employed. In both areas these were followed by occupational groupings such as Craft and Related jobs, Clerical and Technicians. The minor areas of occupation in both areas are Agriculture, Professional, and Legislators.

Table 5-18 Occupational Groupd - Arima Borough and Tunapuna/Piarco (2000)

Occupation (2000)	Arima Borough (%)	Tunapuna/Piarco (%)
Legislator	7.4	7.2
Professionals	6.0	5.5
Technicians	11.1	11.3
Clinical	13.9	13.6
Service & Sales	16.4	15.0
Agriculture	0.8	2.6
Craft & Related	15.2	14.3
Plant & Machinery Operators	8.8	8.0
Elementary	17.1	17.9
Not Stated	3.3	4.6

Source: CSO 2000. 2000 Population and Housing Census

5.14.4 Employment and Industry

In Trinidad and Tobago, the largest proportion of workers, (65.4%) are employed in the service sectors/industry and this pattern is reflected in the Arima Borough and Tunapuna/ Piarco Region. Approximately 66.6% of the individuals in the Arima Borough are employed in the service industry, while approximately 66.0% of individuals in the Tunapuna/Piarco Region are also employed in the service sector. The minority of individuals in both areas were employed in industry sectors such as sugar, mining and quarrying, petroleum refining, electricity and water, textile and apparel.

Table 5-19 Persons Employed by Industrial Group/Sector - Arima Borough and Tunapuna/Piarco Region (2000)

Industry/Sector	Arima Borough Region - 100%	Tunapuna/Piarco Region -100%
Sugar	-	0.1
Other Agriculture	1.8	4.0
Petroleum and Gas	0.3	0.3
Other Mining & Quarrying	0.3	0.1
Sugar Refining	0.0	0.2
Petroleum Refining	0.1	0.1
Food and Beverages	5.8	4.9
Textiles and Apparel	0.9	0.9
Other Manufacturing	8.0	6.7
Electricity and Water	2.1	1.5
Construction	9.5	8.8
Wholesale and Retail Trade	17.4	18.0
Transport Storage & Communication	7.9	7.8
Finance, Insurance, Real Estate & Business	8.2	9.2
Community, social & personal services	33.1	31.0
Not Stated	4.6	6.4

Source: Central Statistical Office (CSO) 2000

5.14.5 Income and Distribution

Statistics for the Arima Borough and Tunapuna/Piarco Region for the year 2000 indicate that a significant number of the individuals within both areas, who had jobs and worked, earned low wages. In Arima Borough, 16.1% of the individuals earned on average $500 or less per month. This is also reflected in Tunapuna/Piarco where 13.1% earned on average $500 or less per month. The majority of persons who worked, earned an average monthly salary ranging between $2,000 -$2,999 in both Arima Borough (22.7%) and Tunapuna/Piarco (22.3%).

In considering these income figures it is important to remember that they are not only based on data that was collected in 2000, but also that respondents may not have divulged the full extent of their income due to concerns over confidentiality and security.

Table 5-20 Income Group/Distribution (%) - Arima Borough and Tunapuna/Piarco Region (2000)

Income Group/Range (TT$/month)	Arima Borough (%)	Tunapuna/Piarco Region (%)
> 500	16.1	13.1
500-999	7.7	7.9
1000-1999	22.7	22.3
2000-2999	17.0	15.4
3000-3999	7.4	5.6
4000-4999	8.5	8.5
5000-5999	3.0	2.3
6000-6999	2.7	3.0
7000+	3.7	4.8
Not Stated	11.2	17.1

Source: CSO 2000. 2000 Population and Housing Census

5.15 QUALITY OF LIFE STATISTICS

The quality of life of people or groups has several dimensions and to this extent we may use a battery of indices to ascertain its character. Fundamental to the quality of life is the satisfaction of basic needs, and one of those is housing. In order to get a sense of the quality of life, we also examined the type of housing amenities available as it relates to lighting, water supply and toilet facilities.

5.15.1 Housing

Within the Arima Borough, there are approximately 8,296 households. Of these, 7,514 households (~90%) took part in the 2000 Census. 68.9% of responding households comprised 2 to 5 persons. The Tunapuna/Piarco population is larger than Arima Borough with 54,381 households within this area. Of these, 46,565 households (~85%) participated in the 2000 Census. The majority of these households (70.5%) comprised 2 to 5 persons.

Within the Arima Borough, 60.3%, of the dwelling units were on land owned by the residents, 11.9% were rented privately, 0.6% was rented by the government, 1.5% were leased privately, 16.8% were government leased, 2.5% were rent free and 4.6% were occupied by squatters.

Like Arima Borough, the majority (54.5%) of dwelling units in Tunapuna/Piarco were on land owned by residents, 19.6% were leased by the government, 8.4% were rented privately, while 5.2% were leased privately.

The majority (77.5%) of buildings in the Arima Borough were made up of brick/concrete. This was 13.2% more than the national figure. The others are made up of wood (8.8%), wood/brick/concrete (7.3%), wood/galvanize (1.4%), wattle/adobe/tapia (2.7%) and other (1.9%).

In Tunapuna/Piarco, the majority of buildings were also made up of brick/concrete (78.0%). Like Arima, the others were made of wood (7.0%) wood/brick/concrete (10.7%), wood/galvanize (2.3%), wattle/adobe/tapia (1.1%) and other (0.4%).

5.15.2 Water Supply

With regards to water supply, the variables used are the 'nature or source of water supply' as well as the 'frequency of water from a public supply'. In the Arima Borough (88.0%) and Tunapuna/Piarco Region (80.7%), the majority of dwelling units received piped directly into their dwelling.

In terms of the frequency of water supplied, the majority of dwelling units in both areas receive a continuous supply. In Arima 62.2% of the dwelling units receive continuous water supply while in the Tunapuna/Piarco Region, 68.5% of the dwelling units receive this frequency of water supply.

Table 5-21 Frequency of Water Supply in Arima Borough and Tunapuna/Piarco Region (%) - 2000

Frequency	Arima Borough (%)	Tunapuna/Piarco Region (%)
Constant Supply	62.2	68.5
3 or more times weekly	28.9	26.1
2x weekly	4.7	1.9
>2x weekly	2.9	1.4
Not at all	0.2	0.7
Other	0.7	0.6
Not Stated	0.4	0.8

Source: CSO 2 2000 Population and Housing Census, Households and Housing Report

Toilet Facilities

The majority of the dwellings units (50.4%) in the Arima Borough have water closets linked to a sewer system. In addition 36.3% of the dwellings units have septic tanks/soakaways and a significant proportion of the dwelling units (11.8%) use pit latrines.

In Tunapuna/Piarco, the majority of the dwelling units (50.2%) have septic tanks/soakaways while 31.7% have water closets linked to directly to sewers. In addition, a significant proportion of the population (16.7%) use pit latrines. The household surveys conducted within the communities in the subcatchment areas indicated that 99% of the houses sampled have internal water closets and only 1% still use pit latrines.

5.16 INFRASTRUCTURE AND SOCIAL SERVICES

5.16.1 Health Facilities

Within and around Arima Borough and Tunapuna/Piarco, there are several health care facilities and health centres. The Arima District Health Facility is located in Arima (Malabar Catchment Area) and is opened from Mondays to Fridays. Services provided by this facility include, but are not limited to, ante natal, paediatrics, child health, dental, and family planning services. The La Horquetta Health Centre is also located in the Malabar Catchment Area and is located in La Horquetta. Services there are similar to those provided in the Arima District Health Facility.

The Maloney Health Centre is located in Maloney Gardens (Maloney Catchment Area) and is also open and accessible on Mondays to Fridays. Services provided in this health centre include school health, ante natal, post natal, home visits, family planning, medical social work and child health. Other health care facilities utilised by residents include the Eric Williams Medical Complex, Mount Hope Women's Hospital, Arouca Health Centre, Macoya Health Centre and Tacarigua Health Centre. The Caura Hospital is within this wider geographic area and provides services for persons seeking Substance Abuse Prevention and Treatment. According to the Ministry of Health, two additional facilities scheduled to be established soon are the Tacarigua Extended Care Facility and the Tunapuna Health Centre.

5.16.2 Police and Fire Services

The Police Services available to residents in the Arima Borough and Tunapuna/Piarco Region are generally provided by the Northern Division. Police Stations are located in Arima, Arouca, Cumuto, La Horquetta, Malabar, Maloney, Maracas/St. Joseph, Piarco, Pinto Road, San Raphael, St. Joseph and Tunapuna. Fire services for Arima Borough and Tunapuna/Piarco Region, are provided under the Central Division. There are three (3) fire stations located in these areas, the Arima Fire Station, the Piarco Fire Station and the Tunapuna Fire Station.

5.17 COMMUNITY SURVEYS

Market Facts and Opinions conducted a household community survey to gauge resident perception of the proposed project and its potential impact on the community. The surveys involved one-on-one interviews with households in locations which have the potential to be affected by the project. A total of 964 households were surveyed during October 2008 in the following areas:

- Calvary Hill
- Mausica/Olton Rd.
- Cleaver Rd./Andrews Lane
- Lower O'Meara Rd.
- Arima Proper
- Mt. Pleasant/Maturita
- Upper Pinto Rd./Gills View
- Upper Malabar/Tumpuna Rd.
- Upper O'Meara Rd.
- Santa Rosa East/West
- Malabar
- Peytonville/Carapo
- La Horquetta/Greenvale
- Maloney

The first thirteen areas are in the Malabar Catchment. Figure 3.1 shows where these sub-catchment areas are located. The Maloney Catchment is smaller so it was not subdivided into smaller units.

A detailed report is presented in Appendix II and the main findings of the report are summarised below.

5.17.1 Demographics

The average resident in Maloney, Malabar and environs tends to be from a middle to low income household. Residents generally have been living in the area for more than 20 years (60%). Moreover, residents are more likely to be employed with a company than to be self-employed.

5.17.2 Community Awareness

There is a marginal level of awareness of the proposed Wastewater Collection, Treatment and Disposal Facility (14%). Discussions on the project are recent, as most respondents have been aware of the project for just about three months (57%) via word of mouth (49%).

Unanimously, respondents are more likely to believe that the project would positively impact both themselves and their community. The prospect of an increased supply of water is the main perceived benefit. Among those who anticipate a negative impact for themselves, untreated water (47%) and to a lesser extent a reduction in the water supply (13%) as well as air pollution (13%) are the main shortcomings of this development.

5.17.3 Perceived Impact on the Environment

While the wastewater system is expected to have both positive and negative impacts on the environment, the sector of the environment most likely to be affected is human beings (95%). The air (68%), rivers (63%), oceans (59%) and plants (57%) round off the top five areas most likely to be affected.

5.17.4 Community Concerns and Involvement

The three main concerns for residents are crime (46%), an irregular water supply (41%) and bad roads (25%). Close to the entire sample is not involved in any village council, non-governmental or community based organization (94%). Those who are involved are more likely to be involved in political party groups (15%) or other neighbourhood village council groups. Calvary Hill and Mt. Pleasant/Maturita residents are more likely to be involved in such community based groups.

The same proportion of respondents who are aware of their community leaders is also satisfied with their performance (15%). Poor representation (44%) and little visibility in the community (29%) are the main areas of displeasure expressed by dissatisfied respondents. It is interesting that a significant proportion of respondents is unaware if there is a community leader, hence, they were unable to express their satisfaction or disapproval.

5.17.5 Impact of Industrial Development in Maloney/Malabar and Environs

Approximately one of every four respondents expressed that they were affected either positively or negatively by business and industrial development in Maloney/Malabar and environs over the past 10 years. Respondents are more likely to have been negatively affected (72%) during this period.

The main negative effects of industrial development experienced are the bad odour (54%) and increased traffic (35%), while ease of shopping (64%) and to a lesser degree more employment opportunities (28%) are mentioned as the main positive impacts.

86% of the residents experience nuisances in their communities. The top three nuisances are crime, odour and traffic. Odour, traffic, noise and dust are the more common nuisances - affecting residents on a daily basis.

5.17.6 Characteristics of the Household

- 71% of the households interviewed spend $300 or less on their water bills quarterly.
- 48% of the residents' sewer bill is included in their water bill; 20% pay $51 - $100 quarterly.
- Most residents (61%) are unwilling to pay an increased price for their sewer service.
- 99% of the households interviewed have internal water closets.
- 81% of the households interviewed have water piped directly to their house by WASA.
- 100% of the households interviewed have a direct T&TEC connection.
- 92% of the households interviewed live in houses built with concrete and bricks and
- 46% of the sample usually access the Arima District Health Facility.

5.17.7 Awareness of and Satisfaction with Public Facilities

- 57% of the residents are satisfied with the service that they receive from the nearest police station.
- 77% of the residents are satisfied with the service that they receive from the nearest fire station and
- 37% of the households interviewed use the recreational grounds in their communities.

5.18 ROAD TRAFFIC SURVEY

Road traffic counts were conducted on 25th November 2008 at several locations within the Maloney and Malabar sub-catchments. Persons to act as traffic monitors were hired from the area (of Maloney and Malabar) in order to minimise resentment from the communities (for jobs given to 'outsiders') and to minimise safety concerns. The persons were given training in terms of traffic monitoring and placed at locations in pairs for monitoring on the sample day. Monitoring consisted of three periods of 3-hour intervals (of 6:00 am –9:00 am; 11:00 am – 2:00 pm; and 3:00 pm – 6:00 pm) at the following locations:

- Churchill Roosevelt Highway West Site (situated west of entrance to Maloney Gardens)
- Arima Old Road
- Maloney Housing Development (at bus shed)
- O'Meara Road
- Tumpuna Road
- La Horquetta
- Pinto Road
- Churchill Roosevelt Highway East Site (close to Pinto Road where there is a dual carriageway)

The results of these are provided in the following tables. Note that the traffic flow along the Churchill Roosevelt Highway (CRH) is extremely heavy during the peak periods in the morning and evening. The pattern on the major road tends to be net flow of all types of vehicles heading west (towards areas such as Port-of-Spain) in the early periods and a net flow east (to areas such as Arima) in the evenings. However, the traffic flow in the opposite direction is quite significant at these times suggesting that Arima is an urban centre that attracts many commuters (for activities such as work, business or schools).

The Maloney Main Road and Mausica Road have higher net flows to the CRH in the morning periods suggesting that these roads are used as arterial routes to the major roadway and to potentially head west (to areas such as Port of Spain). Pinto Road and O'Meara Roads, on the other hand, appear to have a higher net flow north (towards the Arima urban centre and urban centres eastwards) and may be the major arterial roadways to Arima. With all four roadways, traffic levels are similar and can be considered high for roads of this nature.

Tumpuna Road had similar levels of traffic moving in both directions at all the monitoring periods suggesting that both patterns of use of this road exist (to access the CRH or Arima). The La Horquetta and Arima Old Road have a similar pattern with equal proportions of vehicular traffic in both directions, but the numbers of vehicles on these two roadways tend to be lower in comparison to the other roads in the present survey. This pattern suggests that a significant percentage of the vehicles on this road may be localized (to the resident communities) in nature.

Generally the project area is serviced by roads which are arterial in nature and carry considerable traffic under normal conditions. Trenching and excavation associated with the installation of the collection system is likely to result in increased disruption of traffic flow particularly during peak traffic periods. A comprehensive management plan will reduce the impact of these construction activities.

Table 5-22 Traffic Monitoring Results (Present Survey)

DATE: 2008/11/25

LOCATION: Maloney/Malabar.

TIME	Maloney Bus Stop (South)					Maloney Bus Stop (North)					Highway Maloney (East)					Highway Maloney (West)				
	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVS	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles
6:00 – 9:00	420	160	200	1120 340	15	32	25	40	345 65	0	242	975	1055	1080 925	3	94	132	214	715 598	23
11:00 - 14:00	100	100	60	1100 120	0	4	4	20	200 21	0	57	270	400	570 470	0	23	94	160	180 242	8
15:00 - 18:00	100	100	175	1050 120	5	20	20	15	220 20	1	116	245	810	930 855	4	78	343	78	621 569	4
TIME	Tumpuna (North)					Tumpuna (South)					La Horquetta (North)					La Horquetta (South)				
6:00 – 9:00	1025	425	1050	1140 1020	0	395	150	490	1020 450	0	98	78	30	570 380	2	190	92	75	405 525	12
11:00 - 14:00	0	0	0	585 0	0	0	0	0	280 0	0	130	155	120	330 230	10	160	117	67	345 250	6
15:00 - 18:00	0	0	250	1050 0	0	0	0	70	980 0	0	166	93	112	440 500	5	205	164	141	525 518	13

DATE: 2008/11/25

LOCATION: Malabar.

TIME	Pinto Road (North)					Pinto Road (South)					Highway Pinto (West)					Highway Pinto (East)				
	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVS	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles
6:00 – 9:00	115	135	75	475 365	0	46	133	21	390 267	1	113	331	313	113 257	0	19	334	320	722 94	3
11:00 - 14:00	111	211	152	335 230	0	0	0	0	125 0	0	15	190	205	343 180	13	28	334	400	732 111	13
15:00 - 18:00	75	117	10	425 420	0	0	0	0	140 0	0	50	516	510	660 445	1	32	397	131	445 97	0

TIME	Mausica (North)					Mausica (South)					Arima Old Road East					Arima Old Road (West)				
6:00 – 9:00	69	42	92	297 152	0	8	21	126	955 253	0	16	1	35	317 43	0	26	4	77	448 110	1
11:00 - 14:00	43	270	345	447 345	0	22	55	149	684 159	3	19	11	43	226 55	1	18	6	33	246 43	1
15:00 - 18:00	0	0	0	243 0	0	29	22	92	573 228	1	22	5	47	565 87	0	20	0	38	357 51	0

DATE: 2008/11/25

LOCATION: Malabar.

TIME	O'Meara Road (North)					O'Meara Road (South)				
	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVS	Motor Cycles	Maxi Taxis	Heavy Trucks	Light Trucks	Cars & SUVs	Motor Cycles
6:00 – 9:00	37	87	63	238 175	2	55	82	34	185 161	2
11:00 - 14:00	48	141	81	494 223	0	46	102	22	210 201	0
15:00 - 18:00	68	116	88	716 260	0	86	112	30	394 308	0

6 KEY STAKEHOLDER MEETINGS AND PUBLIC CONSULTATIONS

6.1 SCOPE AND PURPOSE

Public and key stakeholder consultations were conducted in an attempt to identify and alleviate potential negative impacts which may arise as a result of the establishment of the WWTPs and collection system in the Malabar and Maloney catchments.

The consultations included stakeholders from various sectors of the society who may be impacted upon, either positively through benefits or negatively by losses accrued. The stakeholders contacted to participate in the meetings/consultations included residents from the catchment and/or subcatchment areas as well as other surrounding communities. Some of the communities which will be directly affected by the proposed project comprise Calvary Hill, Mausica/Olton Road, Cleaver Road/Andrews Lane, Lower O'Meara Road, Arima Proper, Mount Pleasant/Maturita, Upper Pinto Road/ Gills View, Upper Malabar/Tumpuna Road, Upper O'Meara Road, Santa Rosa East/West, Malabar, Peytonville/Carapo, La Horquetta/Greenvale, Maloney Gardens, La Florissante, Lillian Heights, Lynton Heights, La Resource and Santa Monica. Other stakeholders invited include representatives from the industrial and commercial private sectors as well as governmental and non-governmental agencies.

6.2 REQUIREMENTS AS DESCRIBED IN THE FINAL TERMS OF REFERENCE

The Terms of Reference (TOR) for the establishment of the Wastewater Treatment Plants and associated works state that opinions of stakeholders may provide relevant information to the project and assist in the identification and mitigation of impacts while preventing environmentally unacceptable development, controversy, confrontation and delay.

Stakeholders should include government ministries and departments, statutory authorities, businesses interested in the project, people living within the area, environmental organizations, environmental experts, non-governmental organizations and other companies. The Terms of Reference state that meaningful information should be provided and consultation dates should be well advertised.

The TOR require at least two stakeholder meetings in each of the catchment areas of Maloney and Malabar, one at the beginning of the EIA when the project is being presented and the other at the end when findings are presented. This should result in a minimum total of four public consultation sessions. The TOR also recommend the use of questionnaires, surveys, interviews and advertisements. The information in the EIA report should thus include concerns raised during the consultation process as well as suggestions for addressing these issues.

6.3 DESCRIPTION OF THE METHODOLOGY USED

The methods used to disseminate as well as collect information from all the stakeholders included public consultations and household surveys. The methodology was employed to gather information via questions and to be sensitized to concerns or other contributions raised by residents and other stakeholders, concerning the proposed establishment and refurbishment of the Wastewater Treatment Plants and associated works. The use of household surveys was utilized in order to establish residents' attitudes and concerns towards the proposed project.

As stipulated in the TOR, two public consultations each were held in Maloney and Malabar. Maloney public consultations were held on the 18th and 26th November, 2008 at the Maloney Indoor Sport Arena, Flamingo Boulevard, Maloney while the public consultations at Malabar took place on the 20th and 27th November, 2008 at the Larry Gomes Stadium, Nutones Boulevard, Malabar, Arima. Lists of the attendants for these consultations are attached in Appendix III of this EIA report as well as the power point presentations and the minutes taken at the consultations. The information gleaned from the household survey is included in the Appendix II and was used as a significant source of information for the Social Impact Assessment (SIA), also attached at Appendix II.

Table 6-1 Schedule for Public Consultations and Stakeholders Meeting

Stakeholders	Meeting Venue	Meeting Date
Maloney and environs; Public Citizens; Industrial and Ministerial Stakeholders	The Maloney Indoor Sport Arena, Flamingo Boulevard, Maloney.	18^{th} November, 08
Malabar and environs; Public Citizens, Industrial and Ministerial Stakeholders	The Larry Gomes Stadium, Nutones Boulevard, Malabar, Arima	20^{th} November, 08
Maloney and environs; Public Citizens; Industrial and Ministerial Stakeholders	The Maloney Indoor Sport Arena, Flamingo Boulevard, Maloney.	26^{th} November, 08
Malabar and environs; Public Citizens, Industrial and Ministerial Stakeholders	The Larry Gomes Stadium, Nutones Boulevard, Malabar, Arima	27^{th} November, 08

6.4 KEY STAKEHOLDER MEETINGS

Stakeholders Identified

The Ministerial and Industrial stakeholders were identified on the basis of their involvement in the regulation of various components of the project development. A key stakeholder consultation is conducted to solicit information on the respective roles and responsibilities of the stakeholders with regard to approval and/or regulation of the proposed WWTPs and associated works as well as their on-going regulatory and/or inspection authorities during the operational phase of the project and to determine the attitudes and expectations of each key stakeholder with respect to the proposed project. The key stakeholder consultations were held in conjunction with the general public consultations. A list of the stakeholders invited can be found at Appendix III.

6.5 PUBLIC FORUM MEETING

The Environmental Impact Assessment (EIA) process requires the involvement of the affected communities in all environmental impact evaluations and thus consultations with the affected populations must be conducted to provide pertinent project information to these stakeholders. Also significant is receiving information from the stakeholders regarding their attitudes toward a particular development, their aspirations and expectations and any concerns and comments they may have. The process of public consultation is enshrined in good EIA practice and made mandatory in Trinidad and Tobago through the provisions of the Certificate of Environmental Clearance Rules 2001.

In keeping with the EIA process for the WWTPs project, four public meetings were held and the national community invited along with other stakeholders. These meetings were advertised in the print media approximately a week and a half before the meetings were held. They were also advertised in the local community through a mobile loud hailer system on the days prior to the meetings.

The purpose of the meetings was to present the project's development strategy and the findings of the EIA to the national community and to receive feedback by way of comments, concerns and any other relevant information from attendees. Wherever practicable, these comments and concerns will be incorporated into the engineering designs of the facility and into the operational phase, environmental management and monitoring plans for the facility. The proceedings of these public consultations are reproduced verbatim in Appendix III of this report.

Meeting agenda

The following items were tabled for discussion at the key public stakeholders consultation:

- Introduction
- Project Justification and Description
- EIA findings & Results
- Open Discussion

6.5.1 Main Issues And Concerns Raised By Participants

Main issues raised by the public at the meetings related to the proposed project have been identified and compiled into tables below.

6.5.1.1 Maloney Public Consultation I, Tuesday November 18, 2008

Table 6-2 Maloney Public Consultation I

Maloney Public Consultation I, Tuesday November 18, 2008 Venue - The Maloney Indoor Sport Arena	
Questions/Comments/Concerns	Responses
❖Will the project be maintained by HDC and WASA?	❖ According to WASA, the project will not be maintained by HDC. WASA is responsible for the operation and maintenance of the plants.
❖During rainfall residents notice sewage and they get a problem with 'bubbling'… Will the problem still persist?	❖ Cameras in the system (CCTVing) are being used to determine the conditions of the existing sewers in the NHA development. WASA was able to identify that some of the sewers needed replacing and they plan to do so during the integration and construction of the new system. Through this venture the problem should be resolved.
❖Prior to rainfall residents notice not only garbage but cockroaches and rodents coming out of the manholes.	❖ The presence of rodents and pests will be very difficult to eradicate, especially since sewage systems attract different elements. However forms of control are needed to manage it via Ministry of Health and also the Corporation.
❖ Residents were concerned about a possible increase in their WASA bills.	❖ The project will be funded by the central government. The way sewage bills are derived is that presently it is half of the water bill (with a section indicating payment for sewer services). For residents who are not connected to the centralized system, when they are connected to the new system, the water bill would increase (since they will be paying for sewer service). For those who are presently charged a sewage bill, there is no increase. It's only when water rates are increased (generally) then there'll be a concomitant increase in sewage rates. ❖Once the project comes on track the government may put in terms of a major capital outlay and this would mean some form of increase to residents' rates. However, the quantum of increase is not known.
❖To some residents the projected population seemed unrealistic since they expected the figure to be much larger due to internal migration that currently exists and unplanned development. Residents were concerned about the capability of the treatment plant to meet the needs of the growing population.	❖ According to WASA, the figure for the population does sound low and this would be reviewed in terms of completing the design component for the collection system. Population growth with respect to migration will be reviewed.

Maloney Public Consultation I, Tuesday November 18, 2008 Venue - The Maloney Indoor Sport Arena	
Questions/Comments/Concerns	Responses
❖ Why isn't Red Hill or D'Abadie mentioned during the presentation, since these areas mainly use septic tanks and soakaways?	
❖ Would the rates be increased by 100% or 150%, since that would be a very high increase? Is there any way that the increase would be tapered by the company or the public utility for the average consumer? 'I would like to propose that it be considered'.	❖ The Regulated Industries Commission (RIC) is a regulator for both T&TEC and WASA and as part of the legislative requirements, both utilities are required to provide a five-year business plan to the RIC. The business plan provided by WASA included the estimate cost for a number of projects. The proposed figure did factor in projects of this nature. So there was no anticipation that there is going to be an increase. The decision to grant the increase is done by the RIC. WASA could only put forward what they intend to do in terms of the amount of work required to improve the level of service and the estimated cost. The RIC would see fit whether WASA should be granted an increase. If an increase is granted, the central government will decide whether part of the increase or all of the increased will be funded through central government. Even if an increase is granted not all will be borne by the customer. Central government will then provide some sort of subsidy, transfer or subvention to WASA.
❖ A representative of Red Hill Maloney was interested in knowing whether there would be a force main coming out of Nicholas Gardens to attach to Red Hill where the system is leading to the treatment plant.	❖ WASA will be placing a force main with a pumping station since the authority wants everybody to be connected to the collection system. The aim is for everybody to have access to the sewer service especially in order to reduce wastewater discharge, pollution of groundwater, the rivers and environment.
❖ During the [national] budget presentation, it was stated that the wastewater component of WASA would be handed over to SWMCOL. How would that handover impact on the project if it takes place in the next fiscal year?	❖ This was said by the Prime Minister during the budget. However there are a number of things that still need to be 'ironed out'. There are issues in terms of manpower moving and transfer of assets and even handing over of these facilities and infrastructure. It is uncertain whether these issues would be settled before the end of the fiscal year. Until then, WASA has a mandate under the Water and Sewerage Act and will continue to 'discharge our function as we are mandated to do under the law and if this doesn't happen in this fiscal year this project has to take place for the benefit of the community and environment and we are

Maloney Public Consultation I, Tuesday November 18, 2008 Venue - The Maloney Indoor Sport Arena	
Questions/Comments/Concerns	Responses
	committed to ensuring that it goes'. If issues are identified and settled then the project as well as the operation and maintenance of the facility would now be handed over to SWMCOL.
❖ Residents of La Florissante Gardens [Maloney] were concerned about the 'unbearable' stench coming from the treatment plant in La Florissante Gardens. What will be done about these stenches?	❖ If a wastewater treatment plant, it's normally because the plant is not being operated properly or there is some design element to why it's not operating properly. What WASA is trying to do is ensure that communities have an adequately sized plant to handle the population and one that meets EMA's requirements especially in terms of discharge. Once the plant meets these requirements and is operated properly, there should be no scent.
❖ A representative from the Ministry of Agriculture, Engineering Department was concerned about the stench and pollution that emanates south of the intersection of the Churchill-Roosevelt Highway (CRH). This stakeholder is concerned about how the stench and pollution affect farming produce since there is a large farming community south of the CRH. ❖ Where do the farmers get their water from and is it contaminated?	❖ There is a lot of waste in the river which comes from the meat rendering plant. The river is largely dead, with the exception of caimans and it is also highly anoxic. Whether the farmers are actually using the water, one would suspect they are since in the dry season they would need water, which they may pull from there. It's under the EMA Act and Rules that govern water pollution, so this situation should be managed.
❖ Residents showed concern for access to employment, especially for the youth.	❖ In terms of implementation of the majority of the project will be done through contractors. With respect to the labour aspect, one of the components which is normally done is ensuring that there's an element whereby the contractors cater for local labour. If an international contractor is used alongside the local contractor there maybe some skilled trades required…There will be provision for normal labour, but there is also a stipulation which states that contractors should employ within their staff, a certain percentage of the local labour residing within the community. In order to be awarded the contract this must be satisfied i.e. utilizing local labour. The employment opportunities may be short term and more so at the local level because the project is phased over four years. The employment opportunities would come

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	after the completion of the detailed design for the water treatment plant and detailed designs of re-sewering.
❖ What role will the Impact Management Unit (IMU) play in this new wastewater project?	❖ IMU is another unit within WASA. As the contract proceeds there would be continual PR on the project once construction starts. Through this residents would be informed of what is taking place and also gain feedback from residents and address whatever problems on the project if they arise
❖ What kind of supervision will there be to reinstate the road surface, especially since there have been problems in the past such as sinks in the road? ❖ What sort of time frame will there be for reinstating the roads.	❖ The different organizations such as the Corporations and the Ministry of Works, who are responsible for the roads will be informed about the project so programmes for reinstatement of the roads could be scheduled at the most appropriate time so the roads would not have to be dug up after it just got paved, which will require WASA to repave it again.
❖ Some residents indicated that they have problems with water supply and when they do get water it has a horrible smell. They were interested in knowing where the water came from? ❖ Some residents claim that the water that comes from the pipe is 'stink' and cannot be used to drink or wash. Some claim that residents get sick from the water. ❖ Residents think that it is important for WASA to come into the communities to liaise with them and hear their complaints. ❖ One resident stated that children get rashes on their skin because of the water.	❖ …because the east-west corridor is supplied by a number of sources such as the Hollis Reservoir, North Oropouche Water Treatment Plant, Guanapo Treatment Plant Piarco Treatment…there were some difficulties in saying for certain the exact or predominant source of water for residents in Maloney. However a lot of issues surrounding poor water quality arise out of the old and aged nature of the infrastructure. There are a lot of old pipes which have become corroded and especially in areas where you don't have a 24-hour supply…When water returns because there is a lot of pressure fluctuation in the pipeline it causes a scouring action so when water returns its comes back with a high pressure and the debris and corrosion that is encrusted within the pipe becomes loose and is carried into the system. ❖ As part of their master plan programme, WASA has identified a number of pipelines that need to be changed throughout the country in order to improve not only the delivery of service but also to alleviate some of the water supply or water quality issues within the area. WASA also plans to do a lot of PR to ensure that residents are always informed about what is happening as well as to gain feedback.
❖ Will the wastewater pipes in Maloney be changed? ❖ Residents in Maloney complained that they experienced a problem where wastewater would back up	❖ When the plant and collection system in Maloney is being refurbished, some of the lines will be re-laid, like the ones on the side streets. It's unlikely that the smaller ones serving houses on the street will be replaced unless problems are identified by the camera. However, on the main routes, lines

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into their yards or houses and they had to wash it down. The level of this happening decreased however residents still experience similar problem when there is rainfall. ❖ What happens to Maloney if one of the pumps break-down? Is there a system in place in case the pump malfunctions or breaks down?	would be replaced and re-laid so that it could take the flow from the far reaches of the area. Some other aspects of the plant that will be redone include the well; new pumps will also be brought in. The plant will also have standby generators for all the regional plants.
❖ A representative from the Tunapuna/Piarco Regional Corporation reminded WASA that all state agencies are required by law to be a part of the monthly meeting with the Regional Coordinating Committee. This is important since it would give WASA as well as the Corporation an opportunity to carefully schedule activities including cutting and paving of roads	
❖ Will the new system that has been proposed remove all aeration? How effective will it be under unconventional and unusual conditions?	

6.5.1.2 Malabar Public Consultation I, Thursday November 20, 2008

Table 6-3 Malabar Public Consultation I

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Questions/Comments/Concerns	Responses
❖ Will the project have any impacts, positive or negative, on parts of Arima, especially Malabar that does not have a good supply of water?	❖ WASA was not fully able to answer the question…since current project i.e. the Wastewater treatment…focuses on providing a wastewater service for the people in Malabar and the Arima area. There's another project in which the water and wastewater master plan looks at water supply and water distribution throughout the country. That project will address the water issues more effectively.
❖ What is the benefit of the wastewater project? Does it deal with providing more water or with sewage disposal?	❖ The wastewater project will improve the level of centralized sewage coverage for communities within the area. It will also reduce public health issues that arose due to malfunctioning facilities, which would have contributed to pollution of rivers and streams because of the overflowing sewage coming from toilets. The project therefore seeks to improve those issues. ❖ The project seeks to provide a sewage service – a centralized system for everybody within the catchment area. This is necessary to ensure that wastewater going to the plant is adequately treated. This would decrease the amount of pollutants going into the river, streams and the Caroni water treatment plant. The goal is to remove all the ineffective wastewater plants and establish one regional plant to provide sewage services for everybody. With improved sewage services this can mean improved water quality for fishing, water for irrigation of agricultural plants and potable water. Therefore it is going to provide improvement from mainly an environmental point of view as well as public health.
❖ Is it law when persons build a house in the city or town to have it connected to the sewer system or WASA sewer system? There are number of people who build houses in town and don't have a connection. What are the WASA authorities or Borough doing about that?	❖ WASA does not have any sort of enforcement under their Act. The Act says that once you are residing within a quarter mile radius, for water and wastewater, you are supposed to connect. However it does not state where people could be penalized. Persons must connect otherwise there would be damage being caused to the environment since wastewater being discharged is not properly treated. It is hoped that under the master plan that 'beefing up' enforcement capabilities, educating people and getting people to get connected can be done but as it currently stands there are no legal terms to penalize people.

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	❖ WASA is also hoping to fund the component where they could establish the system, lay the lines and make provisions to bring on stream the different households that are not connected to the system
❖ What happens if something goes wrong with the 'mega plant' (regional plant) that is being built. Residents showed concern for the maintenance of the regional plant.	❖ The Earthtech consultant stated that when there are a lot of smaller treatment plants in different areas it is much more difficult to maintain them because they are spread out. If something goes wrong then it's that whole area that is discharging. The same with the mega plant, it is going to be one large treatment plant that provides a fair amount of the ability to have redundancy in it. The new treatment plant has redundancy built in. However if one unit goes out, the treatment plant will not fail. The plant is also going to be designed with 100% back up power in case electricity goes. There will be two feeders from T&TEC and also back-up generators that will be able to power the entire plant in case both feeders malfunction. A well-trained staff on site at all times will increase the reliability of the overall system.
❖ How did WASA and the consultants arrive at the figure for the plant capacity design i.e. the volume that the plant is going to treat?	❖ It started with the work done by the French firm, Safege, in their master plan for the East-West Corridor and they came up with the population equivalents. A project for Port of Spain was done in the late 1990s. With the use of flow monitoring Earthtech came up with numbers in terms of what the unit capacity per population equivalent would be. There was also industrial contribution, a commercial contribution and the use of a fairly large safety factor for the peak flows because the sewer systems, about 30, 40 per cent of the existing sewers, are relatively old and they do have a tendency to leak and so we have the additional capacity there to be able to handle the peak flows. ❖ In addition to the Safege study, the use of aerial photographs of the area...essentially every house that was seen on the aerial photographs was counted (in 2004). Field surveys were done – going out and looking at the areas and identifying any other housing developments that didn't show up on the aerial photographs. Essentially a house count was done – we [Earthtech] had an average household size and then multiplied it by unit factors to come up with the average flow and peak flows.

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❖ Is WASA catering for a particular customer base? How are they catering for this particular customer base? What percentage customer base do they want to get?	❖ This catchment came up from Safege's study and it was not looked at in terms of a customer base. The directive is to provide sewage service as far as possible to everybody within the community. The topography of the area was used since it is necessary to get a gravity feed flow coming to the plant. Therefore WASA and the consultants are guided by the topography or lay of the land and it guides the boundaries of the project.
❖ Is the plant supposed to pay for itself? Was there some reason for doing the treatment plant? Was it to make money?	❖ The major advantage to a wastewater project is the cleaning up of the environment. When you do an economic analysis of a project, in most instances, one must look at the capital cost, the Operation and Maintenance of the project which is fairly high. WASA will more likely seek funding for the major component – the capital works, from the government and for the Authority to think of making back money would be very difficult since the cost is rather high. WASA's focus is to provide centralized facilities so that everybody in the community could be connected to the system.
❖ The funding of the plant is an issue that needs to be addressed, since a cost would be borne by citizens in the community or catchment area. WASA has to indicate that a certain number of house connections be made in order to make it viable or feasible.	❖ Large public works are usually funded through central government and the Operation and Maintenance (O & M) cost is usually borne by the service provider who is WASA. Since the central government generally funds these major capital works, projects letting individual householders pay for it would not happen. ❖ A 'true' cost cannot be attached to the cleaning of the environment and making communities safer for residents and their children. It's a win-win to benefit the communities and environment.
❖ Would the sewage rates increase?	❖ Currently sewage rates are tied to water rates. It is actually 50% of the water bill. Rates for this project will only go up if a rate increase has been granted to WASA. If the project comes on stream and no rate increase has been granted by the Regulated Industries Commission (RIC) then the rate remains the same. Only when a rate increase is granted residents will actually see a concomitant increase in both water rates and the sewage rates.
❖ Will there be dislocation occurring during the project, like those that occurred in the Lock Joint Programme? Is it going to be	❖ The connection from the existing plants to the new plant will not have a lot of disruption. There are streets that need to be dug up in order to install sewers. A large part of the area will have some disruption for the construction. Documents

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hooked up from the existing wastewater plant on the highway or is going to be throughout the streets? Will it involve digging up etc?	will be put together to ensure that the contractor reinstates the street as soon as possible so there won't be large open areas. He will be required to put in a detailed traffic management plan so that major intersections and major thoroughfares are disrupted in the least measure. The project spans for a period of 52 months and different areas would be done one at a time.
❖ When the new project is completed will the manhole covers be removed, since some residents are uncomfortable with it being directly in their yards or in front their houses	❖ The system that is being put into place is almost entirely a gravity system to get water to flow downhill. The manholes are required to keep the system clean. The problem residents may be experiencing with the manholes is the smells or gases from the sewer system that may escape via the holes in the manhole covers. The manhole covers that WASA plans on using for the project are all sealed so they can reduce the issue that residents experience. ❖ In addition, residents may get the sewage smells because the sewers are not flowing properly and if sewage goes to a treatment plant in some areas that are not in service or malfunctioning, then it means the sewers are full of sewage that eventually degrades and produces an odorous smell. Hopefully with the system it will be designed so that everything will flow downhill and have adequate capacity. The new sewer system should not have that type of backup that creates the odour problem and there will be adequate capacity at the new treatment plant.
❖ Residents again showed concern about the quality of water stating that the water from the pipes doesn't taste good and some residents don't drink the water from the pipes. The ones who do use filters to purify their water.	
❖ Residents also complained about the shortage of water/ poor supply that they sometimes experience and expressed to WASA that a more efficient i.e. frequent service be provided for them especially since they also pay water rates.	

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❖ What can and should be done if some residents are letting the wastewater from their machines run at the side of their homes since it creates a stench….	❖ With the centralized sewage service that is being proposed, both black water, that is water from the toilets and grey water, that is water from washing machines, kitchen sinks, showers etc. they are supposed to be connected and flow to the wastewater treatment plant for treatment. For residents who choose to have their waste flow into the environment or drains creates a nuisance to other residents and is a serious cause for concern. ❖ In areas where centralized sewage is not provided, there is the typical septic tank arrangement which will take care of the water from toilets, but the waste from showers and sinks are normally channelled to your drains that run alongside or parallel to homes. Generally in those instances the borough and the public health officer are the ones who are supposed to investigate and deal with the complaints.
❖ Will the lack of a regular supply of water in this area have a negative impact on the project and can WASA provide a more regular supply of water to residents in Malabar?	❖ It is the intention of WASA and through Government's Vision 2020 to improve the level of service. One of the Vision 2020 targets to provide at least 20% of the population with a 24-hr regular supply of water and 75% with centralized sewage facilities. Therefore the number of the projects undertaken by WASA is consistent with what the government has planned for the country.
❖ Residents also commended the project stating that it sounded very good. However they still had some concern most of what are mentioned in the table. ❖ Residents mentioned that there are a lot of communities in Malabar and Arima clamouring for this project.	❖
❖ Is there some sort of system to distinguish industrial waste from household waste since there are quite a number of factories to be operating in the area and chemicals from one will certainly impact on the ability of the bacteria to process the faecal waste?	❖ A survey was done with the industries mostly in the park in Malabar, in addition to some sampling done at the existing Arima and Malabar wastewater treatment plants for a period of approximately 20 days. In terms of findings Earthtech did not find anything there that would be detrimental to the treatment process that is being planned for Malabar. In discussions with WASA, Earthtech found that there hasn't been any major upsets with biological treatment systems at those plants. ❖ The Authority also has a trade effluent standard indicating

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	what can be discharged into the system. There are certain specified limits which will be accepted into the system depending on the type of industry. Thus it is regulated in terms of what industries can discharge in the system.
❖ Is there any plan by WASA to do a pilot project to capture roof water, since most of the residents complained about inadequate water supply?	
❖ What type of aeration will be used? Aerators or diffused air as a method of operation.	❖ The design is based on mechanical aerators. It's a very similar activated sludge plant as used in Beetham.
❖ The concern that some residents had with mechanical aerators is the aerosols that are created, the large aerosol mist that seems to be generated by that type of treatment. Some hoped that in the Malabar plant other options regarding diffused air be used to get rid of the mist.	❖ The decisions for mechanical aerators were determined along the lines of economics and maintainability. Diffused air was considered, but the main difference between what is being done at the Beetham Plant and what has proposed to be done in Malabar …There's little free board between the liquid surface and the top of the tanks because concrete was removed from the tank walls. In Malabar there is a minimum of a metre, so any aerosols would have much less of a chance of actually escaping from the top of the bank
❖ When is the project expected to start	❖ Currently the detailed design phase is being completed and it should be completed by the end of the year. When the documentations and designs are completed, tendering has to be done. Funds also have to be requested from the central government. In addition to this more presentations have to be done with different Ministries. Depending on the success of funding it may begin around the last quarter of next year.
❖ Concern about the pollution in the communities was expressed	❖

6.5.1.3 Maloney Public Consultation II, Tuesday, November 26, 2008

Table 6-4 Maloney Public Consultation II

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Questions/Comments/Concerns	Responses
❖ Would there be any negative consequences arising out of the treated effluent?	❖ No negative consequences are expected since the EMA's requirements for discharge to inland water is to ensure that what is discharged, in fact, is safe for human contact. In addition to the EMA's criteria, a safety factor is also established to make it more stringent in meeting the safety criteria. ❖ Also, in terms of the effluent being discharged to the rivers, 'all our wastewater plants we do in terms of laboratory testing of what is being discharged, so we have like a standard sampling schedule, and, in terms of determining what is the quality of the wastewater, that is like on a continual basis. All the wastewater plants, all these are always continually being tested to determine if we are falling within the, you know, within the limits. So, you know, we have a few things in terms of what, you know, will always have us, they keep on checking, making sure that we meet the effluent limits as stipulated by the EMA'. ❖ Earth tech – 'We're also doing projections in areas that could be built on and projecting what those flows are so if another developer come in and puts in another hundred housing units, in fact the sewer system and the treatment plant can handle that additional flow. So it won't be the matter of you can handle what's there today but as soon as anything more comes in now it fails. So it does have a forward growth looking at also.
❖ Some residents wondered whether WASA would deliver or provide an efficient service to communities.	❖ WASA is willing to provide the water and wastewater services for the communities. However, one of the restricting factors is in terms of funding for the project since water also gets first preference while wastewater is secondary matters. WASA in most instances carries the project as far as it could in terms of delivery. They claim to be ready in Malabar so they can actually go into physical construction, however it will be guided by the required funding to do the project. Government also have their priorities in terms of what must be done…Support via lobbying from communities is encouraged by WASA in order to assist WASA in pushing forward the project.

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Questions/Comments/Concerns	Responses
❖ Residents expressed concern over the sludge treatment whether it would be able to remove all solids and whether disinfection would be effective if solids remained in the water.	❖ It is correct that UV is not very effective under two circumstances, if you have very high solids in the water, because the solids will absorb the UV light, and also the solids can protect the bacteria that you want to kill with the UV light. So it is important to have a good quality effluent that goes back to your treatment system. Typically, package plants that have been put in by developers have relatively small solid separation clarifiers and they can't have high solids, and so the key to the upgrade of the Maloney treatment plant is to size it properly to be able to handle the flows and put out a good quality effluent. The other thing that can be detrimental to the UV disinfection is high levels of colour. According to Earth tech, that's really not an issue here. As long as the plant is properly designed, there should be no issues/problems with it.
❖ Residents wanted to know the effect on farmers and what happens if a breakdown in the system occurred.	❖ Once the plant is properly designed the benefits in terms of reuse of both liquids and solids can arise. The effluent (liquid) can be reused for irrigation while the sludge component that is class B, can be reused for agricultural purposes. When the plant is completed, having a separate O and M contract is significant in operating and maintaining the plant. The model that WASA plans to adopt and utilize is similar to that of the Beetham Plant where there are separate teams operating and maintaining the plant.
❖ Can the plant that is currently in Maloney be operated efficiently for the size of the community? ❖ Does the plant treat the effluent from the communities sufficiently?	❖ This plant only treats the Maloney community and the small additions that have recently been added on. ❖ Yes it can.
❖ Residents identified the backing up of the system as a main problem or concern.	❖ A CCTV inspection of the collection system was done in Maloney, that is, the use of cameras in the sewers to determine the problems with the system and what was discovered is approximately 8 kilometres of sewer lines that need to be replaced. The existing system has its problems which have been identified and will be rectified in the overall project by replacing all the dysfunctional lines and upgrading them to the new plant.
❖ The issue surrounding traffic and the road network is one of the major concerns expressed by residents.	❖ The idea of the traffic monitoring is to identify the areas that are heavily trafficked and the type of traffic, is it a commuter route, you know, is it that people are just returning to their

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Their concerns stem from disruption of traffic and the restoration of the roads. One area in particular i.e. Mausica Road has been identified by the residents as a very busy area that contributes to the traffic. Residents state that it is going to be very difficult for them to tolerate and are concerned about how disruptions can be minimized as well as alternatives to open trenches. ❖ Is funding going to be put in place to address these problems identified in terms of road works and trenches	homes, and then try and predict what the disruption would be if you had to actually block half that road. Mausica may not be the main contributor in terms of traffic flows. Some of the other roads actually, you know, looking at the preliminary data that has been gathered, some of the other roads may be of more concern because of the traffic flows. ❖ One of the most useful strategies for road disruption is the timing in the year that you actually do that activity, which may or may not fall within the construction plan, which is often separate because there are have delays in construction and sometimes things will fall in a time period that was not intended. Probably the lowest traffic period is during the August holidays because once the schoolchildren are off the streets, it means that a lot of the commuter routes have less traffic. That's probably one of the easiest strategies, but certainly traffic has been identified as one of the issues that have to be that worked for this project. The project itself is broken down into several phases – so this aspect should be incorporated into the strategy in dealing with traffic and the roadways. ❖ There is no way to avoid traffic disruption in a project like this because in order to get the sewers the place you typically put them are in the roads because that's a public right-of-way, you're not going through private property. However there are things that can be done in the design and construction requirements to make sure that a contractor does not leave open trenches – that it gets covered, you require the contractor to saw cut the road so when they do dig it up it does not disrupt the entire road, make sure that roads are reinstated to a proper level.
❖ Residents want assurance that the proposed project would accomplish what is has set out to do and that the WWTP and the collection system would be in 'good order'. In the past, residents who have been living in the Maloney area for over 20 years claim that in the past, 'WASA ain't get it right' so they want to be assured that this project	❖ WASA places great emphasis on the planning to ensure that they are able to provide an efficient service to the communities. The aim is to plan ahead in terms of supplying and designing a complete integrated system. There plan is to lay lines throughout the community and have the service available to all, even if there is an empty lot, that service would be made available for individuals to connect at a later time. WASA wants to ensure that they plan properly so they won't have to return a second time to excavate and lay more sewers or do additional repairs.

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would work.	❖ In addition to this, WASA is putting certain details in the tender documents that would guide contractors in terms of what should be done. Having a certain level of supervision on-site is also part of WASA's plan to deal with complaints or problems that may arise.

6.5.1.4 Public Consultation II, Friday, November 27, 2008

Table 6-5 Malabar Public Consultation II

Malabar Public Consultation II, Friday, November 27, 2008 Venue - The Larry Gomes Stadium	
Questions/Comments/Concerns	Responses
❖ In processing the waste solids, what are the plans for the final product of the soil amendments?	❖ No definite plans have been determined for the waste solids, however numerous potential uses have been identified such as for agricultural purposes, landscaping as well as used as a daily cover for landfills to prevent flies.
❖ If decommissioning of a number of plants is going to take place, what happens if malfunctioning of the (new) centralized system/ plant occurs? Is there a back-up in place to deal with these issues?	❖ The new treatment plant is built with redundancy in it, so if one part of the plant malfunctions, e.g. the influent pumping station, there are others like it to ensure that the plant still works. Therefore the redundancy is there for any short-term outage and back-up.
❖ In light of the possible economic downturn of the economy and financial issues, what is the feasibility of looking at repairing and maintaining those that are already in place and somewhat functional [an alternative].	❖ According to WASA in looking at the possibility of trying refurbish and rebuild the existing plants, the problem with that is even if it was done, there would be large areas that have not been sewered and in the many instances where the developers put those plants in, they were probably marginal in terms of being able to handle any kind of peak flows etc. resulting in environmental problems. The main problem with the existing plants is they don't have enough capacity and this would mean having several plants. However, if you have numerous plants, a larger operational staff at all of the plants would be required. The decentralized plants would be less efficient than having one regional plant where you have a highly trained staff to operate and maintain it. ❖ In addition, many of those plants were constructed over 40 years ago and around that time the EMA or rules such as the fixed Water Pollution Rules may not have existed to stipulate requirements or standards that the plants would have to meet. Now with the formation of the EMA, there is a strict discharge limits or requirements to which the plants have to adhere. Therefore the existing plants would have to be upgraded and it would take substantial capital cost to do so. WASA thinks it is best to create the regional facility rather than upgrading the various facilities within the catchment area since some of these plants are also in a state of disrepair and would have had to be reconstructed in order to work efficiently. ❖

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❖ Who is required to pay for the connection of persons who currently have septic tanks and would be required to connect to the new installed sewer systems?	❖ WASA recognizes in the past that customers did not like to pay to do basic things such as connect to a collection system and in the past when pipes were laid and plants were constructed, when it came to connecting customers did not want to connect. WASA stated that in some instances they offered soft loans but residents were still not willing to connect. Under this specific project, WASA has included as a component, the cost for doing the connections for residents who have on-lot systems. Therefore the actual connection from homeowners' system to the line on the street would be funded under the project.
❖ Was there any consultations kept with persons involved in the cleaning of septic tanks, seeing that they would be 'thrown out' of a source of income?	❖ A separate discussion with the septic tank companies was not scheduled by WASA and they claim that they will always have use for these companies if not in Malabar, in other areas. However, at the end of the day WASA is concerned with cleaning up the environment in terms of what is being discharged into the rivers and streams. They see this as a step in improving the quality of life for those who are living within the Malabar catchment area
❖ The plan for almost a five year period is for one area – Malabar, what is planned for the rest of Trinidad and Tobago?	❖ WASA is also addressing the rest of the island and is already looking at other proposals in proceeding with planning for integrated wastewater systems in other areas within the island. Other catchment areas included in the master plan comprise Maloney, Bamboo, San Fernando, and Southwest Tobago. Some of these projects have already started in terms of the detailed design while others will commence soon. These projects require a lot of capital funding, thus timing of construction will depend on funding as well as support from residents in order for WASA to go to the Central Government who in turn can allocate some funding for WASA to proceed with the different phases of the project. This is consistent with the Vision 2020 that the Government is looking to complete 75% coverage by the year 2020.
❖ Residents welcome the improvement WASA wants to bring to Malabar and environs as well as the whole country. However, for now residents are very concerned about the stench that emanates in the community. They wonder whether it is a	❖ In terms of the stench, it all depends on where the stench is emanating from – whether it is the Water Treatment Plant or the chicken rendering plants located in O'Meara. Some more specifics/information would need to be gathered in order to address the problem.

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Questions/Comments/Concerns	Responses
sewer smell and believe that WASA should do a thorough check of the area.	
❖ The need for employment was also raised again by a resident, whether it is temporary employment during the construction phase of the project?	❖ The duration of work is 52 months. Even though the work is contracted there are stipulations in the contract to ensure that as much as possible and feasible that local labour is employed once they are available and have the required skill/s that is required for the particular job under the contract. It must be remembered that even though the project should take approximately 52 months, capital works will take place in the different sub-catchments and it's going to be a small subset of the entire period. So as the construction work moves from area to area, employment opportunities will be extended to persons from the respective local area.
❖ After WASA has completed the project, will they 'foot the bill', fix or compensate residents whose driveways would be dug up due to the laying of lines and pipes.	❖ Anything that gets disrupted by the contractors doing the work will be required to be reinstated to a good or better condition than when it got started.
❖ Residents showed concern for the potential ecological impacts since the treatment facility will be concentrated at one location and the waste water will be released into a nearby stream. Since it is activated sludge there will be an increase in nitrates and phosphates that may be above ambient level being introduced. What sort of mitigative measures would be put in place if that occurs?	❖ While a larger volume of water would be concentrated at one point of discharge and put into a riverine system, the law requires that wastewater be discharged at a specific quality and that quality is defined by the inland surface waters specifications of the Water Pollution Rules of 2006. ❖ The nutrients in the effluent would be much lower than what is presently going into the rivers due to the raw sewage. Samples at both the existing Arima and Malabar treatment plant was done and then Earthtech ran a model on the activated sludge process to see what the effluent would be like under the different treatment operating conditions. EMA's requirement for the nutrients – phosphorous is around 5 milligrams per litre and Earthtech is predicting that it's going to be less than 3 milligrams per litre. Therefore it's going to be less than what the EMA allows for inland waters. ❖ According to the representative from Earthtech, the EMA, does not have a requirement on nitrates being discharged in inland waters but because the discharge is upstream in the Caroni Wastewater Treatment plant, the process that is being put into place has nitrogen removal, so the amount of nitrates being discharged will be less than what would come from this type of

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	treatment plant. ❖ One of the constituents that can be detrimental to the receiving stream is ammonia and the treatment plant will convert all ammonia to nitrates and then remove some of the nitrogen from the nitrates so that the discharge will below what is typically required for this type of treatment system. With the nitrogen removal, nitrogen gas is produced and goes into the atmosphere. The phosphorous and some of the nitrates also go into the sludge and the dried product so it actually has some nutrient benefits for agriculture and landfill covers.
❖ What plans are there to deal with traffic since it has been recognized as a problem?	❖ The traffic management plan is in preparation stages. However some of the obvious measures include control of the access to the roadways and temporarily converting roadways into one-ways to facilitate movement in and out of the area. Disruption to the highways is not anticipated since micro-tunnelling – a no-dig trenching technology would be utilized so that the movement of traffic and people would not be interrupted that way. Another approach to dealing with the traffic is informing residents as well as other users of the road about the project and its' schedule.
❖ Does the ultraviolet light used in the treatment process have any effect on human beings.	❖ The ultraviolet light is used to ensure that bacteria are killed during the treatment process. According the Earthtech it does not harm human beings because the dosage is not big enough to 'handle our big bodies'. There are no lasting effects to human beings from that. ❖ One of the reasons that many treatment plants are now using UV light is that it replaces chlorination – one of the gases itself is very detrimental to humans. These gases may react with other constituents in the wastewater and some of the by-products are actually cancer-causing. So the use UV light eliminates the possibility of the gases getting into the wastewater that is discharged. The UV disinfection has shown to be very effective and is presently being used at the Beetham plant.

6.6 CONCLUSION

Overall, residents and other stakeholders were in support of the proposed project. They identified several problems which they currently experience in the community. The main ones identified were the pungent smell in the area and the poor quality of the water as well as its irregularity. Some of these problems currently experienced by the residents and communities can be rectified by the establishment and refurbishment of the wastewater treatment plants in Malabar and Maloney. These treatments plants will help in treating the raw sewage not adequately treated in the past due to the in-operation or the malfunctioning of the existing plants.

Other concerns raised by residents and stakeholders were associated with other likely potential impacts such as disruption of the roads, increase in traffic, increase in dust and air pollutants. Another significant concern of residents was costs associated with the project which they may incur. Residents wanted assurance that any damages done to the area due to the establishment of the wastewater treatment plants and collection system, would be repaired and restored in a quick and timely manner. They also wanted to be assured that WASA's claims would be delivered and would actually materialize.

Some of these concerns and questions raised by residents were addressed at the public consultation and are addressed in this EIA report. Some negative impacts most likely to arise, such as dust, can be controlled while others, for example excavation of the roads and traffic, would have to be monitored and managed in order to minimize disruption caused to residents and the communities. Mitigation measures to avoid or reduce the negative potential impacts are described in Chapter 8. One of the most significant benefits which residents and the communities stand to derive from the project, is the improvement and efficiency in the treatment and disposal of wastewater and raw sewage, to adequately meet the demands of the growing communities. This would contribute tremendously to cleaner and healthier rivers, streams and wider environment for residents of the area, something they anticipate.

7 ENVIRONMENTAL IMPACT ANALYSIS

7.1 OVERVIEW

This report has thus far presented the proposed project to construct a WWTP in the Malabar catchment and to upgrade the existing WWTP in the Maloney catchment, together with associated sewerage networks. A review of regulatory considerations has been presented in Chapter 2. Specific plant operations and process descriptions have been provided in Chapter 3. Detailed reviews of the existing environmental conditions have been conducted and the results of these environmental studies were presented in Chapter 5. The review of the existing environment provides a multidisciplinary description of the surrounding ecosystem and general social considerations. Baseline knowledge of the project and the local environment permits the identification and assessment of potential concerns and issues with respect to the foreseeable environmental aspects of the proposed project works, and it forms the basis of this EIA.

This chapter presents the methodology for the identification of probable environmental aspects, a review of predicted project impacts, and an evaluation of these impacts. The objective of this analysis is the identification of significant aspects and impacts which will require appropriate mitigation and/or future monitoring.

7.2 METHODOLOGY

The EIA process provides a formalized procedure for obtaining project specific, local environment, and social information as well as, for further evaluating the anticipated or probable environmental consequences of conducting a specific project activity.

This EIA focuses upon the construction and operation of a WWTP at Malabar, the refurbishment and continued operation of the WWTP at Maloney and associated sewerage works. Evaluation of environmental and social impacts involves the following three steps:

1. Identification of environmental aspects related to the project and its location.
2. Determination of predicted environmental impacts (that is, the predicted impact of each aspect of the project on the selected Valued Ecosystem Components (VECs) and
3. Determination of the relative significance of these predicted impacts.

Duration, magnitude, spatial extent, type and probability are the factors considered in the determination of the level of impact which may affect the environmental aspects identified. A rating is assigned to each of these factors. Descriptors and ratings for these factors are given in Table 7.1.

Finally, a significance class is established. The overall effect of each potential environmental impact on the VECs is ultimately assigned to one of six significance classes indicated in the list below and as defined in Table 7.2: The difference between a local scale and regional scale was determined in terms of magnitude and duration of the impact. Based on this interaction, a scale from 1-3 was assigned, resulting in a classification as a major impact (Class 1), a moderate impact (Class 2) or a minor impact (Class 3). Three other classes were also assigned if applicable as listed hereunder.

- Class 1 – Significant, major impact;
- Class 2 – Significant, moderate impact;
- Class 3 – Insignificant, minor impact;
- Class 4 – No impact predicted (impact unknown due to insufficient information);
- Class 5 – Unknown;

- Class 6 – Positive Impact

Table 7-1 Definitions Used in Impact Evaluations

Criteria	Definitions
<u>Duration</u> What is the length of the negative impact?	• None/no effect • Short - less than one year. • Moderate - one to ten years. • Long - greater than ten years. • Permanent - irreversible
<u>Magnitude</u> What is the effect on the resource within the study area?	• None/no effect • Small - affecting less than 1% of the resource • Moderate - affecting 1-10% of the resource • Great - affecting greater than 10% of the resource
<u>Spatial Extent</u> What is the scale of the impact in terms of area, considering cumulative impacts and international importance?	• Local - in the immediate area of the impact • Regional - having large-scale impacts • Global - having trans-boundary impacts
<u>Type</u> What is the impact?	• Direct – caused by the project and occur simultaneously with project activities • Indirect – associated with the project and may occur at a later time or wider area • Cumulative – combined effects of the project with other existing /planned activities
<u>Probability</u> What is the likelihood of an impact occurring?	• Low <25% • Medium 25-75% • High >75%

Table 7-2 Definitions Used in Significance Evaluations

Class	Significance	Description/Comments
1	Significant, Major impact	Impacts are expected to be permanent and non-reversible on a national scale and/or have international significance.
2	Significant, Moderate impact	Impacts are long term, but reversible and/or have regional significance.
3	Insignificant, Minor impact	Impacts are considered to be short term, reversible and/or localised in extent.
4	Insignificant	No impact is expected.
5	Unknown	There is insufficient data on which to assess significance.
6	Positive	Impacts are beneficial to the key VECs.

7.3 IDENTIFICATION OF ENVIRONMENTAL ASPECTS

An environmental aspect is defined as an element of a facility's activities, products, operations, or services which can or will interact with the environment. These interactions and their effects may be continuous in nature, occur periodically, or may be associated only with specific events, such as emergencies (non-routine). Some interactions may be beneficial; however, for purposes of this EIA, identification of negative impacts and subsequent means to minimize those impacts will be the primary objective.

Based on an understanding of the proposed project and the sequence of project activities, the following list of key environmental aspects was determined (Table 7.3). This list is not all-inclusive but rather represents the key likely impacts. The list is presented by project phases: construction, operation, and decommissioning. The operational phase is broken down further in this assessment to provide greater detail.

Following the identification of the environmental aspects, the potential impacts are then predicted. An environmental impact is a change to the environment and such change can be positive or negative.

7.4 PREDICTED IMPACTS

Each environmental aspect of the project has the potential to impact upon the VECs. These impacts may result in a direct impact on the environment, contribute only indirectly to a larger environmental change, or be cumulative with other impacts over time. This chapter presents the potential impacts of various project aspects upon the environment and in particular, upon the VECs.

Table 7-3 Environmental Aspects

Phase	Project Component	Environmental Aspects
Construction	Enabling Works Piling and Establishment of Underground Utilities General Construction External Works (e.g. road construction and landscaping)	• Procurement of construction materials • Storage/staging of construction materials, chemicals and fuel • Use of labour • Transportation (personnel, equipment, machinery) • Storage/staging of construction materials, chemicals and fuel • Use of construction equipment and machinery • Use of lighting • Equipment fuelling and maintenance • Storage and disposal of construction debris and waste • Use of chemicals, coatings and paint • Ground excavation, ground compaction, trenching, piling • Temporary sanitation facilities • Alteration of grade and drainage patterns • Stockpiling of materials (e.g. soils and stone) • Solid waste management • Water supply management
Operation	Wastewater Treatment Operations	• Wastewater treatment • Effluent release to catchments
	General Operations	• Energy consumption • Use of labour • Transport (material and personnel) • Sludge Management • Odour Management

Phase	Project Component	Environmental Aspects
Decommissioning	General Decommissioning	• It is anticipated that a Decommissioning Management Plan will register the environmental aspects relating to this phase prior to commencement of works.

7.5 VALUED ECOSYSTEM COMPONENTS

VECs are by definition, ecosystem components considered to be important or valuable and which merit detailed consideration in the EIA process (Treweek 1999). To aid in the impact assessment, the concept of VECs will be used as a tool to highlight important receptors (individuals or groups), which may experience beneficial and adverse impacts from the key project aspects.

Based on baseline assessment of the project area (as presented in Chapter 5), the environmental resources can be divided into key categories from which the VECs can be selected as listed in Table 7.4.

Table 7-4 Valued Ecosystem Components (VECs)

Category	VEC	Why is it important?
Water	River water quality	• Health implications for all users • Ecological implications
	Bathing water quality	• Health implications for all users
	Water Resources	• Water resource availability in region
Air and Climate	Air quality	• Contribution to global warming • Nuisance odours and health implications for community
Soil	Soil Quality and compaction	• Determines erosion
Ecology and Biodiversity	Biodiversity	• Importance to biodiversity value (International, National and Regional)

Category	VEC	Why is it important?
	Freshwater Ecosystems	• Internationally protected species
Human Environment	Employees, contractors, community	• Health and Safety of employees and contractors • General Health and Safety regarding waste disposal

7.6 CONSTRUCTION PHASE ACTIVITIES

The main activities for the pre-construction and construction phase of the development that would impact on aspects of the environment include:

- Pre-construction surveys
- Transport of heavy machinery and materials to the project site
- Movement of heavy machinery in proposed construction area
- Fuelling of equipment on site
- Trenching, horizontal drilling and backfilling

Environmental concerns associated with the selection of a site are considered to be negligible or minimal due to the urban nature of the study area and the construction in areas with existing infrastructure.

In regard to pre-construction surveys, the primary concerns related to worker health and safety. This potential impact will be minimized by completing pre-activity job safety analysis and training staff in safety procedures prior to any work on project sites.

Pre-Construction Activities

Land Acquisition

The location of the proposed Malabar Wastewater Plant is currently under agricultural activities and the area proposed for expansion of the Maloney Wastewater Treatment Plant is under active agricultural production. These lands are under Government Leases to farmers, with several of the leases set to expire or have recently expired. The proposed development will result in the alienation of agricultural land. This is an unavoidable impact of the proposed development. This will be a localised impact, as only the lands identified for construction will be acquired.

Procurement of Construction Materials

Materials for the construction of the site facilities will be sourced nationally where practical. The raw materials required for the construction of the site facilities will be transported to the site from suppliers throughout the country or through importers organised by the construction management firm and its subcontractors. The delivery of materials will be conducted over time and may temporarily increase the pressure on vehicle use, general road traffic creating short term traffic delays through the surrounding areas.

A positive benefit will result from the trade with local markets for the purchase of raw materials during construction activity. In terms of the sourcing of sustainable or renewable materials, all materials purchased will be chosen based upon balancing strength of materials, material and product compatibility, lifespan of materials, availability of supply, price, and the sustainability of the source. However, as the majority of the construction will require concrete, metal and other specialized materials, there will not be a great deal of opportunity for utilization of sustainable products. However, it is noted that materials, such as concrete and metal, can be recycled. This is a mechanism likely to be adopted during any demolition works undertaken as part of decommissioning.

Overall potential impacts from this aspect include:

- Highly localised and temporary impact to air quality from vehicles emissions
- Periods of increased transport congestion
- Economic benefit through trading with national suppliers

- Increased demand for water during construction will temporarily increase loading on local water resources in Trinidad

Transport (Personnel, Equipment, Machinery)

Transport will include the carriage of personnel to the site as well as the transport of heavy equipment and machinery as required during the construction stages. There will be additional pressure on all road networks surrounding the site and particular heavy use will be along the Churchill Roosevelt Highway. Some very heavy loads may result in vibration to housing structures along the main transport links, plus associated noise. Increased vehicular traffic of all types will lead to increased risk of collision and accidental events, and will also result in increased vehicle emissions, including particulates, carbon monoxide, carbon dioxide, hydrocarbons, and oxides of sulphur and nitrogen. Overall, the impacts will be of short duration and are not expected to have a significant long term impact.

Air Quality:

- Exhaust emissions and noise from heavy construction traffic, site machinery and personnel cars

All local communities:

- Increased traffic to the site causing congestion.
- Periods of traffic delays for local community.
- Heavy vehicle noise/ vibrations through residential areas.
- Need for local drivers, machine operators and
- Personal health and safety.

All local biotic communities:

- River water quality.
- Biodiversity and

- Spills from fuel transfer and handling.

All contractor communities:

- Employees and contractors and
- Increased risk of collision and spillage and subsequent health and safety implications.

Storage / Staging of Construction Materials

Materials will be brought to the site on a demand basis and stockpiled. Some of these operations may generate dust. Stockpiles will alter the profile of the site and may be visually obtrusive to local communities neighbouring the site. Stockpiling of materials may also increase surface water runoff in the absence of proper stormwater management techniques. Overall potential impacts from this aspect include:

All local communities:

- Temporary visual intrusion of landscape features
- Dust generation

Construction Activities

Use of Construction Equipment and Machinery on Site

All personnel responsible for heavy equipment operation will be sufficiently trained to operate the specific construction equipment and machinery. Improper and/or negligent operation of heavy equipment can lead to severe injury and loss of life, and can impact both the operator and nearby victims. Construction equipment and machinery will be sourced from a combination of national contracts (and from abroad where necessary).

The use of construction equipment and machinery will be a potential source of nuisance impacts such as noise, vibration, odours and air emissions. Emissions from the combustion of fuels and greenhouse gas emissions will routinely occur during the use of construction equipment and machinery.

Dust generation is considered to be the most significant potential contributor to air quality degradation in the absence of proper mitigation, with the potential to affect workers on-site and others off-site. Potential receptors include people using the adjacent roads, land or working in areas adjacent to construction (such as during construction of sewerage works).

All local communities:

- Increased air emissions
- Personnel Health and Safety

River Water Quality:

- Fuel / oil spills from on-site maintenance and re-fuelling
- Waste lube oils etc from maintenance

All Communities, Employees and contractors:

- Health and safety implications during accidental events
- Disposal of waste materials, including filters, oily rags, lube oil etc
- Positive opportunity through demand for local fuel supply contractors

Erosion

Erosion potential is associated with two construction activities:

- Clearing and Grading
- Trenching and backfilling

Clearing and Grading:

Soil erosion may occur when the proposed sites for the wastewater treatment plants are cleared and graded because of exposure of soil to wind, when the protective vegetation is removed. However, due to the general flat nature of the proposed sites there is very little erosion anticipated. The layout of the construction activities will be designed to minimize the area of land to be cleared. This impact is unavoidable and of short duration.

Roadways

During the construction period, one of the major impacts that will occur is the disruption to the surface area and roads due to the excavation or digging up of the roads and other surface areas. These activities are essential for the laying of pipes, sewage mains and other underground infrastructure that is necessary for the operation of the WWTPs and the collective sewer system.

All roadways will be crowned and elevated as required above existing ground to provide drainage to adjacent ditches to ensure the pavement structure remains in an unsaturated condition. Roadway profiles will be coordinated with building elevation at delivery points to maintain the appropriate elevation of vehicles in relation to the facility they are accessing. Roadway profiles will also be coordinated with piping layouts to ensure adequate clearance between pavement structures, ditch inverts and pipes.

Drainage

Drainage in the immediate vicinity of the construction site can be impeded if cleared vegetation and soil are improperly disposed. The improper disposal of cleared vegetation is not the only construction activity which might impede drainage. Several other practices have potential to cause flooding of the trenches as well as erosion of backfill. These include:

- Improper storage and disposal of trenched soil, and

- Improper construction across any watercourses.

Surface Water Quality

Impacts on surface water quality may arise from two sources:

- Siltation (as a result of erosion), and
- Fuel spills and disposal of spent lubricants.

These impacts, if they occur, could affect the quality of both surface and ground water. Siltation of streams is closely related to erosion but some silt entrainment may also be expected during the construction near river crossings. Dry season construction will reduce the siltation concerns related to run off.

In general, siltation impacts resulting from construction activities associated with the collection systems, are expected to be transient, lasting only until re-vegetation of the site locations (such as areas adjacent to proposed wastewater treatment sites) or exposed areas are resurfaced (such as roadways), or until the stream beds and banks stabilise after construction. A possible impact is for the transport of silt some distance from the construction site. Depending on the original clarity of the watercourse, the flow velocity, and the column of silt that is entrained, this impact may be noticeable more than 100 m downstream of the construction site.

Site Access

A large amount of construction equipment and vehicles will be moving back and forth into the site and appropriate site access must be provided. Passage of these vehicles may also create traffic congestion. Site access will be restricted to existing roads.

Transportation of Construction Materials and Wastes

As with transportation of pipes and timber, movement of other materials and wastes also have the potential to create traffic congestion. This impact is low, will occur over a period of six months during the construction phase of the project, and will be carefully mitigated with an aggressive traffic management plan to be developed and implemented by WASA and complied with by their construction contractors.

Working Conditions on the Construction Site

Worker health and safety concerns may also arise during construction, for instance, by:

- Use of hazardous machinery.
- Movement of heavy machinery.
- Construction noise, and
- Handling of hazardous chemicals.

Public Health & Safety

All activities associated with the construction of the proposed works will be controlled via a specific Environmental, Safety and Health Plan. This plan will require the Construction Contractor and all subcontractors to embrace a zero accident tolerance philosophy and to manage the Project to achieve the target of zero injury or illness cases, zero fatalities and zero incidents of any nature that could adversely affect the work force, the environment or its inhabitants, property or equipment. The construction activities within the study area may take place adjacent to operational pipelines (potable water and natural gas). At the engineering phase of the project, specifications and design criteria are be established to ensure that any pipeline will be avoided for safe construction of sewerage works.

Clearing and grading activities also have the potential of generating dust emissions, which may aggravate respiratory ailments. The mitigation measures outlined for the control of dust emissions will have the dual function of protecting public health.

Public safety may also be adversely impacted during the transport of heavy machinery and material along public roads. These activities are temporary, lasting only as long as the construction activity. It should be noted that except for transportation, all other activities will occur within the construction zone.

Storage and Disposal of Construction Wastes

The main environmental impacts associated with the storage and disposal of construction debris and related wastes relate to the management and control of the wastes. In the absence of proper controls and storage supervision, spillage and leaks of waste material from containers may contaminate storm water. Improper segregation, lack of proper identification, or negligence can lead to improper disposal, with the resulting potential for soil, groundwater, or surface water contamination.

There is the opportunity to recycle some construction debris for purposes such as landscaping. However for non-recycled material, off-site land filling will be the primary disposal option. There will be no open-burning of waste conducted on the site. The Guanapo Sanitary Landfill is likely to be the main accepting landfill for non-hazardous construction wastes. As such, the disposal of construction wastes poses an additional burden on the landfill capacity of Trinidad. Moreover, the transfer of waste by truck and over-road lorry will mean additional traffic and associated noise, vibration, air quality reductions and road safety implications (particularly in road side communities). The benefits of landfill waste disposal are solely economic with increased revenue potential for selected waste haulage and landfill operators.

Use of Chemicals, Coatings and Paint

The storage and controlled use of chemicals, coatings and paint are important in minimising negative impacts on the environment and workers. All hazardous materials will be stored in a designated zone and personnel will have appropriate Health and safety (H&S) training to use such chemicals. Chemicals, coatings, and paints will be stored under cover where feasible.

Temporary Sanitation Facilities

During the construction phase, temporary sanitation facilities will be set up for use by the construction staff. A temporary treatment system will be utilised for the facility. Impacts are therefore considered to be minimal, unless a rupture of the system occurs. Spills of untreated wastewater may occur on the site or during transfer to a treatment facility. Sanitation facilities will require water supplies, which will be provided by the installation of a proposed water supply main.

7.7 OPERATIONAL PHASE ACIVITIES

Employment

The Malabar and Maloney WWTPs are designed for operating staff being in attendance 24 hr/d, 7d/wk (24/7).

The WWTP on-site staff is categorized as follows:

Staff	Required Number
Managerial	3
Administrative support	2
Operations	6
Laboratory	2
Maintenance	5
Total	18

Additional staff will be required for maintenance of the collection system and lift stations. It is anticipated two crews of one crew chief and two labourers will suffice. The collection system maintenance staff will be housed at a central location within the catchments. A possible location will be the abandoned Arima WWTP where building and equipment for maintenance activities already exist.

This brings the total staff required to twenty-four employees.

In both catchment areas, the responses in the CSO report as well as the household surveys indicate that the majority of the respondents were mainly employed in the service industry/sector. Other significant employment sectors included construction and manufacturing. Most residents were employed in elementary; craft and related; clinical as well as technical jobs. This may indicate that although the level of formal education among the residents within the community, some of them possess the necessary skills to access employment. Therefore, during the construction of the project, residents who possess the required knowledge and skills may have an opportunity to access employment.

However, during the operation and maintenance of the project WWTPs, lift stations and associated collection system, the treatment plant will be operated by the contractor for a period of three months after the issuance of the Taking Over Certificate and before acceptance by WASA. After this period, plant operations personnel will be provided by WASA and they will undergo and complete several training sessions.

The employment opportunities would come after the completion of the detailed design for the wastewater treatment plant and collection systems. Most likely these opportunities for employment will take place during the construction phase and will be short term and minor, i.e. occurring at the local level, since the project is broken up into phases and will take place over a four year period.

Economics

The increase of water and sewerage rates is one of the most likely economic issues to arise due to established and refurbishment of the WWTPs in the communities. This concern was expressed by residents or householders on whether they would have pay any additional fee for the service provided by the new and refurbished WWTPs and associated collection system. In fact, most residents who took part in the household survey conducted by MFO indicated that they were unwilling to pay any additional fees for the service. While the minority who were willing to pay an increased for the services indicated that they were willing to pay an increase of $45.00. This may be of significant concern since residents who are not currently connected to the centralized system would get an increased water and sewerage bill for the new service when they are connected to the new system. For those who are presently connected to the sewer system, they already pay for both water and sewerage and initially for them there is no increase. It's only when water rates are increased for the country as a whole then there will be a concomitant increase in sewage rates. Once the proposed wastewater management national plan (of which the proposed project is a component) comes on track, because of the major capital outlay, the government may increase the water and sewerage rates. However, the quantum of increase is not known.

Noise

With regards to noise levels, with past business and industrial developments, only a minor portion of the residents indicated noise as one of the impacts of the developments. However, residents from several of the communities in the study area identified noise as a nuisance that they experienced on a continuous or daily basis. Nevertheless, there may be minimal increase to the noise level during the operation of the facilities.

The only sources of noise in the collection system are associated with the lift stations. In the Malabar catchment, noise from the small lift stations located in residential areas should be minimal because the facilities are designed for submersible sewage pumps located well below the ground surface in concrete chambers (wet wells). The two larger lift stations have ventilation fans in addition to the sewage pumps. These fans are located outdoors and will be a source of noise, but not at significant levels. In addition, these two lift stations are located away of any residences. The Arima lift station will be located on the site of the existing Arima WWTP, while the Gill's View lift station will be located west of the Arima River and just south of the abandoned train line.

Similar considerations will be taken into consideration when designing the lift stations in the Maloney catchment.

Water Quality

The proposed works will have a positive impact on the water quality in the receiving catchments and the catchment that currently receive untreated sewage from non-functional package WWTPs. The poor water quality of the receiving water bodies has been identified as an area of concern in the management of the tributaries of the Caroni River. The proposed project is expected to be a positive (Class 6) impact and have a long term effect on water quality.

This expectation is strongly supported by the operating experience gained from the New Beetham WWTP serving Port of Spain and its environs. Since it began operation in 2005, it has consistently produced high quality effluent with contaminant levels well below the regulatory requirements. This is significant because the Malabar and Maloney WWTPs will be using the same process as the New Beetham WWTP.

Air Quality

In terms of air, there may be minimal increase in air pollutants during the construction and operation of the proposed and refurbished facilities and if air degradation occurs it would take place mainly at a local level. Residents and communities did not express much concern about the air quality. However, during the public consultations as well as within the household surveys, residents expressed concerns about odours emanating from the facilities. In the past and currently, residents have claimed to smell ‘horrible’ stenches emanating from the plants and they are concerned that this issue may occur during the construction and operation of the new and refurbished facilities. These odours are likely associated with poorly performing or failed systems that allow raw sewage to accumulate and putrefy. The new WWTPs will solve this problem by providing facilities that can be properly operated and maintained by WASA.

The proposed sewering of areas within the Maloney and Malabar catchments will have a beneficial impact (Class 6) for the present conditions in the study area.

Other air quality issues typically associated with WWTP operations relate to pumping the raw wastewater into the WWTP, handling of grit and screenings removed from the raw wastewater, and sludge processing operations.

These issues have been addressed during design of the Malabar WWTP. The influent pumping station is completely enclosed and positively ventilated to ensure odorous gases such as hydrogen sulfide do not accumulate and get released at concentrations above the odour thresh hold. Debris removed in the fine screens and grit chambers will be washed and dewatered to minimize odours. The materials will be placed in covered bins until transported to landfill for disposal. Residual solids processing is also expected to generate minimal odours. Solids will only be removed from the activated sludge process when they can be dewatered immediately. Once dewatered, the cake will be transported to the solar greenhouses for drying. Experience at plants in other parts of the world has shown this treatment process to generate minimal odours. The final level of protection for the surrounding communities is the substantial buffer zone around plant. Any small amount of odour generated on site will be dissipated before reaching the WWTP fence line.

While this description is for the Malabar WWTP, which has been designed, the same concepts will apply to the Maloney WWTP.

Some of the odours reported by residents may also be associated with plugged or failed sewers that allow ponding and putrefying. All the new sewers will be design and installed with appropriate slopes to ensure suspension of solids so they get transported to the WWTPs.

Traffic

As mentioned above, during the installation of the sewage collection system and construction and refurbishment of the WWTPs, one of the significant impacts that would arise out of this project is the disruption to the surface areas and roads. An inevitable spin-off to this impact would also signal a minor disruption to the road networks which would contribute to the traffic in eastern Trinidad. The roads in the study area have been identified by residents as having heavy traffic during peak hours. Within the household survey conducted by MFO, residents complained that business and industrial development in the past has lead to increased traffic. In addition to this, residents in most of the communities also expressed that traffic is a nuisance that they experience on a daily business. Traffic caused by the proposed project would therefore add to the traffic already experienced by residents and commuters in the east. However, the traffic contribution from the proposed project will be vehicles utilised by personnel (of a daily workforce of 24 workers) and vehicles to supply or remove material (such as supply material or remove sludge). This can be considered a minor impact but long term, arising out of the establishment of the WWTPs and the collective sewer system in the east.

Health and the Environment

The proposed project will improve the present water quality of the rivers (tributaries of the Caroni River) that receives untreated sewage from the non-functional WWTPs. The improvement of water quality will be a beneficial impact to the users of the river systems (such as recreational users or farmers extracting water for crops). In particular, the reduction of levels of faecal coliform (Section 5) will be beneficial impact (Class 6) and long term impact.

Decommissioning Phase Activities

The design of the two WWTPs is expected meet the projections to 2035 and beyond. The plants however, should last well beyond the design period since infrastructure such as concrete tanks have a service life of 50 years. While equipment life is much less, equipment will be replaced as necessary during the life of the WWTPS.

As the useful life of the facility approaches, WASA will develop a decommissioning plan in consultation with all relevant statutory authorities that will guide the safe decommissioning of the facility. This plan will evaluate the options of dismantling or removing it entirely. Whatever option decided upon in consultation with relevant stakeholders will consider the best environmental and economic options available at that time.

Table 7-5 Impact Analysis Matrix for the Establishment of a WWTP and Associated Collection System in Maloney and Malabar

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Pre-Construction	Procurement of Construction Materials	Air Quality	Highly localized decline in air quality from vehicles	Short	Small	Local	Indirect and cumulative with other road traffic	Moderate	3
		All local communities Employees and contractors	Increased labour requirement in the construction phase	Short	Small	Local	Direct	High	6
			Personal health and safety from delivery of materials	Short	Small	Local	Direct	Low	3
	Employment and Training	Local communities and potential employees	Employment challenges due to lack of skilled workers, unknown selection criteria/process	Short	Small	Local	Direct	Low	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Employment	All local communities Employees and contractors	Construction related employment.	Short	Small	Regional	Direct	High	6
			Migration of labour to the area	Short	Small	Local	Indirect	Moderate	4
			Employment challenges due to lack of skilled workers, unknown selection criteria/process	Short	Small	Local	Direct	Low	3
	Transportation (Personnel, raw material, equipment and machinery	Air Quality	Emissions (noise and air) from heavy construction traffic, site machinery and personnel cars	Short	Small	Local	Direct and cumulative with private vehicles	High	3
		Local communities	Increased traffic and congestion. Limited road access	Short	Moderate	Local	Indirect and Cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Transportation (Personnel, raw material, equipment and machinery)	Local communities	Heavy vehicle noise/ vibrations through residential areas.	Short	Small	Local	Indirect and Cumulative	High	3
			Need for drivers, machine operators.	Short	Small	Regional	Direct	High	6
			Personal health and safety	Short	Small	Local	Direct	Low	3
		River Water Quality	Increase in surface water run-off due to soil compaction	Short	Small	Local	Indirect	Medium	3
	Transportation (Personnel, raw material, equipment	Local communities River water quality Biodiversity	Spills from fuel transfer and handling	Short to permanent depending on severity of spill	Small to great depending on severity of spill	Local	Indirect	Low	2

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	and machinery)	Local communities Employees and contractors and biodiversity	Increased risk of collision and spillage	Short to moderate depending on severity of spill	Small to great depending on severity of spill	Local	Indirect	Low	2
	Storage/ Staging of Construction Materials	Local communities	Temporary visual intrusion of landscape features.	Short	Small	Local	Direct	High	2
		Air Quality	Dust generation and noise	Short	Small	Local	Indirect	High	3
		River water quality	Change to runoff characteristics and infiltration rates.	Short	Small	Local	Indirect	Medium	4
		Soil quality and Compaction	Compaction of soils	Short	Small	Local	Indirect	Medium	4
	Use of Construction Equipment and Machinery on Site	All local communities	Increased air emissions	Short	Small	Local	Indirect and cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Use of Construction Equipment and Machinery on Site	All local communities	Personnel Health and Safety	Short	Small	Local	Direct	Low	3
		Air and Noise Quality	Increased noise	Short	Small	Local	Indirect	High	3
			Vibrations impacts from heavy machinery usage on site.	Short	Small	Local	Indirect	High	3
			Dust generation	Short	Small	Local	Indirect	High	3
		All Communities	Increased risk of collision and accidental events	Short	Small to great depending on severity of event	Local	Indirect	Low	2
	Use of Construction Equipment and Machinery on Site	Employees and contractors	Health and safety implications during accidental events	Short to moderate depending on severity of accident	Small to great depending on severity of event	Local	Indirect	Low	2

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Vehicle and Equipment Refuelling and Maintenance	Employees and contractors	Health and safety implication in the event of an accidental spill	Short	Small	Local	Indirect	Low	2
		All local communities	Disposal of waste materials, including filters, oily rags, lube oil etc	Short	Small	Local	Direct	High	3
			Positive opportunity via demand for local fuel supply contractors	Short	Small	Regional	Direct	High	6
		Local communities	Increased pressure on Trinidad landfill capability.	Permanent	Moderate	Regional	Direct and cumulative	High	3
Construction		All local communities	Increased heavy transport of waste materials	Short	Small	Local	Direct and cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Vehicle and Equipment Refuelling and Maintenance	Air Quality	Emissions from waste transfer lorries	Short	Small	Local	Direct and cumulative	High	3
		Water Quality	Accidental Spill of fuel and spent lubricant	Medium	Small to Medium	Local	Direct	Low	3
	Storage and Disposal of Construction Material and Wastes	Local communities Employees and contractors	Health and safety implications with waste haulage lorries on public highways	Short	Small	Local	Direct	High	3
		Contractors	Economic benefits for waste haulage and landfill companies	Short	Small	Regional	Direct	High	6
		Excavated Soil, Rock Material and Vegetative Material	Removal of soil cover and excavation of soil/rock material	Short	Small to Moderate	Local	Direct	Medium	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Use of Chemicals, Coatings and Paint	River Water Quality Fishing	Increased risk of spills and hazardous compounds impacting surface water resources.	Short to moderate depending on severity of spill	Small to moderate depending on severity of spill	Local to regional	Indirect	Low	3
		Employees and contractors	H&S issues for site personnel using hazardous compounds	Short	Small	Local	Direct	Low	2
	Horizontal Directional Drilling, Ground Excavation, Compaction and Clearing and Grading	Local communities and Drainage	Localised flooding in association with river as a result of increased runoff	Short	Small	Local	Indirect	Low	3
			Visual impacts for local community	Short	Small	Local	Direct	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Horizontal Directional Drilling, Ground Excavation, Compaction and Clearing and Grading	Air Quality	Noise generation from machinery	Short	Small	Local	Indirect	High	3
			Dust generation from excavation and other works	Medium	Medium	Local	Direct	High	2
		Local Communities	Dust generation from excavation and other works	Medium	Medium	Local	Direct	High	2
		Biodiversity and Soil Cover	Erosion of exposed soil and subsequent sediment laden runoff reaching aquatic systems	Short	Small	Local	Indirect	Low	3
		River Water Quality	Instability of contaminated soil and subsequent water pollution	Short	Small	Local	Indirect	Low	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Horizontal Directional Drilling, Ground Excavation, Compaction and Clearing and Grading	River Water Quality	Tracking of contaminants using unwashed machinery/ heavy plant	Short	Small	Local	Indirect	Medium	4
	Horizontal Directional Drilling, Ground Excavation, Compaction and Clearing and Grading	Water Resources River Water Quality	Ground and Riverine water resources may become partially silted	Short	Small	Local	Direct	High	3
		All Communities	Traffic where boring and restoring pavements are to occur	Medium	Small	Local	Direct	High	2
		All Communities	Site Access	Short	Small	Local	Direct	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Alteration of Grade	River Water Quality Water Resources	Alteration of drainage patterns and impeding of Drainage / Siltation of rivers /Flooding	Short to moderate depending on disposal of trenched soil and debris The amount of impermeable material used	Small	Local	Indirect	Medium	2
	Waste Management Temporary sanitation facilities/ workers camp	River Water Quality	Pollution of surface water from spills and leaks	Short	Small	Local to regional	Indirect	Low	3
	Waste Management Temporary sanitation facilities/ workers camp	All local communities	Odour/ health issues if septic tanks rupture or spills occur during transfer to a waste treatment facility	Short to permanent depending on severity of spill	Small	Local	Indirect	Low	3
		Air and Noise Quality	Increased noise and air emissions from	Short	Small	Local	Direct and Cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Waste Management Temporary sanitation facilities/ workers camp	Air and Noise Quality	emptying machinery						
			Increased vibrations from machinery	Short	Small	Local	Indirect	High	3
	Stockpiling of material	All local communities	Barriers to rights of pedestrian access for local community.	Short	Small	Local	Direct	High	2
			Visual intrusion for local residents	Short	Small	Local	Direct	High	2
		River water quality	Disturbance to contaminated soil and subsequent groundwater pollution	Short	Small	Local	Indirect	Low	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Worker Health and Safety	All Communities/ potential employees	Workers affected by use of hazardous machinery, movement of heavy machinery, working on open trenches	Short	Small	Local	Direct	Low	3
			Security due to increase of workmen and raw material	Short	Small	Local	Direct	Low	3
	Worker Health and Safety		Public affected by transporting of material and increases in traffic and heavy equipment	Short	Small	Local	Direct	Low	3
		Air Quality	Effects from noise and increase in particulates from use of heavy machinery	Short	Small	Local	Direct	Low	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Construction	Water supply management	Employees and Contractors	Use of water supplied privately by water trucks to ensure sanitary conditions and health of workers	Short	Small	Local	Direct	Moderate	6
		Water Resources All Communities	Increased demand for water during construction will temporarily increase loading on water resources	Short	Small	local	Direct	Medium	3
	Solid Waste Management and disposal of material	All Communities	traffic congestions from haulage vehicles transferring non-hazardous solid waste to landfill	Short	Small	Local	Indirect and Cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
	Solid Waste Management	Employees and contractors	Health and safety implications from working with hazardous waste materials	Short	Short to permanent depending on level of exposure	Local	Direct	Low	4
	Solid Waste Management	Water resources	Ground water pollution at landfill site due to leaching	Short	Moderate	Local	Indirect	Low	4
Construction		Environment Land Fill facilities	Increased pressure on land fill facilities	Short	Moderate	Local	Direct	Medium	3
Operation	Wastewater treatment	All Communities	Cumulative effect of further haulage vehicles transferring solid wastes to landfill.	Long	Small	Local	Indirect and cumulative	High	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Operation	Wastewater treatment	Air quality	Indirect air emissions from energy consumption for treatment plant.	Long	Small	Local	Indirect and cumulative	Moderate	3
			Odours from WWTPs	Long	Small	Local	Indirect	Low	3
		Water quality (riverine)	Improvement of water quality	Long	Great	Local	Indirect and cumulative	High	6
	Water supply management	All communities	Long term water supply potential with treated effluent	Long	Small	Local	Direct	Medium	6
	Energy consumption	Air Quality	Air emissions from fuels used for powering equipment such as generators	Long	Small	Local	Direct	Medium	2
Operation	Transport of Materials	Local communities	Increased traffic congestion.	Long	Moderate	Local	Direct and cumulative	Medium	3
			Emissions (noise and air) from heavy maintenance traffic, site	Long	small	Local	Direct and cumulative	Low	3

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Operation	Transport of Materials cont'd	Local Communities	machinery and personnel cars.						
			Generation of dust from traffic on unpaved areas.	Short sessions during life span of plants	Small	Local	Indirect	Low	4
	Security	All Communities	Improved security.	Long	Small	Local	Direct	Moderate	6
	Employment	All Communities	Increase opportunity for employment, training and apprenticeships	Short to long depending on contract	Moderate	Local and regional	Direct	High	6
		All local communities Employees and contractors	Increased transport congestion.	Long	Small	Local	Indirect and cumulative	High	3
			Increased labour requirement	Long	Small	local	Direct	High	6

Project Phase	Aspect	VEC Affected	Impact	Duration	Magnitude	Spatial Extent	Type	Probability	Significance Ranking
Decommissioning	It is anticipated that a De- commissioning Management Plan will register the environmental aspects relating to this phase prior to commencement of works								

Class	Significance
1	Significant, Major impact
2	Significant, Moderate impact
3	Insignificant, Minor impact
4	Insignificant
5	Unknown
6	Positive

N.B It is anticipated that the construction phase of this project will span a period of 30 months for the Malabar WWTP and 34 months for the Malabar Collection System. The construction phase for the Maloney WWTP is expected to span 24 months, and 18 months for the collection system. The operation of both systems would be conducted by WASA and is expected to commence upon the completion of construction starting on the date that the Taking Over Certificate is issued. The operational phase is expected to continue throughout the life of the WWTPs which is approximately 25-30 years.

It can be gleaned from the matrix that the major positive impact is that of opportunity for labour/employment both in the short and long term for both individuals and contractors.

No aspects were found to be of significant major impact (ranking1).

Factors which received a significance ranking of 2 and therefore by definition may result in significant moderate impact, may require mitigation measures to be implemented.

These include such factors as possible spills and increased risk of spills from fuel transfer and handling during transfer of equipment and machinery, which may impact upon riverine water quality and biodiversity. The probability of this event is considered to be low however. Transportation of equipment and machinery can also lead to an increased of collision and fuel spillage thereby impacting on the community and the environment. The probability of this event is also considered to be low.

Visual intrusion of landscape features, and barriers to rights of pedestrian access caused by stockpiling and storage of material and thereby affecting nearby community also received a similar significance ranking because of its high probability. This impact however is expected to be localized and of short duration.

Increased risk of collision in the use of construction equipment and machinery while similarly ranked, is considered to be low in probability. Health and safety implications due to accidental events including spills and handling of hazardous compounds are also considered to be of significant moderate impact. While the probability of the events is considered to be low it should be noted that appropriate HSE policies would be adhered to for the duration of the project.

Construction works including excavation and trenching would lead to impacts on air quality and upon the local community due to increased levels of dust. Increased traffic during construction due to pipe laying works is also expected and mitigation measures are recommended in the following Chapter.

A significant moderate impact may result from the alteration of grade/drainage patterns in the project area and lead to siltation and an impact on riverine water quality. Impacts such as this would require mitigation measures.

Air quality may be impacted upon by emissions emanating from the operation of machinery and equipment. As reflected in the impact matrix, depending upon the amount of machinery and the duration of use, this impact may be significant and moderate and mitigation measures may be required.

The following chapter describes mitigation measures to be employed to limit and control impacts and demonstrates how the mitigation can lead to a reduction in impact and significance ranking.

7.8 CUMULATIVE IMPACTS

Cumulative impacts refer to the combined effects of developmental activities or projects in a specified area or locality. These impacts may occur simultaneously, sequentially or in an interactive manner over a particular period of time. Typically it is the impacts which are permanent or long term and those of high significance ranking and residual impact ranking which significantly factor into to cumulative impact consideration. Additionally, it is those impacts which correspond with similar impacts of other projects within the project locale which factor into cumulative impact consideration. It is noted that currently there are no significant ongoing or future planned projects within the project locale which require consideration regarding cumulative impact. As a consequence cumulative impact study is not pertinent to this project.

Nevertheless, review of the project reveals permanent or long term impacts which include increased pressure on landfill capability, increased traffic and use of vehicles, as well as the associated increase in emissions. These impacts however have a minor significance ranking. In the case of vehicular emissions and increased traffic will be mitigated against to reduce impacts. (Table 8.1 refers).

Impacts with significant moderate impact ranking (2) include risk of collision and spillage and resulting personnel health and safety issues during construction transportation, and visual intrusion of landscape features. These impacts are temporary and do not factor into cumulative impact consideration, in view of the fact that there are no ongoing projects in the area. Other noteworthy impacts include increased vehicular traffic and dust generation during construction. Once again these impacts are temporary and do not factor into cumulative impact consideration.

8 MITIGATION MEASURES

The following sections present in bullet form all of the mitigation measures required to limit and control the impacts to the biophysical and social environment identified in Chapter 7. It is believed that the format chosen will allow WASA to translate these mitigation measures into a working document that can be provided to its contractors and operations personnel for implementation during the construction and operational phases of the project. Note that where impacts were determined to be insignificant, no mitigation is required.

A summary of the mitigation strategies and residual impacts can be found in the framework mitigation management plan in Table 8.1 at the end of this chapter.

8.1 PRE-CONSTRUCTION

8.1.1 Land Acquisition

- Minimise the agricultural land to be acquired.
- Liaise with affected farmers, Farmers Groups, relevant Government Ministries and relevant Authorities and
- Liaise with Ministry of Agriculture, Land and Marine resources for provision of suitable alternative agricultural land as compensation to farmers for loss of formerly Government Leased land.

8.1.2 Employment and Training

- Use a transparent, non discriminatory hiring process and
- Outline the selection criteria.

- Require that WASA Contractor(s) use local labour to the extent that this is possible and
- Where skilled labour is required, potential recruits must satisfy the necessary skill requirements, however training can be conducted to enhance the skills of local labour force.

8.1.3 Erosion (clearing and grading)

- Minimise area of bare soil.
- Schedule clearing for dry season.

8.1.4 Erosion (trenching and backfill)

- Provide an erosion resistant cap over the trench as required.
- Installation of silt fencing or other means for controlling erosion and runoff and.
- Provide paved drains to channel runoff to natural water courses as required.

8.1.5 Slope Instability

- Provide surface and subsurface drains to intercept water flow.
- Minimise the length of trench that is kept open at any time.
- Provide surface storm water diversion berms as may be needed.
- Installation of slit fencing or other means of erosion and runoff control when trenching through open areas and
- Stock piling will be more than 3 m from waterways.

8.1.6 Drainage

- Place mounds of cleared vegetation and excavated material so as to preserve major drainage patterns of surface flow.
- Restore all banks of watercourses and terrain to their pre-construction contours as required to maintain natural surface drainage.
- Restore terraces, levees and drainage ditches to as near their original conditions as required to maintain natural surface drainage and
- Remove spoil, debris, piling, cofferdams and other temporary measures from watercourses to prevent interference of storm water drainage, normal water flow and watercourse use.

8.1.7 Air Quality (Dust)

- Clear only the area needed for construction.
- Wet the cleared area as required for dust control (or use of another dust palliative), especially during the dry season.
- Prohibit burning of waste and
- Minimise and control construction traffic.

8.1.8 Air Quality (Exhaust Fumes)

- Perform vehicle inspections.
- Maintain internal combustion engines.
- Use suitable emission controls and
- Optimize the use of equipment and vehicles.

8.1.9 Noise

- Maintain equipment and vehicles and have them fitted with noise abatement devices (mufflers).
- Confine activities close to populated areas to between the hours of 7 am and 7 pm and
- Conduct dialogue with administrative representatives from the nearby schools prior to construction in the area.

8.1.10 Water Quality: (Fuel Spills & Disposal of Spent Lubricants)

- Identify specific sites for fuelling and servicing (refuelling of vehicles within a minimum of 70 m from surface water bodies, groundwater recharge areas, water wells and WASA facilities will be prohibited).
- Use only approved pumps and nozzles for refuelling activities.
- Place disconnected hoses in containers to prevent spills from residual fuel and
- Use oil absorbent material for mopping up oily sheens from spills and leaks.

8.1.11 Ecology (Terrestrial)

- Minimise the amount of vegetation to be cleared.

8.1.12 Waste Management (Soil and Rock Material)

- Stockpile and replace topsoil after construction and
- Use excavated material as fill, cover and protection.

8.1.13 Waste Management (Sanitary Waste)

- Use portable toilets on site, empty periodically and haul the waste to a sewage treatment plant or a septage facility which is approved by WASA.

8.1.14 Waste Management (Construction Solid Waste)

- Dispose of all non hazardous solid wastes which are not recycled or returned to the supplier at a designated waste disposal areas approved by SWMCOL.

8.1.15 Waste Management (Construction Special Waste)

- Pursue avenues for recycling/reuse as far as practical.

8.1.16 Road & Traffic Access (Excavations for Road Crossings)

- Require WASA contractors to prepare a detailed Traffic Management Plan and submit it to WASA for review and approval before any construction on roadway commences.
- Make road crossings by boring of roads rather than open-trench construction.
- Informing national community of traffic disruptions.
- Make provisions for detours on more lightly-trafficked roads and traces, where crossings will be constructed by open-trench techniques.
- Provide personnel to maintain efficient traffic flow on partially blocked roads with appropriate signage (such as stop/go signs) and safety equipment (such as fluorescent vests).
- Provide adequate warning signs and warning flagging tape for open trenches and

- Restore damaged pavement to its original condition as soon as practical after completion of construction works (the contractor).

8.1.17 Road & Traffic Access: (Transportation of Material)

- Provide designated areas for off-loading, away from the road.
- Ensure all drivers are trained in defensive driving.
- Ensure all vehicles are in good working order and
- Implement a public awareness program.

8.1.18 Worker Health and Safety (Safety Training)

- Employ construction “good practices” to safeguard workers throughout the construction period.
- Require that all personnel on the construction site complete HSE training as required by WASA prior to the start of construction.
- Require that all personnel wear the necessary protective clothing, for example, hard hats, steel tip boots, safety glasses, welding shades, etc. and
- Designate an HSE Representative from WASA to be on site who will have full authority to advise the Contractor that he must be in compliance with all safety and environmental rules and laws.

8.1.19 Worker Health and Safety (Trench Safety)

- Mitigation measures listed under Slope Instability will apply.
- Slope all side hill cuts and fills sufficiently to prevent injury to personnel.

8.1.1 Worker Health and Safety (Noise)

- Require that the Contractor provide protection against the effects of noise for construction personnel when measured sound levels exceed 90 dBA for a time weighted average over an eight hour work dayand
- Account for variations in permissible noise exposure depending upon duration (i.e., length of work day, exposure to periodic fluctuations to sound levels, etc.) per industry practice.

8.1.20 Security

- Provide 24-hour security for public safety protection and also for safe guarding construction equipment.
- Advise the Contractor that only authorized representatives have access to the construction offices and
- Provide adequate security lighting for equipment parking areas.

8.1.21 Public Safety

- The mitigation measures outlined for Security and Road safety (above) will also apply and
- Identify special at-risk populations and provide more intensive protection in those cases.

8.1.22 Road Safety

- The mitigation measures outlined for Road Traffic & Access will also apply.
- Where construction on roadways are near to at-risk groups (such as primary schools) activities can be scheduled for low activity periods (such as school vacations, weekends etc) and adequate personnel provided to control traffic flow and

- Achieve road safety along public roads by compliance with the Highways Act, the Motor Vehicle and Road Traffic Act, and by consultation with the Police Service in the affected areas.

8.1.23 Existing Buried Pipelines and Utilities

- Prior to the start of construction, survey public roads which will be used for transport of materials and equipment to the proposed construction sites and to identify the locations of infrastructure which may become damaged (WASA and the Contractor).
- Consult the appropriate utility agency if any utility pole is identified as a possible obstruction or a hazard.

8.1.24 Easement

Easement

- If it is necessary to acquire construction easements from private owners outside of the proposed construction sites, negotiate compensation with those owners.

8.1.25 Utilities

- Hold discussions with Traffic Management branch of the Police Service in order to plan road transportation issue and
- Implement Waste Management Plan to minimise impact on waste disposal services.

8.2 OPERATION IMPACTS

8.2.1 Air Quality

- Inspect equipment and maintain to control emissions.
- Set up programmes and schedules for cleaning and inspecting the collection system sewers to avoid odours when may arise because of blockages.
- Keep covers on screening and grit containers at WWTPs and frequently transport solids to landfill to avoid odours and
- Maintain all equipment in good working order so residulas and waste solids can be treated and moved off site without producing odours.

8.2.2 Waste Management

- Dispose of wastes in accordance with WASA's waste management guidelines for waste disposal.

8.2.3 Worker Health & Safety

- Workers will be required to wear appropriate PPE.

8.3 DECOMMISSIONING

- Develop a facility decommissioning plan and submit to the relevant Authorities, in the latter stages of the operational life cycle.

Table 8-1 Framework Mitigation Management Plan showing Summary of Mitigation and Residual Impacts

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Pre-Construction	Use a transparent, non discriminatory hiring process	Employment and Training	Local Community and Potential Employees	3	6
	Outline the selection criteria				
	Require that WASA Contractor(s) use local labour to the extent that this is possible				
	Train to enhance the skills of local labour force				
Construction	Require that the Contractor use local labour to the extent that this is possible.	Employment	Local Community and Potential Employees	3	6
	Where skilled labour is required, potential recruits must satisfy the necessary skill requirements				
	Train to enhance the skills of local labour force				
Construction	Perform vehicle inspections	Transportation Use of Construction Equipment and Machinery on Site (causing exhaust emissions)	Air Quality	3	4
	Maintain internal combustion engines				
	Use suitable emission controls				
	Optimize the use of equipment and vehicles				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Construction	Maintain equipment and vehicles and have them fitted with noise abatement devices (mufflers)	Transportation Use of Construction Equipment and Machinery on Site (causing noise)	Air Quality	3	4
	Confine clearing and grading close to populated areas to between the hours of 7 am and 7 pm				
	Conduct dialogue with administrative representatives from the nearby schools prior to construction in the area				
Construction	Develop a transportation Plan in collaboration with Traffic Management, Highways Division and the Regional Corporations	Transportation [personnel, raw material, equipment and machinery] (causing traffic/ limited access)	Local Communities	3	4
	Provide designated areas for off-loading, away from the road				
	Ensure all vehicles are in good working order				
	Develop a transportation Plan in collaboration with Traffic Management, Highways Division and the Regional Corporations				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Construction	Place disconnected hoses in containers to prevent spills from residual fuel	Vehicle Equipment Refuelling and Maintenance (accidental spill)	Water Quality	3	4
	Collect spent lubricants for off-site disposal				
	Ensure that all rolling stock, i.e., trucks and buses, be refuelled at the operation yard				
	Use oil absorbent material for mopping up oily sheens from spills and leaks				
Construction	Place mounds of cleared vegetation and excavated material so as to preserve major drainage patterns of surface flow	HDD, Ground Excavation, Compaction and Clearing and Grading (causing increased runoff/Flood)	Local Communities and Drainage	3	4
Construction	Clear only the area needed for construction	HDD, Ground Excavation, Compaction and Clearing and Grading (causing dust)	Air Quality	2	4
	Encourage natural re-vegetation as early as practical after the completion of construction				
	Wet the cleared area as required for dust control (or use of another dust palliative), especially during the dry season				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Construction	Clear only the area needed for construction	HDD, Ground Excavation, Compaction and Clearing and Grading (causing dust)	Local Communities	2	4
	Encourage natural re-vegetation as early as practical after the completion of construction				
	Wet the cleared area as required for dust control (or use of another dust palliative), especially during the dry season				
Construction	Minimise area of bare soil	HDD, Ground Excavation, Compaction and Clearing and Grading (causing erosion)	Biodiversity and Soil Cover	3	4
	Schedule clearing for dry season				
	Apply mulch to bare soil				
Construction	Avoid stockpiling topsoil or storing backfill near stream channels for more than 10 days	HDD, Ground Excavation, Compaction and Clearing and Grading (causing Soil Instability and Water Pollution)	Water Resources River Water Quality	3	4
	Stock piling will be more than 3 m from waterways				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Construction	Make crossings by boring of roads rather than open-trench construction	HDD, Ground Excavation, Compaction and Clearing and Grading (causing traffic and limited road access)	Local Communities	2	3
	Make provisions for detours on more lightly-trafficked roads and traces, where crossings will be constructed by open-trench techniques				
	Restore damaged pavement to its original condition as soon as practical after completion of construction works (the contractor)				
	Provide personnel to maintain efficient traffic flow				
Construction	Place mounds of cleared vegetation and excavated material so as to preserve major drainage patterns of surface flow	Alteration of Grade (impacting on drainage, causing siltation, flooding)	River Water Quality Water Resources	2	4
	Restore all banks of watercourses and terrain to their pre-construction contours as required to maintain natural surface drainage				
Construction	Stockpile and replace topsoil after construction	Storage and disposal of Construction Material and Wastes	Soil Cover, Rock Material	3	4
	Use excavated material as fill, cover and protection				
	Develop a comprehensive Waste Management Plan				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Construction	Dispose of all non hazardous solid wastes which are not recycled or returned to the supplier at a designated waste disposal areas approved by WASA in collaboration with SWMCOL.	Waste Management	Environment and land fill facilities	3	4
	Pursue avenues for recycling/ reuse, as far as practical.				
Construction	Use portable toilets on site, empty periodically and haul the waste to a sewage treatment plant or a septage facility which is approved by the Water and Sewerage Authority	Waste Management (Sanitary Waste)		3	4
Construction	Require that all personnel on the construction site complete HSE training as required by WASA prior to the start of construction	Worker Health and Safety (Safety Training)	All communities/potential employees	3	4
	Require that all personnel wear the necessary protective clothing, for example, hard hats, steel tip boots, safety glasses, welding shades, etc.				
	Designate an HSE Representative from WASA to be on site with full authority to advise the Contractor regarding compliance with all safety and environmental rules and laws				

Project Phase	Mitigation	Aspect	VEC Affected	Impact Significance prior to Mitigation	Residual Impact Significance
Operation	Dispose of wastes in accordance with WASA's waste management guidelines for waste disposal	Worker Health and Safety	All communities and Potential Employers	3	4
	Workers will be required to wear appropriate PPE				
	Employ programmes for inspecting and cleaning sewers	Odour Management	Air Quality	3	4
	Keep all covers on screening and grit containers at WWTs and frequently transport solids to landfil				
	Maintain all equipment in good working order and treat and move offsite all residuals and waste solids				
Decommissioning	Develop a facilities decommissioning plan and submit to the relevant Authorities, in the latter stages of the operational life cycle	Decommissioning and demolishing works	All communities	..	..

Key

Class	Significance
1	Significant, Major impact
2	Significant, Moderate impact
3	Insignificant, Minor impact
4	Insignificant
5	Unknown
6	Positive

9 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

9.1 OVERVIEW

WASA will either adapt existing in-house plans, or develop specific management plans, over the course of the detailed engineering phase of the project to deal specifically with the following:

- Contractor Terms and Conditions of Work
- Emergency Response
- Occupational Health, Safety and Security
- Traffic Management - Develop new plan in concert with relevant statutory agencies, construction contractor and detailed engineering design team prior to start of work. (See Appendix VII)
- Environmental and Social Impact Monitoring - Adapt plans used in past projects for this one prior to start of work (See Section 9.2 below).
- Waste Management - Adapt plans used in past projects for this one prior to start of work. (See section 9.2 below)

The management of all phases of this project will be the responsibility of WASA who will assign adequate resources and personnel to ensure that the project meets all technical, regulatory and financial requirements. The day-to-day implementation of all management plans will be the responsibility of the contractor(s) hired by WASA to execute various aspects of the construction and operational phases of the project. WASA will retain an overriding audit function of all of its contractor activities.

9.2 ENVIRONMENTAL AND SOCIAL IMPACT MONITORING PLAN

WASA will appoint a designated Health, Safety, Security and Environmental (HSSE) management representative for the duration of the project. The WASA HSSE Representative shall ensure that all the mitigation measures summarized in Chapter 8 above are implemented. In addition, the following sections provide guidance on additional monitoring that should be undertaken to ensure that the mitigation strategies proposed are effective in minimizing impacts and enhancing project benefits. Note that these monitoring requirements are subject to the approval of the Environmental Management Authority.

The key elements of the monitoring plan shall include:

- Periodic visits to the project site to audit and ensure compliance with technical specifications of the contract and inspections of works to ensure compliance with provisions of CEC grant of approval.
- Noise (SPL, Leq, Lpeak) and ambient air quality monitoring (Total Suspended Particulates) to be performed in residential communities along pipeline ROW during construction phase. Several construction phase activities may produce noise and dust which can temporarily affect nearby residents. The specific locations at which noise and air quality monitoring will be conducted shall as a minimum be the locations at which baseline data was gathered during this EIA but will be expanded to include other areas in residential communities adjacent to the site of works at any given period of time. Noise will be monitored monthly over the period of construction for both day time and night time conditions at each location chosen and TSP monitored monthly over the period of construction at these locations as well. For each residential community affected by construction activities, noise and ambient air will be monitored a five locations arranged in an area-wide surveillance pattern, one location placed immediately at the site of works and four other locations in the nearest receptors located to the north, east, south and west of the site of works. Where no

receptors are located within 1 kilometre of the site of works at one or more of the cardinal points, no monitoring location will be established.

- Operational phase monitoring will be confined to quarterly noise monitoring of noise levels at the plant boundaries of the two WWTPs. No ambient air quality monitoring will be required at the two WWTPs, however, WASA shall keep a record of any complaints received from residents adjacent to and downstream of the plant, specifically with regard to complaints related to nuisance odours. Should offensive doors occur during plant operations, WASA shall rectify the cause of such odours within twenty four to forty eight hours of the event occurring.

- Water quality monitoring of rivers downstream of pipe laying, lift station installation and WWTP construction activities are to be conducted. The specific locations to be monitored will varying over the duration of the construction phase as construction works move from place to place, but shall include as a minimum the fifteen locations monitored for baseline conditions during the conduct of this EIA. Monitoring of the parameters, oil and grease, total suspended solids and turbidity shall be conducted weekly at each watercourse adjacent to the site of works.

- During the operational phase of the project, WASA shall conduct weekly testing of the effluent from the WWTPs for the following parameters: NH_3-N, TP, TSS, Faecal Coliform, Total Chlorine, BOD_5. Results will be compared against the permissible levels applicable to inland waters as prescribed in Schedule II of the Water Pollution Rules, 2006.

- Workforce used for construction is to be monitored to ensure that local component of employment is maximized.

- Routine Inspection and Preventative Maintenance are to be undertaken during operational phase in accordance with WASA’s policy over >30 year life of trunk sewer lines, lift stations and WWTPs.

The specific elements of the monitoring plan are provided in Table 9.1 and Table 9.2 below.

Table 9-1: Summary of Monitoring Requirements – Construction

Issue	Activity	Suggested Frequency
River Water Quality	Visual inspection of the construction site temporary drains for oil sheen, turbidity, and solid deposits.	Daily
	Visual inspections of the nearby rivers for oily sheens and solids.	Weekly
	Turbidity levels will be monitored using a portable water meter	Coincide with excavation works
Air Quality	Conduct Monitoring for TSP at nearest receptors	Weekly
Noise Levels	Conduct noise monitoring at nearest receptors	Weekly
	Conduct noise monitoring within site of works	Weekly
Waste Management	Visual site inspection for waste disposal issues	Daily
Road and Bridge Conditions	Inspections of roads and bridges to monitor any deterioration of their condition	Before construction, frequently during construction and after construction
Worker Health and Safety	Perform spot checks for volatile vapours and for specific compounds with low threshold levels in the breathing zone of personnel	Weekly
	Perform spot checks for noise levels in the working zone of construction personnel.	Weekly
	Perform spot checks for Volatile Organic Compounds in air at nearest receptors	Weekly
Public Health and Safety	Record all complaints received from the general public regarding dust, noise, traffic, property access odours at the site of works.	As necessary. All concerns and actions taken will be recorded and made available if requested by the relevant authorities

Table 9-2: Summary of Monitoring Requirements - Operation

Issue	Activity	Suggested Frequency
Noise	Conduct noise monitoring at plant boundaries of WWTPs	Quarterly and after each plant maintenance shut down period.
Water Quality	Conduct testing of effluent discharged to receiving environment from WWTPs	Weekly
Public Concerns	Record all complaints received from the general public regarding odours at the WWTPs and downstream of the WWTPs.	As necessary. All concerns and actions taken will be recorded and made available if requested by the relevant authorities

It is expected that a detailed environmental management and monitoring plan for each phase of the project will be required by the EMA as a condition of the grant of the CEC. These detailed plans will be developed and submitted for EMA's approval prior to implementation by the construction phase engineering procurement and construction contractor. The implementation of the construction phase EMMP will be audited by WASA or its designated representative.

Similarly, WASA or its designated representative will develop and implement the operational phase EMMP that will cover the life of the project.

10 REFERENCES

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