ENVIRONMENTAL IMPACT ASSESSMENT

MARINE SHRIMP FARM EXPANSION (PHASE III)
BRAMPTON, ST CATHERINE,
JAMAICA

Submitted to

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EXECUTIVE SUMMARY

Project Background
Caribbean Mariculture Products Limited (CMPL) is a joint venture between the Jamaica Agricultural Development Foundation (JADF) and the University of the West Indies (UWI) to produce and market farm-raised shrimp. The 29 hectare (70 acre) shrimp farm is located on flat and gently sloping land, south of Old Harbour at Brampton, St. Catherine. The project lands are owned by the JADF and are occupied by earthen shrimp ponds, mango orchards, cotton fields and thorn scrub vegetation. The CMPL proposes to expand its existing shrimp farm facility on immediately adjacent lands.

Environmental Impact Assessment
This document, prepared by Caribbean Environmental Consulting Services Limited (CARECS), is an environmental impact assessment (EIA) of the project which is required by the National Environment and Planning Agency (NEPA). It identifies the environmental issues that may arise as a consequence of project implementation and the measures to mitigate the negative impacts.

Existing Farm Operations
The CMPL farm currently produces 130,000 kg of White Shrimp (*Litopenaeus vannamei*) annually. The farm employs a project manager, 13 skilled and unskilled pond workers, 14 processing plant workers and 2 technical persons (operations management). The existing project draws seawater from Fraser's Gully with a single pump at a rate of 6,000 US gallons per minute (23 m^3/min) for 18 hours each day. This is pumped to a reservoir. From there the water is gravity fed to the production ponds through open concrete drains or PVC pipes. The shrimp are fed pelleted rations over a 5-6 month grow out period and are then harvested by slowly emptying the ponds and passing the discharge through a meshed wooden cage. The shrimp are processed at the farm and sold locally to hotel chains, wholesalers, retail outlets and middlemen.

Proposed Expansion
It is proposed to expand the existing farm by 72 ha (180 acres) to 101 ha (250 acres), most of which will be devoted to seawater grow-out ponds. Two new buildings, a shrimp processing and packing plant and an administration building with offices and laboratory will also be constructed. A security fence will be erected around the entire property. The pond construction and expansion works will be organized into three main phases:

- *Phase 1*
  - construction of a new water pumping station able to deliver 18,000 US gallons per minute (69 m^3/min),
  - deepening of the sump area,
  - extension of the intake water reservoir from 2.3 ha to 6.0 hectares,
  - installation of pumps and a water distribution system
  - construction of 13 ha of production ponds
  - construction of berms in the 'artificial wetland' buffering zone area

- establishment of a fuel pumping station and vehicle service facility.

- *Phase 2*
  - construction of 36 ha of production ponds
  - construction of the processing and packing facility
  - construction of the administrative offices and related buildings.

- *Phase 3*
  - construction of a further 23 ha of production ponds.

At full capacity (6,000 gpm x 4 pumps), the total water usage for the production ponds will be 24,000 US gallons per minute (91 m^3/min). At full operation, the farm will discharge pond effluent at a rate of approximately 98,000 m^3/day, comprising exchange water from the ponds during grow out and water from ponds being drained during harvesting.

At this stage only imported specific pathogen free (SPF) post larvae will be used to stock the ponds and the target culture species will continue to be the White Shrimp. It will be grown under semi-intensive culture conditions at stocking densities of approximately 100,000 PL/ha. All ponds will be mechanically aerated. Shrimp will be harvested at the end of a 5-6 month production cycle by draining the ponds and passing the water through a meshed cage at the outlet. Harvested shrimp will be sorted, cleaned, packaged, frozen and stored on site.

The new processing plant will have the capacity to process about 400,000 kg (882,000 lbs) of shrimp per year. Plant operations will generate BOD rich wastewater and about 360 - 500 kg of waste heads and other solid waste every day. The plant will conform to United States HACCP and European processing standards. All waste wash-water will be collected in floor drains and disposed of in septic tank and absorption pit.

The expanded farm operations will ultimately require, approximately 100 persons in addition to the present staff complement. The training of personnel will done 'on-the-job' in their respective areas/roles and supervisors will also be sent for overseas training courses. In addition, workers at the processing plant will obtain food-handler's permits.

Potential Environmental Impacts

The major impacts related to project implementation are:

- Site clearance entailing the removal of the existing scrub vegetation and associated arboreal habitat.
- Cut vegetation burned on site will give rise to smoke and air borne particulates that could cause respiratory health and nuisance impacts on the surrounding communities.
- Soil exposure resulting from vegetation clearance during site preparation works may result in wind and water erosion of the soil.

- Excavation of the new intake channel between Fraser's Gully and the new pumping station will necessitate soil disturbance that could introduce suspended sediments into Frasers Gully, increasing turbidity levels in the canal and ultimately the receiving waters at Galleon Harbour, during the period of construction.
- The construction of ponds and embankments will involve the use of heavy earth moving equipment on soils containing a high proportion of fine particles that will, in turn, generate dust and noise.
- The construction of the ponds for the existing shrimp farm has modified surface drainage on the site and the proposed expansion will further modify this pattern.
- The sourcing of marl for road surfacing may lead to indirect adverse impacts in terms of public health and environmental degradation if obtained from unlicensed quarries.
- The movement of trucks and equipment over local parochial roads during the construction and the operations phases could lead to their further deterioration. This would increase the difficulties presently being encountered by vehicles in the area and could lead to ill feeling towards the project.
- The pond embankments will be 2-3m high and those at the western side of the property will be visible from the main road and cause some measure of visual intrusion.
- The project entails the conversion of a terrestrial habitat to an aquatic one and the replacement of agricultural resources with those suited for aquaculture.
- The installation of a barbed wire fence around the site that is required to achieve the necessary levels of farm security will debar access to the area by traditional/informal users of the land.
- The project will have positive benefits for local employees as well as for contracted support services, at a time when the national economy is depressed and particularly in an area where chronic unemployment exists.
- Given the current levels of soil erosion from the pond embankments and effluent drains, increases in the transport of suspended solids in the pond effluents can be expected as the farm expansion proceeds and that will be exacerbated during periods of intense rainfall. As a result there would be increased deposition of sediments in the 'artificial wetland' area, but more importantly at the culverts under the Thompson Pen Lane road as well as in the drain, beyond the farm perimeter. Sedimentation and blockage of these drainage features will worsen the impacts of natural flood events on the local community. The backup/retention of water on the farm property under these circumstances would increase the likelihood of breaching of the earth berm on the southern boundary of the property.
- High nutrient levels in effluent pond water may give rise to eutrophication in the mangrove forests and coastal waters of Galleon Harbour, to the detriment of these vital coastal ecosystems.
- Shrimp stocks are vulnerable to viral diseases, especially under the stressful and crowded conditions that prevail in intensive monoculture. Viruses can cause major losses in farmed shrimp and deplete local stocks of crustaceans.

No major viruses have been identified in Jamaica to date, but a rigorous disease prevention and biosecurity programme is essential.

- There is a risk of groundwater contamination due to improper disposal of sewage, and hazardous materials such as petroleum hydrocarbons and lead batteries. However, this is not considered significant.
- Increased abstraction of groundwater from the aquifer at the site could cause increased salinity of the groundwater given the proximity of the farm to the sea.
- The National Water Commission provides domestic water to the property. The proposed expansion will increase the staff complement by about 100 persons, which is not expected to significantly increase the domestic demand at the site.
- The constant transit of refrigerated transport trucks along the local parochial roads during the operations phase would lead to further deterioration of the roads. This would increase the difficulties presently being encountered by taxis and other vehicles in the area and could lead to animosity towards the project.
- There will be some level of dust generated by the movement of project related vehicles over the marl roads on the farm, especially during the dry season. This may be an infrequent nuisance factor to farm workers but should not affect the adjacent communities due to the remoteness of the farm.

All of the identified significant potential impacts can be avoided or mitigated through careful project planning and project implementation practices. The irreversible loss of terrestrial vegetation and habitat through site clearing represents an environmental trade-off between unproductive agricultural lands and a highly productive saltwater aquaculture system.

There are also some potential adverse impacts on the project, apart from natural hazards (see below), arising from activities, events and conditions occurring outside of the project boundaries. These include:

- ***Intake water quality***. The existing saltwater intake for the farm is situated on the estuarine portion of Fraser's Gully, where water salinities are dictated by the relative flows of surface water from the catchment system and the tidal stage. Whereas the salinity concentrations are acceptable under normal circumstances, salinities as low as 5 parts per thousand have been recorded at the inlet. Also, the quality of the water at the intake to the farm can be compromised by poor quality pond effluent discharges from the fish farms located on the opposite side of Fraser Gully.

There are some potential hazards associated with natural events. These are:

- ***Flooding*****.** The site is prone to flooding by surface runoff generated north of the site. During several recent flood events, the farm was not affected directly but sediments eroded from the ponds blocked the culverts at Thompson Pen Lane and worsened flooding in the local community.
- ***Earthquakes*****.** Most of the larger earthquakes impacting Jamaica over the past 300 years originated offshore. Earthquakes occurring on land tend to be

of low magnitude. The single-storey structures to be constructed at the site constitute a moderate to low earthquake hazard risk with respect to life and property. The subsurface condition below the site is also typically not conducive to soil liquefaction and therefore this impact is not considered significant.

- ***Hurricanes and Storm Surges***. Hurricanes, tropical storms and tropical depressions are frequent occurrences in Jamaica. Based on the record of hurricanes affecting the island over the past 300 years, the south coast lies within the track of major hurricanes and tropical storms. Hurricanes and tropical storms may generate storm surge and cause coastal flooding. Whereas there are no direct measurements of storm surge on the island, in general, coastal areas below 6m above sea level are considered to be at risk to storm surge. Most of the shrimp farm site is above 6m and therefore the hazard relating to storm surges is not considered to be significant.
- ***Crocodiles.*** To date there has been a very low incidence of crocodiles being found on the site. However, these animals are known to frequent the general area, especially after prolonged rainfall events when there are extensive areas of flooded land. Although records of attacks on human beings are few, it would be advisable for workers on the shrimp farm to be constantly vigilant, especially during harvesting.
- ***Birds.*** The potential impact of birds on the shrimp farm is not restricted to predation, a management issue, but to the possibility that they can catch, carry and drop shrimps in nearby local waters, thus becoming agents for non-native species introductions.
- ***Rats***. These vermin are known to infest feed manufacturing operations in the region. This population thus becomes a source of animals that could infest the shrimp feed store on the farm and increase the human health risk.
- ***Radiation.*** Two JPSCo 138 kV transmission lines enter and cross the northern section of the project site. The new farm access road has been placed beneath these transmission lines. It has been confirmed that there are no radiation risks associated with these lines. In the case of a line breakage, immediate fatality would result should the line hit anyone before it touched ground.

Project alternatives and risk assessment:
This project is an expansion of an existing shrimp farm operation, taking place on lands owned by the JADF, which does not compromise coastal wetlands. Consequently, no consideration has been given to any alternative project site.

Three types of systems used for shrimp farming depending on the desired level of production and investment in pond management. These are extensive, semi-intensive and intensive. This classification is based on variations in stocking density, rate of water exchange, the extent of aeration of the system, the feeding regime and fertilization of the pond water, with the most input into intensive systems resulting in highest production. The CMPL project is undertaking semi-intensive culture. The project currently operates as an open water supply and discharge system and intends to do so for the expansion phase.

The use of large mesh traps to harvest the shrimp necessitates the excavation of the embankments in order to fit the boxes. This exacerbates the problem of embankment soil erosion. Instead, it is suggested that long harvest nets be used to help alleviate this problem.

Much of the proposed expansion area was under mango orchards, a fruit for which the export market is no longer economically feasible. Shrimp farming offers a use of these lands that are not ideally suitable for conventional agriculture. Without the project, the national economy, and particularly the local communities faced with chronic unemployment, would not benefit from productive use of the lands.

The impact monitoring programme is designed to overcome the deficiencies in the current monitoring programme, which is focused solely on water quality measurements, and which does not incorporate response and feedback mechanisms. The final programme should include the objectives, standards and management responsibilities, the details of the proposed sampling methodology, the monitoring frequency schedule, and the formats for the monitoring reports.

It is understood that NEPA will allow the Client to undertake the monitoring and make the results available to the agency in a manner to be specified. Also, NEPA has the legal right to enter the premises at any time to conduct its own independent monitoring for data verification purposes.

The programme should be initiated with a baseline study of the air quality parameters to be monitored, prior to project construction, followed by the procedures for monitoring the construction and operation phases. It should be borne in mind that regular harvesting operations will continue during the construction of the new ponds. The duration of the construction phases and the appropriate frequency and type of monitoring should emerge later in the project design and planning process.

Pre-project air quality background data include ambient noise levels and levels of suspended particulates (dust) at two stations located at the edge Thompson Pen Lane, in the vicinity of the houses, and along the main road at the western (downwind) side of the property. Fortnightly site visits will facilitate inspections to ensure compliance with mitigation measures and collection of biweekly data on the following to ensure compliance with NEPA standards:

- Air quality measurements (noise and dust) at selected stations
- Effluent water quality[1] - measured at the stations corresponding to each effluent outfall from the farm as well as at sedimentation basin, culvert, drain, salina, and mangroves.
- Sewage treatment plant effluent quality – (monthly samples, initially)

[1] *Water quality parameters should include pH, TSS, TDS, BOD_5, DO, COD, phosphates, nitrates (nitrate + nitrite), salinity, faecal and total coliforms.*

- Site inspections to ensure compliance with mitigation measures, including:
  - Preparation of viral outbreak contingency plan (at project outset).
  - Harvesting methods (measures taken to reduce re-suspension of sediments and prevent species escape).
  - Solid waste management practices.
  - Verification of SPF source of PL's.
  - Establishment of an emergency response plan.

1. INTRODUCTION

1.1 BACKGROUND

Caribbean Mariculture Products Limited (CMPL) is a limited liability company established as a joint venture between the Jamaica Agricultural Development Foundation (JADF) and the University of the West Indies (UWI). The CMPL operates a 28.3 ha (70 acres) marine shrimp farm on lands owned by the JADF at Brampton, St. Catherine. It is proposed to expand this facility on immediately adjacent lands by 73 hectares (180 acres) to comprise a total area of 101 ha (250 acres). A processing plant will also be constructed as well as an administrative office. The construction and operation of a hatchery is planned for the future but this will be at a different location.

As part of the development approval process, an environmental impact assessment (EIA) is required by the National Environment and Planning Agency (NEPA) to identify and determine any environmental issues that may arise as a consequence of project implementation. This document, prepared by Caribbean Environmental Consulting Services Limited (CARECS) presents that assessment.

1.2 TERMS OF REFERENCE

Two previous environmental studies have been carried out with respect to the Brampton shrimp farm. These were *Initial Environmental Assessment of the UWI's Pilot Shrimp Mariculture Project at Brampton, St. Catherine*, prepared by Chow (1993), and *Environmental Impact Study Caribbean Mariculture Products Shrimp Farm Phase II, at Brampton, St. Catherine*, prepared by Davis, Ross & Stewart (1997).

This current study of the third phase farm development proposal refers extensively to the environmental background information on the project site provided by those documents and focuses particularly on the proposed area for the expansion and on the cumulative impacts induced by the expansion works. It is apparent that several recommendations made in the earlier studies and that some conditions of the development permit have not yet been fully implemented, for which reason this assessment also looks at environmental issues related to the current operations of the farm.

The Terms of Reference (TOR) for the EIA of the third phase of the project are presented at Appendix 1. They conform to NEPA requirements and were approved by that agency on 26 August 2002.

1.3 STUDY TEAM

The multidisciplinary core team assembled to carry out the EIA was comprised of the following persons:

- ◊ Peter Reeson, M.Sc. CARECS Principal and EIA Specialist
- ◊ Paul Gabbadon, M.Sc. Aquaculture Specialist
- ◊ David Narinesingh, M.Sc. Coastal Ecologist
- ◊ Earl Wright, M.Sc. Hydrogeologist
- ◊ Francis Severin, M.Sc. Sociologist

2. PROJECT DESCRIPTION

2.1 OVERVIEW OF SHRIMP INDUSTRY

Shrimp is one of the most popular seafood items worldwide with the demand being particularly high in the United States, Japan and Europe. The harvest of wild shrimp from marine waters has remained more or less constant at around 2,000,000 metric tons/year with declining harvests in some areas, due to overfishing, being replaced by catches from new fishing areas. However, it appears that the wild catch of shrimp has reached or may have exceeded the maximum sustainable yield (National Research Council, 1992). If this is so, then the catch of marine shrimp will begin to decline in the future (FAO, 1996). Such a decline could be exacerbated by the ongoing deterioration of the marine environment.

Since 1987, shrimp farming has become a major industry in many nations, now accounting for approximately 35% of the shrimp on the world market. It has provided economic opportunities in many countries through the creation of jobs in production, processing, transportation, marketing, and related services. As could be expected in a young and rapidly growing industry, mistakes have been made with adverse consequences on the natural and social environment (destruction of mangrove forests, salinisation of agricultural land, water pollution by pond effluents, and accidental introductions of non-native species). These have arisen largely as a result of poor planning and farm management by shrimp farmers and government agencies rather than as a consequence of shrimp farming per se. Where conducted properly, shrimp farming has been profitable, environmentally sound and beneficial to coastal communities and national economies.

Jamaica imports about 52,000 kg of shrimp each year. CMPL currently supplies the local market but the intention is to raise production levels to enter the export market. The project, therefore, would benefit Jamaica's net foreign exchange position by reducing imports and earning foreign exchange from the export of shrimp. There is another shrimp farm project being established by foreign investors at Longville, Clarendon, geared towards the export market.

2.2 EXISTING CMPL SHRIMP FARM

The shrimp farm is located on flat and gently sloping land, south of Old Harbour at Brampton, St. Catherine (Plate 1). Figure 2.1 shows the location of the farm. The project lands are owned by the JADF and are comprised of earthen shrimp ponds, mango orchards, and thorn scrub vegetation. The mango orchards are being taken out of production and 100 ha have been allocated for the proposed expansion of the shrimp farm. Another 1.6 ha (4 acres) of land have been identified for the associated processing plant and administrative buildings.

2.2.1 Shrimp farm layout

The existing layout of the farm is shown in the schematic drawing provided in Figure 2.2. The farm was originally established as an 8.5 ha (21acres) pilot project in 1993 and later expanded by 20 ha (50 acres) after 1997. At present, the farm consists of 48 ponds or 28 ha of production ponds and a 2.3 ha (5.7 acres) reservoir (Plate 2), a pumping station (Plate 3), water supply and drainage systems (Plates 4), and an 'artificial wetland' area (Plate 5). The farm buildings include a processing and packaging facility (Plate 6) and farm manager's residence.

A new access road to the farm was recently built opening from the Old Harbour – Old Harbour Bay Main Road. This replaces the older and more distant entrance from Thompson Pen Lane. The new road is marled and situated below the Jamaica Public Service Company's (JPSCo) 138 kV transmission lines where these cross the JADF lands (Plate 7).

Plate 1. CMPL shrimp farm production ponds at Brampton.

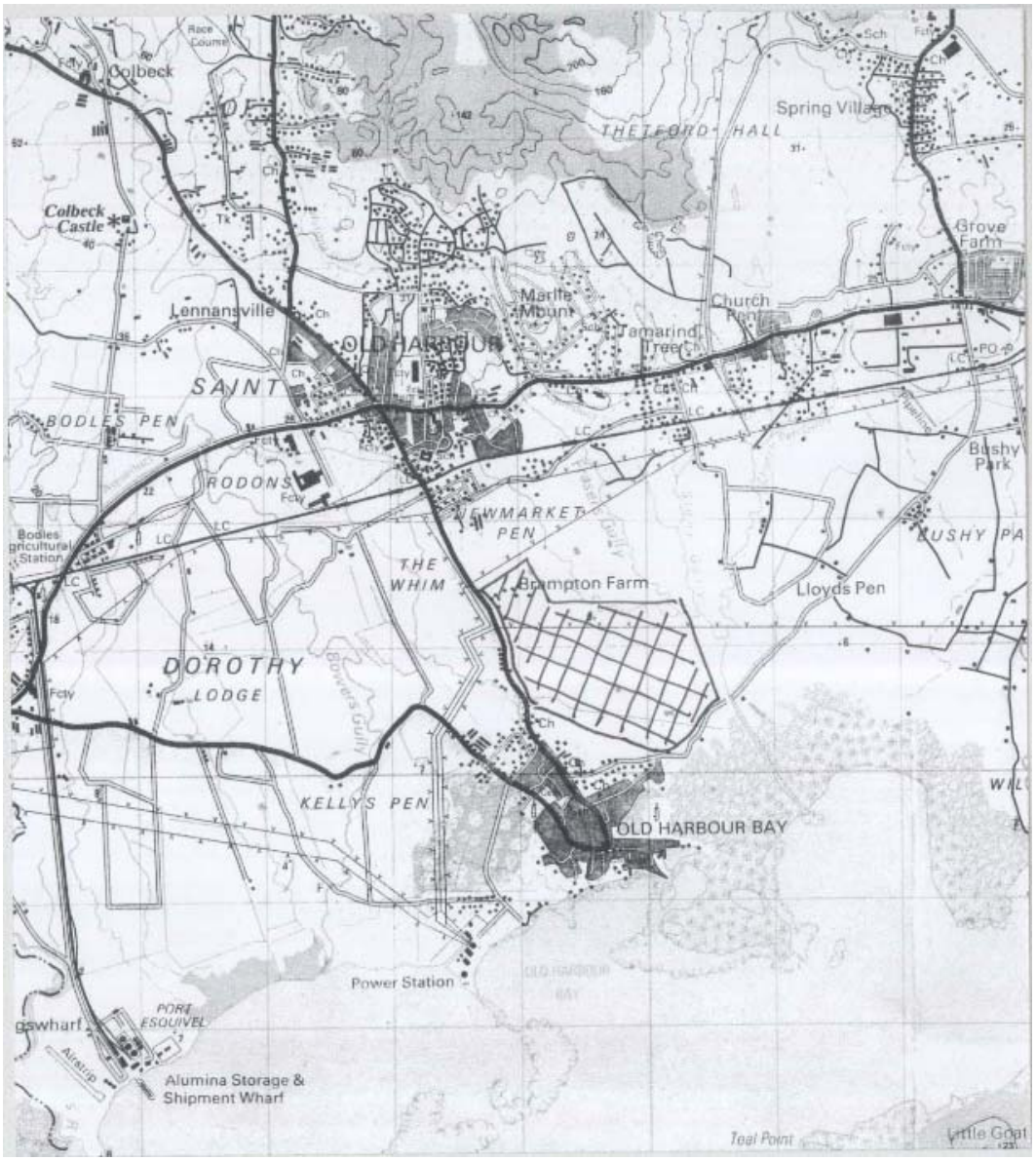

Figure 2.1 Location of CMPL shrimp farm (cross hatched area) at Brampton, St. Catherine.

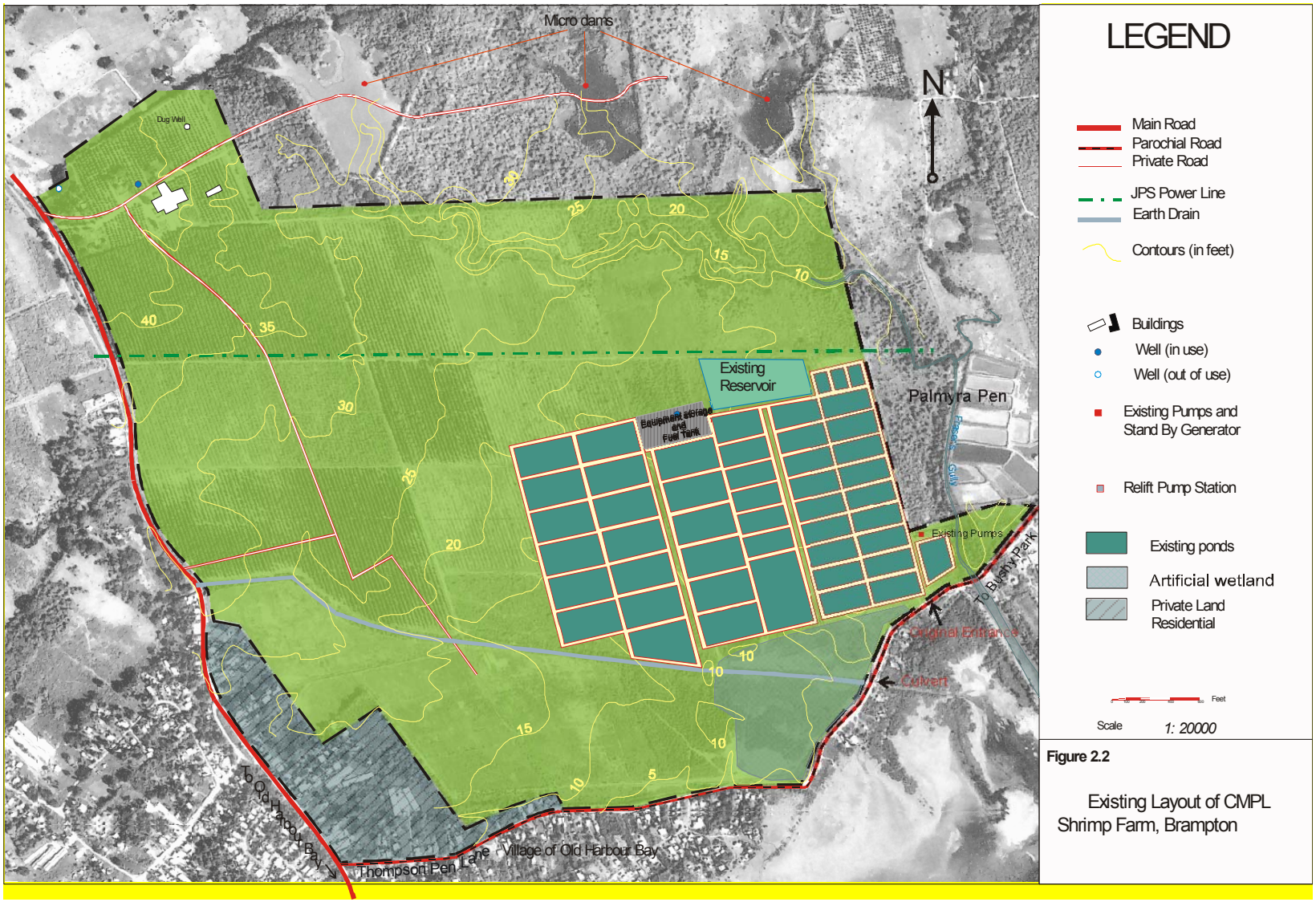

Figure 2.2

Existing Layout of CMPL Shrimp Farm, Brampton

Figure 2.2 Existing layout of CMPL shrimp farm at Brampton, St. Catherine.

Plate 2. Existing reservoir for CMPL shrimp ponds.

Plate 3. Existing pumping station extracting water from Frasers Gully, Brampton, St. Catherine.

Plate 4. Water supply system to CMPL production ponds.

Plate 5. The 'artificial wetland' area.

Plate 6. Existing processing and packaging facility at Brampton, St. Catherine.

Plate 7. Access road to shrimp farm situated under high-tension power lines.

2.2.2 Current operations

The project presently pumps seawater to the production ponds from an intake channel and sump at a rate of approximately 324 m^3/day (81,000 US gal/day). The intake draws water from Frasers Gully, a canal that connects to the sea at Old Harbour Bay. The water is first pumped into a reservoir via an aeration fountain and then gravity-fed to the ponds through open concrete conduits (Plate 8) or PVC pipes.

The CMPL farm produces 130,000 kg of white shrimp *Litopenaeus vannamei* annually, grown in a semi-intensive monoculture system. Post-larvae are imported from a hatchery in Florida, USA, acclimatized and then stocked in production ponds at a density of 20/m^2 (70-100,000/ha). The shrimp are fed a supplemental ration of approximately 35% crude protein for about 150-180 days before they are harvested.

Harvesting is done by slowly emptying the ponds and passing the discharge through a wooden net cage trap (Plate 9). The use of the traps often requires the excavation of the drains to accommodate them. The shrimp are sold directly from the pond bank to wholesalers, or processed at the plant and sold to retail outlets or directly to clients. The harvest also includes incidental catch such as tilapia (O*reochromis mossambicus*) (Plate 10). tarpon (*Megalops atlanticus*) and snook (*Centropomus undecimalis*), and crabs (*Callinectes sp*.) which enter the ponds as larvae contained in the influent water. These species are taken by the workers.

Plate 8. Concrete water supply system to shrimp ponds at CMPL.

Plate 9. Wooden meshed cage used for harvesting shrimp at CMPL.

Plate 10. Incidental catch of tilapia during harvest of CMPL shrimp ponds.

2.2.3 Erosion of embankments and drains

It is very evident that the farm is presently experiencing severe problems with soil erosion that is occurring on the inner sides of the ponds (Plate 11), on the outer slopes of the pond embankments and the drains (Plate 12). The erosion in the ponds is being caused by wave action and runoff from the tops of the embankments during heavy rainfall. The erosion of the outer slopes of the embankments and the drains is also being caused by runoff, but more so by the flow of pond effluents (Plate 13). The latter is of environmental significance since much of the sediments carried in suspension are taken across the 'artificial wetland' (a sedimentation area) and deposited in the culverts under Thompson Pen Lane (Plates 14 and 15) as well as in the drain leading to the salina (Plate 16). This is causing periodic blockages of the culverts that exacerbates the problem of flooding in the local community during periods of heavy rainfall.

For this reason, Davis *et al* (1997) had recommended the construction of an artificial wetland on the site, an area that would allow for settlement of the suspended sediments contained in the discharge effluent and also to effect some level of nutrient polishing. This effluent treatment system was never properly constructed; the area was simply cleared such that the pond effluent flowed along fairly well defined streams and did not spread out over the designated area in a manner that would enhance particle settlement and nutrient removal prior to exit into the salina (Plate 17 and 18). Recently, however, improvements have been made by blocking the streams so as to induce spreading of the effluent. Recommendations for further improvement of this settlement basin are provided at Section 5.3.3.

2.2.4 Effluent quality

Archived data from the current environmental monitoring programme (see Table 4.5.1) shows that the water quality of the influent exceeds NEPA standards with respect to COD and nitrates. Except for these same parameters, the quality of the farm effluent at Station 8, where it enters Old Harbour Bay, does not exceed NEPA industrial trade effluent standards.

2.2.5 Current employment

Apart from the project manager, the farm employs the following number and categories of workers:

- 13 pond workers – unskilled and semi-skilled
- 14 processing plant workers
- 2 technical persons - operations management

Plate 11. Erosion of inner sides of pond embankment at CMPL.

Plate 12. Erosion of outer sides of drain embankments at CMPL.

Plate 13. Typical erosion caused by pond effluents during draining of ponds.

Plate 14. Concrete drainage culverts across Thompson Pen Lane. (Photo taken after clearance of culverts)

Plate 15. Sediment deposits at culverts across Thompson Pen Lane.

Plate 16. Clearing of silted drain leading to salina.

Plate 17. Storm water drain passing through farm emptying into 'artificial wetland' area.

Plate 18. 'Artificial wetland' area showing flood containment berm.

2.2.6 Current permit conditions

NRCA Permit #116P97 was issued in 1999 for the first expansion of the project, from the 8 ha (20 acre) pilot phase to the current 28.3 ha (70 acre). The specific conditions of the permit were, *inter alia*:

- Submission of an environmental monitoring plan;
- Importation of disease and parasite free brood stock certified by the Veterinary Division, Ministry of Agriculture;
- Construction phase noise levels not to exceed 70 dB at distance of 50m of property boundaries;
- Conformance to air quality standard for suspended particulates of 150 ug/m^3 for a 24-hour averaging time;
- Conformance of pond discharges with NRCA's trade effluent standards;
- Implementation of all mitigatory measures and recommendations outlined in the EIA dated January 1997 (Davis, C. et al, 1997).
- Construction of a perimeter ditch to prevent flow of water from the site onto the roadway (*N.B. The road was not specified but presumably refers to Thompson Pen Lane*);
- Construction of a series of settling ponds to act as sediment traps and to aid removal of nutrients from the effluent;
- Construct embankments along the southern side of the property and along the sides of the drain leading to the salina (*N.B. presumably beyond the site perimeter*) so as to prevent flooding of adjacent homes; and
- Planting of appropriate vegetation such as mangrove trees in the salina to enhance its flushing and absorption properties.

An environmental monitoring plan (EMP) was not included as part of the 1997 EIA report. One is presented at Section 8 of this report to cover the new construction phase and operations.

It was noted that there was a need to make improvements to the current manner of farm construction and operation in order to comply with existing permit conditions. These include stabilising the sides of the production pond embankments, improving the effectiveness of the settling ponds in retaining sediments and removing nutrients, and improving floodwater control structures at the southern perimeter. The farm has now instituted a programme whereby *Batis* and *Sesuvium* are planted on the exposed embankments during the wet season. During construction of the new ponds the topsoil will be stockpiled and used for surfacing the new embankments – thus the soils will be reseeded.

2.3 PROPOSED EXPANSION PROJECT

2.3.1 Farm expansion plan

It is proposed to expand the existing farm by 72 ha (180 acres) to make a total of 101 ha (250 acres). Most of the project area will be devoted to seawater grow-out ponds. A shrimp processing and packing plant and an administrative offices and laboratory will also be built. A security fence will be erected around the

entire property. The proposed pond construction and expansion will be organized into three main phases and will include:

- **Phase 1** – construction of a new water pumping station, deepening of the sump area, extension of the intake water reservoir from 2.3 ha to 6.0 hectares, installation of pumps and water distribution system, construction of 13 ha of production ponds, construction of berms in the artificial wetland buffering zone area, and establishment of a fuel pumping station and vehicle service centre.

- **Phase 2** – construction of 36 ha of production ponds, and construction of the processing facility and administrative offices.

- **Phase 3** – construction of 23 ha of production ponds.

The schedule for the above construction works is summarised below at Table 2.1.

Table 2.1 Summary of development phasing of the CMPL shrimp farm expansion project.

Phase	Schedule	Summary of Activities
1	2002	• optimize and increase artificial wetland area • construct 13 ha of production ponds • increase size of sea water reservoir • build new pump station • build vehicle service facility
2	2003	• construct 36 ha of production ponds • expand water supply and drainage system
3	2004	• construct 23 hectares of production ponds • expand water supply and drainage system

Farm development activities, with the proposed expansion phases, are shown in Figure 2.3. Note that a buffer area will be left between the ponds and nearby residences along Thompson Pen Lane at the southern side of the farm.

2.3.2 Reservoir and production ponds

The new reservoir and shrimp grow-out ponds will be constructed from the clayey soils found on the site. The surface layers of soil will be removed using crawler tractors until the underlying clay material is exposed. The clay will be used to line the bottom and sides of the ponds and compacted to form an impermeable lining. The soil removed during the excavation will be used to form the bunds around the ponds and thus no material will have to be imported onto the site for pond construction purposes. Marl will be sourced elsewhere to form the access roads on top of some of the embankments.

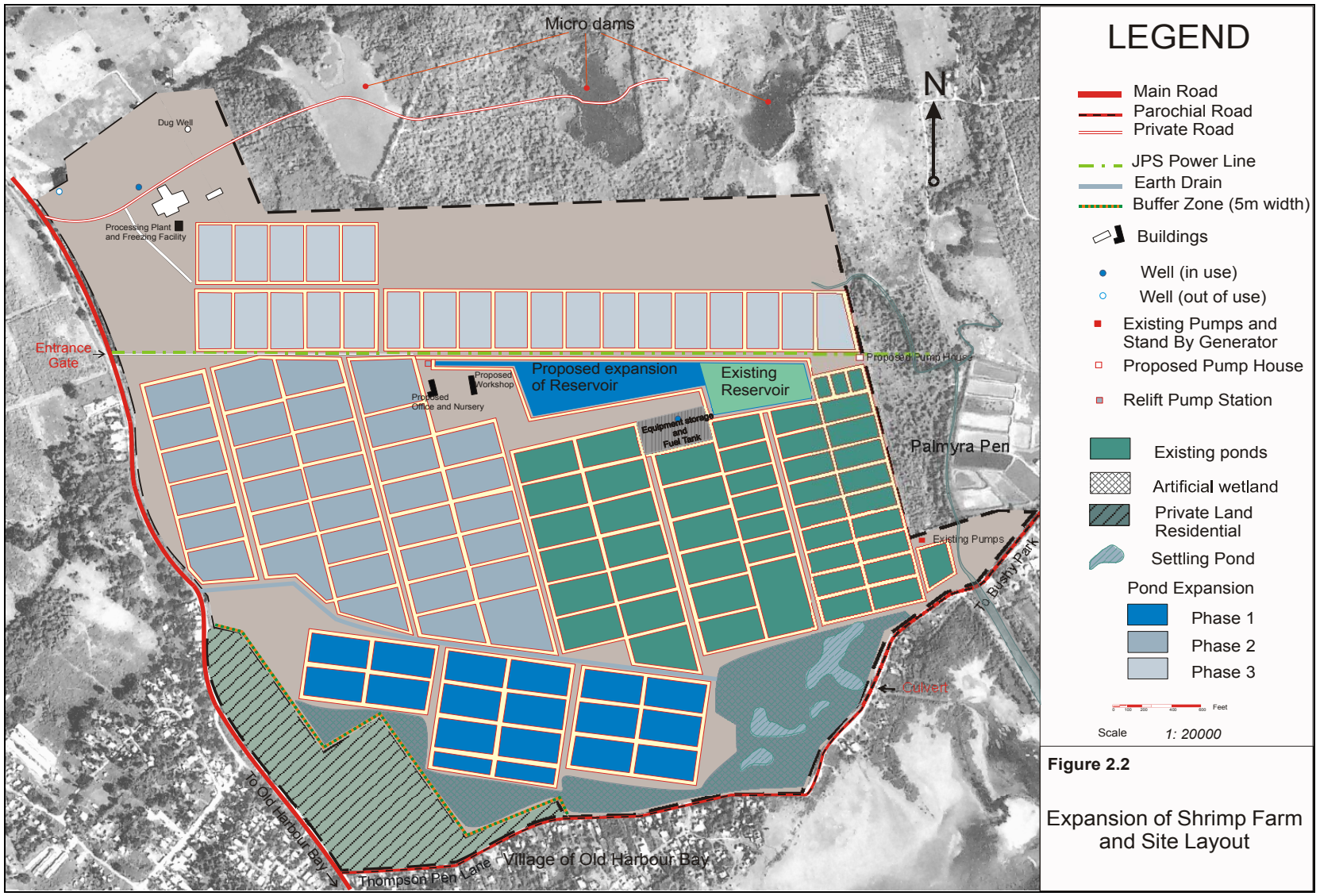

Figure 2.2

Expansion of Shrimp Farm and Site Layout

Figure 2.3 Layout of proposed expansion at CMPL shrimp farm.

The seawater reservoir will be expanded from its present size of 2.3 ha to 6.0 ha, to provide a total capacity of 120,000 m^3 (30 million gallons). The earth will be compacted in 45cm (18") layers with heavy-duty bulldozers. The expanded section will be constructed and compacted before the common embankment is breached.

The new ponds will be approximately 0.9 ha in size with depths of approximately 1.8m. There will be a total of 77 ponds constructed during the three expansion phases, most rectangular in shape and variously oriented in relation to the prevailing winds. The ponds are to be laid out in such a manner that each will be accessible from a roadway built on top of the berm. The farm will have a total water surface area of approximately 100 hectares.

Concrete weirs or monks will be built into the berm of each pond for drainage, water exchange and to facilitate harvesting (Plate 19). The monks will each be fitted with filter screens (mesh size = $^1/_8$ inch at the top; $^1/_{16}$ inch at the bottom) and closed with hardwood slats. The slats will be sealed and made watertight with clay soil. A supply inlet will be situated at the opposite end of the drain. This will be fitted with a 500 micron screen.

2.3.3 Water supply and drainage

The location of the new seawater intake structure, upstream of the present intake, has been determined (see Figure 2.3). Construction will entail dredging and paving of a new channel between Frasers Gully and the intake basin. Three 14" Ø 100 hp diesel engine pumps will each deliver 6,000 US gallons per minute of seawater from the sump for 18 hours each day into the raised storage reservoir that will distribute the water throughout the farm. At full capacity (6,000 gpm x 4 pumps), the total water usage will be 24,000 US gallons per minute (91 m^3/min) for 18 hours each day.

Water will be supplied to the ponds via concrete conduits and emptied by controlled manipulation of the wooden slats in the outlet monks. The effluent water will be discharged into the drainage system to which each pond is individually connected. The filter screens will prevent escape of shrimp from the ponds during periods of water exchange.

Throughout the production cycle, the water in each pond will be replaced at varying rates depending on the growth stage of the shrimp, resulting in a more or less continuous flow of water from the farm into the environment.

At full operation the farm will discharge pond effluent at a rate of approximately 98,000 m^3/day (25,900,000 gal/day). This effluent will be comprised of water from ponds in which the water is being exchanged and water from ponds being drained for harvesting.

All of the pond drains will direct pond effluents into the 2.8 ha (7 acre) 'artificial wetland' area before final exit through the four culverts under Thompson Pen Lane into the adjacent salina and coastal mangroves (Plate 20).

Plate 19. Drained shrimp pond showing concrete monk in foreground.

Plate 20. Salina flat with mangroves in background (looking SW).

2.3.4 Culture species

Only specific pathogen free (SPF) post larvae (PL), imported from hatcheries in the Dominican Republic and USA, will be used to stock the ponds. The project will eventually produce and select its own brood stock and produce post-larvae, in a proposed new hatchery to be established at another location.

The target culture species will continue to be the white shrimp (*L. vannamei*). This species will be grown under semi-intensive culture conditions, i.e. approximately 173,000-247,000 PL/ha (70,000-100,000 PL/acre). Stocking of the ponds will be done on a phased basis so that harvesting will be a continuous year round process.

All ponds will be aerated, to increase dissolved oxygen concentrations, using mechanical aeration devices. There are two types of aeration devices presently used on the farm and this will continue in the expanded phase. They are 1 HP and 2 HP paddle-wheel types that mix air and water with motorized paddles (Plate 21) as well as the 2HP Aero-02 type, which involves injecting and circulating air in the water (Plate 22).

The ponds will be harvested at the end of a production cycle by draining the ponds completely and passing the pond effluent through a net cage at the outlet monk to capture the grown shrimp.

2.3.5 Processing plant and administrative office

A new shrimp processing plant will be built next to the existing fruit processing facility located north of the ponds where shrimp processing is currently being carried out (see Plate 6). This will be a block and steel structure (Figure 2.4 – inserted in back cover pocket) erected during the second phase of the project approximately 18 months after start-up of the first phase. The existing processing facilities on the farm will continue to be used during the initial stages of the expansion programme.

The new office building will be a block and steel structure with office space, a laboratory, bathrooms and a workshop occupying 700 sq. ft. Sewage disposal will be via septic tank and absorption pit.

2.3.6 Grow-out and harvesting

In addition to utilising the natural productivity of the ponds, supplementary feed in the form of pellets will be applied to the ponds, either by hand-fed broadcasting or on feeding trays. The feed will be a commercial formula containing 35% crude protein.

At the beginning of the production cycle the bare pond soils will be fertilized (~50lb/ha) and also during filling (~50lb/ha) using inorganic super-phosphate fertilizer to maintain a plankton bloom. Thereafter, the rate of application will be reduced as the amount of feed (also a source of nitrogen) is increased to meet the requirements of the growing shrimp.

Plate 21. Paddle wheel aerators under repair.

Plate 22. Air injection aerator in shrimp pond.

The amounts of fertilizer applied will depend on the nutrient quality of the source water and the rates of application will be adjusted according to individual pond requirements. The amount of feed applied will be monitored regularly to ensure its optimal use, the maintenance of a healthy growth medium, and the reduction of costly waste.

After the ponds have been filled with seawater, they will be stocked with imported SPF post larvae at a rate of 173,000 - 247,000 PL/ha. Under the above conditions, it takes the shrimp about 150 -180 days (2 cycles/year/pond) to reach harvest size, a factor also determined by market preference and demand.

At harvesting, the water will be released from the ponds and passed through a net cage attached to the outlet monk. It is preferable to do this at night when the shrimp are most active and therefore most easily caught. The harvested shrimp will immediately be placed on ice in trays, which will then be collected and taken to the processing plant on small tractor-drawn carts. The use of a net cage for harvesting is preferable to the alternative of seining as it minimizes disturbance of the pond sediments.

After harvesting, the empty pond will be left to dry (see Plate 19) and to facilitate solar disinfection of the pond bottom.

2.3.7 Pond drainage/effluent and disposal system

It is difficult to accurately predict the quality of the effluent discharged from the farm ponds. Not only is this dependent on the quality of the source water, which will be affected by various other agricultural discharges into Frasers Gully and Old Harbour Bay, but also by the chemical behaviour of the individual ponds, the metabolic rates, the harvested size of the cultured species, and culture medium management practice.

It is almost inevitable in an enterprise of this nature that the water quality in a few of the ponds will go 'bad' during the production cycle and the quality of those effluents may thus exceed these standards. However, given the dilution by the effluent from other ponds, such events would not be expected to cause a serious environmental problem. In any event, the retention capacity of the 'artificial wetland' area should be adequate to take care of the 'unevenness' in the water quality of the discharges.

2.3.8 Processing

At the processing plant workers will de-vein, remove heads, wash and pack the shrimp in plastic-lined boxes. The shrimp will be blast frozen (-40^{o}C), and stored under refrigeration (-20^{O}C) ready for loading and transport in refrigerated trucks for shipment. At full capacity, the new plant will process about 1,095 kg (2,500 lbs) of shrimp per day or 400,000 kg (882,000 lbs) per year. The water used for washing the shrimp and scrubbing the tables will contain one teaspoon of household bleach to every five gallons of water.

Plant operations will generate, on a daily basis, an undetermined volume of waste water, and about 360 kg of waste heads (~33% of total weight) and other solid waste. Waste wash-water will be collected in floor drains and discharged to a septic tank and absorption pit. The heads will be collected and sold to pig farmers for use as animal feed.

The plant will conform to United States HACCP and European processing standards so as to meet export requirements. The Veterinary Division of the Ministry of Agriculture will also inspect the plant. Particular attention will be paid to sanitation and the control of vermin and other disease-carrying pests.

2.3.9 Electricity supply

Electricity supply to the farm is provided by the Jamaica Public Service Co. Ltd. (JPSCo) Given the special billing arrangements that CMPL has with JPS it is difficult to determine the actual daily demand. To compensate for supply outages 1,500kVA and 250kVA standby generators will be installed for the purposes of the farm and the processing plant respectively.

2.3.10 Fuel pump/storage & vehicle maintenance facilities

A 9,000-litre fuel tank and pump for the storage and dispensing of diesel fuel has been installed. The tank is skid-mounted and placed within a bund wall, 0.8 metres high (Plate 23). This facility has been built to the suppliers' specifications (Shell Company [WI] Limited).

Plate 23. Fuel pump and storage tank facility under construction.

2.3.11 Employment and training

The expanded farm operations will ultimately require, approximately, 100 persons additional to the present complement, in the following categories:

- 40 Pond workers
- 50 Processing plant workers
- 2 Technical staff
- 4-5 Security personnel

The training of personnel is done on-the-job in their respective areas/roles. Technical staff associated with the processing plant will also be sent for overseas on training courses. Workers at the processing plant will be qualified with food-handler's permits.

3. LEGISLATIVE AND REGULATORY FRAMEWORK

3.1 RESPONSIBLE AUTHORITIES

Several authorities are responsible for regulating and facilitating environmentally sound development in St. Catherine and these will have jurisdiction over the proposed shrimp farm project. These are as follows:

- **National Environment and Planning Authority (NEPA).** Established in 2000 by the amalgamation of the Town and Country Planning Authority, the Natural Resources Conservation Authority, and the Land Utilisation Commission, NEPA is now the principal agency responsible for administering the Town and Country Planning Act (1958; amended 1993) and the Natural Resources Conservation Authority Act (1991). Now placed within the Ministry of Land and Environment, it is responsible for national physical planning and enforcement and the management, conservation and protection of natural resources in Jamaica.

  The NRCAA allows the Authority to request an environmental impact assessment for developments or construction works considered likely to have adverse effects on the environment. Failure or refusal to submit such a document is an offense under the law. The NRCA is also responsible for administering the recently passed Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996), the Beach Control Act (1956) and the Wildlife Protection Act (1945; amended 1988).

  The NRCA has also established standards for trade effluents discharged to the environment and has issued draft air quality standards.

- **Water Resources Authority (WRA).** This agency administers the Water Resources Act (1995) and is responsible for the regulation, allocation, conservation and management of the water resources in Jamaica.

- **St. Catherine Parish Council.** The St. Catherine Parish Council is responsible for administering the Parish Council Act (1901; amended 1978) and the Local Improvements Act (1914). General approval under the Parish Council Act is needed for building permits. Section 11 of The Town and Country Planning Act also empowers the council to make decisions for the approval of development projects on its behalf.

- **Environmental Control Division (ECD).** The ECD, in the Ministry of Health, administers the Public Health Regulations (1976) under which air, soil and water pollution control standards are established and monitored. This agency is primarily concerned with public health issues insofar as pollution is concerned.

3.2 PLANNING AND ENVIRONMENTAL LEGISLATION

3.2.1 Town and Country Planning Act (1958; amended 1993)

The TCPA formulates and coordinates strategic plans for area development in the form of Development Orders consistent with the Town Planning Law (1975). Development Orders establish area-specific standards for land use, density and zoning. They cover most of the urban areas of Jamaica and several parishes.

Whereas Section 11 of The Town and Country Planning Act empowers local planning authorities (parish councils) to make decisions on approval of developments (based on the above mentioned Development Orders), Section 12 of the Act states that the Town and Planning Authority may require that any application for permission to develop land be referred directly to the Authority instead.

3.2.2 Natural Resources Conservation Authority Act (1991)

Under the NRCA Act the whole island has been designated as a prescribed area and the law binds the Crown. This Act empowers the NRCA to issue permits to persons undertaking any new development, construction or enterprise, anywhere in Jamaica, and licences for the construction or modification of any work causing the discharge of trade or sewage effluent into the environment. Under Section 9, designated or Prescribed Activities will require a permit from the NRCA and the agency may request the preparation of an Environmental Impact Assessment of the proposed activity (Section 10 of the Act).

3.2.3 Natural Resources Conservation (Permits and Licences) Regulations, 1996, and Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996.

The Order prohibits the construction and development of a number of listed enterprises without a permit. The list of prescribed categories includes irrigation

or water management and improvement projects; sewage treatment facilities; the modification, clearance or reclamation of wetlands; and the introduction of species of flora, fauna and "genetic material".

The application for a development permit requires submission and review of a Project Information Form (PIF). If an EIA is required the Terms of Reference (TOR) for the EIA are also reviewed by the agency to ensure that the relevant environmental issues are identified for analysis. This has been done for this project and NEPA's concerns are reflected in the TOR. A permit is issued once the project proponent has satisfied the requirements of NEPA and the permit fee has been paid. A permit and licence is also required for the construction and operation of a sewage treatment plant. The licence is valid for 5 years.

NEPA usually requires implementation of an environmental monitoring programme during construction works. The ECD and local planning authorities are also supposed to monitor construction to ensure that their development restrictions and requirements are adhered to.

3.2.4 Wildlife Protection Act (1945; amended 1982)

The Wildlife Protection Act (WPA) is administered by NEPA and seeks to protect the habitats of animals and plant species categorized as protected or endangered by the Act. The American crocodile (C*rocodilus acutus*) is an endangered species and protected under the WPA (Section 2, Schedule 3). The WPA therefore extends to the protection of the crocodiles that are reported by local residents to frequent the general area and the mangroves near the site.
The Amity Hall mangal was declared as a Game Sanctuary under the WPA in 1997. This area lies to the east of the CMPL shrimp farm.

3.2.5 Public Health Act (1985)

Under the law, Parish Councils have the power to enforce the relevant regulations and orders, including the medical examination and certification of persons engaged in the food trade and in the slaughter of animals or poultry for human consumption. The regulations include inspection and prevention from contamination of food intended for human consumption, and control and destruction of rodents and other vermin.

The **Air, Soil, and Water Regulations (1976)** under this Act specifies that persons responsible for any construction, repair or alteration activities must take reasonable precautions to prevent particulate matter from becoming airborne.
With regards to the proposed project, the Public Health Act will have a bearing on the construction phase of the project, specifically those activities that may generate significant levels of fugitive dust.

The Act also covers details for sewage disposal; in particular, design criteria for pumping stations, screening and grit removal facilities, treatment ponds, sludge handling and disposal, and outfalls. It also deals with issues such as emergency power facilities, fencing and appropriate signage around the treatment facilities.

3.2.6 Water Resources Act (1995)

Under Section 19 of the Water Resources Act, unless a right of access to the source of water is owned and the water is slated solely for domestic purposes, no person or organisation is allowed to abstract and use water (or construct, alter or cause to be altered any works for the abstraction and use of water) without a licence granted by the WRA.

Persons and organisations requiring such a licence must make an application in writing to the WRA (Section 20). Where the use of the abstracted water is likely to result in the discharge of effluents, an application should also be made to NEPA for a licence to discharge the effluent and a copy of that application must be submitted along with any application made to the WRA (Section 21). Application to the WRA to sink, enlarge or otherwise alter a well must be accompanied by the relevant maps, documents, and information as well as the licence application fee.

Under Section 38 of the Act, the WRA has the power to determine the "safe yield" of any aquifer for the purpose of guiding determinations concerning the abstraction and use of water from the aquifer. (The "safe yield of an aquifer is the amount of water which may be abstracted which would not reduce the supply to such an extent as to render abstraction harmful to the aquifer itself or its water quality.)

3.2.7 Local Improvements Act (1914)

The Local Improvements Act controls the subdivision of land and invests in the local Parish Council the power to approve or deny subdivision applications within their boundaries, based on the advice of their Planning and Building Subcommittee and the local Fire Superintendent. The Parish Council must, by law, refer the subdivision application to the Government Town Planner for advice, and to the Chief Technical Officer of the Ministry of Works for his approval.

3.2.8 Country Fires Act (1942, last amendment 1995)

The Act makes it illegal to set fire to any crop or trash unless notice has been given to the nearest police station and the occupiers of adjoining lands within ½ mile of the place of fire. Furthermore, an open space of 15ft around the fire must be cleared and all inflammable material removed. A permit is required if the area is one in which fires are prohibited. This Act would apply if CMPL propose to burn the vegetation cleared from the pond construction sites.

3.2.9 Factories Act (1943, with amendments to 1968)

The processing plant is included in the definition of a factory under the Act and it would have to be registered as such and the building plans approved. The plant would be subject to inspections and the regulations require notification of accidents and industrial diseases.

3.3 DEVELOPMENT POLICIES AND GUIDELINES

3.3.1 Aquaculture

The South Coast Sustainable Development Study (Sustainable Development Guidelines, 1999) and the *NRCA Mariculture National Policy (1997)*, together promote and recognise the need for expansion of the aquaculture sector in Jamaica. The sustainable use of coastal and marine resources for the production of food and the generation of employment and income is also encouraged and consistent with the development objectives of the Government of Jamaica. Both documents, however, also recognise that such development potentially may have significant negative impacts on the environment.

The most obvious effect is the clearing of land and the establishment of aquaculture ponds, which can be most damaging in coastal areas such as mangrove swamps and other wetlands. *The NRCA Mangrove and Coastal Wetlands Protection Draft Policy and Regulation (1996)* seeks to highlight the need for protecting Jamaica's mangroves and wetlands against dredging, filling, industrial effluent disposal and sedimentation. Permit applications for construction on or adjacent to mangrove ecosystems and coastal wetlands must be submitted to both the NRCA and the local planning authority and all developments planned for wetlands are subject to an EIA.

Other potential impacts of aquaculture projects on the environment, identified in the policy and guidelines, include:

- Erosion and siltation problems arising during the construction phase of the project;
- Coastal and surface water pollution from pond effluent;
- Introduction of exotic species with subsequent damage to native stocks by competition, predation, spread of disease and parasites;
- Competition between the ponds and other traditional users for water and land resources;
- Salinisation of prime agriculture lands by shrimp farming where ground water is pumped from coastal aquifers (causing salt water intrusion) and where there is poor construction and operation of the ponds.

Mitigation measures suggested include:

- Prohibition of ponds in areas of ecological sensitivity;
- Limitation of areas converted to ponds and restriction of clearance to only areas needed for the ponds;
- Pond construction during the dry season;
- Stabilization of exposed soil with grass, etc.;
- Dilution and treatment of pond water prior to release into the receiving environment;
- Controlled introduction of exotic species with safeguards against escape;
- Involvement and recruitment of members of the local community;
- Avoiding the establishment of ponds on high quality agriculture land of high economic and ecological value;

- Proper construction and operation practices on the part of the developer.

The main factors to be monitored during operation should include:
- Water quality at the farm and within pond effluent and receiving waters;
- Hydrologic effects of the ponds;
- The presence of fish diseases and parasites;
- The increase in water-borne and water-related disease vectors.

3.3.2 Portland Bight Protected Area

Several natural areas in Jamaica have been identified for special protection under the NRCAA. One of these is the Portland Bight Protected Area (PBPA) , a marine and land area of 1,876km^2 that was declared in 1999. The land portion of the protected area extends from the Hellshire Hills in the east to Parnassus – Macarry Bay in the west. Thus the CMPL shrimp farm lies within the boundaries of this area and presumably will eventually become an integral part of a regional multiple-use management plan.

Although the Caribbean Coastal Area Management (CCAM) Foundation was set up in 1999 as the NGO responsible for managing this area, this entity has not yet been endorsed by the government. The CCAM Management Plan 1999 – 2004 identifies the CMPL farm as an industry located within PBPA. It also proposes the establishment of a Portland Bight Industrial Council to assess, monitor and control industrial pollution in Portland Bight.

Reference has been made above to the Amity Hall mangal having been declared as a Game Sanctuary. This area lies to the east of the CMPL shrimp farm.

4. PROJECT ENVIRONMENT

4.1. FIELD METHODOLOGY

4.1.1 Water quality

The University of the West Indies (UWI), between June 2000 - September 2000 and September 2001 - February 2002, collected water samples on a monthly basis. The samples were collected as part of a routine water quality monitoring programme for the existing Phase 1 development. The locations of the eight sampling stations are shown in Figure 4.1 These were:

N1- Intake (Fraser's Gully)
N2 - Reservoir
N3 - West outflow from ponds
N4 - East outflow from ponds
N5 - Combined outflow
N6 - Salina
N7 - Mangrove
N8 - Creek

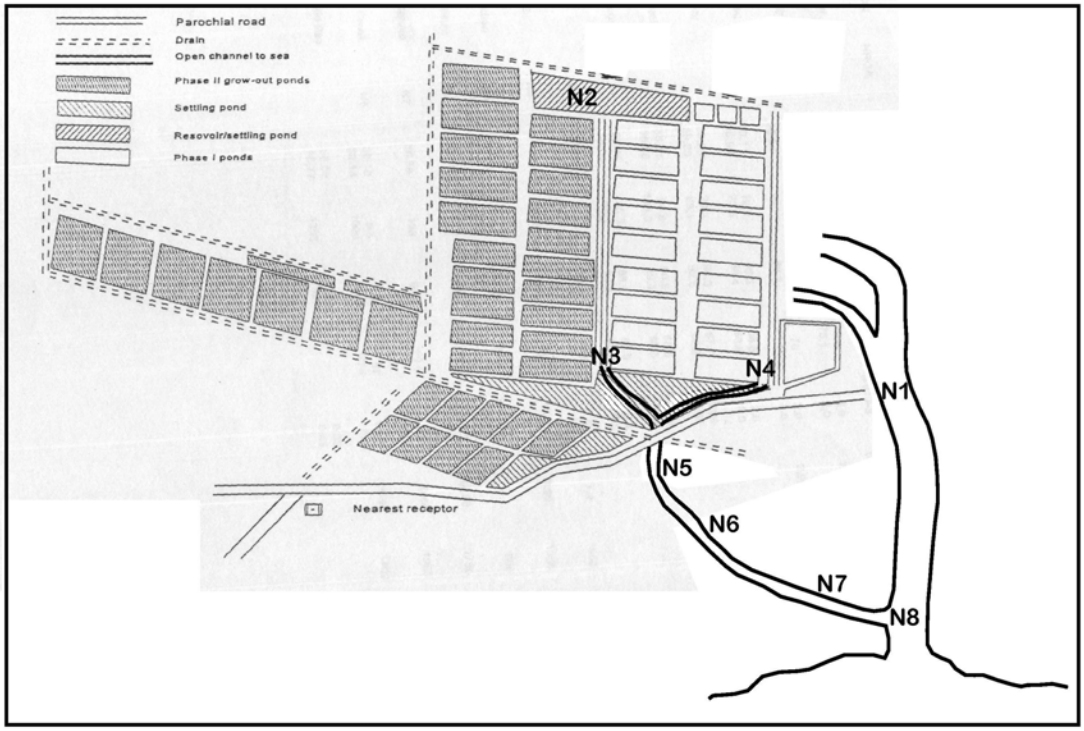

Figure 4.1 Schematic showing location of UWI water quality monitoring stations.

The seven parameters collected and analysed for the monitoring programme were:

- Dissolved Oxygen (DO)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Nitrate (NO_3)
- Phosphate (PO_4)

For the purposes of the present EIA, the 10 months of data were averaged. These values are presented at Section 4.5.

4.1.2 Terrestrial ecology

A simple visual assessment of vegetation on the site, and within surrounding salina/mangal wetlands, was conducted on 16 & 28 July, 2002, to verify the accuracy of a descriptive account and vegetation community map compiled by Chow (1993). This account was referred to extensively in the subsequent EIA done for the first phase of the project (Davis *et al*, 1997). Existing descriptive accounts of flora at the project site, and within its surroundings, were updated during the current surveys and observed plant species were identified.

Avifaunal surveys were also conducted during the present vegetation surveys. These were conducted between the hours of 9:30 and 11:30 am (16 & 28 July 2002). Species were recorded based on actual sightings and bird calls. Species not immediately identifiable were noted and field guides (Bond, 1985; Downer *et al*, 1990) were used to verify their identity.

4.1.3 Socio-economics

Two visits were made to Thompson Pen Lane, the road running along the southern border of the farm site. The first, a reconnaissance visit to scope the pertinent issues, also included a drive around the immediate area and Old Harbour Bay.

The second visit involved observations of existing circumstances and interviews with key-informants from Thompson Pen Lane, the community that would most directly be affected by the proposed expansion works. These key-informants were not recognised community leaders but rather residents representing several walks of life and who directly experienced the issues. Interviews were conducted with both individuals and groups.

The socio-economic impact assessment provided below (Section 4.8) focuses on the community of Thompson Pen Lane, although it is understood that the social and economic impact of the shrimp farm expansion will extend beyond the confines of this geographic location.

4.2 CLIMATE

The meteorological station nearest to the study area is located at Bodles, approximately 5km northwest of the site. Data for rainfall, temperature, evaporation and wind is presented in Table 4.2.1.

Monthly mean maximum temperature at Bodles for the period 1931 - 1980, ranges from 29.5^{o}C in January to 32.2^{o}C in July. Monthly mean minimum temperatures for the same period range from 16^{o}C in February to 20.5^{o}C in July.

The mean monthly rainfall at Bodles ranges from 38 mm in January to 201 mm in October. The two dominant rainfall periods are May to June and September to October. The mean monthly rainfall at Old Harbour ranges from 37 mm in February to 213 mm in October. The mean annual rainfall for Bodles and Old Harbour is 1044 and 1069 mm respectively.

The mean daily evaporation for the Bodles Station ranges from 4.1 mm in January to 7.1 mm in July. With the exception of September and October, the mean monthly evaporation exceeds the mean monthly rainfall, hence the typically very dry condition at the site.

Table 4.2.1 - Climate Data - Bodles Meteorological Station

PARAMETER	J	F	M	A	M	J	J	A	S	O	N	D	MEAN
Max. Temp ^{o}C	29.5	29.5	29.7	30.5	30.7	31.4	32.2	32.1	41.4	31.0	30.6	30.4	30.8
Min. Temp ^{o}C	16.5	16.0	17.3	18.4	19.7	20.5	20.5	20.4	20.1	19.5	19.4	18.2	18.9
Evaporation (mm)	127	148	180	192	198	192	220	183	159	146	129	133	171
Rainfall (mm)	38	42	49	53	116	88	58	97	159	201	90	53	87
RH (%) 0700hrs	92	90	88	83	86	85	84	87	89	89	89	89	88
RH (%) 1300hrs	64	62	62	64	66	64	60	65	68	68	66	63	64
Wind Speed (kts)*	6.7	8.1	8.3	7.7	9.4	11.5	10.8	8.7	7.6	6.1	5.5	6.1	

***** Daily mean wind speed in knots at 10 m above ground level for the Norman Manley International Airport.

Wind data for the Norman Manley Airport is considered representative of the site. The dominant wind direction is from the southeast, occurring 30.6 percent of the time. Winds from the east and north occur 27.5 percent and 15.8 percent of the time respectively. The mean daily wind speed at 10m above ground level varies from 5.5 knots in November to 11.5 knots in June. Wind speed of 18 knots is typical in the summer months between 12:00 noon and 2:00 p.m.

4.3 TOPOGRAPHY, HYDROLOGY AND DRAINAGE

Located on the southern side of the St. Catherine Plains, the general area of the site is flat and gently sloping. The elevations above mean sea level at the northeast corner of the site are in the order of 12m (40 ft), falling to 3m (10 ft) at the eastern side and 1.5m (5 ft) at the southern side. The construction of the ponds has modified the topography of the site as the tops of the embankments are approximately 2m above ground level.

The drainage area impacting the site is approximately 20km^2 (2000 ha). The drainage area extends from Thetford in the northeast and Bannister in the northwest to the salina in the south, as shown in Figure 4.2. Surface runoff from the town of Old Harbour, via the gullies, also influences the area of the site.

Fraser's Gully, together with its tributaries, Stony Gully, Church Pen Gully and an unnamed gully, is the main drainage system within the defined drainage area. Fraser's Gully crosses the northeast corner of the project site and forms the eastern boundary of the site. It eventually drains into the northwest corner of Galleon Harbour, (part of Portland Bight) via a dredged canal through the mangroves.

The estimated flow in the Fraser Gully (i.e. combined flow of the Fraser, Church Pen and Stony Gullies) ranges from 80m^3/sec for the 10 Year Return Period to 192m^3/sec for the 100 Year Return Period as shown by Table 4.3.1.

Table 4.3.1 Fraser Gully – Estimated flow rates.

RETURN PERIOD	10 Year	25 Year	50 Year	100 Year
Flow (m^3/sec)	80.8	99.2	151.2	192.2

There are three microdams, located on these gullies, situated immediately to the north of the farm. These were constructed in the 1970's. They are now in a state of disrepair and do not significantly affect the hydrology of the area.

A gully also crosses the southern section of the site (Plate 24). This collects storm water generated largely by surface runoff from the land to the northeast of the farm (The Whim) and flows from west to east. This gully opens into the area of the farm designated as the 'artificial wetland' (a sedimentation basin) before flowing into the salina south and east of the project site (see Plate 17).

Surface runoff generated on the western side of the Old Harbour - Old Harbour Bay main road is channeled away through a drain running beside the road and is discharged at Old Harbour Bay.

Figure 4.2 Map of surface drainage system (black lines) affecting CMPL.

Plate 24. Gully at Old Harbour main road, looking southeast across JADF property.

It is also relevant to note that the recent building of the new Old Harbour Bypass highway (not shown on Figure 4.2 but which runs along the southern side of the railway) involved construction of bridges and pavements at all the gully crossings. It is not yet clear how these modifications to upstream drainage characteristics will affect surface drainage in the vicinity of the farm.

In general, the project site is fairly well drained. However, drainage is poor immediately south of the farm in the vicinity of the salina. Due to the flat topography, poor drainage, and the relatively large catchment area, the homes located along Thompson Pen Lane are prone to flooding (Plate 25). Based on informal interviews with local residents, this area had a history of flooding prior to the establishment of the shrimp farm. High tidal stages coinciding with heavy gully flows exacerbate flooding conditions in the community.

This community, south of the site, was flooded during the May-June, August and September 2002 flood events during which period the farm itself was not seriously affected. The rainfall causing the severe island-wide flooding in May-June had a return period of 25 years and it is therefore not surprising that the area became flooded. However, a contributing factor was the blocked condition of the culverts under the road at Thompson Pen Lane that facilitate drainage from the site into the salina. These were blocked by sediments eroded from the pond embankments and the drains at the shrimp farm (see Plate 15). The culverts and the drain were cleared recently and the excavated material placed on the banks of the drain (see Plate 16). These berms are being built up and

Plate 25. Homes along Thompson Pen Lane vulnerable to flooding.

compacted to reduce the incidence of overflows and flooding.

Both the alluvium and the limestone underlying the farm site function as aquifers. The groundwater in the limestone is saline and therefore cannot be used for domestic or agricultural purposes without extensive treatment.

The groundwater table in the alluvium is less than 1.5 m above mean sea level and the direction of flow is south, towards the coast. This alluvial groundwater is brackish and therefore of marginal quality for domestic purposes.

4.4 GEOLOGY AND SOILS

The site is underlain by the Rio Cobre Alluvium Formation. This consists of a mixture of sand, silt and clay. The thickness of the alluvium is highly variable, ranging from 27m in the northern section of the aquifer to 140m in the southern section. Limestone occurs below the alluvium. There are no significant geological structures in the vicinity of the site.

The soils at the site are classified as the Salt Island Series. Typically, these soils are a deep and finely textured clay, dark brown in colour. The soils are strongly saline and sodic (high sodium) and therefore of low fertility. When dry, the soil cracks and becomes very friable. These soils are also highly erodable, as

evidenced by the damage to sides of the farm pond embankments noted above at Section 2.2.3.

4.5 WATER QUALITY

The results of the ten water sampling events carried out during the water quality monitoring programme conducted by UWI were averaged for each parameter. These are presented in Table 4.5.1.

Table 4.5.1 Averaged water chemistry data (10 events, June 2000 – February 2002).

PARAMETER	STATIONS								NEPA STANDARD
	N1 Intake	N2 Reserv.	N3 West Out.	N4 East Out.	N5 Comb.	N6 Salina	N7 Mang.	N8 Creek	
DO (mg/l)	3.54	5.48	6.07	6.19	5.06	7.42	3.37	3.82	>4
BOD (mg/l)	2.01	2.54	5.41	4.61	5.76	6.52	1.56	0.84	30
COD (mg/l)	1070	1190	1186	1744	1226	1390	1372	830	<100
TSS (NTU)	27.99	21.19	215.81	165.51	255.74	93.94	55.67	21.28	50
TDS (mg/l)	33.72	30.54	136.17	89.85	32.89	38.20	65.32	35.21	1000
Nitrate (mg/l)	46.47	42.56	38.67	37.57	39.05	38.86	38.57	52.24	10
Phosphate (mg/l)	3.53	2.93	1.50	1.43	1.45	1.79	1.45	1.60	5

The main feature of these data is that COD and nitrate levels were consistently high and significantly above NEPA standards at all stations. However, it should also be noted that these values also exceeded the standards at the intake. TSS values were high and above NEPA standards within the effluent stream leaving the existing shrimp ponds but showed a gradual reduction as the stream passed through the salina and mangrove, falling below NEPA standards by the time it reached the Creek. Within the Creek TSS levels were just below those of the farm's intake supply.

4.6 AIR QUALITY

Davis et al (1997) noted that ambient air quality data was not available for the vicinity of the site. Values of total suspended particulates measured at Bodles ranged from 9 to 40 μgm^{-3} and averaged 18 μgm^{-3}, which is only 33% of the Jamaican ambient air quality standard. These values were typical of readings for other rural sites, which ranged from 15 to 48 μgm^{-3} (op cit).

4.7 ECOLOGY

4.7.1 Terrestrial vegetation

A map of the vegetation of the area is shown at Figure 4.3. Chow (1993) described the vegetation at the original shrimp farm site as Acacia thorn scrub. It was noted that this community was relatively open and comprised of two layers.

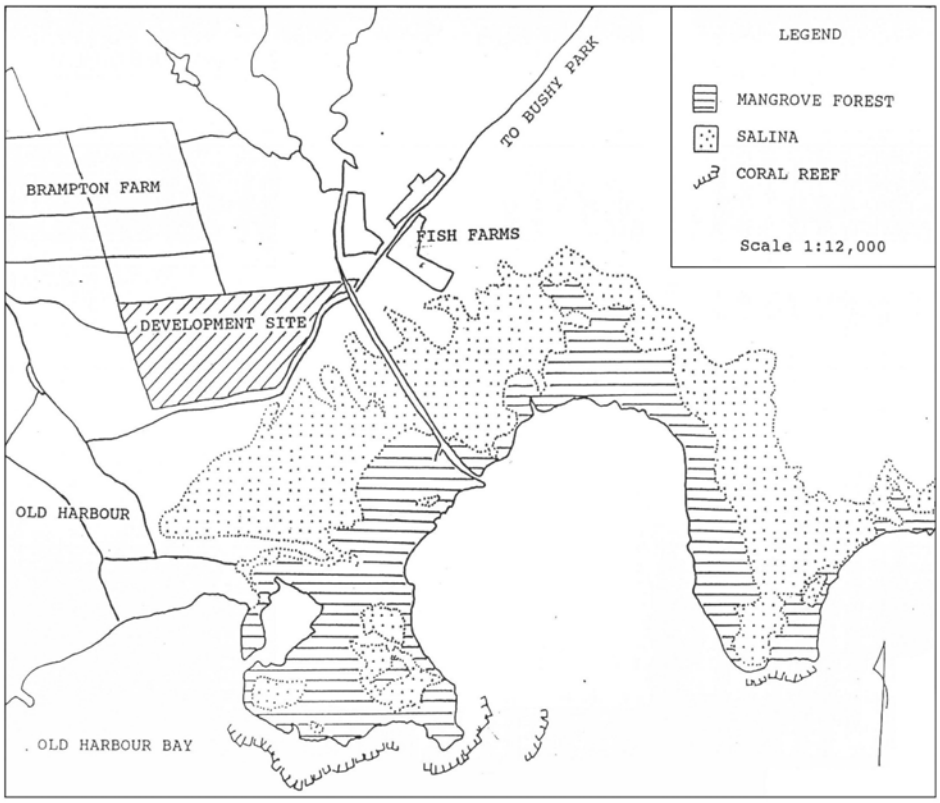

Figure 4.3 Vegetation map of Brampton, Old Harbour. (Taken from Chow, 1993)

These were an upper layer, 3 m high, consisting of various *Acacia sp.* and columnar cacti such as *Stenocereus hystrix*; and a lower layer, 1 m high, with shrubs dominated by *Batis maritima* and scrambling herbaceous species of Compositae. Within the last 10 years, this vegetation has largely been removed during the conversion of land use to marine shrimp production ponds. The original *Acacia* thorn scrub, as described by Chow (1993), remains as the characteristic vegetation type to the northeast of the JADF lands.

The lands proposed for future phased expansion of the shrimp farm, mainly consisting of the area between the existing farm and the Old Harbour – Old Harbour Bay main road are either covered in ruinate, are recently taken out of mango cultivation, or are under cotton cultivation (Plate 26). As a result, there are no floral species of any conservation value present in these areas.

Plate 26. Project lands currently under cotton cultivation.

Table 4.7.1 lists the plant species observed at the farm site during the current site visits. These species dominated the vegetation occurring on sides of the intake water storage reservoir and the shrimp ponds, and within the proposed artificial wetland/effluent sediment settlement area. No endemic species were encountered.

Table 4.7.1 List of terrestrial plant species at CMPL site.

FAMILY	BOTANICAL NAME	COMMON NAME	DAFOR*	HABIT
Aizoaceae	*Sesuvium portulacastrum*	Seaside Purslane	F	Shrub
Avicenniaceae	*Avicennia germinans*	Black Mangrove	O	Shrub/Tree
Bataceae	*Batis maritima*	Jamaican Samphire	D	Shrub
Cactaceae	*Harrisia gracilis*	Torchwood Dildo	R	Cactus
Mimosaceae	*Acacia tortuosa*	Wild Poponax	R	Shrub
Typhaceae	Typha domingensis	Reedmace	O	Shrub

*** KEY:**

D	-	Dominant	-	Many dominate the site
A	-	Abundant	-	Many individuals observed
F	-	Frequent	-	Individuals observed frequently
O	-	Occasional	-	Individuals observed a few times
R	-	Rare	-	Individuals observed once or twice

4.7.2 Salina flat & mangroves

Land to the east, southeast and south of the project site were classified by Chow (1993) as open salina and mangal wetlands, the extent of which were demarcated on the vegetation community map shown above at Figure 4.7.1. The mangal wetlands are well developed with *Rhizophora mangle* fringing the seaward margins of the wetland, and along waterways like Frasers Gully. *Avicennia germinans* is found landward of the red mangrove fringe and in areas adjoining the salinas. *Laguncularia racemosa* and *Conocarpus erectus* are present but rare in occurrence (Chow, 1993).

The landward sections of the fringe mangrove forest are bordered by an extensive salina, approximately 450 - 600 m in length. The substratum of this salina is comprised of heavy clay, mixed with fine black sands. Vegetation on the salina was sparse and comprised of scattered bushes of *Batis maritima*. Vegetation cover was estimated at 5% of the total area of the salina and was more profuse in the wetter southern zones that are more frequently inundated by the daily tides. For the most part, however, bare mudflats are predominant, with thick layer of fine filamentous algae overlying the wet mud surface (Chow, 1993).

No significant changes were observed in the overall extent of the salina and mangal vegetation communities and the open salina and mangal wetlands appear to have undergone little, if any, change since the Chow (1993) study. The proposed expansion of the CMPL shrimp farm will not encroach on the salina and mangal wetlands.

Table 4.7.2 lists the plant species observed within these communities during the current study. No endemic species were encountered.

Table 4.7.2 List of terrestrial plant species observed within the salina and mangal wetlands, south of the CMPL site.

FAMILY	BOTANICAL NAME	COMMON NAME	DAFOR*	HABIT
Aizoaceae	*Sesuvium portulacastrum*	Seaside Purslane	F	Shrub
Avicenniaceae	*Avicennia germinans*	Black Mangrove	F	Shrub/Tree
Bataceae	*Batis maritima*	Jamaican Samphire	D	Shrub
Cactaceae	*Harrisia gracilis*	Torchwood Dildo	R	Cactus
Cactaceae	*Stenocereus hystrix*	Cholla/Dildo Cactus	F	Cactus
Combretaceae	*Laguncularia racemosa*	White Mangrove	O/R	Shrub/Tree
Mimosaceae	*Acacia tortuosa*	Wild Poponax	O	Shrub
Rhizophoraceae	*Rhizophora mangle*	Red Mangrove	F/D	Tree

*** KEY:**

D	-	Dominant	-	Many dominate the site
A	-	Abundant	-	Many individuals observed
F	-	Frequent	-	Individuals observed frequently
O	-	Occasional	-	Individuals observed a few times
R	-	Rare	-	Individuals observed once or twice

4.7.3 Birds and other fauna

Table 4.7.3 lists the birds observed during the current surveys carried out at the project site and within the salina/mangal wetlands, south of the project site. Eleven (11) different bird species were observed, none of which were endemic. (It should be noted that most of these species, were observed within the salina/mangal wetlands, south of the project site.)

Table 4.7.3 Bird species observed at the project site and within the salina/mangal wetland.

FAMILY	SPECIES NAME	COMMON NAME	NUMBERS	STATUS*
Ardeidae	*Ardea herodias*	Great Blue Heron	1	CWV
Ardeidae	*Bubulcus ibis*	Cattle Egret	5	VCR
Ardeidae	*Egretta caerulea*	Little Blue Heron	2	CR
Ardeidae	*Egretta thula*	Snowy Egret	1	CR
Charadriidae	*Charadrius semipalmatus*	Semipalmated Plover	4	CWV
Fregatidae	*Fregata magnificens*	Magnificent Frigatebird	3	CR
Laridae	*Sterna antillarum*	Least Tern	2	CSR
Pelecanidae	*Pelecanus occidentalis*	Brown Pelican	1	CR
Scolopacidae	*Tringa flavipes*	Lesser Yellowlegs	2	CWV
Scolopacidae	*Arenaria interpres*	Ruddy Turnstone	1	CWV
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	1	CWV
		Total	23	

*** STATUS KEY** (Based on Downer & Sutton, 1990):

CR	-	Common resident
VCR	-	Very common resident
CSR	-	Common summer resident
AR	-	Abundant resident
CWV	-	Common winter visitor

Surprisingly, bird activity at the project site itself was generally low, both in terms of species and numbers of individuals. The observed species were the wader, *Egretta thula* (Snowy Egret), and a single *Plegadis falcinellus* (Glossy Ibis). These egrets were observed in the vicinity of the effluent sediment settlement area, the intake water storage reservoir and surrounding inundated wet areas.

In contrast to the above, the number of species and individuals observed within the salina/mangal wetlands, south of the project site, were high and indicative of the fact that these wetlands are clearly the locus of bird activity in the region. Chow (1993) reported 25 different species within the salina/mangal wetlands and local residents reported that, in the evenings, hundreds of birds descend on the mangrove forest to feed and roost. Data collected by BirdLife Jamaica (Chow, 1993) support the conclusion that the salina and mangrove wetlands east, southeast and south of the project site are important sites for a large variety and number of resident and migrant bird species. The findings of the current surveys concur with this fact and confirm the important role these wetlands play in supporting and maintaining the high avifauna biodiversity and activity in the region.

In addition to the avifauna, other non-domestic fauna worthy of note at the site include various land crabs (*Cardisoma guanhumi* and *Ucides cordatus*) and mangrove crabs (*Aratus pisonii* and *Uca sp.*). These individuals were observed within burrows and on mangrove trees along the banks of the intake water storage reservoir.

No crocodiles or evidence of crocodile activity/tracks were observed at the site or within the salina/mangal wetlands, during the present field visits. The presence of the endangered crocodile species (*Crocodylus acutus*) in the Old Harbour area has been confirmed by a reported sighting made by Chow (1993) and they are frequently encountered in fish ponds in the area (C. Swaby, pers. comm). The CMPL project manager has indicated that crocodiles are not often encountered in the shrimp ponds.

Davis *et al.* (1997) suggest that manatees and marine turtles may also frequent the mangroves fringing Old Harbour Bay.

4.7.4 Marine ecology

The northeastern shoreline of Old Harbour is characterized by a number of small bays, which include Old Harbour Bay and Galleon Harbour. Enclosing Galleon Harbour, immediately offshore of the northeastern shoreline of Old Harbour, are Little Goat Island and Great Goat Island.

Water depths, close to the shore within the sheltered bays, are typically 0.25 – 2.0 m. They support extensive turtle grass (*Thalassia testudinum*) meadows, which with their associated fringe shoreline mangrove forests, are regarded as one of the most important marine nursery areas on the south coast of Jamaica. The *T. testudinum* beds are part of a large area of seagrasses extending southward towards Little Goat Island, Great Goat Island and the Cabarita Flats,

southwest of Walker Bay. *Penaeus schmitti* (White Shrimp), *Oreaster reticulatus* (Cushion Sea Star) and *Lytechinus variegatus* (Variegated Urchin) are the dominant species within these seagrass meadows (Chow, 1993).

4.8 SOCIO-ECONOMY

4.8.1 Settlement

Thompson Pen Lane runs alongside the southern perimeter of the CMPL shrimp farm and joins Salt Gully Road at the southwestern side of the farm. The community living beside this road would be that most directly affected, at least physically, by the expansion of the shrimp farm. It is a small, close-knit, economically depressed community within the larger Old Harbour Bay area. Old Harbour Bay is Jamaica's largest fishing beach.

Old Harbour Bay is located about 5km (3 miles) from the nearest main residential and commercial centre, Old Harbour. Both are situated in St. Catherine, the largest parish in Jamaica, spanning an area of 1,192.4 km^2 (460 square miles).

Thompson Pen Lane consists of houses on either side of the single road running through the community. The road is a rocky strip of gravels and mud, which becomes muddy and waterlogged during bad weather conditions (Plate 27).

Plate 27. Thompson Pen Lane during wet season.

The problem with flooding is a major one, especially on the salt plain (salina) adjacent to the Salt Gully area. As respondents explained, the threat of flooding is due to the fact that the salt plain is low lying and receives the drainage from the surrounding higher land, this becoming a problem during periods of intense rainfall. (The salina is also subject to tides.)

The dwellings along the upper part of Thompson Pen Lane (i.e., those nearer the entrance from the Old Harbour Bay main road) are constructed of concrete blocks and are in a better condition (Plate 28) than those further down at its lower end (Salt Gully Road). The latter units are constructed with a mixture of materials including block, wood, and zinc (Plate 29).

4.8.2 Demography

The Thompson Pen 'community' is comprised of approximately 2,000 persons. The estimates provided independently by several respondents corroborated roughly regarding the age profile of Thompson Pen Lane. Table 4.1 summarizes these estimates.

Table 4.1 Reported Age Profile Estimates of Thompson Pen Lane.

0-14 Years	15-34 Years	35-64 Years	65+ Years	15-64 Years
30%	40%	20%	10%	60%

The above figures closely conform to the general St. Catherine age profile given in the 1998 JSLC[1]. The dependent population of Thompson Pen Lane therefore comprises 40% and the working age or economically productive population (15-64 years) 60% of the total. This proportion is a fairly positive indication for future development of the area and the relatively high proportion of young adults (15-34 years) in the working age cohort speaks to the availability of a continuous labour supply, all other things being equal. The 1998 JSLC figures are above the national average, St. James, Kingston and St. Andrew being the only other areas where this obtains.

The 65+ years age cohort was larger in earlier years but diminished, relatively speaking, due in part to the large influx of young adults into the area. Questioned as to what the pull factors might be, respondents said that it was the result of the low crime and, in general, the laid back character of Thompson Pen Lane.

In terms of the gender profile, respondents generally agreed that males were preponderant, although they varied slightly as regards the proportion. Table 2 shows three versions.

[1] Statistical Institute of Jamaica & Planning Institute of Jamaica (1999). Jamaica Survey of Living Conditions 1998. Kingston: STATIN/PIOJ.

Plate 28. Concrete houses at upper end of Thompson Pen Lane.

Plate 29. Typical house at lower end of Thompson Pen Lane.

The foregoing, like the age profile, has implications for the direction and focus of development in the Thompson Pen Lane area simply because occupation and employment are still relatively gender-bound and conventional, especially in the rural setting.

Table 4.2 Reported Gender Profile Estimates (3) of Thompson Pen Lane.

FEMALE	MALE
40%	60%
50%	50%
35%	65%

This also has special implications for family life. Most families may be defined as single parent, with mainly females playing the role of parents. Respondents opined that, by and large, the houses are not too crowded. Typically, a household comprises three adults and four children, an average of seven per unit.

4.8.3 Education levels, skills and employment

Referring in particular to the economically productive population, respondents said that the educational level was generally primary with a small number having attended high school. In general, there was little or no college or higher education graduates, although some respondents said that the area was home to two magistrates and one or two lawyers. A couple of teachers and other white-collar workers lived in Thompson Pen Lane, their places of employment being mainly Old Harbour.

As expected, skills, occupational roles and employment are divided by gender. The economy is based on fishing and most activity focuses on that sector. Men fish and women engage in vending/retailing and fish cleaning. Fishing is a relatively expensive enterprise and fishermen seek the capital outlay for their ventures through bank (or otherwise) credit and/or depend upon remittances from family members abroad.

Apart from this major activity, males also have welding, carpentry, masonry, plumbing, electrician, and mechanics skills, among others. They utilize these skills at Thompson Pen Lane, the adjoining communities, and at Old Harbour. In Old Harbour, females are employed mainly as teachers, domestic helpers, laundresses, waitresses, as well as in offices and supermarkets/shops. They also retail fish as well. Farming is not a tradition in the community and therefore such skills are not widespread there, although they may be readily learnt.

Most of the earth works during construction of the expansion phase will be accomplished using heavy equipment. Operations of the shrimp farm requires the following skills:

- o routine farm labour;
- o shrimp processing;

- o water quality assurance procedures;
- o masonry and carpentry.

From the foregoing, it may be concluded that, except for water quality assurance procedures, the requisite skills may be readily available in the local community. The limiting factors that obtain in the Thompson Pen Lane community regarding skills availability for the shrimp farm expansion are:

- o absence of a large pool of high school graduates from which to choose the most employable for water quality assurance procedures, and
- o degree of willingness of those educated at the primary level to be trained in shrimp processing skills.

4.8.4 Land use

From the interviews conducted, there was no evidence that the projected expansion of the shrimp farm will intrude on any traditional or customary land use in the community. Charcoal production is minimal, farming is to all intents and purposes non-existent, and there is little proof of systematic livestock production. The large number of goats roaming the area, respondents said, are not reared for commercial use, but traditionally kept by families for subsistence purposes. They are usually slaughtered at special festive occasions for immediate and extended family gatherings.

4.8.5 Community health

a) *Medical facilities*. There were no reports of visits by medical personnel to the community, apart from a clinic for babies every six weeks. All other medical matters, including emergencies, had to be sought at Old Harbour.

b) *Water supply*. Water supply is adequate and most dwellings are supplied by piped and potable water. Although the supply is occasionally 'cut', one respondent said that he was satisfied because that is how "the wheel turns". There are no public standpipes; this is not problematic due to the fact that everyone has access (to a greater or lesser extent) to piped water. Some persons reported having rainwater tanks in case of any contingencies.

c) *Solid waste management*. Responsibility for garbage collection rests with Central Metropolitan Parks and Market. Most respondents reported that waste collection was poor. They estimated that at times, 1-2 months may elapse before the garbage truck made its rounds. In the meantime, residents deposit their garbage in a central spot and burn it. This practice has its own environmental consequences because burning apparently is done at the roadside in close proximity to dwellings. One respondent reported that the buildup of garbage in particular areas was harmful to the fishponds.

d) *Sewage disposal*. All sewage disposal in the community is via soakaway, whether from pit latrines or flush toilets, despite the clayey soils.

4.8.6 Community organisation

From reports, there appears to be little community organisation. Respondents mentioned a couple of fellowship groups, but these were more religious than civic. While not overlooking the importance of religious groupings to Thompson Pen Lane, the lack of local leadership for organising residents at such times of change and, in general, coordinating local development, is a fundamental setback. The major organised activity is football.

4.8.7 Housing

As noted earlier, the dwellings observed at the entrance to Thompson Pen Lane were in better conditions than those further in. The former are separate units constructed mainly of block and steel while the latter appeared to be constructed of a combination of wood and zinc. Many of the dwellings nearer to and alongside the Salt Gully Road are ramshackle with signs of patchwork. Roofing material is mainly zinc. Many dwellings have electrical lighting.

Of particular concern were those homes, and house foundations, built immediately beside the salina, an area obviously prone to flooding (Plate 30).

Plate 30. Foundation of house being built immediately adjacent to salina.

4.8.8 Community's perceptions of project

Respondents believe that the proposed shrimp farm expansion project will be a boon for the community. This is especially so given their positive experience with and therefore impression of CMPL. It sponsors many football teams in the area and generally supports the football league. Some said that CMPL sometimes provides them with fish from the ponds. This goodwill towards CMPL is integral to the community's acceptance of the expansion.

They also believe that the necessary skills required by the farm exist within the area and therefore there is the hope that employment will be a fundamental result of the expansion. The following summarizes what the community might consider the best conditions for the success of the expansion.

- ***Cooperation/partnership.*** The continuation and extension of CMPL's goodwill and social responsibility towards Thompson Pen Lane and its neighborhood is considered vital, especially given the depressed conditions. While not specifying how this goodwill may be extended, respondents believed that football was a good example since the sport engaged otherwise idle youth and helped to maintain the peacefulness of the community. They affirmed the high regard in which CMPL is held.

- ***Flooding and drainage.*** Respondents conceded that housing construction on the salt plain was irresponsible in the first place. They are aware of the flood prone conditions of the entire area and therefore recommend that CMPL take the necessary steps to prevent or at least minimize flooding.

- ***First offer of employment.*** As expected and consistent with the concerns of most communities anticipating project development, Thompson Pen Lane's residents are resolute that first employment choice ought to be theirs. 'Outsiders', they fear, might disrupt the peace of the community, not only by bringing into the community unfamiliar practices, but by provoking negative responses/attitudes from residents who may feel cheated of opportunities.

4.8.9 Social strengths and weaknesses of Thompson Pen Lane

Table 4.3 sets out the community's strengths and weaknesses as identified by respondents. The intention here is not to weigh the strengths against the weaknesses, or to provide a scientific 'balance sheet' statement of strengths and weaknesses. Rather, the aim is to highlight the issues or areas the community can build upon as well as those it should attempt to counteract.

Table 4.3 Strengths and Weaknesses of Thompson Pen Lane.

STRENGTHS	WEAKNESSES
• Relative lack of serious crime, e.g., gun crime, abuse of hard drugs, etc.;	• Lack of formal employment; underemployment reflected in the irregularity of rewarding jobs for tradesmen;
• Very religious community, assuming religiosity might be judged by number of churches (estimated 15 churches in the vicinity);	• Negative North American cultural influence (e.g., reported engagement in prostitution among the female 15-34 years' age cohort);
• Informal neighbourhood crime and anti-social behaviour watch: people look out for each other;	• The lure of a 'quick dollar' as a result of location near to beach - inimical to personal development including educational ambitions, among others; real potential for drug trafficking;
• Active participation in sports by youth (There is a large playfield close by);	• 'Prohibitive' taxi fare to and from Old Harbour where many are employed or seek employment and access to various services;
• No apparent political divisiveness;	• Lack of civic/community organisations;
• No apparent security risk to shrimp farm.	• Generally low educational levels;
	• Mistrust or cynical views of politicians.

4.9 ARCHAEOLOGY AND HISTORICAL RESOURCES

If there were any historical sites on the shrimp farm site, then these have long disappeared – there are no evident ruins in this regard. There is a hand dug well near to the proposed location of the new office building but this is of fairly recent origin. It has been covered and safeguarded by the project.

Inquiries of the Jamaica National Heritage Trust (D. Gray; 10/10/02) revealed that there are historical references (18th C) to a small military post located by the mouth of the creek in the center of Old Harbour Bay. There are supposed to be several cannons stuck in the ground beside the road.

5. POTENTIAL IMPACTS AND MITIGATION MEASURES

5.1 IMPACT IDENTIFICATION

An environmental impact is defined as any change to an existing condition of the environment. The nature of the impacts may be categorized in terms of:

Duration – long or short term
Location – direct or indirect
Magnitude – large or small
Extent – wide or local

To systematically identify the impacts associated with the proposed expansion of the marine shrimp farm, an impact matrix was constructed which arrayed the main project activities against the relevant environmental factors. Consideration was also given to issues related to current operations of the farm. This matrix is shown at Table 5.1. A list of the potential impacts associated with the proposed expansion of the marine shrimp farm is provided below.

- Construction Impacts – Production ponds & Processing plant
  - Increased employment of services and labour, including incidental employment of nearby residents
  - Terrestrial and arboreal habitat loss due to vegetation removal
  - Smoke and soot generated by waste vegetation disposal
  - Suspended sediments and turbidity in Frasers Gully due to excavation of new intake channel
  - Creation of aquatic habitat
  - Noise and dust related to earth moving and construction activities
  - Soil erosion from cleared lands and construction areas
  - Modification of surface drainage pattern
  - Illegal marl quarrying
  - Wear-and-tear of parochial and farm roads due to project related traffic
  - Landscape alteration / visual aesthetics
  - Loss of traditional corridors / amenity use

- Operations impacts – Production ponds
  - Entrainment of marine larvae and organisms at salt water intake
  - Pond embankment erosion due to harvesting methods, effluent discharges, and runoff
  - Increased farm discharge of effluent and sediments to salina and mangroves
  - Salina / mangrove pollution
  - Possible eutrophication of aquatic habitats from high nutrient discharge

Table 5.1 Environmental impact matrix for proposed marine shrimp farm expansion.

Increased demand on electricity supply
- Noise and oil spills associated with 1,500 kVA stand-by generator
- Escape and introduction of exotic species into local waters
- Viral disease introductions / infection of wild stocks
- Soil and groundwater contamination from diesel oil and lubricant spillages
- Water supply shortages due to farm water demand
- Groundwater salinisation due to water abstraction
- Employment and quality of life improvement
- Dusting and road wear-and-tear
- Flooding diversion

- Operations impacts – Processing plant
  - Water supply shortages due to plant water demand
  - Ground water salinisation
  - Solid waste disposal
  - Plant effluent and sewage disposal
  - Increased demand on electricity supply
  - Noise and oil spills associated with 250 kVA stand-by generator
  - Employment / quality of life improvement

In addition to the impacts created by project implementation, there are potential impacts on the project brought about by external factors, outside of the control of the project. These are:
- External impacts
  - EMF radiation from overhead transmission lines
  - Water supply contamination from adjacent land uses
  - Natural hazards
    - Flooding
    - Earthquakes
  - Pests and vermin
    - Crocodiles
    - Birds
    - Rats

These impacts are discussed below under the two major categories of project activities. For ease of discussion and presentation, the corresponding impact mitigation measures are presented after the discussion of each impact. Following that, the impacts on the project due to external environmental factors are discussed.

5.2 CONSTRUCTION PHASE IMPACTS AND MITIGATION

5.2.1 Terrestrial and arboreal habitat loss

Site clearance and construction practices generally mean the removal of the existing vegetation at and around the footprints of the expanded production pond area. In turn, this means the loss of bird habitat associated with that vegetation. As previously discussed under Section 4.0, the vegetation on the site has undergone a series of changes within the last nine years and most of the original thorn scrub vegetation has been removed and replaced by mango orchards, cotton fields, and shrimp production ponds. Most of the area of the site proposed for construction of the new shrimp ponds has already been cleared while approval is awaited to proceed with the construction of the new production ponds. However, no significantly important floral species or communities have been negatively impacted by this clearance.

Similarly, any potentially negative impacts on the avifauna associated with this cleared vegetation are not expected to be significant. The proposed project will not modify, alter or directly affect the salina and mangal wetlands east, southeast and south of the site, which are rich in bird life.

Mitigation:

◊ Not required.

5.2.2 Air quality deterioration due to disposal of waste vegetation

Typically, cut vegetation is burned at source. This gives rise to smoke and the dispersion of ashes, which cause negative impacts on the surrounding communities in terms of respiratory health and nuisances from settled ashes. Given the considerable amount of vegetation that has been removed in this instance, burning of the waste vegetation must not take place on or off the project site.

Mitigation:

◊ To reduce the amount of organic waste generated by site clearance, branches and small pieces of vegetation can be put through a commercial wood chipper. The chips may then be used, onsite or offsite, as a soil cover for landscaping. Tree trunks and large branches could be made available to local charcoal burners. Otherwise, the organic wastes must be disposed of at an approved disposal site.

◊ The project could investigate the potential of using the ash for intake water quality improvement (filtration system).

5.2.3 Water turbidity arising from excavation of new intake channel

Excavation and paving of the new intake channel (3m deep X 2m wide X 50m long) to lead water from Fraser's Gully to the new pumping station (see Figure 2.3) will necessitate soil disturbance. This could introduce suspended sediments and increase current turbidity levels in the gully water, resulting in short term

deterioration of water quality in Fraser's Gully and ultimately the receiving waters at Galleon Harbour.

Mitigation:
- ◊ The excavation and paving works for the channel should be carried out in isolation of Fraser's Gully so as to minimise the introduction of soil into the water column. The final connection to the gully can be made when the majority of the construction works have been accomplished.
- ◊ Soil material removed from the channel should be removed from the gully banks and placed where it cannot be washed into drainage features.

5.2.4 Air quality deterioration due to earth moving and pond construction

The construction of ponds and embankments will involve the use of heavy earth moving equipment, the motors of which will generate loud noises. This work will be carried out on soils containing a high proportion of fine particles, and it can be anticipated that a considerable amount of dust will be produced.

The project site is located in a fairly remote area, thus reducing the potential effects of noise and dusting that would be more acute in the vicinity of denser human settlement. Still, some of the ponds to be built are located fairly close to adjacent residences on Thompson Pen Lane.

Site workers, in the vicinity of working machinery, are prone to hearing damage due to periodic high noise levels during the construction phase.

Mitigation:
- ◊ Drivers and workers in the vicinity of earth moving equipment must be supplied with ear mufflers, as well as goggles and nose masks if necessary. Where there is reluctance, they must be encouraged/instructed to wear them.
- ◊ Noisy activity must be restricted to normal working hours when operating in the vicinity of human settlements. Potentially affected persons, e.g. along Thompson Pen Lane, should be advised when such activities are due to take place.
- ◊ The use of heavy equipment during pond construction should cease during periods of high winds when dusty conditions may prevail.

5.2.5 Creation of aquatic habitat

The construction of production ponds represents the conversion of terrestrial habitat into an aquatic one. This is seen as a positive impact, especially as shrimp production results in higher economic returns from the area of land under ponds than could be achieved with conventional agriculture.

Mitigation:
- ◊ Not required.

5.2.6 Soil erosion due to land clearance

Vegetation removal during site preparation works, of necessity, removes protective plant cover and exposes the underlying soil to erosive wind and surface water runoff forces

Mitigation:

- ◊ The clearance of any other areas of the site slated for development should be phased and only cleared as the need arises. This will minimise the extent of exposed soil and thereby help to reduce the risk of soil erosion during heavy rains and flash flooding.
- ◊ Exposed soils that are being worked should be wetted in the event of windy or high dust conditions, especially in the vicinity of human settlements.
- ◊ Areas of exposed soil should be replanted with ground cover as soon as possible after exposure to reduce soil erosion and dusting. The locally abundant, salt-tolerant succulents, *Sesuvium portulacastrum* (Seaside Purslane) and *Batis maritima* (Jamaican Samphire), are suggested and should be tested for this purpose.

5.2.7 Modification of surface drainage / flooding

The construction of the ponds for the existing shrimp farm has modified the drainage on the site and the proposed expansion will further modify this pattern. However, Fraser's Gully and the drain crossing through the southern section of the site primarily control the drainage pattern. The proposed expansion will not significantly increase runoff from the site but will concentrate the runoff into defined drainage paths and ultimately into the main gullies.

The farm is generally not prone to flooding and any apparent flooding on the site is the result of a temporary ponding of water. On the other hand, the community south of the farm is normally prone to flooding. The runoff from the site represents less than five percent (5%) of the runoff from the entire catchment area of Fraser's Gully and the vulnerability of this community to flooding is more related to its location rather than to the construction of ponds on the farm.

In the above regard, the major concerns are the culverts linking the farm to the salina, the condition of the drain south of the culvert and the earth berm on the southern boundary of the property. High levels of siltation arising from soil erosion on the farm cause blockages of the culverts and the filling of the drain south of the culvert. This, in turn, impedes the flow of runoff and greatly increases the likelihood of flooding. In addition, the earth berm at the southern perimeter of the site was breached during the May 2002 floods, leading to further discharge of water beyond the culverts.

Mitigation:

- ◊ Employ means to minimize soil erosion on the farm so as to reduce soil erosion and siltation of the culverts and drain (see Sections 5.3.2 & 5.3.3 below).

◊ Clean the culvert and the southern drain regularly, especially prior to the rainy season (*N.B. This is now being done twice yearly and the excavated material is being used to build up a flood retention berm – see Section 4.3*).
◊ Improve, shape and stabilize the berm on the southern boundary of the site. This may be done using rock or some other appropriate method.
◊ Ensure that the construction of ponds on the northern side of the site do not occlude or alter the existing channel for Fraser's Gully.

5.2.8 Illegal marl quarrying

Marl supplies will be required to surface the farm roads and those on top of the pond intersects. The sourcing of this marl from unlicenced quarries may indirectly lead to adverse impacts in terms of public health and environmental degradation.

Mitigation:
◊ Ensure marl supplies are only obtained from properly licenced quarries. (Copies of the current licences should be made available for inspection.)

5.2.9 Road wear-and-tear

The constant transit of trucks and equipment along the local main roads during the construction phase would undoubtedly lead to deterioration of the roads, already in poor condition. This would increase the difficulties presently being encountered by taxis and other vehicles in the area and could lead to animosity towards the project.

Mitigation:
◊ The St. Catherine Parish Council should be made aware of the increased traffic induced by the project so that the appropriate attention can be given to road maintenance.

5.2.10 Landscape alteration

The sides of the ponds will be 2 - 3m high, and those at the western side of the property will be visible from the main road. However, these would be no higher than the orchard trees that earlier occupied the site and thus would not obstruct views to any further extent. Furthermore, the embankments will eventually be planted with ground cover to stabilise the soil and this will also serve to visually blend the sides of the ponds into the general landscape. The general terrain is flat and there are no landscapes of high value to be affected.

Mitigation:
◊ Plant native vegetation as ground cover on all embankments.

5.2.11 Loss of traditional amenity use

Apart from the conversion of land to shrimp ponds, proper security of the farm will require the erection of a barbed wire fence around the perimeter of the site and a chain link type fence around the processing plant and intake area. This will mean that persons who previously used the land for animal grazing, charcoal

wood gathering, subsistence farming or who traversed the land for whatever purpose will no longer be able to do so.

Mitigation:
- ◊ Explain to local residents the purpose of the project, its sensitivity to viral diseases, export certification requirements, and the reasons for their exclusion from the land.
- ◊ Opportunities for employment on the project must be first offered to the local community where appropriate or possible.

5.2.12 Increased employment

The likely requirements for labour employment have been indicated in Section 2.3.11 The project would have significant positive benefits for labour as well as for contracted support services, at a time when the national economy is depressed and particularly in an area where chronic unemployment exists.

Mitigation:
- ◊ Give preference to the employment of local persons, especially those from Thompson Pen Lane and Old Harbour Bay.

5.3 OPERATIONS PHASE IMPACTS AND MITIGATION – PRODUCTION PONDS

5.3.1 Entrainment of marine organisms

The eggs and larvae of marine organisms as well as small floating invertebrates may be entrained in the flow of water being pumped from the Fraser's Gully estuary. The potential impact that this may have on the population dynamics of the affected species has not been evaluated but it is considered not to be significant given the fairly localised effect of the intake flow.

Mitigation:
- ◊ Not applicable.

5.3.2 Soil erosion of embankments and drains

The current levels of soil erosion from the pond embankments and effluent drains (see Section 2.2.3) are ample evidence that incremental increases in the transport of suspended solids in the farm effluent could be expected as the expansion programme proceeds. Such erosion would be worsened during periods of intense rainfall. As a result there would be increased deposition of sediments in the so-called 'artificial wetland', at the culverts below the Thompson Pen Lane road, and in the drain leading to the salina outside of the farm perimeter. Sedimentation and blockage of these drainage features would worsen the impacts of natural flood events on the local community. The backup/retention of water on the farm property under these circumstances will increase the likelihood of breaching of the earth berm on the southern boundary of the property.

Soil erosion of the pond embankments and effluent drains is considered to be the most serious adverse environmental impact associated with the shrimp farm expansion programme. Implementation of the mitigation measures outlined below is essential.

Mitigation

- ◊ The slopes of the embankments for the new ponds should be properly designed and engineered to optimise natural stability.
- ◊ The discharge and drainage channels should be sized (widened) so as to prevent scouring. It may be necessary to pave the bottoms of the drains with concrete.
- ◊ Angle the pond outfall pipes to discharge effluent along the alignment of the drains and in the direction of the drainage flow.
- ◊ Install rock beds or concrete platforms at the pond outfalls to prevent scouring and induce sedimentation.
- ◊ Appropriate vegetation, preferably grasses, should be planted on the outer slopes of the pond embankments to reduce soil exposure and erosion. Naturally occurring ground cover species (e.g. Seaside Purslane and Jamaican Samphire) do not sufficiently cover the soil and tests should immediately be carried out to identify a suitable species (e.g. Zoysia grass).
- ◊ Depending on cost considerations, side drains could be constructed for the roads on the banks of the ponds with storm water runoff from these being diverted down the banks of the ponds via defined drains rather than as sheet flow.
- ◊ Revisit the method of capturing harvested shrimp so as to avoid having to cut the embankments in order to fit the mesh traps (e.g. use long harvest nets).
- ◊ Where practical, the ponds should be oriented so to reduce wind fetch and wave action.

N.B. CMPL intends to stockpile the topsoil removed during pond construction and to place this on the sides of the ponds after their construction so as to provide better surface cover. This procedure would also have the advantage of inducing reseeding from the soil. Also, Seaside Purslane and Jamaican Samphire are being planted on the inner sides of the existing ponds to provide better cover and protection from erosion.

5.3.3 Sedimentation, nutrient polishing and flood control

As noted at Section 2.2.3 above, the artificial wetland area, as presently constructed, is not effective in sufficiently inducing settlement of suspended sediments in current levels of pond effluent discharge. As used now, it is a single contiguous area that has an uneven surface so that discharge flows have formed several discrete streams leading to the culverts. Thus these flows are not being spread and dissipated over the available area. Until this area is properly designed and constructed it will not sufficiently reduce the sedimentation at the culverts and exit drain to the salina, particularly at the higher rates of effluent discharge expected with farm expansion. Thus the potential for exacerbating

flooding conditions at Thompson Pen Lane will remain, with mitigation requiring frequent and costly clearing of the culverts and drain.

Davis et al (op. cit.) suggested the planting of sea grass (*Thalassia testudinum*) in the artificial wetland area to aid settlement of sediments and to effect nutrient removal. The present authors do not agree with this specification for several reasons, including the difficulty inherent in transplanting sea grasses, the levels of turbidity that are likely to inhibit plant growth, and the likely variability in water levels which could periodically expose the plants to desiccation. However, if the settlement basin is properly constructed so as to retain a consistent depth of water the planting of sea grasses could be tested, including trials with Irish Moss (*Gracilaria sp*.)

The construction of the perimeter drain and dyke were never properly completed so that floodwaters within the farm boundaries were not properly controlled and were able to spread haphazardly into the adjacent community. CMPL intends to heighten and shape the berm.

Mitigation:

- ◊ Properly design and engineer the sedimentation basin (a term preferred to that of 'artificial wetland') to effect complete removal of suspended sediments and control floodwaters within the perimeter of the farm. The design of the sedimentation basin is beyond the scope of the present EIA, but it is envisioned that this basin should be compartmentalised (with redundant sumps) and designed so as to provide water retention sufficient to allow sediment settlement and some form of biological nutrient uptake.
- ◊ Build and vegetate an effective storm water berm along the southern perimeter of the project site.
- ◊ In association with the above, construct a perimeter drain to discharge floodwaters effectively at the culverts. The latter may need to be enlarged.

5.3.4 Eutrophication of salina, mangroves and coastal waters

Field surveys during the Chow (1993) and the present EIA studies revealed the presence of extensive mats of black/dark-green filamentous algae covering the sediments of the salina mudflats, south of the project site. The fact that these were recorded by Chow before implementation of the initial stages of the shrimp farm suggests that their presence is not related to eutrophication by elevated levels of nutrients (i.e. nitrates and phosphates) contained in the pond effluent.

Eutrophication is the primary cause of algal blooms within wetlands and coastal waters around the island, to the detriment of vital coastal ecosystems. There has been a concerted national effort, within the last 10 to 15 years, at reducing and addressing the problems of coastal eutrophication. It is therefore critical that the shrimp farm does not worsen these problems.

Mitigation:

◊ During the operational phase of the project, it is imperative that effluent discharges from the shrimp farm ponds consistently meets NEPA effluent discharge standards, prior to its final release into the drain leading to the salina/mangal wetlands south of the project site. If need be, nutrient stripping technology/plant species should be employed within the onsite sediment settling basin (see Section 5.3.3), to ensure that NEPA standards are consistently met.

5.3.5 Introduction of exotic species into the wild

Given the inherent difficulty of completely preventing such events, it is very likely that escapes of L. vannamei have already occurred from the farm. However, it is not known at present whether L. vannamei has become established in local waters or whether it could do so successfully. The impact of the establishment of the exotic on local species is not known. The establishment of an escaped exotic species in a new environment may lead to decline of local species due to aggression, over-competition, etc. Experience in Ecuador (F. Millet, pers. com.) suggests, on the other hand, that this species would occupy a different biotope and therefore would be able to co-exist without detriment to local species.

Mitigation:

◊ Screen all sources of escape of exotic culture species into the surrounding environment.

◊ Periodically sample drainages within and outside farm to determine presence of the exotic shrimp.

◊ Water levels in the ponds should be carefully controlled and maintained at a level at which they will not be overfilled by heavy rain.

◊ Pond waters should be lowered in the event of impending extreme rainfall events to prevent overtopping.

◊ Exercise great care against escapes occurring, especially during harvesting.

◊ Explain to pond workers of the importance of preventing escapes and provide proper instruction on procedures for avoiding escapement.

5.3.6 Viral infection of wild stocks

Shrimp stocks are vulnerable to viral diseases, especially when under stressful or crowded conditions as in intensive farming. Viruses can deplete existing local stocks and cause major loss in farmed shrimp. No major viruses have been identified in Jamaica to date but a rigorous health management programme is necessary at the farm.

However, the importation of shrimp viruses (via infected brood stock, etc.) and the spread of infections in local wild stocks is becoming an increasing concern elsewhere, especially in countries which have major wild shrimp fisheries. Jamaica does not have an economically significant shrimp fishery but a decline in local stocks due to this cause may have a considerable effect on those persons who derive a livelihood from the catching and sale of marine shrimp. These viruses may also infect other crustacean species (eg. callinectid swimming crabs

for which there is a local market, and lobsters, for which there is both a local and international market).

N.B. It should be noted that shrimp viruses offer no risk to humans.

Mitigation:
- ◊ Adopt a bio-security system for the shrimp farm, processing plant and environs to prevent contamination.
- ◊ Adopt appropriate procedures to prevent infection, e.g. use of probiotics and natural bacteriocidal compounds that meet drug administration regulations.
- ◊ An emergency action plan to monitor, identify and contain an outbreak of viral infection on the shrimp farm should be prepared post haste. (Similar procedures should be prepared for the marine shrimp culture industry as a whole by the relevant government agencies.)
- ◊ Continue to use only SPF (specific-pathogen-free) post-larvae for stocking production ponds.
- ◊ Monitoring of shrimp and crustacean stocks for presence of known shrimp viruses.
- ◊ Adopt systems of production that lower the risk of virus contamination (improved water quality, lower densities, dry-out periods etc.).
- ◊ In the event of a shrimp viral outbreak, the ponds should be sealed and chlorinated for 4 – 5 days. They should then be emptied and the pond bottoms left to dry in the sun before refilling.

5.3.7 Groundwater contamination

The site is underlain by approximately 24 m of clay/loam soil and the depth to groundwater is 11.0 m. Given the inherent low permeability of clay and the depth to groundwater, the vulnerability of the aquifer to contamination is considered low. The risk of groundwater contamination due to inappropriate disposal of effluent, sewage and hazardous substances such as hydrocarbons is therefore not considered significant.

Increased abstraction of groundwater from the aquifer at the site could cause increased salinity of the groundwater given the proximity of the site to the sea and the existing marginal quality of the groundwater.

Mitigation:
- ◊ There should be no direct disposal of effluent or hazardous substance to the soil at the site.
- ◊ The pumping water level in the existing well or new wells constructed at the site should be maintained at or above mean sea level.
- ◊ (see also Section 5.3.13)

5.3.8 Depletion of domestic water supply

The National Water Commission provides domestic water to the property. The proposed expansion will increase the staff complement by about 100 persons,

and their demand is not expected to adversely affect the capacity of the NWC supply to the region.

The well located on the property is no longer used to provide make-up water for the ponds to reduce salinity. It is not anticipated that there will be any significant increase in demand for water from the well.

Mitigation:
◊ Not required.

5.3.9 Depletion of brackish water resources

Water for the ponds is obtained from the Fraser's Gully. At the point of the intake the water in the Fraser's Gully ranges from brackish to seawater, depending on the level of land runoff. There is adequate supply of water for the ponds and therefore the increased demand is not expected to be a problem.

Mitigation:
◊ Not required.

5.3.10 Electricity supply reduction

Electricity is required at the ponds for lighting and operation of the aerators as well as by the office and laboratory facility. The incremental demand created by the expansion is not expected to exceed the capacity of the JPSCo supply.

Mitigation:
◊ Not required.

5.3.11 Stand-by generator operation

In the case of outages, electricity will be supplied by a 1,500 kVA generator for which fuel storage will be required. Details of the storage tank or its location have not been provided. When in operation the generator could produce vibration and noise, which may be locally disturbing but which should not be noticeable beyond the boundaries of the farm.

Mitigation:
◊ The fuel tank for the stand-by generator must be enclosed in an appropriately sized containment area.
◊ The generator should be properly muffled against noise and vibration.

5.3.12 Road wear-and-tear

The constant transit of refrigerated transport trucks along the local parochial roads during the operations phase would lead to some deterioration of the roads, already in poor condition. This would increase the difficulties presently being encountered by taxis and other vehicles in the area and could lead to animosity towards the project.

Mitigation:
◊ The St. Catherine Parish Council should be made aware of the increased traffic induced by the project so that the appropriate attention can be given to their maintenance.

5.3.13 Dusting due to farm traffic

There will be some level of dust generated by the movement of project related vehicles over the marl roads on the farm, especially during the dry season. This may be a nuisance factor to farm workers but should not affect the adjacent communities due to the remoteness of the farm

Mitigation:
◊ The marl roads may be wetted during very dry periods.

5.3.14 Soil contamination at vehicle maintenance facility

A vehicle maintenance yard and shed will be constructed for the servicing of farm tractors and equipment. It will have a diesel fuel pump and storage tank. The plans of this facility have not been provided but the potential impacts associated with activities at the site would be soil contamination by spillages or poor disposal of engine oils, lubricants, hydraulic fluids, diesel fuel, and batteries.

Mitigation:
◊ The vehicle maintenance area should be paved with concrete and provided with a site perimeter drain and sump to collect spilled oils and lubricants.
◊ Proper storage and containment of hazardous materials must be provided (e.g. lead batteries, paints, etc.).
◊ A waste management plan should be prepared and put into effect at the site.
◊ Mechanics must be made aware of and be monitored for clean maintenance practices.

5.3.15 Social impacts

There are both direct and external or “spillover” effects which could result from the expansion of the shrimp farm. The side effects or unintended consequences, like the direct effects, may be both positive and negative. They are outlined below in Table 5.4.

Table 5.4 Possible Direct and Secondary (Externalities) Impacts of Shrimp Farm Expansion.

Positive (Benefits)	Negative (Costs)
• Increase in employment opportunities • Long-term increase in standard of living (access to more services and consumer goods) • Increase in demand/earnings for local shops/merchants • Increase in achievement motivation (increase in training and other development possibilities) • Increase in family stability, assuming sufficient jobs are directly or indirectly generated to employ parents	• Flooding, if run off is not properly managed • Possible conflict if it is perceived that outside labour is preferred

5.4 OPERATIONS PHASE IMPACTS AND MITIGATION – PROCESSING PLANT

5.4.1 Domestic water demand and supply

See 5.3.8 above.

5.4.2 Electricity demand and supply

Electricity is required at the processing plant for blast freezing and cold storage purposes, internal and external lighting. The incremental demand created by the expansion is not expected to exceed the capacity of the JPSCo supply.

In the case of outages, electricity will be supplied by a 250 kVA generator for which fuel storage will be required. Details of the storage tank or its location have not been provided. When in operation the generator could produce vibration and noise, which may be locally disturbing but which should not be noticeable beyond the boundaries of the farm.

Mitigation:

◊ The fuel tank for the stand-by generator must be enclosed in an appropriately sized containment area.

◊ The generator should be properly muffled against noise and vibration.

5.4.3 Solid waste disposal

The operations of the shrimp processing plant will generate considerable amounts of solid organic waste, primarily in the form of crustacean body parts and used packaging materials. The shrimp heads will continue to be sold to local pig farmers, as is done presently and this category of waste should therefore not pose an environmental threat.

The packaging material, mainly paper and plastic, is to be burned and the disused silos at the plant site are presently used, on a fortnightly basis, for that purpose (Plates 31 & 32). Not only does this practice generate smoke, but also the burning of plastic produces toxic dioxin gases.

Mitigation:

◊ The practice of burning of organic waste by CMPL must stop and, instead, arrangements must be made to have the material stored and transported on a regular basis to the landfill site at Riverton.

◊ A waste reduction and recovery plan should be designed and implemented by CMPL.

5.4.4 Plant effluent and sewage disposal

The main effluents to be discharged from the plant will be wash water from the processing room and sewage from the toilets. Both will have high BOD levels and the wash water will also contain low levels of household bleach. Currently, these effluents are discharged to a soakaway. The plans for the new plant call for discharge of effluent to a septic tank and then to an absorption pit. Estimates of the projected volume of effluent from the processing room have not been provided and the designs of the septic tank are not yet available. Account should be taken of the fact that a functioning well is situated about 200m NW of the processing plant site.

Mitigation:

◊ The design of the septic tank will have to be such that BOD levels are reduced to <30mg/l before discharge to the absorption pit.

5.4.5 Employment and training

(See Section 5.2.12 above)

Mitigation:

◊ Where possible, give preference to the employment of local persons, especially those from Thompson Pen Lane and Old Harbour Bay.

Plate 31. Paper material and plastic wrapping Dumped inside silo for burning.

Plate 32. Abandoned silo used for burning waste.

5.5 SUMMARY OF SIGNIFICANT IMPACTS

A summary and classification of the impacts is given at Tables 5.1a and 5.1b.

The significant potential impacts attributable to the farm expansion programme are:

- Increased levels of soil erosion from pond embankments and drains leading to increased levels of sedimentation in settlement area and exit drain and exacerbation of flooding incidents in adjacent community.
- Levels of nutrients in farm effluent exceeding NEPA standards for trade effluent quality.
- Increased risk of escape of shrimp species not native to Jamaican waters with potential for affecting populations of local species.
- Increased risk of introducing viral diseases into wild populations of crustaceans in Jamaican waters due to infected post larvae, poor pond management, and insufficient bio-security practices.

The above impacts can be mitigated.

5.6 EXTERNAL IMPACTS

This section addresses those potential impacts on the project arising from activities and events occurring from outside of the project boundaries.

5.6.1 Water supply contamination

The existing saltwater intake for the farm is situated on the estuarine portion of Fraser's Gully, where water salinities are dictated by the relative flows of surface water from the catchment system, described above at Section 4.3, and the tidal stage. Whereas the salinity concentrations are acceptable under normal circumstances, during the recent flood rains salinities as low as 5 ppt were recorded at the inlet. Provided that the change in salinity of the pond medium is gradual, *L. vannamei* is able to tolerate these lowered salinities.

A greater threat to the intake water quality are the pond effluent discharges from the fish farms located along Fraser's Gully on the opposite bank. The location of the proposed new intake for the shrimp farm further up the stream should improve this situation.

5.6.2 Natural hazards

- ***Flooding*****.** The site is somewhat prone to flooding by surface runoff generated north of the site. However, as was demonstrated during several recent flood events, the farm was not affected directly but sediments eroded from the ponds blocked the culverts at Thompson Pen Lane and exacerbated flooding of the local community.

Table 5.1a Summary of potential environmental impacts – Construction Phase.

POTENTIAL IMPACTS	DIRECTION		Impact Mitigatable	DURATION		LOCATION		MAGNITUDE		EXTENT	
	Positive	Negative		Long	Short	Direct	Indirect	Large	Small	Wide	Local
Construction Phase											
Loss of terrestrial habitat		✕	NO	✕		✕		✕			✕
Vegetation burning		✕	YES		✕	✕		✕			✕
Turbidity in Frasers Gully		✕	YES		✕	✕			✕		✕
Creation of aquatic habitat	✕		N/A	✕		✕		✕			✕
Noise and dust generation		✕	YES		✕	✕			✕		✕
Soil erosion / sedimentation		✕	YES		✕		✕	✕		✕	
Surface drainage modification		✕	YES	✕		✕			✕	✕	
Illegal marl quarrying		✕	YES		✕		✕				
Road wear-and-tear		✕	YES		✕	✕			✕		✕
Landscape alteration / Visual aesthetics	✕		N/A	✕		✕			✕		✕
Loss of traditional corridors / amenity		✕	YES*	✕		✕			✕		✕
Increased employment	✕		N/A		✕	✕		✕			✕

Table 5.1b Summary of potential environmental impacts – Operations Phase.

POTENTIAL IMPACTS	DIRECTION		Impact Mitigatable	DURATION		LOCATION		MAGNITUDE		EXTENT	
	Positive	Negative		Long	Short	Direct	Indirect	Large	Small	Wide	Local
Operations Phase – production ponds											
Entrainment of marine organisms		✕	YES	✕		✕			✕		✕
Soil erosion and sedimentation		✕	YES	✕		✕		✕		✕	
Coastal water pollution		✕	YES	✕		✕			✕	✕	
Introduction of exotic species		✕	YES	✕		✕		✕		✕	
Viral infection of crustacean wild stocks		✕	YES	✕		✕		✕		✕	
Groundwater contamination		✕	YES		✕	✕			✕		✕
Domestic water supply shortage		✕	N/A	✕			✕		✕		✕
Reduction of electricity supply		✕	N/A		✕		✕		✕		✕
Stand-by generator noise and vibration		✕	YES		✕	✕			✕		✕
Dusting and road wear-and-tear		✕	YES		✕	✕			✕		✕
Soil contamination		✕	YES	✕		✕			✕		✕
Increased employment and training	✕		N/A	✕		✕		✕		✕	
Improved quality of life	✕		N/A	✕			✕		✕		✕
Operations Phase – processing plant											
Domestic water supply shortage		✕	N/A	✕			✕		✕		✕
Reduction of electricity supply		✕	N/A		✕		✕		✕		✕
Solid waste disposal		✕	YES	✕		✕		✕			✕
Sewage and plant effluent disposal		✕	YES	✕		✕			✕		✕
Employment and training	✕		N/A	✕		✕		✕		✕	
Improved quality of life	✕		N/A	✕			✕		✕		✕

- ***Earthquakes*.** Most of the larger earthquakes impacting Jamaica over the past 300 years originated offshore. Earthquakes occurring on land tend to be of low magnitude. From a siesmic perspective the site is no more prone than any other area on the island. Southern St. Catherine falls within the moderate seismic hazard zone classification.

  The single storey structures to be constructed at the site constitute a moderate to low earthquake hazard risk with respect to life and property. The subsurface condition below the site is also typically not conducive to soil liquefaction and therefore this impact is not considered significant.

- ***Hurricanes and Storm Surges***. Hurricanes, tropical storms and tropical depressions are frequent occurrences in Jamaica. Based on the record of hurricanes affecting the island over the past 300 years, the south coast lies within the track of major hurricanes and tropical storms.

  Hurricanes and tropical storms may generate storm surge and cause coastal flooding. Whereas there are no direct measurements of storm surge on the island, in general, coastal areas below 6 meters above sea level are considered to be at risk to storm surge. Most of the proposed site is above 6 m and therefore the hazard relating to storm surges is not considered to be very significant.

5.6.3 Pests and vermin

- ***Crocodiles.*** As was noted in Section 4.7.2 above, to date there has been a very low incidence of crocodiles being found on the site. However, these animals are known to frequent the general area, especially after prolonged rainfall events when there are extensive areas of flooded land. Although records of attacks on human beings are few, it would be advisable for workers on the shrimp farm to be constantly vigilant, especially during harvesting.
- ***Birds.*** The potential impact of birds on the shrimp farm is not restricted to predation, a management issue, but to the possibility that they can catch, carry and drop shrimps in nearby local waters, thus becoming a source of the non-native species introduction.
- ***Rats***. These vermin are known to infest feed manufacturing operations in the region. This population thus becomes a source of animals that infest the farms feed store.

5.6.4 EMF radiation

Two JPSCo 138 kV transmission lines enter and cross the northern section of the project site. The new farm access road has been placed beneath these transmission lines. It has been confirmed that there are no radiation risks associated with these lines. In the case of a line breakage, immediate fatality would result should the line hit anyone before it touched ground.

6. PROJECT RISK ASSESSMENT

Risk assessment is the identification and characterization of existing and potential adverse effects to humans and the environment resulting from exposure to environmental hazards. Risk is a function of the probability of an event occurring and the degree of damage that would result should it happen. The assessment allows significant risks to be identified so that that they can be targeted for action.

Risk assessment involves several steps. These are:

- **Hazard identification** - involves identifying those project activities that could lead to adverse effects on the environment, impair human health, result in a nuisance, or decrease the amenity of local residents. The major hazards identified in the EIA are:
    - Site preparation and vegetation clearance
    - Pond construction and earth moving
    - Pond water exchange and draining
    - Importation of post-larvae
    - Pond harvesting
    - Breaching of pond embankments
- **Hazard analysis** - considers the likelihood of an environmental hazard being realized.
- **Consequence analysis** – determines the effect on the environment should the risk be realized.
- **Ranking** – the magnitude of the risk is either estimated or ranked in order of importance. Rankings should be reviewed as actions are taken to eliminate or reduce the risks.

Table 6.1 presents a summary of the risk assessment for the expansion and operations of CMPL. The introduction of viral diseases via importation of infected post larvae and/or via other poor bio-security practices is the most dangerous risk posed by the farming of non-native shrimp species. Viral diseases associated with marine shrimp culture can infect native stocks of crustaceans (e.g. lobsters, crabs, etc.), not just shrimp populations.

Table 6.1 Risk assessment for CMPL expansion and operations.

Hazard	Likelihood of occurrence	Consequence	Duration	Severity	Ranking of risk
Site preparation & vegetation clearance	High	Terrestrial habitat loss,	Long-term	Minor	**5**
		Air quality impairment (dust)	Short-term	Minor	
Pond construction & earth moving	High	Air quality impairment (dust, noise)	Short-term	Minor	**6**
Importation of infected post-larvae	High	Introduction of crustacean diseases	Long-term	Major	**1**
Pond water exchange & draining	High	Soil erosion, sedimentation and flooding	Long-term	Major	**2**
Careless pond harvesting	High	Exotic species escape	Long-term	Uncertain / Major	**3**
Breaching of pond embankments	Low	Flooding of nearby residences	Long-term	Moderate	**4**

7. PROJECT ALTERNATIVES

7.1 PROJECT SITE

This project is an expansion of a previously existing shrimp farm operation, taking place on lands owned by the JADF. The existing farm and the expansion phase do not compromise coastal wetlands. Consideration of project site alternatives is not appropriate in this instance.

7.2 CULTURE SYSTEM

Three types of systems may be used for shrimp farming depending on the desired level of production and investment in pond management. These are extensive, semi-intensive and intensive.

- ◊ In extensive systems postlarvae are stocked at rates of 8 – 10 shrimp per square metre. The shrimp feed on plankton, benthos, particulate organic material in the water and detritus. Plankton blooms are stimulated and the shrimp depend on the natural productivity of the ponds. Most extensive ponds are filled by the tide and water exchange achieved by natural tidal changes. Little management of the ponds is required. Production rates are in the order of 400 – 500 kilograms per hectare during a 100 – 140 day production cycle. Due to the low tidal fluctuations in Jamaica, extensive farming is not appropriate, as sufficient pond water exchange rates could not be achieved.
- ◊ Under semi-intensive conditions, large ponds are used and stocking rates are usually between 10 – 25 postlarvae per square metre. The pond bottoms are often treated with lime and inorganic fertilisers at the start of the cycle in order to obtain a good plankton bloom and manufactured feeds are applied during the grow out period to supplement the natural food. The pond waters are exchanged deliberately, using pumping systems, at rates between 5% - 15%

of the pond volume per day. Production rates of 1,000–3,000 kg/ha are achieved.

◊ In intensive shrimp farming small ponds are used, not usually exceeding 1 hectare in size. The ponds are stocked at densities of 25 – 80 post-larvae per square metre. Plankton blooms are artificially stimulated and manufactured feeds are applied at increasing rates as the biomass increases. Pond aeration is mandatory. The water is exchanged at rates similar to that for semi-intensive farming. Production rates of 4,000 – 8,000 kg/ha are achieved.

With respect to the above stocking density figures it should be noted that they are related to the type and size of shrimp (biomass). The CMPL project is undertaking semi-intensive culture.

7.3 OPEN vs CLOSED SYSTEM

As discussed in Section 2.2, the project currently operates as an open water supply and discharge system and intends to do so for the expansion phase. Given the present potential problems associated with the quality of the intake water, it may become desirable to change over to a closed system at a later stage. In such a system, the water would be continuously recirculated with little or no discharge of pond effluents to the open environment and therefore with minimal potential impacts related to water eutrophication or escape of the cultured species. To implement such a system would require the construction of an independent drainage system and recharge basin, an undertaking that could prove to be uneconomic.

7.4 HARVESTING METHODS

The use of large mesh traps to harvest the shrimp necessitates the excavation of the embankments in order to fit the boxes. This exacerbates the problem of embankment soil erosion. Instead, it is suggested that long harvest nets be used to help alleviate this problem.

7.5 NO PROJECT SCENARIO

Much of the proposed expansion area was under mango orchards, a fruit for which the export market is no longer economically feasible. Shrimp farming offers a use of these lands that are not ideally suitable for conventional agriculture. Without the project, the national economy, and particularly the local communities faced with chronic unemployment, would not benefit from productive use of the lands.

8. IMPACT MITIGATION MONITORING PLAN

The environmental impact monitoring plan for the proposed shrimp farm is outlined below. The plan is designed to overcome the deficiencies in the current monitoring programme, which is focused solely on water quality, and which does not incorporate response and feedback mechanisms. The final plan should include the objectives, standards and management responsibilities, the details of the proposed sampling methodology, the monitoring frequency schedule, and the formats for the monitoring reports.

It is understood that NEPA will allow the Client to undertake the monitoring and make the results available to the agency in a manner to be specified. It is also understood that NEPA has the legal right to enter the premises at any time to conduct its own independent monitoring for data verification purposes.

The proposed plan would be initiated by a baseline study of the air quality parameters to be monitored, prior to project construction, followed by the procedures for monitoring the construction and operation phases. It should be borne in mind that regular harvesting operations will continue during the construction of the new ponds. The duration of the construction phases and the appropriate frequency and type of monitoring should emerge later in the project design and planning process.

8.1 BASELINE STUDY

Collection of comparative pre-project air quality background data:

◊ Ambient noise levels and levels of suspended particulates (dust) at two stations located, I) at the edge Thompson Pen Lane, in the vicinity of the houses, and ii) along the main road at the western (downwind) side of the property.

8.2 CONSTRUCTION PHASE

Fortnightly site visits:

◊ Inspections to ensure compliance with mitigation measures:
- Site clearance - vegetation disposal, replanting of soil cover, etc.
- Pond construction – dusting, noise, soil erosion control, waste management, replanting, inspection of quarry licences, etc.
- sedimentation basin construction,

◊ Collection of biweekly data on the following to ensure compliance with NEPA standards:
- Air quality measurements (noise and dust) at selected stations
- Effluent water quality measurements at selected stations

8.3 OPERATIONS PHASE

Collection of data on the following to ensure compliance with NRCA standards:

- Effluent water quality[1] - measured at the stations corresponding to each effluent outfall from the farm as well as at sedimentation basin, culvert, drain, salina, and mangroves.

Site inspections to ensure compliance with mitigation measures, including:

- Preparation of viral outbreak contingency plan (at project outset)
- Harvesting methods (e.g. measures taken to reduce re-suspension of sediments and prevent species escape)
- Solid waste management practices
- Verification of SPF source for PL's

[1] *Water quality parameters should include pH, TSS, TDS, BOD_5, DO, COD, phosphates, nitrates (nitrate + nitrite), salinity, faecal and total coliforms.*

9. EMERGENCY RESPONSE PLAN

CMPL's emergency response plan (ERP) is shown at Appendix 3. That document is incomplete and needs to be considerably improved so as to have a set of detailed procedures that are unambiguous, that clearly assign responsibilities for action, that provide explicit instruction for each kind of eventuality, and that lay out reporting and documentation procedures

The plan also needs to be widely promulgated so that every employee is aware of the appropriate response to emergencies. The mechanism/s by which this will be achieved needs to be stated and scheduled.

It is recommended that CMPL immediately set about enhancing the ERP with initial focus on:

- the immediate containment of viral disease outbreaks,
- the appropriate response to possible breaching of the pond embankments, especially in the vicinity of Thompson Pen Lane, and
- the avoidance of site induced flooding in the community.

10. REFERENCES

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Downer, Audrey & R. Sutton (1990). *Birds of Jamaica (A Photographic Field Guide).* Cambridge, Great Britain: Cambridge University Press. 152 pages.

Jamaica Survey of Living Conditions 1998. Statistical Institute of Jamaica & Planning Institute of Jamaica (1999).. Kingston: STATIN/PIOJ.

Soils and Land-Use Surveys, No 1, Jamaica, Parish of St. Catherine, 1958. Regional Research Centre, Imperial College of Tropical Agriculture, Trinidad. 42 pages.

11. APPENDICES

Appendix 1. EIA Terms of Reference

The following Terms Of Reference for the project incorporate comments (in red font) made by NEPA in letter dated 26 August 2002 (Ref. No. L14/203)

Caribbean Mariculture Products Ltd. propose to expand their marine shrimp farm at Old Harbour Bay by 180 acres to create a total of 250 acres of production ponds. This expansion will take place on ruinate ex-agricultural lands owned by the JADF immediately adjacent to the existing facility. It is also proposed to construct a processing plant at the site. A draft of the proposed TOR for the EIA of the shrimp farm project is presented below.

1. *Introduction - Identify the development project to be assessed, its purpose and explain the executing arrangements for the environmental assessment.*

2. *Background Information - Briefly describe the major components of the proposed project, the implementing agents, a brief history of the project including compliance with its initial NRCA Permit (# 116P97), and its current status.*

3. *Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project. This will include the proposed area for expansion as well as the area of influence of the existing operations*

4. *Scope of Work - The following tasks will be performed:*

   Task 1. Description of the Proposed Project - Provide a full description of the project and its existing setting, using maps at appropriate scales. This is to include: general layout (size, capacity, etc.); preconstruction and construction activities, operation and maintenance activities including water supply and pumping, pond fertilisation, quality and fate of discharges, processing plant and related waste streams, the means of providing utility, waste disposal and other necessary services, schedule for construction and commissioning project elements, and project life span.

   Task 2. Description of the Environment - Compile and present existing data on the relevant environmental characteristics of the study area, including the following:

   a) *Physical environment: topography, soils, climate and meteorology, surface and groundwater hydrology, inshore coastal waters, existing polluted discharges and sources, receiving water quality, and natural hazard vulnerability esp. flooding.*

b) Biological environment: flora, fauna, rare or endangered species, sensitive coastal habitats (esp. mangroves), species of commercial importance, and species with potential to become nuisances, vectors or dangerous.

c) Socio-cultural environment: adjacent communities and structure, employment, land use, other planned development activities, distribution of income, goods and services, recreation, public health, customs, and archaeological resources.

Task 3. Legislative and Regulatory Considerations - Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting and land use control.

Task 4. Determine the Potential Impacts of the Proposed Project - Distinguish between significant positive and negative impacts, direct and indirect impacts, immediate and long term impacts. Identify negative impacts that are cumulative (including those of other facilities within the locale), unavoidable or irreversible. Impacts are to be described quantitatively where possible. Special attention should be paid to:

- *Site drainage and vulnerability to flooding;*
- *Existing water use, surface water quality and pollution;*
- *Incremental freshwater demand, sources and availability;*
- *Vegetation clearance and solid waste disposal related to new pond construction activities;*
- *Air quality during construction phase (dust and noise);*
- *Visual impacts and landscaping;*
- *Pond water discharges to the salina/mangroves and their fate;*
- *Mangrove wetland protection measures;*
- *Sewage treatment and discharge from plant and office;*
- *Process waste and other solid waste management,*
- *Fuel storage, containment & spill control;*
- *Disease control and use of medications;*
- *Potential escape of exotic species into the natural environment;*
- *Existing archaeological / historical sites*
- *Analysis of existing socioeconomic impacts and community perceptions of project;*
- *Employment opportunities and community involvement;*
- *Potential impacts of the project on adjacent property owners,*
- *Potential impacts on the project arising from external factors (e.g. other regional development plans and land uses, polluted discharges, natural hazards).*

A risk assessment of the project will be performed, including the exposure of marine life to diseases associated with imported shrimp species.

Task 5. Analysis of Alternatives to the Proposed Project – Describe the alternative land use for the area proposed for farm expansion Including the alternative of not constructing the additional ponds. Alternative sites and technologies should be identified and analysed, and the basis for the preferred option (site and technology) clearly outlined.

Task 6. Development of Impact Mitigation Management Plan - Recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels.

Task 7. Development of an Emergency Response Plan – Outline plan for emergency response to flooding events, breaching of pond bunds, and shrimp disease outbreak.

Task 8. Development of a Monitoring Plan - Prepare a plan for monitoring the implementation of mitigating measures and monitoring the impacts of the project during the construction phase. Estimate costs of those measures and the institutional and training requirements to implement them.

Task 9. Assist in Inter-Agency Coordination and Public/NGO Participation - Assist in co-ordinating the environmental assessment with the relevant government agencies and in obtaining the views of local NGO's (esp. CCAM) and affected groups. A public presentation of the findings of the EIA will be made.

5. *Report - The environmental assessment report should be concise and limited to significant environmental issues. The main text will focus on findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to the outline below.*

- *Executive Summary*
- *Policy, Legal and Administrative Framework*
- *Description of Proposed Project*
- *Description of the Environment*
- *Significant Environmental Impacts*
- *Analysis of Alternatives*
- *Mitigation Management Plan*
- *Environmental Monitoring Plan*
- *Inter-Agency and Public/NGO Involvement*
- *List of References*
- *Appendices*

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Appendix 2. CMPL shrimp farm water requirements.

101 ha of production ponds at 2.25 crops per year:

• Total pond area (250 ac)	101 ha (1,010,000 m^2)
• Average depth of ponds	1.2 m
• Total water volume	1,212,000 m^3
• Evaporation & seepage at 1.2 m per year	1,212,000 m^3
• Evaporation and seepage at 1.2 m per crop	538,667 m3
• Total filling, evaporation & seepage per crop	2,424,000 m^3
• Annual demand (f, e, & s)	5,454,000 m^3 at 2.25 crops/yr
• Water exchange at 15% per day	181,800 m^3
• Annual water exchange	66,357,000 m^3
Total water demand per year	71,811,000 m^3
Water demand per day	196,742 m^3
Water demand per hour	8,198 m^3
Water demand per second	2.3 m^3

<u>Water use</u> (Confirmed with Noel Thompson - 01/07/03)

- *New Pump Station* — *3 x 6,0000 gal per minute for 18hrs/day*
- *Old Pump Station* — *6,000 gal per minute for 18hrs/day*

TOTAL — *24,000 gpm for 18 hrs/day*
or 432,000 gals/day
or 157,680,000 gals/year

- Evaporation + seepage = ½"/acre/day

Appendix 3. Emergency response plan currently in place at CMPL.

EMERGENCY PROCEDURES FOR CARIBBEAN MARICULTURE PRODUCTS LIMITED (CAMP)

1. Oil Spills
2. Disease Outbreak
3. Flooding
4. Hurricane
5. Pesticide Contamination

Internal Oil Spills

A bun-wall (enclosure) is built around the fuel tank. This ensures that should there be fuel seepages (leaks) from the tank, the bun-wall will prevent spreading to the wider environment (inclusive of ponds).

Any future oil/fuel storage facility must be built with this safety feature. Oil spilled will be collected and disposed of in the correct manner.

Oil Spills Affecting Water Source

- Stop pumping
- Report the matter to the relevant authority
- Minimize the use of water, flush and exchange water in ponds only in emergency cases
- Utilize mechanical aerators to maintain water quality
- If the problem persists, consideration would be given to recycling

Chemical Contamination

(same as above)

DISEASES OUTBREAK

- Identify the specific disease in question
- Determine whether or not it is treatable, and if so, put in place the appropriate treatment.
- If it is viral, send samples to a lab to confirm specie of virus or exact disease. Lab should specialize in this type of work.
- Once confirmed, the farm should be quarantined
- Harvest all affected ponds immediately and the other ponds as they mature. Adequate time should be allowed for proper drying out of the ponds and the various waterways/canals/piping systems, etc. over a period of four to six months.

  Note – Extra screens should be added at the point of draining the Ponds to prevent against the escape of animals.

Hurricane & Floods

Where there is a serious threat of hurricane, ensure the following:

a) Adequate fuel for stand-by power
b) Lower all ponds by about twelve inches (12in)
c) Ensure that all flood screens are clean
d) During storm turn off all electric power and also keep all screens clear to prevent ponds overflowing.

To prevent flooding to the surrounding residential areas, the Southern drains and embankments should be maintained and upgraded over time to ensure adequate protection. Also, the three 4ft. culverts that lead from the farm into the Salina/mangrove will be cleaned and maintained on a regular basis.

Farm Quarantine - General

A program designed to restrict unauthorized entry on the farm Is to be introduced to ensure protection against disease, contamination and theft. This will involve:

a) Proper perimeter fencing

b) Single entry and exit point
c) Security patrol
d) No on-farm sales
e) Visitors should not have had contact with any other shrimp Farm over the past 48 hours.
f) Issuing of gate passes