A SANITATION PLAN FOR A FISHING VILLAGE IN JAMAICA THAT INCORPORATES EVAPOTRANSPIRATION BED TECHNOLOGY

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A REPORT

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This report “A Sanitation Plan for a Fishing Village in Jamaica that Incorporates Evapotranspiration Bed Technology” is hereby approved in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING.

Civil and Environmental Engineering
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Preface

Research for this report was conducted between July 2002 and August 2004, while I was serving as a Water and Sanitation Peace Corps Volunteer in Kingston, Jamaica. After seven (7) weeks of community-based training in the Tryall Heights, St. Catherine, I was based in Kingston, the capital city. I collaborated with my supervisor and counterpart, Mr. Peter Knight and Mr. Devon Malcolm, respectively, in designing and implementing an improved sanitation plan with a local fishermen's cooperative.

This report is submitted to complete my master's degree in environmental engineering from the Master's International Program in Civil and Environmental Engineering at Michigan Technological University. The paper focuses on the design and implementation of an improved sanitation plan with a local fishermen's cooperative at Half Moon Bay, Hellshire Beach, Jamaica. Although this was a major part of my work, other responsibilities included researching, designing and implementing improved medical waste disposal facilities at Ministry hospitals and health centers and evaluating proposed onsite wastewater treatment systems for new housing and commercial developments.

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I would like to thank Jim Mihelcic for his time and his creative advice on this project and on my professional ambitions over the last three years. Special thanks to Peg Gale, John Gierke and Tom Van Dam for giving their time to serve on my graduate committee. I am particularly grateful for having the opportunity to share Hellshire Beach and Jamaica with Jim Mihelcic and Karen Curry Moran. I am indebted to the Master's International Peace Corps Program and Michigan Tech University for providing this important forum for advocating the delicate relationship between environmental engineering and international development.

Thanks to Half Moon Bay Fishermen's Cooperative for including me in this project and spending so much time in discovery creative solutions. I am particularly grateful for the executive committee: Mr. Devon Malcolm, Ms. Donnette Prendergast, Mr. Gladstone White, Mr. Christopher Brown, Mrs. Cox and Mrs. Hyacinth Johnson for their absolute dedication to improving the living and working conditions at the beach. And to Mr. Malcolm, my dearest friend, Jah knows your endearing support and belief in the beauty of Jamaica, the life of the Caribbean waters and the inner-strength of the Half Moon Bay residents is unwavering.

My mentor, Mr. Peter Knight, thank you for allowing me the time to work on this research and providing that necessary support to finding a means to the end. And, the entire Environmental Health Unit staff for having patience with me as I learned the 'ropes'. I have only touched briefly in this report on the information you all shared with me on the past and present public environmental conditions of Jamaica. A special thanks to Mrs. Nilsia Johnson for her perceptive advice and to the National Public Health Laboratory for introducing me to the island and real medical waste. I am especially grateful to the Peace Corps/Jamaica staff for developing a commendable community environmental health sector and welcoming the Masters International Program.

I am indebted to Ms. Suzanne McLean and Thandi and Dayne Buddo for providing me with not only a home, but a family. Karen and Peter John Thwaites for introducing me to island pleasures and always being no less than a phone call away. Mrs. Eula McKay, my Jamaican mother, your food and faith will keep my belly and heart full. Special thanks to Peace Corps/Jamaica and Human Rights Volunteers for absolutely everything.

As always, I am grateful to my family who faithfully encouraged my decision to pursue these experiences and patiently waited for me to finish. Wes, thanks for coming to Jamaica twice. We lived through it all and still flew home in class.

And last, a special acknowledgement to Wetland Studies and Solutions, my new life, for allowing me a little time during the day to finish up this big chapter.

Abstract

Globally 2.4 billion persons are without adequate access to improved sanitation, while 1.1 billion are without access to improved water supplies (UNICEF et al., 2000). The disparity of access to these basic services is predominately evident in peri-urban and rural communities of developing countries. Literature confirms that community-based sanitation plans that partner with the construction of appropriate sanitary conveniences and hygiene education reduces the risk to illnesses linked with poor sanitation practices. (Kalbermatten et al., 1982; Cairncross et al., 2003; UNICEF et al., 2000; Rosensweig et al., 2002).

This report documents the process used by a Fishermen's Cooperative to develop an environmentally appropriate sanitation plan within their 10 acre coastal community that will accommodate both the 62 fishermen residing at the beach and the hundreds of daily visiting bathers. In total, 17 fishermen camps have improved sanitation of which 13 are flush toilets and four are dry pit latrines. Of the thirteen flush toilets ten connect to a holding tank, while three connect to absorption pits. Fishermen with no sanitation facility within their camp use a field adjacent to the community or use the public toilet facility, a single flush toilet that discharges to a holding tank.

The Fishermen's Cooperative employed several techniques to gather information about the beach community; including, oral survey questionnaires, community mapping techniques, historical reviews and stakeholder interviews. From this, the fishermen developed a sanitation plan that addresses the social, economical and environmental needs of the community.

To meet the socio-cultural preference for flush toilets and the economical limitations that restrict access to consistent potable water, the sanitation plan proposes the installation of two different technologies: (1) Ventilated Improved Double Pit (VIDP) dry, composting latrine and (2) Onsite wastewater disposal

system that employs Evapotranspiration Bed (ET) technology. The VIDP and ET technologies accommodate the environmental design restrictions apparent in the coastal community.

An ET system is a sealed, gravity-fed sand and gravel bed that treats septic tank effluent via plant transpiration and soil evaporation. The proposed area is 372 sq meters (4,000 sq feet) with a two (2) foot depth, assuming a loading rate of 3.0 mm/day (2.2 US gal/ft^2). The loading rate is comparable to local and international recommendations (Bennett et al 1978; Salvato, 1992; Silvia 1990).

The plan also allocates resources for a local water and sanitation consulting agency to promote hygiene education on the beach and provide technical training for constructing the improved sanitation facilities and decommissioning irreparable facilities previously constructed within fishermen camps. This sanitation plan acknowledges the increase in access to potable water by incorporating both onsite wastewater technology for treating liquid waste and dry sanitation technology for fisher folk without potable water access. As more developing countries improve access to potable water, an increased need for an appropriate decentralized sanitation plan that accommodates the increase in water-based sanitation facilities will be required.

1 Introduction

Globally 2.4 billion persons are without adequate access to improved sanitation, while 1.1 billion are without access to improved water supplies (UNICEF et al., 2000). Defined by UNICEF, "*Sanitation is a process whereby people (men, women and children) demand, effect and sustain a hygienic and healthy environment for themselves. This is achieved through a combination of hardware (latrines), hygiene promotion any other supporting software activities and the development of an enabling environment to ensure that hardware and software can be delivered* (UNICEF et al., 1999). The disparity of access to these basic services is predominately evident in peri-urban and rural communities of developing countries. Peri-urban regions are communities located at the interface of urban and rural economies along the fringe of metropolitan populations (Birley et al., 1999). A benefit for rural communities near urban centers is the access to potable water. This access also presents a preference for water-based sewerage in households (Scott et al., 2003). This increase in wastewater without proper access to treatment, storage or disposal contributes significantly to the increase in water-born and related diseases (Feacham et al., 1983).

In Jamaica, 92 percent of the 2.5 million residents have access to an improved water supply, with nearly all relying on groundwater sources. In 2001, nearly 96 percent had access to improved sanitation, including water-less and water-based systems. More than 2.0 million persons (80 percent) are dependent on onsite wastewater or excreta disposal systems. Of the water systems, less than one-third connect to a central treatment facility. The Pan American Health Organization (PAHO) estimates only 15-20 percent of the domestic wastewater that is centrally collected receives any significant treatment prior to discharge (PAHO, 1998). This equates to less than three (3) percent of households utilizing flush toilets that connect to central treatment facilities actually receive treatment for their waste produced. The combination of inadequately operating

treatment facilities and insufficient onsite treatment and disposal systems creates a high opportune for contamination of groundwater (Cave et al., 1999). Contamination of underground water sources may be exasperated if vulnerable environmental conditions exist, including, predominately sandy soils, limestone/calcareous features and shallow aquifers along the populated coastal zones.

This report documents the continuing work to develop an appropriate environmental sanitation plan for a fishing village, Half Moon Bay, a ten (10) acre beachfront with 200 occupants along the south coast of Jamaica. This plan accommodates the fishermen in addition to the daily and the typical weekend visiting patrons. Hygiene education and technical training is a significant portion of this sanitation plan. In determining the type of toilet facilities to construct, community members and planners considered social, economic and technical factors.

Of the burden of all diseases affecting humanity, six (6) percent is attributed to diarrhea (UNICEF et al., 2000), a direct result of poor hygiene and sanitation practices (Cairncross et al., 2003, UNICEF et al., 2000). Literature confirms that community-based sanitation plans that partner with the construction of appropriate sanitary conveniences with hygiene education reduces the risk to illnesses linked with poor sanitation practices. (Kalbermatten et al., 1982; Cairncross et al., 2003; UNICEF et al., 2000; Rosensweig et al., 2002).

The onsite wastewater technologies proposed at Half Moon Bay include Evapotranspiration Bed systems and Ventilated Improved Double Pit Latrines (VIDP). The former is a common technology installed in Jamaica's urban centers, while the later is employed in rural areas that have inadequate access to potable water. Half Moon Bay fishermen have individual potable water connections at their camps and food sheds that are from a safe, consistent municipal source (Greater Portmore Health Care Centre, 2003). With the

combination of cultural preference and the accessibility of potable water, most fishermen prefer flush toilets. Unfortunately, some fishermen are not able to afford the high commercial rate for potable water. As a result, the sanitation plan includes both dry and flush toilet system technologies. With frequent installation of the proposed systems across the island, these systems shall be easily incorporated on the beach. As Jamaica moves towards increased access to running water, more persons will expect to have a flush toilet system. Soon this accessibility will include other remote fishing villages. A map identifying the 121 fishing villages, according to the Ministry of Agricultures, Fisheries Division, (Figure 1).

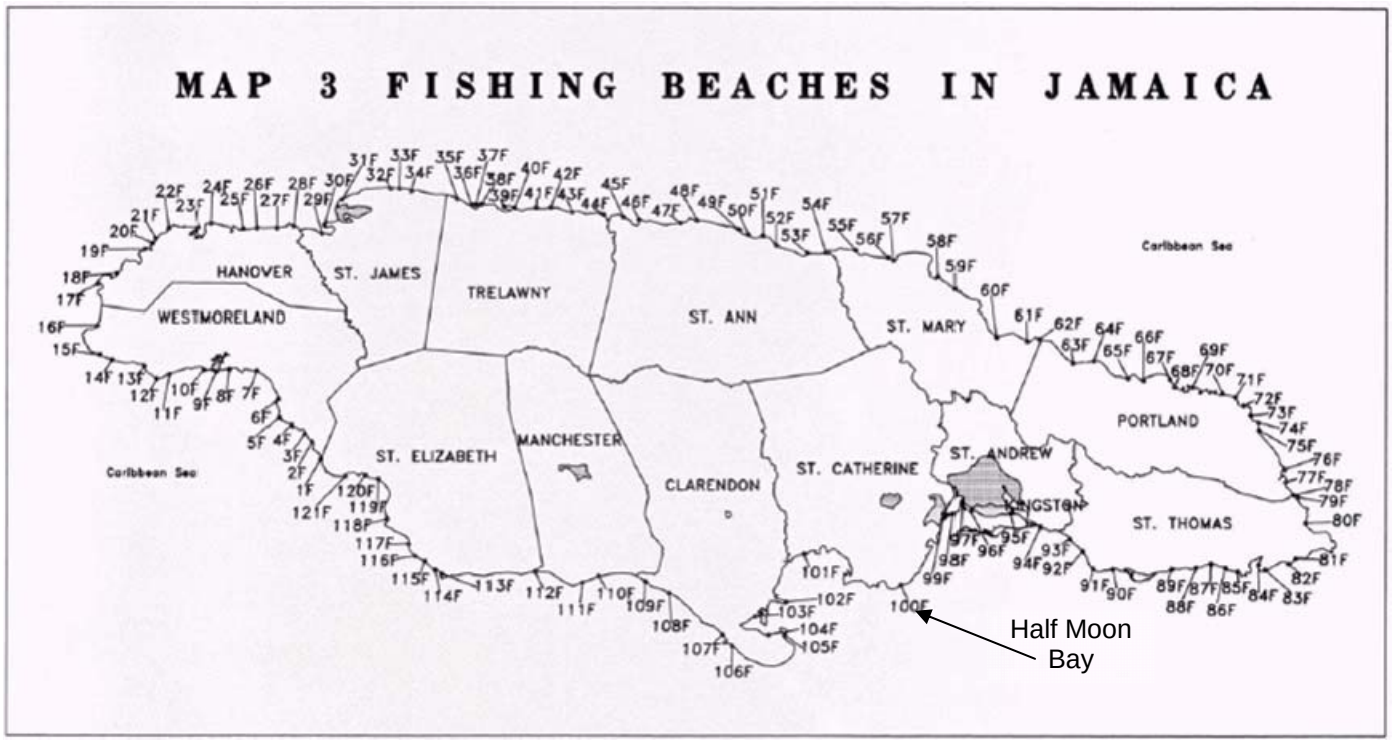

Figure 1: Fishing Beaches in Jamaica. Adapted from Beach Policy NEPA, Half Moon Bay, Hellshire Beach is designated as 100F, located on the South east of the island

The evapotranspiration bed system is a specific, appropriate technology for treating wastewater generated from public toilets in regions with a shallow groundwater, unsuitable soils for a proper percolation rate or fractured bedrock features. This technology is widely used in developed countries for treating domestic wastewater (USEPA, 2002) The Jamaican government widely approves of this system in urban and coastal areas (Silva, 1990). Currently, the government, through the Scientific Research Council is conducting a pilot study on evapotranspiration disposal of food industrial waste.

Accordingly, the objectives of this report are:

1. Discuss measures employed by a fishermen's cooperative to gather information from fishermen, beach staff, visitors and technical consultants and stakeholders to assess the immediate and proposed sanitation needs at Half Moon Bay.
2. Outline the components to the Sanitation plan and the economic, social, and environmental factors considered in the development of the sanitation technologies.
3. Provide details on design, construction and fundamental processes for evapotranspiration pond technology.

2 Background

This report originates from the St. Catherine Parish Health Department request for assistance from U.S. Peace Corps to develop sanitation programs with two of their five parish fishing villages. The first project was initiated with the Half Moon Bay Fishermen's Cooperative at Half Moon Bay, Hellshire. Hellshire is located within the parish of St. Catherine, which neighbors the Kingston/St. Andrew metropolitan area (Figure 2).

Figure 2: Political Map Jamaica, Map with the Parishes of St. Catherine and St. Andrew are Highlighted. Map adapted from (About, 2005).

In this area, numerous housing developments have been procured to absorb population overflow from Kingston. The proximity of housing developments in Spanish Town and Portmore to the Half Moon Bay fishing village has created a unique symbiosis between fishermen and bathers at the formerly dominant fishing beach. As early as the 1970s, fishermen have established small food establishments, fry fish sheds, to cook their fish for patrons. With the benefit of having a market to sell their fish on their beach, the fishermen population has increased from 14 to 181 (Table 1).

Table 1: Population Census for St. Catherine towns [1]

Town	1970	1982	1991	2000 [2]
Portmore/Greater Portmore	2,197	77,648	93,799	
Spanish Town	39,204	87,975	110,379	
Hellshire	14 – 40 [3]	66 [3]	100 [3]	181 [4]

[1] Data was extracted from the following source, unless indicated. (Caribbean Coastal Area Management Foundation 1999)
[2] 2000 data was extracted from (Demetrius, Elie June 1982).
[3] (Urban Development Commission June 1999). The document states sixty dwellings, this estimates to approximately 100 persons residing at beach.
[4] (Greater Portmore Health Centre May 5, 2003)

In 2001, the Urban Development Corporation allocated ten (10) acres of beachfront property to the Half Moon Bay Fishermen's Cooperative for use for storing gear and selling raw and cooked fish. This is one of the first Cooperatives to be allocated land, previously owned by the government. During the land negotiations, UDC and the Cooperative agreed the Cooperative would construct sanitary, environmentally appropriate toilets for both visitors and fishermen. With assistance from the Ministry of Health / Environmental Health Unit, local health department and Peace Corps, the Cooperative developed a sanitation plan and acquired funding from a local funding agency. Components of the plan are discussed in Chapter 5 and the proposal is available in Appendix 2. This plan addresses appropriate wastewater treatment technology, funding acquisitions, construction implementation and daily operations and maintenance.

2.1 Geography and Demographics

Jamaica was called *'XAYMACA', 'Land of wood and water'*, by its original inhabitants, the Arawaks and Tainos. On discovering the island on May 4, 1494, Christopher Columbus declared it 'the *fairest land ever eyes beheld... the*

mountains touch the sky ". Evidence of this beauty is still noticeable under the negative deposits from anthropogenic pollution and influences.

Jamaica, the third largest Caribbean island, at 10,991 sq kilometers (4,244 square miles) is located approximately 145 kilometers (90 miles) south of Cuba (Figure 3). The island has mostly a mountainous interior with some discontinuous coastal plains and over 120 rivers. Jamaica's tropical and subtropical ecosystem is characterized with a rich floral and faunal diversity and high proportion of endemic species. The highest point on the island is the Blue Mountain Peak at 2,256 meters (7,402 feet). Approximately, 67 percent of the island is covered in limestone, shale, weathered igneous and metamorphic rocks, while swamplands cover another 15 percent. The abundant red soil in the island's interior has significant reserves of bauxite, the principal ore for aluminum (CIA Factbook, 2003).

The average annual temperature in Jamaica is 27 degrees Celsius (82 degrees Fahrenheit), with mountain temperatures dropping to 10 degrees Celsius (50 degrees Fahrenheit). Mean annual precipitation varies throughout the island from 750 to 7,000 millimeters (30 to 276 inches). Two rainy seasons occur during (1) October and November and (2) May and June (Water Resources Authority, 1985).

Jamaica is divided into three (3) counties (Middlesex, Cornwall, and Surrey) and 12 parishes (St. Thomas, Portland, St. Ann, St. Mary, St. James, Hanover, Trelawny, Manchester, St. Elizabeth, St. Catherine, St. Andrew and Westmoreland). The capital and financial center, Kingston, is located on the southeastern coast. Montego Bay, the second largest city and major tourist destination, is located along the northwest coast (Figure 2 and Figure 3). The Kingston Harbor is recorded as the seventh largest harbor in the world.

Figure 3: Caribbean Sea with Jamaica Highlighted. Refer to Figure 2 for enlarged picture of boxed area. Map adapted from (CIA Factbook, 2003)

Jamaica is a lower middle income country with a population of approximately 2.5 million and per capita GNP of US$2,820. Growth is estimated at 0.66 percent (CIA Factbook, 2003). Twenty-seven (27) percent of the current population resides in the Kingston Metropolitan area. The Jamaican population is primarily black at 90.9 percent with minority populations of East Indian (1.3%), white (0.2%), Chinese (0.2%), mix (7.3%) and other (0.1%) (CIA Factbook, 2003). Over (60%) of the population practices Protestant religious traditions with the largest churches being Church of God (21%), Seventh Day Adventist (9%), Baptist (9%) and Pentecostal (7.5%). Other significant Protestant churches include Anglican, Methodist, United Church, Brethren, Jehovah's Witness and Moravian. Minority religions include Catholicism (4%) and Rastafarianism (30%) (World Religions, 2004).

Jamaica is an Anglophone country with a local creole, patois, spoken island wide. Patois is an English-based creole with influences of African phonics, American English and old English vocabulary. The standard British English is recognized as the official language and is spoken in formal settings, while patois is typically spoken in informal or social environments.

2.2 Economy

The Jamaican economy is service dependent with (56.2%) services, (37.2%) industry and (6.7%) agriculture (CIA Factbook, 2003). The largest income sources include remittance, tourism and bauxite mining. Main agriculture crops include sugar cane, bananas, coffee, citrus, yams, vegetables, pimento and coconut. Other products include poultry, goat, milk, crustaceans and mollusks.

Nearly 2.2 million tourists travel to Jamaica annually providing millions of dollars to the Jamaican economy. The balance of civil peace on the island, cooperating weather conditions and global peace have influenced a positive increase in the Jamaican tourist industry. Unfortunately, the typical enclave nature of tourism continues to discourage the distribution of monies throughout the local economy.

A major burden on the economy is the 3:1 ratio of national debt to GDP. The Bank of Jamaica continues to stabilize the economy through various financial programs. From 2001 until 2003, the Jamaican currency ($J) fluctuated between $50J and $60J per $1US.

Wealth disparity in Jamaica has fostered the presence of distinct social groups within the society, dictating different norms in communication, social appreciation and consumption patterns. The mean per capita annual consumption expenditure of the wealthiest 10 percent of the population is 11.2 times that of the poorest 10 percent (Table 2). The economic distribution among the population is comparable to other middle income Latin America and Caribbean countries.

Table 2: Percent (%) of Consumption Expenditures Among the Jamaican Population

Description	% consumption [1]
Poorest 10%	2.7
Poorest 20%	6.7
Wealthiest 10%	30.3%
Wealthiest 20%	46%

[1] World Bank 2002.

The World Bank estimates two (2) percent of the resident population earn less than $1 US per day. Unemployment is approximately 16 percent, with the predominant unemployed population young males of the urban poor. Female employment is high at over 40 percent. Fortunately, the stratum of jobs available for women is improving as more women continue to pursue managerial and professional careers.

2.3 Government and Political Environment

Jamaica attained independence from Britain in 1962, becoming an independent Commonwealth Nation. The current government is parliamentary democratic state with the British queen as the monarch. The government is headed by a Prime minister, who is assisted by a Cabinet of elected ministers. The National Legislative body is comprised of a House of Representatives with 60 members and a Senate of 21. General elections are constitutionally required every 5 years. The Queen of England is recognized as head of state with the General Governor as her representative. The Judicial body is comprised of a Supreme Court, a Court of Appeal and local courts. Final appeals are made to the Judicial Committee of the Privy Council in the United Kingdom. During the author's tenure, the Jamaican government was coordinating with neighboring Caribbean countries to develop a supreme court within the West Indies region.

Currently, the dominant political parties are Peoples National Party (PNP) and Jamaica Labour Party (JLP). The PNP typically advocates moderate socialist policies, while the JLP focuses on private enterprise development. Jamaica's political parties are historically linked with extreme violence and corruption. Since 1992, Percival Noel James (PJ) Patterson, the PNP majority leader has been Jamaica's Prime Minister, while Edward Seaga served as Opposition Leader during most of this time.

2.4 Health Conditions

The Ministry of Health claims the leading causes of death in Jamaica are no longer infectious or communicable diseases, rather chronic conditions, including cardiovascular diseases, diabetes and obesity (MOH, 2004). In 2000, the leading causes of death included disease of circulatory system (30%), neoplasms (17%), endocrine, nutritional and metabolic diseases (11%) and respiratory system conditions (6%). For young men ages 10 to 19 and 20 to 24, their leading cause of death is due to violent acts, (32.4%) and (15.4%), respectively. From 1998 until 2002, the MOH estimates these violent deaths at 44 deaths per 100,000 capita, one of the highest in the world (MOH, 2001). Table 3 summarizes the social, economic and health data provided by the World Bank (2004).

Table 3: Jamaica Social, Economic and Health Data (1997 – 2003)[1]

Parameter	Jamaica	LAC countries[2]	LMI Countries[3]
Poverty (% below national poverty line)	**19%**		
Urban population (% total population)	**52%**	77%	50%
Life expectancy at birth (years)	**76%**	71%	69%
Infant mortality (per 1,000 live births)	**17**	28	32
Child malnutrition (% children under 5)	**4%**		11%
Illiteracy (population above 15 years)	**12%**	11%	10%

1. (World Bank, 2004)
2. LAC: Latin American Countries
3. Lower Middle Income Countries: Classification per World Bank Group economy classification (2003 Gross Net Income per capita, calculated using the World Bank Atlas method: *low income*, $765 or less; *lower middle income*, $766 - $3,035; *upper middle income*, $3,036 - $9,385; and *high income*, $9,386 or more.)

Another increasing cause of death in Jamaica is from complications from the HIV/AIDS virus. UNAIDS and the World Health Organization estimates 1.2 percent of adults ranging in age from 15 to 49 are currently living with the HIV/AIDS virus. This estimate may be low because of the limited capacity for identifying infected persons due to the cultural stigma related to the virus. The Caribbean and Latin American region is the second most affected region in the world among adults (UNAIDS/WHO, 2004).

The public and private sectors in Jamaica have successfully promoted immunization programs and improved potable water and sanitation infrastructure. As a result, infectious diseases and communicable diseases are no longer a major threat on the island. Malaria is no longer endemic, but dengue fever still persists with the last major outbreak in 1988. Additionally, the MOH reports (2001) ninety (90) percent immunization coverage annually since 2000.

2.5 Environmental Health

Jamaica has improved public environmental health conditions significantly by developing successful vector control program, immunization campaigns, healthy lifestyle initiatives and other public health activities.. Unfortunately, many communities in Jamaica have high-density populations, inadequate sanitation structures and poor hygiene practices that inevitable support an environment for communicable or infectious disease outbreaks.

In 2002, the World Bank/Health Nutrition and Population Program (HNP) estimated over 90 percent of the Jamaican population have access to an improved water source, while nearly 100 percent have access to improved sanitation facilities (Table 4). Unfortunately, PAHO (1998) estimates only 10 – 15 percent of the domestic wastewater that is collected receives any significant treatment prior to discharge.

Table 4: Access to Improved Potable Water Sources and Improved Sanitary Systems per Rural and Urban Populations, 2002[1]

		Jamaica	LAC Country[2]	LMI Country[3]
Access to improved water source (%)	**Total**	92%	86%	81%
	Urban	98%	94%	94%
	Rural	85%	65%	70%
Access to improved sanitation facilities (%)	**Total**	99%	77%	59%
	Urban	99%	86%	80%
	Rural	99%	52%	42%

1. (World Bank, 2002).

2. LAC: Latin American Countries

3. Lower Middle Income Countries: Classification per World Bank Group economy classification (2003 Gross Net Income per capita, calculated using the World Bank Atlas method: *low income*, $765 or less; *lower middle income*, $766 - $3,035; *upper middle income*, $3,036 - $9,385; and *high income*, $9,386 or more.)

In 2001, 62 percent of the population had access to water closets, while 36 percent used waterless toilets. Less than a quarter of the water closets, pour-flush or flush toilets, were connected to central sewerage systems. (PAHO, 1998). As more households install water closets, the potential of contaminating the extensive sources of groundwater will increase.

Less than half of Jamaicans have access to intermittent solid waste removal programs with the locally approved ten (10) landfills with others receiving no collection or collection goes to unapproved landfills. No landfills on the island have liners or leachate systems. A national program is in effect to improve the availability and reliability of services to rural communities. Communities and families that do not have consistent solid waste either burn their household trash or store waste in an informal dump site.

Another crucial public environmental health concern in Jamaica is vector control and protection. As an island, Jamaica has a natural barrier to harmful mosquitoes and rodents from other countries. To protect the island's population and visitors, the Jamaican Government has extensive guidelines for all airplanes, boats and other transportation vehicles for rodent and mosquito control.

Air pollution is a concern in the urban and rural areas of Jamaica because of the high number of vehicles and persistent burning of trash. No significant data is available to confirm air pollution levels, but the government is developing a monitoring program.

2.6 Peace Corps/Jamaica

> *To support in her attempt to participate effectively in the activities of the new and dynamic global environment. As the global community takes shape, Jamaica is at a point of access but it requires support to improve its technical capacity, information base and synergy to effectively manage the transition. One of the components to support this pursuit is Peace Corps' intervention, utilizing Peace Corps Volunteers with appropriate skills, knowledge, experience and attitude to advance this process. Through this intervention, Peace Corps Volunteers would begin to understand the dreams, aspirations and ambitions of the Jamaica people and support them to address their expressed needs through appropriate technical assistance.*
>
> *- The Peace Corps Jamaica Mission Statement (1994)*

Jamaica was the ninth country to accept assistance from the United States Peace Corps Program. In 1962, Peace Corps/Jamaica (PC/J) trained 13 volunteers to focus on teaching and demonstrating vocational and industrial trades. Over the past 40 years, PC/J has worked with numerous community development projects utilizing over 3,275 volunteers (Table 5). As a member of

the seventy-third training group in Jamaica, the author was able to celebrate with Jamaica and PC/J in 40 years of partnering in community development programs and 40 years of national independence.

Table 5: Peace Corps/Jamaica Projects (1962-2002)[1]

1962-1972	1972-1982	1982-1992	1992-2002
Rural Development	Special Education	Health	**Community Envtl Health**
Library Development	Early Childhood Education	Agriculture/Envtl management	Environmental Education
Vocational Education	Home Economics	Small Business Development	Information Technology
Home Economics	Dance	Education	Youth-at-risk
Health	Mathematics	Youth-at-risk	AIDS Education
Trades Training	Agriculture		
Mathematics	Industrial Arts		
Agriculture	Medical Services		

[1] US Peace Corps/Jamaica 2002.

Group 73 volunteers participated in five community development sectors: (1) youth-at-risk, (2) environmental education, (3) community environmental health, (4) information technology and (5) AIDS education. The author participated in the Community Environmental Program as an environmental engineer. The program was established in 1995 in response to the Ministry of Health's request for PC/J to assist with water and sanitation issues. The Program will be re-evaluated for possible continuation in 2005. The Group 73 Environmental Health and Sanitation Sector have fourteen (14) advisors and five (5) engineers. Typically, engineers are assigned to the Ministry of Health national and regional offices, while advisors are assigned to communities or non-government organizations on the local level.

The author was assigned to the Ministry of Health / Environmental Health Unit (EHU), in the capital city, Kingston. EHU staff work directly with parish health departments to disseminate information and programs regarding public environmental health issues. Specific responsibilities of the author included (1) researching, designing and implementing improved medical waste disposal facilities at Ministry hospitals and health centers, (2) evaluating proposed onsite wastewater treatment systems for new housing and commercial developments and (3) designing and implementing an improved sanitation plan with a local fishermen's cooperative.

3 Half Moon Bay Fishing Village and Bathing Beach: Site Overview

In Jamaica there are an estimated 121 (National Environment and Planning Agency, 2000) artisanal fishing villages that are managed by the Fisheries Division within the Ministry of Agriculture. Fishing villages are reserved coastal areas where working-poor fishermen have built storage sheds or camps. Camps are a combination of gear sheds and residences. These villages often have few sanitary facilities or access to clean, potable water due to the combination of low-income, small camp lots, temporary structures and remoteness.

For over 30 years, the fishing village, Half Moon Bay, along Hellshire Beach, St. Catherine has been patronized by not only fishermen, but also Kingstonites, foreign tourists and Jamaicans island wide. The beach is nationally recognized for its 'cultural ambiance' with a spectacular ocean view, white sands, close proximity to Kingston and fry fish with festival dinners. Through the years, fishermen have constructed temporary wood and zinc structures to sell raw and fried fish. As more patrons found refuge in this rustic beach environment, more fishermen constructed fry fish sheds. This symbiosis between the fishermen and patrons continually plague the Half Moon Bay with over-development. This over-development along the beach without proper solid waste management and public and private toilets has created an unsustainable and unsanitary environment

3.1 Location

The Half Moon Bay Fishermen Community is situated on ten (10) acres at the southern end of the Green Bay at Half Moon Bay Point within the Portland Bight Protected Area (Figure 4).

An estimated 3,000 persons with over 1,500 vehicles utilize the beach on a weekly basis along with the 200 fishermen and their families that live on the beach (Goodbody, 1989). Many persons from Kingston and the growing

Portmore communities frequent this beach because it is the closest beach that has not been extremely degraded by pollutants from Kingston Harbour.

Half Moon Bay totals 0.16 square kilometers (38.4 acres) and consumes 2,231 feet (680 meters) of eastern coastline in Hellshire, St. Catherine (Figure 4). The fishermen have jurisdiction of one-quarter of the Bay area. Hellshire lands incorporate approximately 117 square kilometers (28,800 acres) of limestone rolling hills, coastal mangrove wetlands, swamp land and narrow sand beaches. Elevations in the area range from sea level to 244 meters (800 feet) (UDC, 1999). Though less than 13 kilometers (8 miles) from Kingston, Hellshire remained relatively undisturbed until the 1970s because of the dry climatic conditions, rough terrain, and limited access by boat or trail (Fisheries Division, 1982).

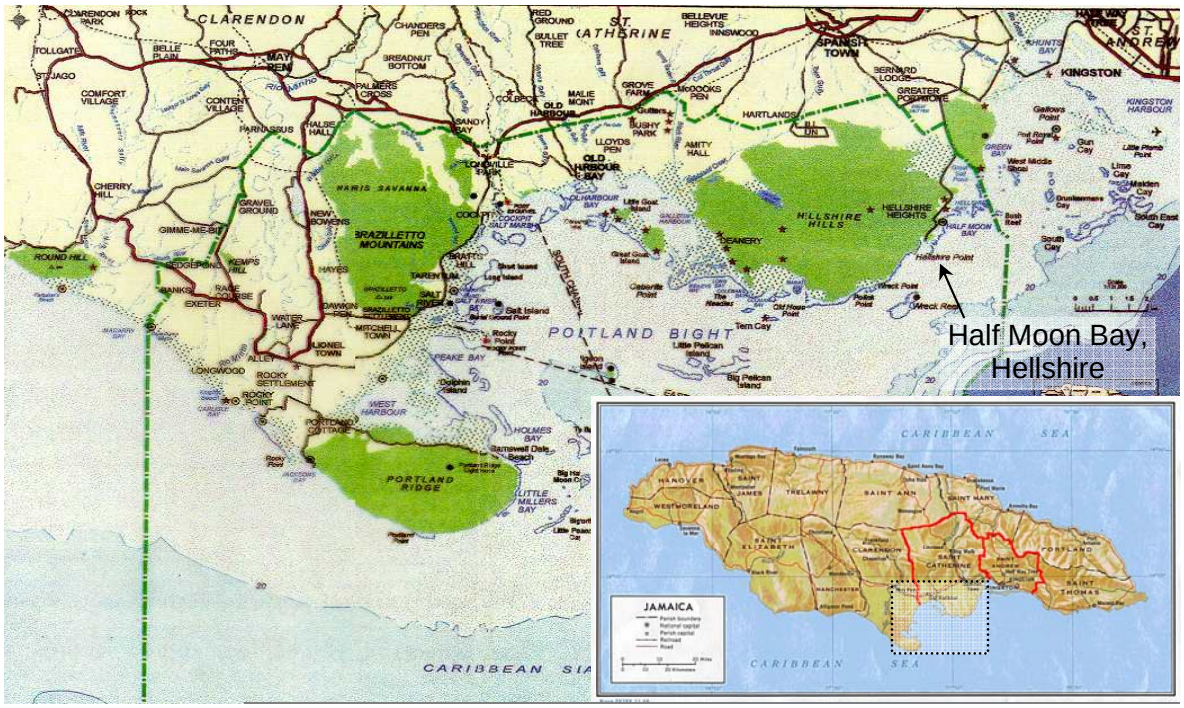

Figure 4: South Coast of Hellshire, St. Catherine (Jamaica) with Jamaica Political Map insert. Half Moon Bay is highlighted by red circle. Adapted from Caribbean Coastal Area Management (C-CAM, 1999) and About Maps (About, 2005).

3.2 Fishermen's Cooperative

Since the early 1970s, the Fisheries Division and other relevant government agencies have assisted fishermen in organizing Cooperatives. A Cooperative, as defined by the Department of Cooperatives and Friendly Societies is "*an autonomous association of people, usually of limited means, who join together on a voluntary basis to achieve a common objective* (Cooperatives and Friendly Societies, 2001). Together these agencies assist Fishing Co-operatives in providing a cohesive voice within fishing villages. As Cooperatives organize, the fishermen have been able to request sanitation and infrastructural technical and financial assistance from local government agencies and funding organizations. Sanitation assistance projects have included sanitation workshops from local health departments, technical assistance from the Ministry of Health and utility acquisition from the National Water Commission and Jamaica Public Service Company.

Initially, the Forestry Department managed Hellshire and Half Moon Bay as a forest reserve. At this time, two fishermen retained temporary residency at the beach by paying the Forestry Department one (1) shilling annually. In 1973, development increased in the surrounding area with construction of numerous housing developments along Hellshire Hills. With the increased population and improved access to the beach, more patrons frequented the beach.

Also, more fishermen established in-formal residency at the beach and built fry fish sheds as more paying customers frequented the beach for cooked and raw fish. A survey conducted in 1973 by the Urban Development Commission (UDC) identified 40 fishermen residing at the beach with their families. Fishermen continued to establish residency at the beach by constructing zinc and wood shelters (Fisheries Division, 1982).

By 1977, the fishermen had begun to formally organize on the beach but were not recognized by the Registrar of Cooperatives because the fishermen had not identified a viable project and member illiteracy was too high (Demetrius, 1982). The Cooperative was finally recognized in 2000 when the members worked together to improve the marl access road to the beach and acquire potable water through the National Water Commission. Also, the Cooperative negotiated land tenure with the government agency, Urban Development Commission. This land tenure for 10 acres protects the fishermen from future development at the beach.

As an organized, semi-cohesive team, members of the Cooperative are appropriated the responsibilities to manage their member's social and economic affairs and activities carried out on the acquired ten (10) acres of land at the beach.

3.3 Historical Relevance

The historical development and political agendas of Half Moon Bay and its stakeholders is critical in understanding the potential positive development of a proper sanitation plan at the beach. In 1968, the Forestry Department transferred the Hellshire lands to the Urban Development Corporation (UDC) because of the need for more housing near the Kingston Metropolitan Area. UDC was given sole responsibility to develop the area in an effort to absorb population overflow from Kingston and prevent development on agricultural lands. Besides developing affordable housing, this project proposed developing Half Moon Bay and three neighboring beaches (Fort Clarence, Wreck Bay and Sisters Cave) as a resort beach for 1.2 million patrons. At these negotiations, the Half Moon Bay population estimated at fourteen (14) fishermen. The estimated patron capacity at Half Moon Bay was 4,000 persons (Fisheries Division, 1992).

In 1973, UDC financed the construction of the access road from Portmore to Half Moon Bay and initiated construction of the Hellshire Hills housing schemes.

Once the development commenced, the fishermen residing at the beach increased along with the number of beach patrons. The fishermen population increased 35 percent from fourteen to 40 occupants (Fisheries Division 1982). Table 6 illustrates the continuing growth at Hellshire Beach. At this time, UDC initiated dialogue with the Half Moon Bay fishermen because their gear shed and camps would have to be relocated to accommodate the proposed resorts.

Table 6: Hellshire Beach Population

Year	1973	1977	1981	2003
Population	14	40	66	194

Over the next two years, UDC worked with the fishermen to define a relocation plan. In 1975, UDC formally proposed a $J0.25M financial plan that included relocation of fishing equipment and boats to Wreck Bay and provision of living quarters in Hellshire Hills scheme. Wreck Bay is located a few miles south of Half Moon Bay. The fishermen did not approve of Wreck Bay because rough waters did not permit safe docking of boats. As for the Hellshire Estates, the fishermen were divided. Before dialogue was completed, the project was indefinitely postponed because funding was not available from pertinent stakeholders (Fisheries Division, 1982).

In 1977, the government organized a task force to help re-initiate plans that still had not come to fruition at Half Moon Bay. During this year, the government formally recognized the use of ten (10) of the total forty (40) acres at Half Moon Bay by the fishermen. A copy of the land title is provided in Appendix 3. Though UDC recognized the fishermen's use of the land, no formal title transfer was commenced.

Due to decentralization of the government, the responsibilities of this task force were transferred to the St. Catherine Re-development Committee in 1980. This

committee worked diligently with the Fishermen to address the following key issues:

1. fishermen housing;
2. reservation of agricultural lands;
3. potable water at beach and; and,
4. fishermen gear sheds.

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With lack of government funding and disorganization among fishermen few aspects were completed. Another critical factor that delayed the Committee's efforts was the increased fishermen population since the project's launch. This increased the capital required to support relocation efforts. Also, the committee proposed changing the land allocation from ten (10) acres along Half Moon Bay to five (5) acres reserved at Hellshire Hills scheme for fishermen housing and five (5) acres along Half Moon Bay reserved for fishermen gear sheds. This controversial change was not agreed upon due to lack of government funding and lack of organization among the fishermen (Fisheries Division, 1982). Fortunately, the task force worked with the fishermen to install a stand pipe at the beach. This stand pipe was a direct benefit from the nearby housing scheme water supply.

Twelve (12) years after UDC was allocated lands at Hellshire, subdivisions were being planned and built, but no organized development had been initiated at Half Moon Bay. With increased infrastructure in the area, more patrons visited the beach for recreation and bathing. Additionally, more fishermen were establishing their gear shed and beach camps.

By 1999, the fishermen had organized into a semi-cohesive cooperative, Half Moon Bay Fishermen's Cooperative. Also, UDC was appropriated money to develop the beach. With this in order, UDC reinitiated dialogue with the fishermen. The Cooperative and UDC were unable to come to an agreement on the five (5) acres of land dedicated for fishermen housing off the beach.

By May 2001, UDC and Cooperative agreed to combine the acreage into one unit within Half Moon Bay. After much deliberation, the title for the ten (10) acres was dedicated to the Cooperative with Commissioner of Lands responsible for holding the title in trust. As agreed, the Cooperative would be entrusted the land title after the meeting the following conditions: (1) provide sanitary public toilets for beach visitors, (2) register all fry fish shed operators and staff via food handling permits and (3) demonstrate Cooperative cohesion and longevity (Fisheries Division, 2001).

Within the first year of land tenure, a European consultant assisted the Cooperative in allocating funding from the Environmental Foundation of Jamaica (EFJ). The proposal was approved to construct one (1) flush toilet with onsite treatment via anaerobic digester. With lack of organization and confusion of land tenure, this project was never completed.

Also, the St. Catherine and Portmore Health Departments assisted the fishermen in improving sanitary conditions and practices at the beach with food handling and public health presentations. In 2003, the Portmore Health Department conducted a Rapid Assessment Survey (RAS). This survey detailed the beach population at 194 with (62) residences, (73) food and bar establishments, (5) private toilets and (1) public toilet. Realizing the imminent need for toilets in the area and the enthusiastic and organized Cooperative, the St. Catherine Health Department requested assistance from the Ministry of Health / Environmental Health Unit (MOH/EHU) in developing a sanitation plan at the beach. Chapters 4 and 5 of this report documents the sanitation plan's development and initial implementation.

The author started working with the fishermen at completion of the Rapid Assessment Survey (RAS) in May 2003. By fall 2003, the Cooperative had submitted a proposal to the Environmental Foundation of Jamaica (EFJ) funding

agency for phase one of the sanitation plan (Appendix 2). The proposal was approved in March 2004. Approvals from National Environment and Planning Agency (NEPA), Water Resources Authority (WRA), Ministry of Health / Environmental Health Unit (MOH/EHU) and relevant health departments were submitted by April 2004.

4 Methods used to Assess the Needs of Fisher folk and Beach Visitors

The small business venues at Half Moon Bay create a unique overlap of urban and rural economies, often referred to as peri-urban. This interface of rural and urban populations must be considered and included in the planning of a sanitation plan because of the different social requirements from the different populations. Many international development agencies have developed methods and/or manuals for sanitation plans for these peri-urban, small towns or other relevant community situations (Simpson-Herbert et al., 1997, Rosensweig et al., 2002, Kalbermatten et al., 1982). A summary of social, environmental and technical factors employed by this sanitation plan to address the peri-urban interface are provided in Table 7.

Table 7: Summary of Social, Environmental and Technical Factors

Social	Technical	Environmental
Community health profile	Identify and cost technically feasible options	Government regulations
Sanitation practices and preferences	Operations and maintenance	Soil type
Community financial status	Access to potable water	Groundwater depth
Aesthetic preferences		

Half Moon Bay primarily referenced *Appropriate Sanitation Alternatives: a Planning and Design Manual* (Kalbermatten et al., 1982) when developing the community's sanitation plan. This manual recommends a holistic plan that includes wastewater, potable water and solid waste management. Community participation is highly recommended in the planning phase with inclusion of consultation meetings with relevant stakeholders. The manual also proposes a series of interlinking social, environmental and economic factors for evaluating and addressing the sanitation needs of a community (Kalbermatten et al., 1982).

The Cooperative did reference Participatory Hygiene and Sanitation Transformation (PHAST) data collection methods for community mapping and survey distribution (Simpson-Herbert et al., 1997). The Environmental Health Project (EHP) used a similar modern 10-step development process (Rosensweig et al., 2002). White Horses, St. Thomas, a village along the south east coast of Jamaica used this method to develop their sanitation plan. This peri-urban village is diverse with a combination of extremely isolated, semi-isolated and dense housing situations. The finding from this study is available through Construction Resource and Development Commission (CRDC).

For evaluating the sanitary needs at Half Moon Bay all these factors were incorporated along with the consideration of all representative persons: fishermen, fry fish vendors, visiting bathers and fry fish customers.

The Cooperative members employed numerous techniques for gathering information about the current and proposed future needs at the beach, including; surveys, presentations and informal and formal interviews. Specifically, the Cooperative members interviewed fishermen and their families, along with fry fish shed vendors about their current sanitation practices. The members also consulted numerous funding organizations, government agencies and concerned citizens about their perspective on future development at the beach. This initial collection of information consumed four (4) months until the funding proposal for the sanitation plan components were submitted to the funding agency. The proposal components are discussed in Section 6.2 of this report and a copy of the proposal is available as Appendix 2. During the information gathering phase, fishermen and food establishment managers worked together to determine a cohesive approach to the development of the beach. This increased a sense of awareness and ownership to the sanitation project.

4.1 Assessing the Current Environmental Health Conditions of Half Moon Bay

4.1.1 Environmental Conditions

Documentation as early as the 1980s recognized the environmental stress from improper development at Half Moon. Studies conducted through the University of the West Indies confirmed significant beach erosion, depletion of beach flora and deterioration of nearby coral (Goodbody, 1989). This study titled, *Caribbean Coastal Management Study: The Hellshire Coast, St. Catherine Jamaica* reported the current and potential effects of development stress on Hellshire. (Goodbody, 1989). The environmental integrity of the beach is threatened from increases in:

- Land use for construction of fishermen camps and fry fish sheds
- Vehicular traffic within 100 feet of the coast
- Poor sanitation practices, including the construction of pit latrines in the sandy soil structure
- Improper disposal of solid waste (Figure 5).

Conclusions from this study, document the dramatic degradation of the beach foreshore by removal of vegetation along the coast and aeolian erosion on the beach. One recommendation implemented from this study is the establishment of a preservation area along Hellshire coastline, titled the Portland Bight Protected Area (PBP). PBP totals 724 square miles (1,876 square kilometers), includes the entire southern tip of Hellshire and additional lands to the west (Goodbody, 1989).

Figure 5: Environmental Conditions at Half Moon Bay.

Notice the debris in the sand and densely spaced zinc structures.

Photo courtesy of K Stanforth, 2003.

4.1.2 Housing and Living Conditions

Half Moon Bay is a coastal community with a high population density of unorganized, informal small lots, sand vehicular access roads and few permanent structures. Ideally, facilities for a fully functional fishing beach should include gear sheds, individual lockers, improved sanitation facilities, water supply, a petrol pump, electricity, fish cleaning troughs, repair shop, cooperative store and offices, vendors' stalls, showers and garbage disposal facilities. The facilities at the majority of fishing beaches in Jamaica, including Half Moon Bay, however, are either in poor physical condition or inadequate for the fishermen (NEPA, 2000).

At Half Moon Bay, 62 fishermen have private camps to store personal fishing supplies and maintain a temporary sleeping quarters (Greater Portmore Health Centre, 2003). The camps are identified by their zinc or wood structures. Housing material is typically zinc, stone, concrete block, bamboo or wood (Figure 6). Approximately one-quarter of Camps have improved sanitation.

Figure 6: Typical Fishermen's Shed with Restaurant/Bar Attached at Half Moon Bay. Photo Courtesy of K Stanforth 2003

All Camps have access to a vehicular access road. These roads are sand based and sufficiently wide for passing automobiles. Fishing boats are stored along the east shoreline.

4.1.3 Standard of Living

Fishermen at Half Moon Bay are considered the working poor, receiving on average $J7,000 ($128 US) annually. If the fishermen make four (4) to six (6) successful trips during one week, they may expect to profit $J20,000 to $J60,000 ($363 US to $1,090 US). The profit may be divided among accompanying apprentices and fishermen or boat owners. This value may not be reliable because many fishermen would not disclose their actual income and no reports are available for south coast fishermen salary.

A study conducted by the Environmental Management Unit at the University of West Indies at the Ocho Rios Marine Park estimated weekly revenues for fishermen using hand lines and nets at approximately J$21,356 ($390US) and J$15,380 ($280US), respectively (Environmental Management Unit, 2001). This value far exceeds the probable income for fishermen at Hellshire because the salary assumes 5 outings per week, with an average catch of 20 pounds and J$100 per pound ($0.55US). Also, this Marine Park is located along the north coast, where artisanal (traditional) fishing is more successful. The Ministry of Agriculture / Fisheries Division recognizes south coast fishing as less successful, especially near Half Moon Bay and the Kingston Harbor.

Of the more than (62) fishermen working from Half Moon Bay, (13) boats are in operation with only half with engines. These population demographics were obtained during a survey by the Half Moon Bay Fishermen's Cooperative (2004). Fishermen without boats will assist boat owners during short or long term excursions. To compensate their fishing income, most fishermen operate a food or bar establishment at the beach. In the 70s and 80s over 1,500 people were known to frequent the beach restaurants weekly for the Caribbean famous Hellshire fry fish and festival meals (Goodbody, 1982). A more recent survey has not been conducted, but fishermen and patrons continually claim the visiting population may still be near this estimate. Most of these businesses are located

along the south bathing area. The facilities are constructed with ply board, unfinished wood, zinc and concrete. The cooking area is a wood burning stove. Figure 7 is a typical fry fish shed cooking area. Table 8 is the number of camps and food/bar establishments that were operating from the beach in April 2003.

Table 8: Number of Camps and Food Establishments Operating from Half Moon Bay, Hellshire Beach

Establishment	Quantity
Camps	62
Food Sheds	21
Bars	9
Restaurants	37
Other Premises	6

[1] Results from Rapid Assessment Survey conducted by the Portmore Health Department (St. Catherine), 28 April 2003. See Section 4.2.1 and Appendix 4.

Figure 7: Typical Fry Fish Shed at Half Moon Bay.

Photo Courtesy of K Stanforth 2003

4.1.4 Potable Water Status

Since 1980, the fishermen have had access to potable domestic water from the local water commission, National Water Commission, (NWC). The first installation was a standpipe. Due to large amounts of water being wasted, NWC installed a single meter from which persons connected lines from their Camps. The Cooperative was responsible for paying the water utility bill for this meter. With lack of funds the water was locked off numerous times. After a three (3) month lock-off during the summer of 2003, NWC worked with the Cooperative to install individual meters at a central location. Now individuals are responsible for paying their water bill. If payments are not provided in a timely manner, NWC reserves the right to lock off their meter, but not the entire beach.

4.1.5 Current Toilet Facilities

At present, one public toilet facility is available for the numerous beach staff, fishermen and beach visitors. According to a survey completed in May 2003, approximately 200 persons are residing on the beach in 62 camps. In total, 17 camps have improved sanitation of which 13 are flush toilets and four are dry pit latrines. Of the thirteen flush toilets ten connect to a holding tank, while three connect to absorption pits (Greater Portmore Health Department, 2003). No person interviewed remembered if their holding tank had been emptied. Most toilets have been installed within the last two years.

A caretaker manages the public improved sanitation facility during the day and collects a $30J per-use fee. Often, the caretaker only works weekends because the user fee does not cover her stipend. As of February 2004, the improved sanitation facility is rarely open because the Cooperative could not afford to pay the caretaker and empty the holding tank.

To compensate for the lack of public toilets three (3) fry fish shed operators constructed flush toilets for their patrons. All three (3) toilets connect to individual holding tanks.

4.2 Assessing the Immediate Needs of the Fisher folk

4.2.1 Rapid Assessment Survey

A Rapid Assessment Survey (RAS) of Half Moon Bay was completed by the Greater Portmore Health Department in April 2003. The RAS is available in Appendix 4 and a summary is provided in Table 9. A RAS is a survey often employed by local government authorities to quickly assess the current status of living conditions within a community. The Health Department conducted this

survey over a two-day period with four (4) health inspectors. The information was gathered by asking representatives from each housing structure a series of questions. The RAS established the current number of fry fish shops and bars operating from the beach. The total number of persons residing at the beach at the time of this survey was 194. This survey estimates 181 of the residents have access to improved sanitation facilities, while 19 others defecate in nearby open field. The type of toilets constructed at the beach include non-flush pit toilets and flush toilets that connect to either a holding tank or absorption pit (Table 10)

Table 9: Rapid Assessment Survey - Statistical Report[1]

	Total	**Satisfactory [2]**	**Unsatisfactory [2]**
Fisher Camps	62	16	44
Food Shops	21	8	13
Bars	9	5	4
Restaurants	37	2	35
Other Premises	6	1	5

[1] (Greater Portmore Health Clinic, 2003). Report provided in Appendix 4

[2] The RAS report does not define satisfactory or unsatisfactory

A follow-up survey conducted by the Fishermen's Cooperative in August 2003 concurred with population estimates but found five times more toilets on the beach. These survey results are discussed in Section 4.2.2.

Table 10: Estimate of the Type of Sanitary Convenience used by Fisher folk

Sanitary Convenience	Residences[1]
Non-flush, pit latrine[2]	1
Flush, holding tank[3]	4
Public Toilet[4]	54
Nothing[5]	3

[1] Residences equates to the number of fisher camps that utilize the specified sanitary conveniences.

[2] Waterless system that utilizes an absorption pit lined with broken stone, approximately six-inch diameter. The absorption pits at Half Moon Bay are no more than 5 feet deep due to the high water table.

[3] Water-based systems that flush to a holding tank.

[4] Many residents claimed to use the public toilet, a flush toilet where wastewater is stored in a holding tank.

[5] Residents that stated they have no access to any improved sanitation facilities. These residents defecate in nearby field.

4.2.2 Fishermen's Cooperative Surveys and Interviews

In an effort to establish the imminent needs of the fisher folk, the local Fishermen's Cooperative and the author conducted a series of interviews and surveys of persons residing at the beach and persons working on the beach. Two surveys were employed to accommodate (1) persons living at the beach and (2) persons operating a fry fish shed or similar venue from the beach. The survey questions were developed from the results of the Rapid Assessment Survey (RAS).

The Cooperative wanted to compile information on the type of improved sanitation facilities being constructed on the beach, the locations of these toilets

and the type of toilets the fishermen envisioned at the beach for the visitors and fisher folk. Figure 8 provides the list of questions used during the surveys. Table 11 summarizes the quantity and type of sanitary conveniences the current fishermen residents have within their camps. The survey was conducted by the author and one Cooperative member, who is a well-respected member of the community and active member of the Cooperative.

Figure 8: Survey Questions used by the Half Moon Bay Fishermen's Cooperative

Survey I: Food Vendor Operators

1. Are you a Cooperative member?
2. How many persons do you employ?
    a. How many of these persons live on the beach?
    b. How many of these persons commute to the beach?
3. What toilet facility do you use at the beach?
    a. If you use the public toilet, how much do you pay to use it?
4. If the Fishermen's Cooperative builds a public toilet at the beach, what would you like to have?

Survey II: Fisher Folk with camps at beach

1. What is your income source? (fishing, fry fish shop, off beach)
2. How many persons reside with you at the camp? (adults/children)
3. What type of toilet facility do you use?
    a. If you use the public toilet, how much do you pay to use it
4. If the Fishermen's Cooperative builds a public toilet at the beach, what would you like to have?

The survey was used as a mechanism to talk informally with persons working and living at Half Moon Bay about improved sanitation infrastructure, personal hygiene and environmental concerns. Also, while doing the walk-about for this survey, the Cooperative members sketched a plan view drawing of the community. The map identified camps, fry fish venues and other structures (Appendix 5).

Table 11: Number of Toilets Identified at Half Moon Bay During Cooperative Survey (2003)

	Total Facilities	Facilities with Dry, Absorption Pit	Facilities with Flush, Pit	Facilities with Flush, Holding
Fisher Camps	**67**	6	12	2
Food Venues	**34**[1]	0	1	2
Cooperative	**1**			1

[1] The RAS estimates 52 food venues, while the Cooperatives survey estimates 34. This may be explained by the Cooperatives survey including food venues connected to homes as fisher camps and not as food venues.

4.2.3 Historical Review of Fishing and Bathing Activities

The team also consulted the Fisheries Division of the Ministry of Agriculture to acquire historical information on the beach. This historical information clarified population growth and significant historical dates for the beach. Appendix 6 is a compilation of these significant reports.

4.2.4 Assessment of Needs for the Beach Visitors and Bathers

A series of meetings with concerned citizens, selected cooperative members and the author were held to discuss the future development of the beach. The discussions at these meetings focused on many areas of interest, including

- Sanitary conveniences (public and private),
- Solid waste,
- Infrastructure (fisher camps and fry fish sheds),
- Beachfront preservation; and,
- Visitor Accommodations

Though no survey was developed for accessing the needs of beach visitors and bathers, these meetings provided the Cooperative with sufficient information. From these development meetings patrons and concerned citizens explained the need to locate pubic toilet facilities in close proximity to the beachfront and fry fish sheds. Bathers will not use the toilet facilities if they have to walk back to the beach's main entrance or walk through the fishermen camps.

Beyond the development meetings, the Cooperative consulted numerous private agencies and government offices. Table 12 provides a brief summary of assistance these agencies provided.

Table 12: Pertinent Stakeholders during the Sanitation Planning Process

Agency	Assistance Provided
Construction and Resource Development Corporation	Administrative, Project implementation, Technical support (sanitation workshops)
Cooperative and Friendly Societies	Administrative support
Environment Foundation of Jamaica	Funding and technical assistance
Local Health Departments	Rapid Assessment Survey, technical assistance, Public health education
Ministry of Health, Environmental Health Unit	Technical assistance, Toilet design criteria
National Environment and Planning Agency	Environmental policy
Ministry of Agriculture, Fisheries Div	Past experience in sanitation projects at fishing villages, historical information
Private Sector	Small business support, marketing, fishermen rights
US Peace Corps	Technical assistance

4.3 Assessment Summary: Factors incorporated into Sanitation Plan

A summary of the factors incorporated into the proposed sanitation plan at Hellshire Beach is provided in Table 13.

Table 13: Proposed Toilet Facilities at Half Moon Bay

	Public - Communal	Fishermen – Communal	Fishermen – Camps
User	▪ Day beach visitors ▪ Food shed staff	▪ Fishermen ▪ Family (children/spouses)	▪ Fishermen ▪ Family (children/spouses)
User/day (#)	20 – 70 [2]	na	3 (users per toilet)[3]
Current Toilet (#)	1	0	20
Proposed Toilets (#)	10	4	Not determined
Factors considered in the design	▪ Flush (public preference) ▪ caretaker ▪ affordable ▪ clean ▪ odor-less ▪ environmentally appropriate	• available 24-hours ▪ clean, easy to maintain ▪ affordable ▪ works during water ▪ lock-off ▪ odor-less ▪ location near camps ▪ environmentally appropriate	▪ affordable ▪ simple construction ▪ odor-less ▪ design for limited space
Current Toilet(s)	Flush toilet to holding tank	Not available	▪ Dry Pit ▪ Pour flush to holding tank ▪ Pour flush to pit ▪ Flush to septic tank/tile field
Proposed Technology	1. Holding tank 2. Central Sewerage Connection 3. Evapo-transpiration 4. Recirculating Sand Filter to wetland 5. VIDP (no water)	1. VIDP (no water) 2. Holding tank 3. Evapo-transpiration 4. Recirculating Sand Filter to wetland	1. VIDP (no water) 2. Holding tank 3. Evapo-transpiration 4. Recirculating Sand Filter to wetland

[1] The proposed treatment systems are approved technologies by the Ministry of Health.

[2] User estimate from conversations with caretaker and Cooperative president during May 2003 and June 2003. This estimate may be low because for actual number that will use new facility that is more accessible and aesthetically preferable.

[3] This estimate is high to accommodate visiting family and neighbors that may use toilet

4.3.1 Socio-Cultural Factors

The fishermen had to consider social parameters for the various sanitation solutions, including (1) flush versus non-flush technologies, (2) privacy infrastructures, (3) access to maintenance, (4) communal versus private improved sanitation facilities, and (4) the unique interface of rural and urban populations.

In Jamaica, non-flush improved sanitation facilities, Ventilated Improved Double Pit Latrine (VIDP), are not widely accepted because these systems are often recognized for the poor. A detailed description of VIDP is provided in Section 5.1.2. Evaluation of VIDP sanitation projects in Jamaica show that VIDP owners rarely empty excreta contents from structures after recommended composting duration. Also, owners do not properly care for the systems, such as inputting extra water, cleaning agents and non-composting materials. (McDaniel, 2002). Other studies indicate communal VIDP toilets are less likely than privately-owned systems to be properly maintained (Deverill et al., 2002, Kalbermatten, 1982).

To compound this issue, potable water is accessible only intermittently at the beach due to the fishermen not paying their utility fees. When the water is locked-off, fishermen and vendors must pay for trucks to deliver water to the beach because no rivers or natural springs are accessible in the area. The intermittent availability of potable water was evinced in the summer of 2003 when the water was locked off for three months. The Cooperative used salt water from the ocean to flush the public toilet when they could not pay the water truck to deliver water.

As for privacy infrastructure, the proposed toilets, communal or private, must be aesthetically-acceptable. The current toilet structure is of plywood board, and the entrance is constricted by a small, abandoned vending stand (Figure 9).

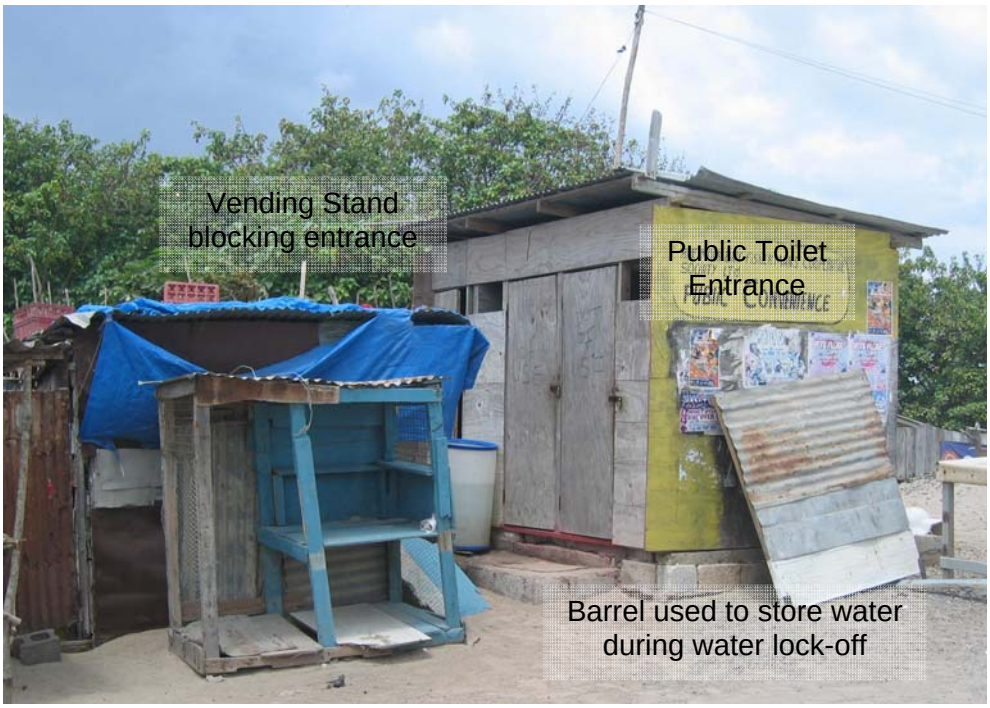

Figure 9: Half Moon Bay Fishermen's Cooperative Public Sanitary Convenience. Photo Courtesy of K Stanforth (2004)

Besides establishing the use of flush or non-flush toilets, the Cooperative also had to consider if communal or private toilets would be most appropriate for the beach. Deverill (2002) summarizes experiences in India in which his findings show that communal facilities that have restricted access to a limited number of families were more likely to remain clean and properly tended. The best option was single-family facilities in which systems were financed by the family. The Cooperative at Hellshire understood the later option is not economically probable for all residents, so a communal facility with restricted access would be considered.

Operation and maintenance of the proposed toilet facilities is critical to the long-term improvement of sanitation of any small community, Half Moon Bay (Kalbermatten et al., 1982, Cairncross et al., 2003). Currently, a caretaker, when finances are available to pay wages, maintains the public toilet during the day. She flushes the toilets, collects the user-fee, mops the floors and locks the doors

at nightfall. If the caretaker is not available to work or the Cooperative cannot pay her wages, a member of the Cooperative handles the key.

Another socio-cultural factor that has a significant influence on the sanitation needs at the beach is the unique interaction with the general public and the fishermen at the beach. This interface between rural and urban populations creates significant public health concerns, but at the same time creates an important market for selling their fish. For example, Half Moon Bay residents rely on urban visitors to purchase food and other retail items. This same benefit creates a problem by increasing non-biodegradable solid waste, e.g. plastic and Styrofoam that the fishing village must have significant financial resources to remove from the beach. In addition, the residents benefit from the close proximity to clean, reliable potable water source available from the nearby housing scheme, but this creates an increase in wastewater produced from flushable toilets. The Cooperative must allocate land and resources to wastewater treatment or storage facility to accommodate the visiting public. The overcrowding of the beach and the over-fishing in the area has detrimental effects on the fishermen's livelihoods. Resources are continually exploited, which reflects on the reduced visitors to the beach and the increased price of fish.

This small fishing village is the result of a unique symbiosis between the fishermen, the natural environment and the nearby metropolitan population. The socio-cultural factors evaluated during the development of the sanitation plan incorporated these diverse needs of both the fisher folk and visiting patrons.

4.3.2 Economic

The potential of a stable economic market at Half Moon Bay is plausible when the fishing teams are successful at sea and the patrons are plentiful at the beach for the purchase of the fish. If the Half Moon Bay fishermen make four (4) to six

(6) successful trips during one week, they may expect to profit $J20,000 to $J60,000 ($363 US to $1,090 US) (Malcolm, 2004).

Assuming the public toilet requires two US gallons per flush and the holding tank volume is 1,615 US gal (6 ft x 6ft x 6 ft) the holding tank will reach capacity after 538 users. If all persons donate the required per use fee of $J30 ($0.55 US), then profits per tank equate to $J16,158 ($293 US). The Cooperative typically pays a cesspool operator $J10,000 ($182 US) to empty the holding tank. Also, the Cooperative pays a caretaker $J3,000 ($54 US) per week to manage the toilet. Typically, the Cooperative empties the tank every four (4) months (135 patrons per month). Profits will be less than expenses if the caretaker fee totals $J12,000 ($219 US) for four (4) months and emptying fee of $J10,000 ($182 US). To augment this issue, many patrons and fry fish shed managers do not pay every time they use the toilet facility. The Cooperative's only supplemental income is the weekly beach operations and maintenance fee of $J200 ($3.60 US) charged to each fry fish shed. Again, the Cooperative does not enforce timely payments.

The dire economic situation for the Cooperative is largely due to improper management of funds and lack of enforcement to pay for use of the beach and the toilet facility.

4.3.3 Environment

The beachfront at Hellshire Beach is extremely degraded from litter, construction on sand dunes, burning trash in the sand and organic materials from fish cleaning. Many fry fish sheds are operated from persons not residing at the beach. Further, many fry fish vendors are not members of the local Fishermen's Cooperative. These two factors contribute to the lack of ownership of the beach. Vendors continually do not pay the Cooperative weekly dues for maintenance and upkeep of the beach ($J200 or $3.60 US). As a result, the Cooperative, who

is responsible for contracting solid waste haulers and beach cleaning staff, are unable to make payments. The sanitation plan has to address this lack of ownership and unwillingness to contribute to beach upkeep.

4.3.4 Applicable Government Policies and Recommendations

Safe and reliable treatment of domestic wastewater is an important task for the Jamaican government and her people because of the large dependence on potable water from groundwater sources. To prevent contamination of this natural resource, wastewater must be properly treated and disposed. In an effort to enforce proper treatment, the Jamaican government requires residents installing decentralized wastewater treatment facilities in urban or coastal areas to follow strict treatment recommendations.

The technologies employed on the beach had to be approved by the National Environment and Planning Agency (NEPA) and the Ministry of Health / Environmental Health Unit (MOH/EHU). NEPA strictly enforces all toilet facilities to be constructed beyond 24 meters (800 feet) of the coastline, while MOH requires facilities constructed within coastal zone to be meet tertiary treatment standards. MOH defines tertiary treatment by the treatment technologies, rather than discharge standards (Table 14).

Table 14: Onsite Tertiary Treatment Technologies Typically Approved by the Ministry of Health[2]

▪ Biodigester Septic Tank + Subsurface Wetland
▪ Septic Tank[1] + Evapo-transpiration Bed
▪ Septic Tank[1] + Re-circulating Sand Filter
▪ Septic Tank[1] + Intermittent Sand Filter + Tile Field
▪ Septic Tank[1] + Intermittent Sand Filter + Reed Bed (subsurface wetland)

[1] Septic Tanks may be of traditional two-chamber systems, aerobic, anaerobic digester or comparable technology.

[2] Other technologies may be approved upon individual consideration.

Many government and private agencies were also consulted to understand the legal and social implications from improper management of wastewater and solid waste, as provided in Table 12 in Section 4.2.4 . The government provides strict regulations on water quality of bathing beaches (NEPA, 2000). Also, the consultants assisted the fishermen and food vendors in understanding the options available to them.

5 Implementation of the proposed sanitation plan / Developing a Sanitation Plan to Accommodate both fisher folk and beach visitors

The Half Moon Bay Fishermen's Cooperative is a team of artisanal fishermen and their families. These working poor families are responsible for the general operations and maintenance at one of the most popular south coast beaches on the island. The sanitation plan proposed by the Cooperatives tries to accommodate persons working and residing at the beach and at the same time, provide appropriate facilities for visiting bathers and diners.

5.1 Components of Proposed Sanitation Plan

As chapters 4 and 5 emphasized, the Cooperative researched numerous sanitation solutions for beach. The first recognition was the need for different types of toilets, strategically located throughout the beach. The three (3) toilet systems are (1) public communal facilities for beach staff and visitors, (2) fishermen communal facilities for fishermen and overnight guests that do not have a private toilet facility and (3) fishermen improved sanitation facility design that will accommodate fishermen that plan to build a toilet system within their camp. The later is not addressed in the first phase of this sanitation plan. The Cooperative then established the most critical category as the public communal facility because of public health concerns for visiting patrons. A summary of components of the proposed sanitation plan are provided in Figure 10.

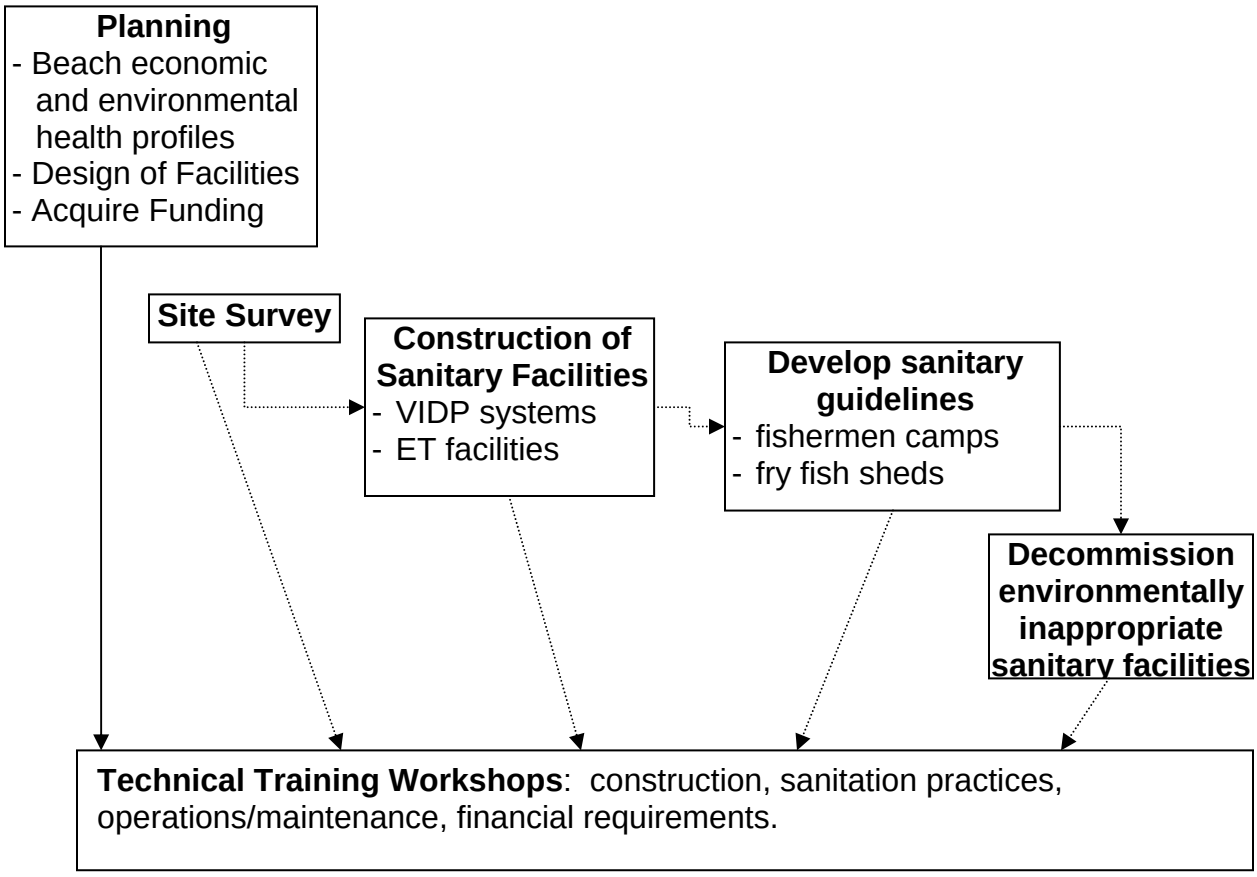

Figure 10: Components and Relevant Factors for Proposed Sanitation Plan

5.1.1 Evapotranspiration Bed System

Salvato (1983) defines ET systems as *"a subsurface sewage disposal unit, sometimes elevated in whole or in part, preceded by a septic tank or aerobic tank, and designed to dispose by surface evaporation and vegetable transpiration, all the sewage and precipitation entering the bed*." The Ministry of Health / Environmental Health Unit approves Evapotranspiration Bed Systems (ET) that treats septic tank effluent as a tertiary treatment technology. The design principles and parameter for ET systems are provided in Chapter 6 of this

report. Half Moon Bay Fishermen's Cooperative considered the ET bed technology for treating wastewater from the public toilets at the beach for numerous reasons, including strict government treatment requirements, socio-economic preferences and geological limitations as proposed in section 5.2 of this report.

Further, visiting patrons prefer flush toilets and local funding agencies prefer to fund projects that incorporate dual-technologies (flush and non-flush). With no central treatment connection available during the planning of this proposal, the fishermen had to consider onsite wastewater treatment. Concurrently, the lack of sufficient subsurface soil prevents the application of typical tile fields or absorption trenches. Also, the safe disposal of wastewater effluent to the ocean is not practical or safe because of the natural coral reef barrier. As a result, the Cooperative investigated and incorporated the use of ET bed systems into their sanitation plan. Detailed design parameters and diagrams are provided in Chapter 6. Significant research has been conducted on various improved sanitation facilities systems in developing countries (WEDC / WELL, 2005). D. Duncan Mara has provided a plethora of research on simplified sewerage (2004). The World Health Organization (WHO) Water, Sanitation and Health Program (2004) provides a significant network for wastewater effluent reuse. The combination of these resources assisted the Cooperative in developing their specific plan for the beach, but the proposed technologies by these agencies and authors were not appropriate.

Two other reasons for selecting the ET system over other tertiary wastewater treatment technologies include the economic and maintenance features of the systems. ET systems require less capital cost than required for other recommended tertiary treatment technologies, such as, intermittent sand filters or aerobic septic tanks systems. These later systems require the installation of moving mechanical equipment that is not only costly, but requires systematic maintenance and part replacement. ET systems will require maintenance, such

as emptying of the septic tank and maintaining grass and shrubs. If designed properly the system should require little upkeep and no part-replacement. ET systems are still costly and will require significant training of Cooperative members.

The Cooperative also prefers to eliminate their monthly dependence on the cesspool emptying service companies because of the combination of insufficient funds and lack of trust in the cesspool operators. Effluent from the current public toilet is stored in a holding tank prior to removal by local cesspool operators. At the time of this report, few cesspool operating companies had reliable, safe treatment facilities. Moreover, the Cooperative often did not have the resources to contract operators to collect the wastewater on a routine monthly schedule.

By removing the holding tank and replacing with the ET bed, the Cooperative eliminates the need to allocate more space for the toilet structure. Sufficient space around the current toilet facility should accommodate the proposed structure and ET bed.

5.1.2 Ventilated Improved Double Pit Latrines

At worst, pit latrines that are badly designed, constructed and maintained provide foci for the transmission of disease and may be no better than indiscriminate defecation. At best, they provide a standard of sanitation that is at least as good as other more sophisticated methods (Franceys et al., 1992).

Figure 11: Ventilated Improved Double Pit Latrine (VIDP), Trelawny, Jamaica. Photo courtesy of Ben Liu, 2002**.**

VIDP system is an onsite excreta disposal system that does not employ the use of water as a carrier (Peasey, 2000). This dry sanitation technology has proven both successful and unsuccessful in numerous sanitation projects throughout the developing world (Franceys et al., 1992). The Cooperative proposed the installation of these systems to accommodate fishermen and overnight guests on the beach.

The VIDP design proposed for Hellshire follows the common design typically employed in Jamaica (Figure 11). The system has two concrete-sealed chambers for storing excreta. One chamber will be used until full, then it will be sealed and the other chamber will be opened. Research indicates the full chamber should be sealed for a minimum of two years prior to emptying (Franceys et al., 1992). The two-chamber system extends the life of the system and allows a significant composting time prior to removal of the waste.

Other important features of the VIDP system is the mosquito and odor control measures employed in the design. The key factors in promoting mosquito control and preventing odor nuisances is: (1) shutting the door to keep the superstructure dark and (2) installing a vent pipe with wire mesh protective cap that extends beyond the roof of the building.

Odor control is satisfied by the careful installation of a 4-inch diameter vent pipe that extends through the base superstructure floor to above the superstructure roof. Air circulation will be significant if a small window along the opposite wall of the vent pipe and a small opening is provided to the chamber. The air will circulate through the window, down the chamber and up through the vent pipe. Odors will disperse above the roof of the structure. This will only work if the door is kept closed and only one window is installed. Figure 12 shows the proper and improper movement of air through a simple pit latrine. Mosquito control requires the superstructure to allow minimum light into the room and the installation of a small wire mesh on top of the vent pipe. Mosquitoes that reproduce in the pit will fly towards the only light, the vent pipe. The protective fly screen will prevent the escape of the mosquito, eliminating their nuisance in the nearby vicinity of the toilet (Gage, 2004).

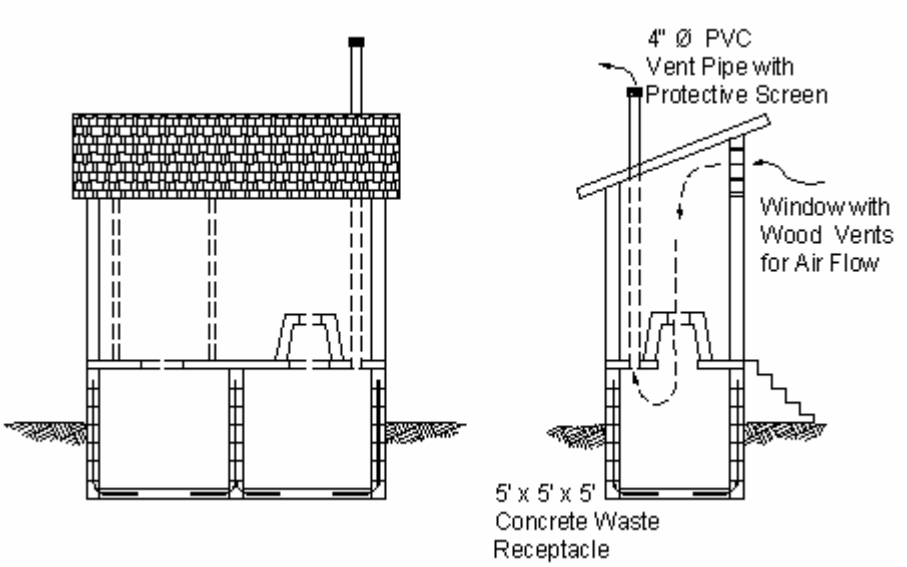

Figure 12: Proper ventilation through single window in VIDP

The public communal flush toilets will only be available when the caretaker is available during daylight hours. After hours, the public toilets will be locked and the water turned off. This safety measure will protect the toilets from being vandalized or inappropriately used. Also, the Cooperative also understands water lock-offs at the beach are common. During these intermittent times, the flush toilets will be inoperable. As a result, waterless systems would need to be available for patrons.

The locations for the VIDP systems were selected near the fishermen's camps, while one VIDP will be installed adjacent to the proposed ET bed system. This dual technology facility will accommodate beach guests if flush toilets are closed for any reason.

Emptying the contents of the chambers has not been a successful venture in rural Jamaica (McDaniel, 2002). Typically, the family will abandon the VIDP if the system overloads with moisture or becomes full because emptying dry excreta must be done by hand in Jamaica. If the contents were high in moisture-content, similar to septic tank sludge, the local cesspool operators could dispose of the waste. After discussions with numerous health inspectors, the

Cooperative proposed to build the two-chamber VIDP. After both chamber are full, the Cooperative plans to reopen the first chamber, without emptying and using again until full. This should extend the life of the system.

As Francey (1992) states in his Onsite Sanitation Manual, the level of success obtained from the installation of VIDP systems will be based primarily on the level of acceptance and responsibility provided by the community.

5.1.3 Decommissioning or repairing improperly constructed toilets

Fishermen are currently building pit toilets or holding tank systems that potentially leak directly into the groundwater. On two occasions, the author witnessed overflowing pit latrines on the beach after a flood event. Ideally, no more toilets will be constructed on the beach, but the reality is fishermen have space within their camps to construct a toilet and the potable water is readily accessible. The Cooperative wants to develop a plan for assisting fishermen in decommissioning the toilets that are not environmentally safe or that produce offensive odors. At the same time, the Cooperative wants to provide fishermen with design concepts for constructing safe, and economically-appropriate toilets within the confines of their ranch. This phase of the sanitation plan was not fully addressed.

5.1.4 Capacity-Building/Education

Another element to this sanitation plan is the training that incorporated teamwork, financial transparency and system maintenance. As part of the funding, the Cooperative invited a non-government organization to conduct a series of training sessions. These workshops assisted the Cooperative members in understanding the proposed sanitation plan and the implementation of the funding grant. The overall goal of the workshops is to:

- Increase awareness of proper hygiene practices
- Enhance the sense of ownership at the beach, in an effort to improve beach aesthetics.
- Enforce smart small business practices by understanding the needs of the customer
- Increase the knowledge base on construction, operations and maintenance of toilet systems.

The first sessions acclimated members to the proposed methods to assure funding transparencies. Later workshops focused on proper operation and maintenance of ET and VIDP systems. During these sessions, fishermen privately consulted CRDC about problems with their personal toilets. With illiteracy so high on the beach, the workshop leaders used predominately visual drawings and dialogue. The workshops held in cooperation with CRDC and the Cooperative continually enforced the importance of working as a cohesive team. The funding also allocated monies to CRDC for assistance with developing sanitary guidelines, training workshops and general accounting.

Public Health Inspectors from the local health department were also invited to discuss proper handling of potable water, especially during the storage phase.

The inspectors reviewed chlorine treatment techniques. The inspectors also provided recommendations on ET system design and construction techniques.

5.2 Acquire Funding

A funding proposal for the sanitation plan was submitted to the Environmental Foundation of Jamaica (EFJ) in October 2003. EFJ is and independent foundation established by a formal debt-swap agreement between the Governments of Jamaica and the United States of America. All program assistance is allocated to local community and non-profit groups to address issues of the environment and child survival and development. Refer to Appendix 2 for the original proposal submitted.

5.3 Implementation Schedule

The Cooperative reserved 18 months to construct toilets and complete implementation of the funding proposal. The first project included the construction of the public communal toilets to satisfy patrons and the public health inspectors. The user fee would assist the Cooperative in maintaining the facility, allowing the additional grant monies to be dedicated to constructing the VIDP systems. After the VIDP systems are constructed, the Coop plans to assist the fishermen decommission any polluting toilets. This later phase is saved for the final step in an effort to provide sufficient time to educate fishermen on proper toilet construction and the benefits of safe hygiene practices. During the course of this project, a private consulting firm has been contracted to lead training workshops. The implementation schedule is provided separate from the original sanitation proposal in Appendix 7.

6 Evapotranspiration Bed Design

6.1 Design and Principles

6.1.1 Description

ET system is a prepared sand bed with a distribution network that is sealed by an impermeable liner to prevent liquid waste from seeping into the surrounding soils. The basic principle of ET systems is to distribute septic tank effluent through the base of the sand bed, and then water will travel to the upper portion of the bed through capillary action. At the surface, water will evaporate directly to the atmosphere or through plant transpiration.

6.1.2 Acceptance and Typical Applications

ET systems are accepted technologies in arid and semi-arid regions of the United States (USEPA, 2002) and in various regions of Canada (Bernhart, 1973). In 1978, Bennett conducted an extensive study on ET systems that demonstrates treatment via evaporation and transpiration is a viable option in regions where evaporation exceeds precipitation. The study specifically recommends ET systems for recreational parks and seasonal homes. Other studies have found similar results (Bernhardt, 1973, Salvato, 1992). These authors agree ET systems should only be considered for areas where geological conditions prevent the use of subsurface disposal and all other onsite treatment options are explored and deemed inappropriate or unfeasible.

Sites that are preferential to ET beds include:

1. soils inhibiting sufficient percolation (percolation exceeds 120 minutes), and
2. soils that are too permeable (percolation less than 5 minutes)
3. areas where the treatment zone is inadequate prior to groundwater or ocean discharge (EPA onsite manual).
4. limestone or other bedrock features that have naturally occurring fractures.

Though no extensive studies establish the viability of ET systems as an appropriate onsite treatment option in Jamaica, D Duncan Mara does address the use of ET technology in hot climates in his textbook titled, *Sewage Treatment in Hot Climates* (1976), as follows, "*The size of the evapo-transpiration beds is calculated on the basis of the transpiration rate being 80 percent of the rate of evaporation from a free water surface or on the basis of providing about 15 d storage (during the rainy seasons) of the effluent in the sand layer, whichever gives the larger area.*" Many ET systems have been successfully installed for urban homes in Jamaica following Mara's recommendation along with the Ministry of Health's parameter of maximum allowable loading rate of 2.4 mm/day (0.06 US gal/sf·day). In 1990, the Ministry of Health in Jamaica provided documentation on the acceptable use of ET systems in coastal areas or areas where the groundwater table is less than four feet from the surface (Silvia, 1990). Currently, the Scientific Research Council (SRC) is testing the use of ET technology to dispose of effluent from a food processing plant.

The Half Moon Bay Fishermen's Cooperative considered the ET bed technology for treating wastewater from the public toilets at the beach for numerous reasons, including strict government treatment requirements, socio-economic preferences and geological limitations. Foremost, potable water is available at the beach; as such patrons and fishermen expect flushable toilets. To iterate the importance of including flush toilet designs in sanitation plans, Jamaican funding agencies do

not prefer to approve funding for construction of Ventilated Improved Double Pit Latrine (VIDP) or dry pit toilet systems in regions where potable water is accessible. Concurrently, no central treatment connection was available at the beach during the initial planning of this project. As a result, onsite treatment and disposal for water-based system had to be investigated.

6.1.3 Design Parameters

6.1.3.1 Precipitation and Evaporation

Precipitation and pan evaporation parameters employed for the design of the ET bed were acquired from the Rio Cobre Watershed area. Figure 13 identifies the Rio Cobre River. The data was obtained from the Water Resources Authority during the 30 year period, 1950 – 1980 at Bernard's Lodge in Innswood, St. Catherine (Table 15, Figure 14). This site is approximately 24 km (15 miles) inland from Hellshire Beach. Bennett (et al, 1971) suggests evaporation and precipitation data from the critical one-year of a ten-year span is sufficient.

Figure 13: Jamaica Map, Identifying the Rio Cobre River

(Map adapted from Hold, Reinhart and Winston (HRW)
http://go.hrw.com/atlas/norm_htm/jamaica.gif Last accessed March 16, 2005)

USEPA notes ET systems are generally limited to sites where the evaporation exceeds annual rainfall by at least 620 mm (24 inches) (US EPA 2002). From the data in Table 15, the estimated annual precipitation is 1,184 mm (47 inches) and the estimated annual evaporation is 1,873 mm (74 inches), a difference of 690 millimeters, or 27 inches.

Studies indicate that proper sloping of the topsoil cover will impede approximately 30 percent of total precipitation from seeping into the ET bed (Bernhardt, 1973; Salvato, 1992). The Bennett study (et al, 1978) recommends assuming 100 percent infiltration of precipitation. Salvato (1983) found rain events that exceed one-inch in 24 hours have a higher runoff rate after initial abstraction than storm events less than one-inch in 24 hours. Specifically, the study found a two-inch storm event with four (4) percent surface bed slope has 26.2% runoff, while a one-inch storm event with similar surface bed slope has 3.46% runoff. Salvato (1983) also recommends the topsoil cover, or root zone, should be a mixture of sandy, silty clay loam with a grass vegetated surface. This soil mixture holds moisture for plant growth and promotes evaporation and transpiration.

As such, 70 percent of precipitation will infiltrate the ET bed, so the annual evaporation will exceed annual precipitation by 1,044 millimeters (41 inches). For the critical months of September and October, the precipitation will continue to exceed evaporation. This runoff estimation is only applicable for the proposed ET bed design because (1) the precipitation and evaporation data is specific to the southern portion of the local parish, St. Catherine and (2) the recommended slope of the topsoil cover and the material for the cover will promote runoff.

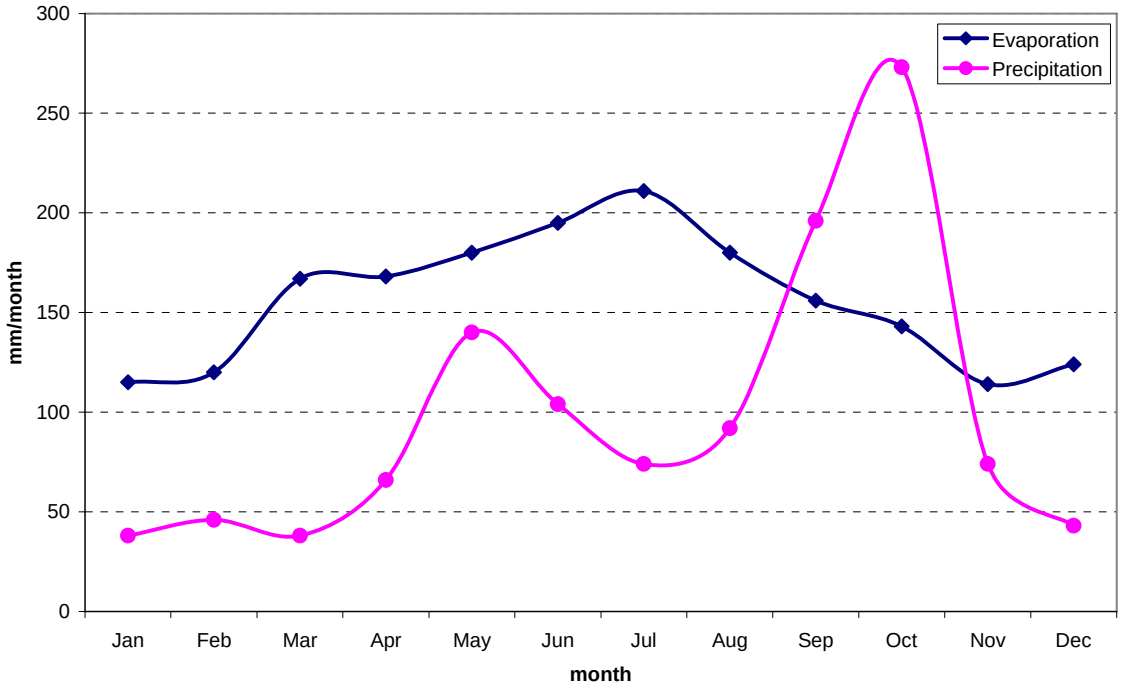

Figure 14: Precipitation and Pan Evaporation at Bernard's Lodge, St. Catherine, 1951-1980

Table 15: Monthly Evaporation and Precipitation Data.

Month	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation[1]	**mm/mth**	115	120	167	168	180	195	211	180	156	143	114	124
	mm/day	3.83	4	5.57	5.6	6	6.5	7.03	6	5.2	4.77	3.8	4.13
Precipitation[1]	**mm/mth**	38	46	38	66	140	104	74	92	196	273	74	43
	mm/day	1.3	1.5	1.3	2.2	4.7	3.5	2.5	3.1	6.5	9.1	2.5	1.4

[1] *Precipitation and Evaporation monthly data collected at Bernard's Lodge, St. Catherine by the Water Resources Authority.*

The precipitation and evaporation data used for this ET bed design was collected at a site approximately 24 kilometers (15 miles) inland. Though this area is similar in elevation to Half Moon Bay, potential differences in the small climatic zone may vary. For example, the Bay has a much higher wind factor due to the coastal breezes. Additionally, the annual precipitation at Norman Manley Airport (Kingston, Jamaica) is approximately 910 mm (36 inches) or nearly 275 mm (11

inches) less than Bernard's Lodge. The airport is located along the Kingston Harbor approximately 30 kilometers (20 miles) east of the beach. With geographical similarities to both sites, the Bay may receive less annual precipitation than assumed.

6.1.3.2 Evapotranspiration

Evapotranspiration is influenced by soil pore size and distribution, soil moisture, wind, relative humidity, and vegetative type. Salvato (1983) found "the minimum annual evapotranspiration rates have been reported to approximately equal the minimum Class A pan evaporation rate during the winter in California". For design purposes, Salvato recommends using the monthly pan evaporation minus precipitation in the wettest year of a 10-year period.

Many references agree pan evaporation correlation with evapotranspiration is sufficient for ET design. Pan evaporation data is considered equivalent to evaporation from a saturated vegetated surface (Salvato, 1992; Kadlec et al, 1995), or potential evaporation. Lake evaporation, evaporation from a free water surface, is typically less than pan evaporation because pan evaporation is influenced by the metal container surface (Kadlec, et al, 1995). Evaporation from a non-saturated vegetated surface, or land evaporation, comparable to an ET bed, ranges from 0.7 to 0.8 of the pan evaporation (Bennett et al, 1978; Kadlec et al, 1995; Bernhart, 1973).

Many studies found evaporation actually increases as the depth of the free water surface increases to 200 mm (8 inches) below the surface. Evaporation is still occurring, but at slightly lower rates as the free water surface declines between 200 mm (8 inches) to 760 mm (30 inches) below the surface (Wilkensen, 1996; Bernhart, 1973). Salvato found the evapotranspiration rate is less than pan evaporation if the water depth is greater than thirteen inches from the surface

and he also found that evapotranspiration rates may increase more than ten times the pan evaporation.

Empirical equations, such as Penman Method and Thornwaite Equations may not be sufficient in considering the long-term impact of humidity and wind (Bennett et al, 1978). Appendix 11 includes evapotranspiration rate estimates using a Thornwaite-based calculation method (Kadlec et al, 1995). The method requires the following input values: soil field capacity, root zone depth, latitude, monthly precipitation and temperature. Soil field capacity is defined as the capacity of the soil to retain moisture under gravity-drained conditions, which depends of the soil type and vegetation.

The results indicate if the root zone is 300 mm (12 inches) and the soil field capacity is less than five (5) percent the ET rate is equivalent to the precipitation, except for October in which ET is less than precipitation. As a result, the annual discharge is estimated at 164 millimeter water equivalents. In assuming the same field capacity (five (5) percent, with the root depth only in the six (6) inch (150 mm) upper topsoil layer, the discharge increases slightly to 171 millimeter water equivalents.

Appendix 9 includes evapotranspiration rate estimates using a Thornwaite-based calculation method (Kadlec et al, 1995). The method requires the following input values: soil field capacity, root zone depth, latitude, monthly precipitation and temperature. Soil field capacity is defined as the capacity of the soil to retain moisture under gravity-drained conditions, which depends of the soil type and vegetation.

The results indicate if the root zone is 300 mm (12 inches) and the soil field capacity is less than five (5) percent the ET rate is equivalent to the precipitation, except for October in which ET is less than precipitation. As a result, the annual discharge is estimated at 164 millimeter water equivalents. In assuming the

same field capacity (five (5) percent, with the root depth only in the six (6) inch (150 mm) upper topsoil layer, the discharge increases slightly to 171 millimeter water equivalents.

More than likely under the conditions encountered at Half Moon Bay, the root zone will exceed the entire depth of the bed (600 mm, or 24 inches). In increasing the soil field capacity to 30 percent along with the increased bed depth, the annual discharge by the Thornwaite Equation is estimated at seven (7) millimeter water equivalents. This result supports the results of the pan study. Furthermore the Thornwaite estimation method may underestimate the actual ET rate because the method is proposed for naturally-occurring, gravity-drained soil features.

No transpiration rates were available for Jamaica. Research indicates transpiration is an unreliable parameter because the life expectancy of the vegetated surface is unpredictable and that soil surfaces have similar ET rates as vegetated surfaces (Bennett et al, 1978). Bernhart (1973) recommends transpiration increases lake evaporation by approximately 100 percent during the growing season, while Salvato (1992) recommends 33 to 50 percent increase. The Bennett study actually found alfalfa decreased overall ET during the summer months (Bennett et al, 1978).

Most studies of ET systems were conducted in areas where snowfall is a factor during the winter months. As a result, the critical months are often December through February, when snow and freezing temperatures prevent evaporation at the sand bed surface (Bernhardt, 1973; Bennett et al, 1978). For Hellshire, the critical months are during the two rainy seasons, April and October. During October in particular, precipitation exceeds evaporation by 690 millimeters (27 inches). Salvato (1992) and Bernhardt (1973) agree storage of small amounts over a short period of time is acceptable. Bennett, (et al, 1978) disagrees

because his field tests indicate ET beds overloaded during one month may not recover.

With the tropical weather conditions in Jamaica, ET systems are in operation the entire year, resulting in positive climatic conditions for evaporation and transpiration. ET systems in Jamaica treat combinations of waste, including industrial, domestic grey-water and domestic wastewater. Though few studies have been done in the region, systems of successful are operating without failure.

6.1.3.3 Loading Rate

An allowable liquid loading rate per unit of surface area was estimated after establishing the evaporation and precipitation values for the proposed ET bed. Table 16 shows the monthly loading rate assuming influential factors of precipitation and evaporation. Determining the allowable loading rate per surface area is the most critical factor of designing an ET system (USEPA, 2002; Salvato, 1992; Bennett et al, 1978).

Table 16: Loading Rate of ET Bed considering only Evaporation and Precipitation

	Evap	Precip	Infiltration 70%	ET_{total}	ET_{total}	Loading[1]
	mm/month	mm/month	Precip	mm/mth	in/mth	USgal/mth ft^2
Jan	115	38	26.6	88.4	3.48	2.17
Feb	120	46	32.2	87.8	3.46	2.15
Mar	167	38	26.6	140.4	5.53	3.45
Apr	168	66	46.2	121.8	4.80	2.99
May	180	140	98.0	82.0	3.23	2.01
Jun	195	104	72.8	122.2	4.81	3.00
Jul	211	74	51.8	159.2	6.27	3.91
Aug	180	92	64.4	115.6	4.55	2.84
Sep	156	196	137.2	18.8	0.74	0.46
Oct	143	273	191.1	-48.1	-1.89	-1.18
Nov	114	74	51.8	62.2	2.45	1.53
Dec	124	43	30.1	93.9	3.70	2.30

[1] US gallons per month = 0.623 inches per month, (7.48 US gallons per cubic foot, 12 inches per foot)

Bennett estimates a loading rate for summer homes at 4 to 8 mm/day (0.1 – 0.2 US gal/sf·day) for Boulder, Colorado (et al, 1978). The U.S EPA uses the lower value in the Onsite Wastewater Treatment Manual (2002). Bernhardt recommends a loading rate at 4.1 mm/day (0.1 US gal/sf·day). Ministry of Health (Jamaica) literature recommends a daily loading rate at 2.4 mm/day (0.06 US gal/sf·day) (Siliva, 1990). This is comparable to the average monthly loading rate estimated from the climatology data of 2.2 US gal/sf·month (3.0 mm/day).

In applying this provided loading rate, the assumed area for the ET system at Hellshire is

280 US gal / 0.06 US gal/ sf·day = 4,667 sf

To verify this proposed area, the author conducted a water balance for the ET system by correlating the monthly pan evaporation data with the estimated precipitation. This method is similar to that used by others (Wilkensen, 1996; USEPA, 2002; Salvato 1992; Bernhardt, 1973).

6.1.3.4 Water Balance

A water balance was conducted to determine the appropriate size of the evapotranspiration bed (Table 17). Factors included in this water balance study are transpiration (T), evaporation (E), infiltrated precipitation (P_i), wastewater inflow (Q_i) and wastewater outflow (Q_o) (Figure 15). The wastewater outflow is equivalent to zero because the design is based on non-discharging criterion. In order for an ET bed to operate properly, net evaporation and transpiration must exceed infiltrated precipitation and wastewater inflow. For two months (September and October), the evapotranspiration rate does not exceed the inputs, so the ET bed includes a storage area for the accumulated wastewater until evapotranspiration exceeds inputs and precipitation amounts are decreased. Maximum allowable depth to insure sufficient capillary action 610 mm (24 inches) (Salvato, 1992; Bennett et al, 1973; USEPA, 2002).

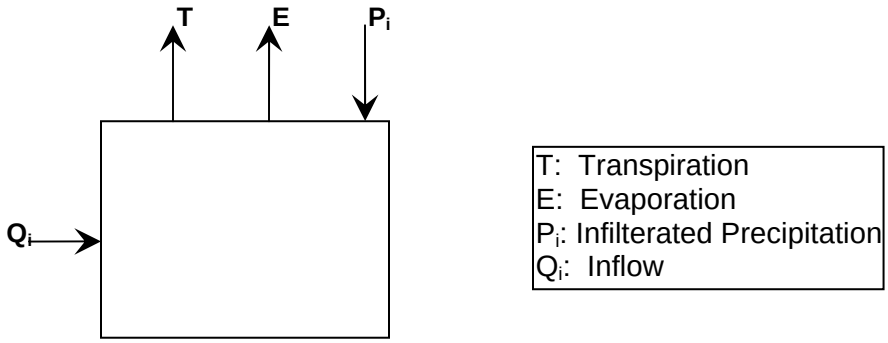

Figure 15: Water Balance

The ET bed system is designed for a maximum wastewater inflow of 1,050 Liters per day (280 US gallons per day). This is equivalent to twice the current demand at the beach on major holidays (Table 17). This assumption may be too low to accommodate the actual weekend demand.

Table 17: Inflow Quantities

Case	Description	Persons per day [1]	Liters per flush (US gal)	Flow, Liters/day (US gal)
1	Typical Week Day	20	7.5 L (2 US gal)	150 L (40 US gal)
2	Typical Weekend	45	7.5 L (2 US gal)	338 L (90 US gal)
3	Typical Holiday Weekend	70	7.5 L (2 US gal)	525 L (140 US gal)

[1] *Number of 'persons per day' from current use information for the (1) public toilet facility at beach, data collected May 2003 and July 2003.*

Table 18: Percent (%) Monthly Bed Capacity Assuming 70% Infiltration of Precipitation[1]

Month	Loading Rate[2] US gal/sf month	Evaporation[3] US Gal / month	Input[3] US Gal / month	Surplus/ (deficit)[3] US Gal / month	Cumulative[3] US Gal	% Bed Capacity[3]
Oct [3]	-1.18	(4643.25)	8,400	13043.25	13,043	22%
Nov	1.53	6004.37	8,400	2395.63	15,439	26%
Dec	2.30	9064.47	8,400	(664.47)	14,774	25%
Jan	2.17	8533.54	8,400	(133.54)	14,641	25%
Feb	2.15	8475.62	8,400	(75.62)	14,565	25%
Mar	3.45	13553.27	8,400	(5153.27)	9,412	16%
Apr	2.99	11757.75	8,400	(3357.75)	6,054	10%
May	2.01	7915.72	8,400	484.28	6,539	11%
Jun	3.00	11796.36	8,400	(3396.36)	3,142	5%
Jul	3.91	15368.09	8,400	(6968.09)	(3,826)	0
Aug	2.84	11159.24	8,400	(2759.24)	(6,585)	0
Sep	0.46	1814.82	8,400	6585.18	(0)	0%

1. Data was collected at Bernard Lodge in Innswood, St. Catherine from 1951 – 1980, (Water Resources Authority).
2. Refer to Table 17 for monthly loading rate calculations
3. Evaporation = EVAP RATE (US gal/sf month) * BED SIZE (sf)
   Input = INFLOW (US gal/month)
   Surplus/Deficit = Input (US gal/month) + Evaporation (US gal/month)
   Cumulative = Total SURPLUS (US gal) from month 1 to month (n)
   % Bed Capacity = CUMULATIVE (US gal) / BED VOLUME (US gal)
4. The loading rate for October is negative because precipitation exceeds evaporation during the month.

The ET Bed design parameters are presented in Table 19. The critical storage is during the peak rainy season month, October, when 26 percent of the bed will be used for storage. Assuming the void ratio at 30 percent and the depth at 0.6 meters (2 feet), the saturated water surface will 0.9 feet (274 millimeters) below the surface. The average loading rate is 2.2 US gal/ft$^{2.}$month (3.0 mm/day), which meets the recommendations of Salvato (1992) and Silvia (1990).

Table 19: ET Bed Design Features

Parameter	**Metric Units**	***SI Units***
Loading rate	3.0 mm/day	*(0.13 US Gal/ft$^{2.}$day).*
Volume	31,752 Liters/mth	*(8,400 US Gal/mth*
Area	372 m^2	*(4,000 ft^2)*
Length	33.5 meters	*(110 feet)*
Width	11.0 meters	*(36 feet)*
Depth	0.6 meters	*(2 feet)*
Void Ratio	30%	
Slope (topsoil)	1 – 2%	
Maximum Storage	26%	

6.2 Construction

Two public communal units shall be constructed near the beachfront food sheds that utilize the abovementioned ET bed technology. Each unit shall have (a) two-female toilets, (b) one male toilet and (c) one urinal. The toilets will be gravity fed to a 2,650 Liter (700 US gal) three-chamber septic tank followed by a 372 m^2 (4,000 ft^2) evapotranspiration bed. A hand-washing station shall be provided outside which will drain to a soak-away pit. Design parameters and dimensions are provided.

Installation of the ET system has several components, including selection of sand bed material and other devices, location of ET bed and establishing a relative cost.

Septic tank effluent is distributed through the lower portion of the ET bed, in which, the liquid wastewater will move to the upper portion of the bed through capillary action. Pore size and distribution, studies indicate a uniform sand in size range of D_{50} equivalent to 0.10 millimeters promotes capillary rise to above three (3) feet. Pore sizes less than 100 microns retards capillary rise with potential of only () (0.28 meters) and will promote bed clogging. Particle sizes too large will also have insufficient capillary rise (Salvato, 1983; Bernhart, 1973). As discussed in Section (), the sandy, silty, clayey, loam soil layer on the top of the ET bed surface with vegetative cover will promote this wicking action by maintaining a sufficient moisture content within the bed.

The cross-section of a typical ET Bed (Figure 22) shows the distribution piping within gravel fill placed at 19 to 63 millimeters (0.75 to 2.5 inches) from the impervious liner. The gravel fill is presented as potential storage area with a depth of 300 millimeters (12 inches). Additional design considerations include

1. spacing the distribution pipes at 1.2 meters (4 feet) or less,
2. providing 600 to 750 millimeters (2 to 2.5 feet) of sand with D_{50} (50 percent by weight smaller than) equal to 0.10 mm (0.04 inches)
3. overlaying the sand with a loamy soil-sand mixture or topsoil
4. Pre-treatment of wastewater with 3-chamber septic tank with 1.5 day retention
5. Sand should promote capillary action without enhancing natural clogging.
6. Vegetation should be tolerant of both wet and dry conditions, and be salt-tolerant

6.2.1 Components

The proposed ET bed shall be 0.6 meters (2 feet) deep with areal dimensions at 33.5 meters by 11.0 meters (110 feet by 36 feet). A plastic liner shall be placed at the ET bed base, followed by 200 mm (8 inches) of hard, clean gravel with an average diameter of 20 mm. On top of the gravel, twelve lines of 100 mm (4 inches) perforated distribution pipes shall be placed at 0.9 meters (3 feet) on centre along the length of the ET bed. These pipes shall be covered with 300 mm (12 inches) of sand. The sand shall be level with the ground surface. To promote runoff of precipitation a 100 mm (4 inches) topsoil (at center) cap shall be used with a one to two percent slope.

The U.S. EPA Onsite Wastewater Treatment Manual (2002) states that ET systems installed where the soil was too permeable or groundwater was shallow shall have a protective 20-mil polyethylene liner. Other references had similar statements (Salvato, 1992; Bernhart, 1973; Bennett et al, 1978). Since 20-mil liner is not available in Jamaica, two-layers of 10-mil liner will be utilized.

Wastewater entering the ET bed shall be pre-treated via a three (3) chamber septic tank with minimum 1.5 day retention. The sand shall have a small enough diameter to produce a capillary rise greater than the depth of the sand bed. Bennett recommends D_{50} (50 percent by weight smaller than) equal to 0.10 mm (0.04 inches) (Bennett 1978); other sources provide similar estimates (Salvato, 1992; Bernhart, 1973). A smaller diameter will promote excessive clogging, therefore, decreasing the sand bed's life expectancy.

A sandy, silty, clayey loam topsoil of layer, approximately 100 mm (4 inches) shall be placed on the surface to support the vegetative surface and protect the sand bed. A perimeter fence shall be installed.

6.2.2 Location

Locating an ET bed is critical in assuring the greatest wind and solar effects (Bennett et al, 1978). The location of both ET systems was difficult due to lack of space and organization at the beach. After months of deliberations the Cooperative members invited the National Environment and Planning Agency (NEPA) to assist in this effort. NEPA representatives used a GPS system to properly log the proposed coordinates of the toilets onto a digital map. This overlay of information with an aerial map was able to confirm if the toilets would be constructed on the sand dune. Figure 16 identifies the locations of these ET systems. The sand dune has naturally regressed from the coastline, due to construction of fry fish sheds along the beach. Instability of the sand dunes and government restrictions prevent the Cooperative from construction the facilities on the dunes.

Figure 16: Topographic Plan of Half Moon Bay identifying the proposed ET sanitation facilities. The natural sand road identified on the map follows along the sand dunes

Five (5) sites were strategically selected within the 10 acre property. Site 1 and 2 are near the bathing and fry fish shed areas. These facilities will be flush toilet systems that will be maintained by the caretaker. Site 1 is an abandoned foundation where goats' currently pasture (Figure 17) and adjacent to the entrance road. Site 2 is the current public toilet that will be transformed into an ET system with more operating toilets. This site requires remodeling of the current public toilet facility from septic tank/holding tank to septic tank/ETB/holding tank and improving the toilet infrastructure. Before converting this toilet system to the proposed, the storage sheds adjacent to the toilet entrance doors (Figure 18) must be removed. Both locations may be easily identified by beach visitors.

Figure 17: Proposed site for ET System I.

Figure 18: Current Location of Public Toilet &
Proposed site for ET System II

6.2.3 Cost

The estimated capital cost for one ET system, including structure, toilets, ET bed and septic tank is $J147, 660 ($2,685 US). Appendix 8 provides a list of materials used for the estimate. Bennett (1978), estimated $1.50US per square foot for construction of ET beds. Without inflation, this compares to the ET cost proposed in Jamaica. EPA estimates installation costs at $10,000US to $15,000US with annual operations and maintenance at $20US - $30US
EPA estimates $10,000 (2002).

6.2.4 Construction – Economic Comparison

MOH recommendations are from a report completed in 1990 by the Environmental Controls Division (Appendix 9). Many recommendations provided in this report are from designs installed in the United States and Canada. ET systems in North America, typically take into consideration the dormant winter period. Little to no data from the systems installed in Jamaica prior and post this report is available to verify the recommendations.

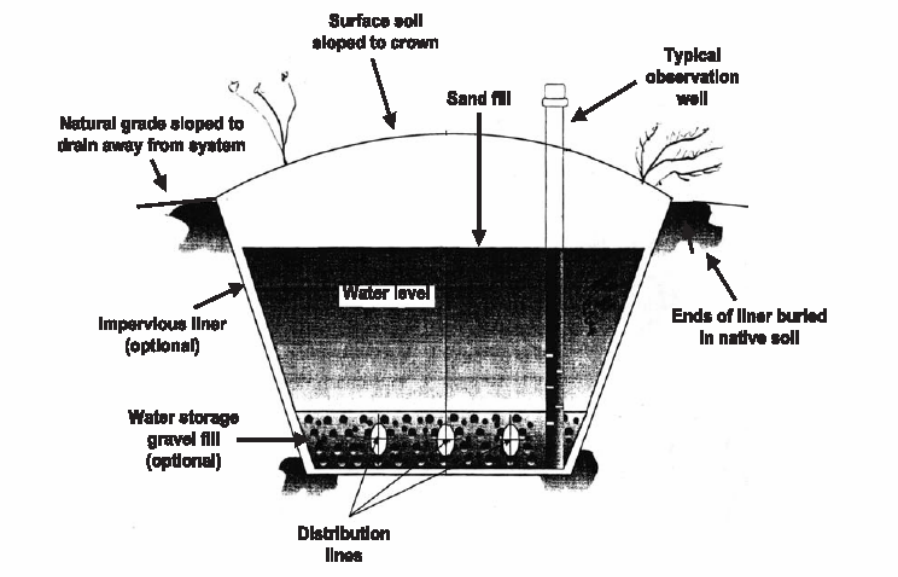

Figure 19: Cross-Section of a Typical Evapotranspiration Bed (USEPA, 2002)

USEPA Fact Sheet for ET systems provides concerns of storing wastewater too deep in a gravel storage area because the wicking properties of the gravel may restrict capillary rise of wastewater to the surface for evaporation (2002). As a result, the EPA design places the distribution piping low in the sand bed (Figure 19). Salvato (1992) and Bernhart (et al, 1973) addresses this concern by recommending installation of sand or gravel ridges that promote

evapotranspiration and capillary rise (Figures 20, 21). The Salvato (1992) design utilizes sand ridges that start at the base of ET bed and stop 152 mm (6 inches) from topsoil base. The 152 mm (6 inches) between the ridge and topsoil is a layer of clean sand. Between the ridges are washed gravel, in which the distribution piping is placed. Another design (Bernhart, 1978) recommends a total bed depth of 457 mm (18 inches) with 152 mm (6 inches) of gravel, 305 mm (12 inches) of sand and a thin layer of topsoil. The distribution lines are placed on top of the gravel bed.

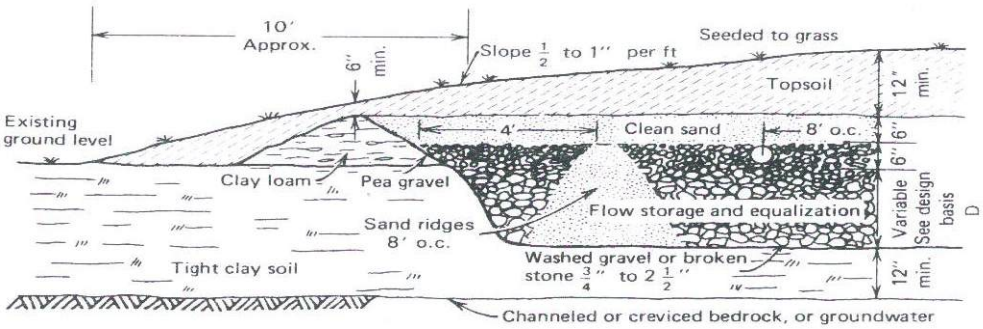

Figure 20: ET cross section proposed by Salvato (1992). Salvato also proposed a similar design with the sand ridges replaced by gravel ridge and the bed substrate replaced with clean sand.

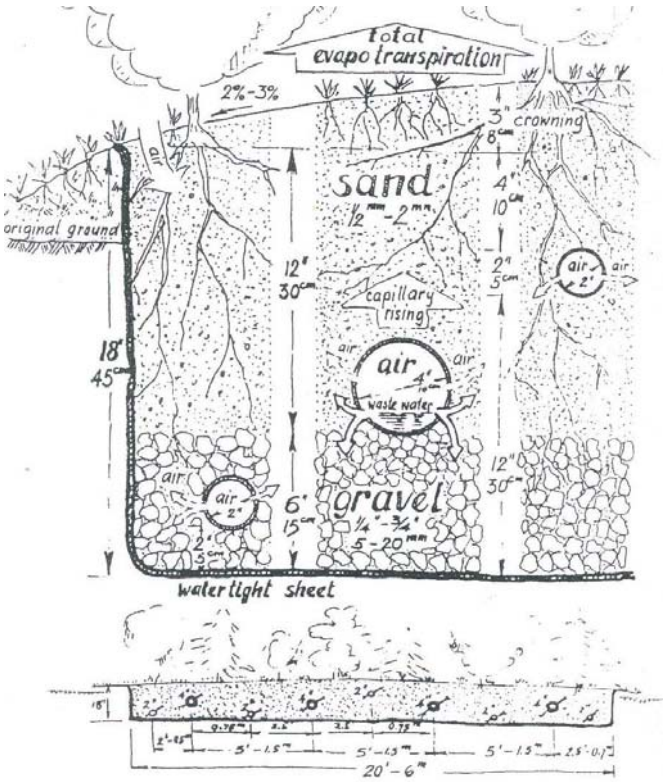

Figure 21: ET cross-section proposed by Bernhart (1973). Notice the two vent pipes of varying sizes. This design does not include the sand ridges as proposed by Salvato (1992), therefore simplifying the construction, but the increase in plastic pipe would increase the cost.

The design proposed for Hellshire Beach includes recommendations for all the abovementioned systems (Figure 22). The sand and gravel ridges will not be as significant in this design in an effort to simplify installation. Additionally, twenty-mil polyethylene liner is not available in Jamaica. As a substitute, this design will utilize two-layers of a 10-mil polyethylene liner. As protection from sharp stones, a thin layer of sand (1 inch) will overlay the liner. The bed medium will consist of 204 mm (8 inches) of gravel, 152 mm (6 inches) of sand, 102 mm (4 inches) of topsoil (at center). The distribution lines (102 mm, 4 inch diameter) will be placed at 0.9 meters (3 feet) on center at the top of the gravel with a one to two percent slope.

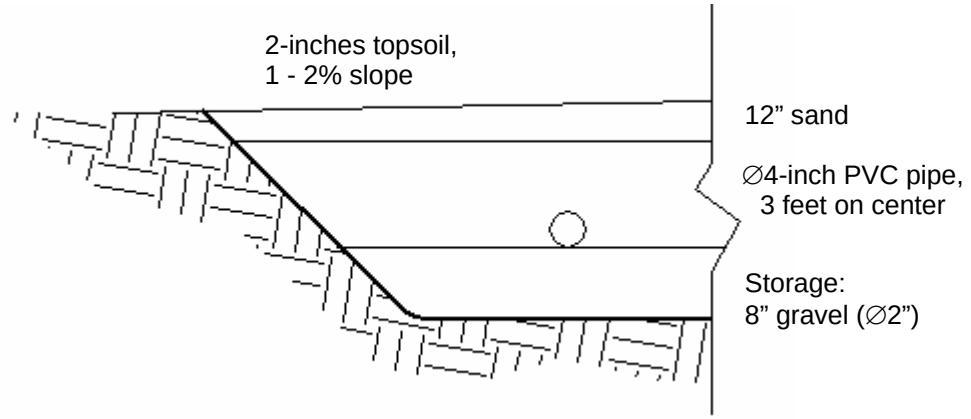

Figure 22: Hellshire Beach cross-section

6.3 Design – Conclusion

The MOH recommends a maximum daily loading rate of 2.4 mm/day (0.06 US gal per square feet) and have a properly installed protective liner of clay or comparable material. Additionally, the perforated pipeline shall be of 102 mm (4 inches) diameter and spaced 0.9 meters (3 feet) on center. Influent to the ET bed shall be pre-treated with septic tank effluent with a minimum 1.5 day retention. These requirements were fulfilled with the proposed design, except the loading rate. The loading rate, 2.9 mm/day (0.07 US gal/sq ft) is acceptable, as it slightly exceeds the MOH recommendation of 2.4 mm/day (0.06 US gal/sf), and is within range from other sources (Bennett et al 1978; Salvato, 1992).

6.4 Obstacles

Obstacles to the successful and sustainable implementation of ET technology can be environmental, societal, and economic. For example, the wastewater inflow considered for this design is the current maximum flow (1,050 liters/day, 280 US gal/day) which presently occurs on major holidays. If the typical weekend flow of (300 liters/day, 80 US gal/day) is applied the ET bed size decreases by 30 percent to 680 m^2 (754 ft^2). Unfortunately, the number of current users is exceptionally lower than the actual number of visitors at the

beach. This may be explained by the poor upkeep and short operational hours of the current facility. As a result, the proposed public communal units will not be sufficient for all visitors on the weekend. In addition, the Cooperative is unwilling to invest in more toilet systems at this first phase of development. The members want to ensure they do not exceed their staff and financial resources.

Another obstacle for the Cooperative is the required area for this treatment system. As proposed, the Cooperative must allocate nearly 372 sq meters (4,000 sq feet) for the treatment of wastewater. The funding for the public facilities is sufficient for the construction of two units. This required area, in addition to the toilet facilities far exceeds the available land at the beach.

Some environmental concerns include the shallow water table and sandy soil conditions. Inadequate treatment zones occur if the distance to groundwater is limited or if the soil between the water table and ground surface does not provide a slow enough percolation rate for wastewater to be properly treated. Also, clay soils may be too dense, therefore inhibiting sufficient percolation.

Additionally, the inherit non-discharge concept of the system also presents constraints on the successful, long-term use of this technology. For example, the prevention of liquid waste entering the surrounding soils also prevents solids, salts and other chemicals from leaving the system. As such, many studies recommend installation of a seepage bed to prevent pre-mature clogging of the bed material (Bernhart, 1973; USEPA 2002; Salvato, 1992). This seepage component could also reduce the required surface area, by allowing some liquid waste to be disposed via seepage, along with the precipitation and evaporation mechanisms.

7 Global Relevance and Appropriateness

Remote fishing villages across the island are becoming more accessible by vehicle because of the improved roadways. Along with accessible roadways, these villages are also acquiring sufficient potable water from the local Water Commission. Unfortunately, many of these areas will not have access to central wastewater treatment systems. At present, 85 percent of the Jamaican population has access to potable water, while less than 50 percent have access to central wastewater treatment facilities. As a result, the fishermen will need small-scale onsite wastewater treatment and disposal systems to accommodate the wastewater from both the increased visitors and their families. The treatment systems must consider the fragile environmental conditions at these coastal villages and the low-income of the artisan fishing families.

The methods employed by the Half Moon Bay Cooperative to develop a sanitation program may be employed by other fishing villages in Jamaica or other developing countries. Sanitary projects for fishing villages in developing countries are rarely discussed in literature. These coastal communities have greater access to construction supplies and technical assistance as compared to similar communities in under-developed countries. As a result, the Cooperatives of these communities must find effective and economical onsite wastewater treatment systems.

Fishing villages have many factors to consider when developing a sanitation program at their beach. First, the beach visitors require a communal toilet that is clean and readily available. In order to properly maintain a communal toilet, a caretaker shall have to be employed. The caretaker may be responsible for collecting a user fee, distributing tissue and cleaning the facilities. Second, flush toilets will require readily accessible potable water. If water is scarce, a plan must be developed to accommodate collection of water for flushing or the incorporation of waterless, composting sanitation facilities. Third, finances to

maintain and operate communal toilet facility may be quite excessive, so a careful financial review must be considered.

This Cooperative proposed constructing ET systems for the flush toilets, along with VIDP, dry composting systems. The former is a successfully applied onsite treatment and disposal system in Jamaica's urban centers, while the later is a somewhat successful dry technology employed in rural Jamaica.

In the United States, evapotranspiration bed systems have been an acceptable on-site wastewater technology in arid climates, such as the southwestern states Arizona and New Mexico (USEPA, 2002). In some small regions of countries with tropical climates, evapotranspiration onsite wastewater treatment technologies may be appropriate because evaporation will exceed precipitation. Though little research has been done on ET technology in tropical regions, Jamaica has been successfully applying this technology for over ten years. Precipitation and evaporation data from Kingston and St. Catherine parishes illustrate annual evapotranspiration may exceed precipitation.

8 Conclusions

As proposed in this report, the Half Moon Bay Fishermen's Cooperative developed an environmentally appropriate sanitation plan within their 10 acre coastal community that will accommodate both the 62 fishermen residing at the beach and the hundreds of daily visiting bathers. In total, 17 fishermen camps have improved sanitation of which 13 are flush toilets and four are dry pit latrines. Of the thirteen flush toilets ten connect to a holding tank, while three connect to absorption pits. Fishermen with no sanitation facility within their camp use a field adjacent to the community or use the public toilet facility, a single flush toilet that discharges to a holding tank. The proposed plan provides communal composting facilities (VIDPs) that will be available at all times. Additionally, the plan includes

installation of ET systems that will be available during normal beach operating hours. A caretaker will manage the facility and collect a per-use fee.

The Fishermen's Cooperative employed several techniques to gather information about the beach community; including, oral survey questionnaires, community mapping techniques, historical reviews and stakeholder interviews. The Portmore Health Department initiated the first questionnaire by conducting a Rapid Assessment Survey (RAS). The Fishermen's Cooperative followed this survey with an oral interview questionnaire to confirm the number of improved sanitation facilities within fishermen ranches and to establish the proposed needs of the fishermen. The Cooperative's survey conducted four (4) months after the RAS. This may be explained in combination by the summer installation of more toilets and the improved disclosure of information between Cooperative members than health inspectors. The Cooperative also sketched a map of the 10 acre property that identified all building structures with that specified owners and type of improved sanitation facility. This map was used as a preliminary drawing for the official surveyed site plan conducted August 2005.

The historical review was predominately conducted through the reference materials at the Ministry of Agriculture's Fisheries Division. Reports were read aloud to Cooperative members during meetings. Discussions assisted the Cooperative in remembering past decisions and identifying pertinent stakeholders and concerned community members.

From this information, the fishermen developed a sanitation plan that addressed the social, economical and environmental needs of the community. To meet the socio-cultural preference for flush toilets and the economical limitations that restrict access to consistent potable water, the sanitation plan proposes the installation of two different technologies: (1) Ventilated Improved Double Pit (VIDP) dry, composting latrine and (2) Onsite wastewater disposal system that employs Evapotranspiration Bed (ET) technology. The VIDP and ET

technologies accommodate the environmental design restrictions apparent in the coastal community.

The plan also allocates resources for a local water and sanitation consulting agency to promote hygiene education on the beach and provide technical training for constructing the improved sanitation facilities and decommissioning irreparable facilities previously constructed within fishermen camps. This sanitation plan acknowledges the increase in access to potable water and accommodates appropriately through onsite wastewater technology.

An ET system is a sealed, gravity-fed sand and gravel bed that treats septic tank effluent via plant transpiration and soil evaporation. The proposed ET system is 372 sq meters (4,000 sq feet) assuming a two (2) foot depth and a loading rate of 3.0 mm/day (2.2 US gal/ft^2). The loading rate is comparable to local and international recommendations (Bennett et al 1978; Salvato, 1992; Silvia 1990).

As more developing countries improve access to potable water, an increased need for an appropriate decentralized sanitation plan that accommodates for the increases in water-based sanitation facilities will be required. Improved sanitation facilities that incorporate evaporation and transpiration in treating septic tank effluent are appropriate for communities in regions where evaporation exceeds precipitation.

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APPENDIX 1: Environmental Foundation of Jamaica: Half Moon Bay Sanitation Proposal (Cooperative Financial Statements not included)

1. BASIC INFORMATION

PROJECT TITLE: Sanitary Convenience Improvement Project at the Half Moon Bay, Hellshire Beach – Project 1

NAME OF ORGANIZATION: Half Moon Bay Fishermen's Cooperative Society, Limited

LOCATION OF PROJECT: Half Moon Bay, Hellshire (St. Catherine)

NAME OF CONTACT PERSON: Mr. Devon Malcolm

POSITION: Secretary

TELEPHONE: 404.0697

Project Summary:
This project will assist in alleviating the current demand for more sanitary conveniences at Half Moon Bay, Hellshire Beach through the construction of toilets, creating sanitary guidelines for the beach area, decommissioning pit latrines and a survey of the current beach development. The later will assist in properly locating the proposed toilets and assist in locating toilets to meet the increasing weekend and holiday demands.

A training component will include a minimum of four (4) workshops for cooperative members and training sessions for selected members to assist in maintenance of installed systems.

The Project duration is estimated at eighteen (18) months.

Total Project cost is estimated at J$2,647,200.

Half Moon Bay Fishermen's Cooperative is asking for J$1,928,600.

Project objectives

1. Meet the immediate need for access to sanitary, economical and environmental appropriate toilets for fishermen, beach staff and visitors at the beach.
2. To have an accurate and current site plan of beach to assist in locating environmentally sensitive areas (restricted development) and development areas (parking, toilets, fishermen ranches, fry fish sheds).
3. Promote development of appropriate sanitary conveniences on the property that will have less potential for direct contamination of groundwater with excreta.

2. Applicant Information

TYPE OF ORGANIZATION: Community-based organization, Fishing Co-operative Society

DATE OF FORMATION OF ORGANIZATION: February 2, 1993

NAMES AND POSITIONS OF OFFICERS IN ORGANIZATION

1. President – Mr. Christopher Brown
2. Vice President – Mr. Desmond Abrahams
3. Secretary – Mr. Devon Malcolm
4. Assistant Secretary – Mr. Gladstone White
5. Treasurer – Ms. Donnette Prendegast

PURPOSE OF ORGANIZATION:

The Half Moon Bay Fishermen's Cooperative Society manages member's social and economic affairs at Hellshire Beach and activities carried out on ten (10) acres of land at Hellshire Beach.

PROJECTS IMPLEMENTED OVER THE PAST TWO YEARS:

1. Solid Waste Collection and Disposal. Initially trash generated on the beach was disposed via burning and burial or accumulated in stagnate corners of the beach. To address this unsightly condition, the Cooperative rented a skip in February 2002 from a private hauler and initiated a contract to have the skip emptied three (3) times per week. Also, the Cooperative posted a sign to remind persons to bag their waste prior to placing in the bin. At present, less waste is burned and buried on the beach.

2. Road Improvement Project. Initially, cars could not reach beachfront after light or heavy rains because stormwater would accumulate at gated entrance. In the summer of 2002, the Cooperative alleviated this problem by hiring a contractor to raise the road with marl. At present, stormwater is diverted off the main road to the nearby mangrove wetland.

3. Public Toilet. No public toilet was available for beach staff, fishermen or visitors before the Cooperative installed the flushable public toilet in July 2001. A caretaker who also collects a $30J per use fee currently maintains the toilet.

4. Potable Water Distribution to Fishermen Ranches and Restaurants. Since summer 2001, the beach has had access to potable NWC domestic water. This past summer, the water was locked-off due to lack of payments from users. The Cooperative worked with NWC to reinitiate the water on the beach. As a result, individual meters have been installed for persons who have paid their water bill and all illegal connections are disconnected.

FINANCIAL INFORMATION:

See attached financial statements

3. Project Background and Description

Half Moon Bay Community is situated on the southern end of the Green Bay at Half Moon Bay Point in with the Portland Bight Protected Areas. The white sand beach has been utilized by visitors island wide since the early 1960s. As estimated 3,000 persons with over 1,500 vehicles utilize the beach on a weekly basis. Hellshire Beach, specifically, Half Moon Bay Point, is nationally recognised for its spectacular ocean view, white sand and fry fish and festival.

In May 2001, the Urban Development Commission (UDC) transferred the ten (10) acres titled as Volume 1150 Folio 468 to the Commissioner of Lands to be held in rust for the use and benefit of the Half Moon Bay Fishermen's Cooperative. Within this property is a small mangrove wetland that stretches beyond the northwest corner of the property.

At present, the Cooperative Members include both fishermen, scale-fishermen and fish vendors. On the property are sixty-two (62) fishermen ranches and thirty-seven (37) fry-fish sheds. As estimated in a spring 2003 survey a population of 194 persons reside at the beach. The ranches include a gear shed for personal fishing equipment and overnight accommodations. Most fishermen currently have their primary residence as their ranch. The ranches and sheds are typically constructed with concrete block, stone and board.

Income for the Cooperative members is primarily from the sale of raw and cooked fish on the property.

4. Problem Statement

Half Moon Bay Fishermen's Cooperative is currently addressing the inadequate access to environmentally appropriate domestic and public toilets on the beach. Most beach residents do have access to a toilet, and a result, fishermen are beginning to construct soak-away pit and holding tank flush toilet systems within their ranches. As for beach day-staff and visitors, the Cooperative maintains one holding tank, flush toilet.

The root cause for the improper installation of toilets on the fishermen's ranches is the Cooperative's lack of sanitary guidelines for the beach. As for the public toilet, the Cooperative subsidizes the current user fee ($30J) to maintain the toilet. With this subsidization, the Cooperative is unable to support another public toilet facility.

The effects of improper and inadequate toilets on the beach effects the fishermen, fry-fish shed staff and visitors with offensive odours, obnoxious mosquito population, unsightly appearance of human excreta on the ground and susceptibility to communicable diseases through direct contact with excreta.

Also, the nearby ground and ocean waters are directly affected by the use of soak-away pit latrines. Within the property, the water table is approximately three feet below the surface. With pit latrines at five (5) feet depth, the excreta have direct contact with the groundwater before proper absorption treatment is possible. Also, the heavy rains, contribute to overflowing pit latrines.

Consequences for not improving the availability to environmentally appropriate toilets for domestic and public use on the beach will effect fishermen, residence, visitors, beach staff, beach flora, beach fauna and the nearby waters.

The consequences will promote:

1. Degradation of water quality in the area with the input of excessive nutrients and faecal matter,

2. Erosion of sand if the toilet facilities are constructed improperly or in inappropriate locations, and;
3. Public health nuisances at the beach including offensive odours and unsanitary conditions.

In July 2001, the Cooperative constructed one (1) flush toilet near the fry-fish sheds at the southeast of the property. A private hauler is contracted to empty the 810 cubic foot holding tank approximately every three (3) months. A caretaker was hired to maintain the toilet and collect the $30J per use fee seven (7) days per week from 8:00 am until 5:00 pm. The toilet continues to be well utilized by beach staff and visitors. Unfortunately, the acceptable user fee is unable to sustain the overall costs of the toilet is which includes, emptying the storage tank, paying the water bill and paying caretaker.

The Cooperative has informally discussed with members that any toilet constructed on the ranches should be a flush toilet with a holding tank or dry-pit latrines. Unfortunately, many members and non-members have constructed soak-away pit flush toilets or leaky holding tank systems.

The proposed project will include

1. Construction of public toilets that are both cost-effective and environmentally appropriate for the beach environment and beach activity.
2. Decommission of inappropriate domestic toilets and provide sufficient, safe public toilets for all-day access and appropriate guidelines for toilet construction within ranches.
3. Completion of a site survey to assist in appropriately locating the proposed toilet systems and assisting the Cooperative in preparing lands for more public toilets for beach visitors.

5. Project Scope

a) **GOAL OF THE PROJECT**:
The Cooperative members will provide economical and environmentally appropriate toilets for the public and decommission unsanitary and inappropriate toilet systems on the beach.

b) **PROJECT DESCRIPTION**:
The project has five (5) components.

1. Construct two (2) evapo-transpiration systems (ETB) for public use, which will be maintained by a caretaker. Each evapo-transpiration system will have two (1) female flush toilets, one (1) male flush toilet and one (1) urinal. A washbasin will be constructed outside the building, which the grey-water will be fed to a soak-away pit.

2. Construct (4) Ventilated Improved Double Pit Latrines (VIDP) for fishermen and their visitors.

3. Decommission improperly constructed toilets in fishermen ranches and provide guidelines for Ministry of Health approved toilet systems.

4. Contract a surveyor to generate a site plan of the ten (10) acres to assist in locating the proposed toilets, preparing lands for more public toilets and preparing a development plan.

5. Sensitise the members and beach visitors to the importance of environmentally appropriate, sanitary toilets at the beach through workshops, posters and brochures.

c) **OBJECTIVES, OUTPUTS, INPUTS AND COSTS**:

PROJECT OBJECTIVES	**OUTPUTS**	**NEEDS/INPUTS**	**BUDGET DIRECT COSTS**
Obj 1a. Construction of ETB systems and VIDP	Construct two (2) ETB systems And Construct four (4) VIDP systems	Contractor 2 Labours Technical Team Cooperative Member Exterior Door Padlocks with access Entrance Lockset Hook and eye Faucet (outdoor) Flush Toilets Urinals Angle Valves Flex Tubes (16") 4" PVC Pipe (Solid) Pond Liner (6 mil) PVC Coupling (4") Concrete Sand Gravel Reinforcements Cement Paint	J$1,008,000
Obj #2 Site Survey of Property	Complete site survey of current development at beach	Contracted Surveyor	J$453,600
Obj #3 Decommission Unsanitary toilet systems and sensitise Cooperative members and beach visitors	Determine toilets to be decommissioned and provide guidelines for appropriate toilet Complete four (4) sensitisation and training workshops with Cooperative Development and distribution of sanitary guidelines, educational & Display of brochures/ posters	Public Health Inspectors Cooperative Member Labourer Sand Gravel Cement Technical Assistant Cooperative Member Technical Assistant Cooperative Member Printing Materials	J$252,000 J$80,000 J$187,000

d) RESULTS TO BE ACHIEVED

Acres of Protected Area to be Conserved: 10

Number of Children and Youth to Benefit: average 350 per week

Number of Indirect Beneficiaries: island wide

Number of Direct Beneficiaries: 200 fishermen and overnight visitors
1,500 to 3,000 day visitors per week
100 fry fish vendor staff

6. Methodology

The sanitary conveniences provided through this project is not the total required to support the weekend and holiday beach visitors. Instead, the toilets will meet the immediate needs of the fishermen, day staff and visitors. The requested site survey of the property will assist the Cooperative in locating the most appropriate sites for the remaining required toilet facilities. Without this foresight, the toilets may be improperly located.

The first endeavour for the Cooperative is to apply for a permit to construct the toilets through the National Environmental Planning Agency (NEPA) and other relevant stakeholders. The assigned Executive Committee member will acquire the materials for construction and assist the contractor in beginning his work. The Evapo-transpiration Bed Systems (ETB) will be constructed first, followed by the Ventilated Improved Double Pit Latrines (VIDP). The U.S. Peace Corps Volunteer will be available for each day of work to provide technical assistance. Ministry of Health / Environmental Health Unit (EHU) Representative will also be available for technical assistance.

Construction Research Development Commission (CRDC) will assist with developing the sanitary guidelines, training workshops and general accounting. Formal Workshops will be held to acclimate members to the project and assist in keeping information well shared within the community. Also, training and maintenance workshops will assist in sustaining the toilets after project funding ends.

The flush toilets will be constructed first to eliminate the Public Health nuisance due to unavailable public toilets.

The Cooperative Treasurer will maintain the accounting requirements for the project, while the day manager for the project will submit the appropriate update reports. Financial and quarterly reports will be submitted to EFJ.

During the construction of the toilets, the Cooperative Executive Committee will begin working with members to identify toilets on the beach that require decommissioning. After identifying the toilets to abandon, the Cooperative will assist in filling-in and capping the pits. Before abandoning the toilets, the owners will be given the appropriate guidelines for building a personal toilet facility at the beach, which will be scribed by a Cooperative member.

Brochures and posters will be distributed and displayed throughout the beach to sensitise members and beach visitors to the project goals, objectives and progress.

7. Collaboration and Alliances with Others

Ministry of Health / Environmental Health Unit. The Ministry of Health will approve the location and proposed toilet system designs.

Ministry of Health / Parish Health Department. The Public Health Inspectors will provide technical assistance before, during and after construction of toilet systems.

U.S. Peace Corps. A U.S. Peace Corps Volunteer is working with the Cooperative in determining the sanitary needs at the beach for public and domestic use. The Volunteer will provide technical assistance, offer assistance in overall planning of the project and assist in educational presentations.

Commissioned Land Surveyor. The Surveyor will be contracted to develop an accurate site plan of the property.

National Water Commission. NWC representatives will assist in installing metres for the ETB systems.

Construction Research Development Commission. CRDC will assist with developing the Sanitary Guidelines, sensitisation and maintenance workshops and general project accounting.

Implementation Schedule

START DATE: January 2004

END DATE: March 2005

ACTIVITIES	TIME (MTH)	PERSON RESPONSIBLE	TIME LINE IN MONTHS 1	2	3	4	5	6	7	8	9	10
Site Survey	1	Contracted Surveyor										
Permit for toilets	2	CER[1] and PCV[2]										
Accounting	18	TA[4], CER										
Purchase of Equipment	1	TA, CER										
Purchase of Materials	14	TA, CER										
Construction	15	Contractor, CER, PCV										
Workshop 1	0.5	TA, CER, PCV										
Report to EFJ #1	0.5	CER										
Workshop 2	0.5	TA, CER, PCV										
Develop Sanitary Guidelines	4	TA, CER, PCV										
Report to EFJ #2	0.5	CER										

[1] *Cooperative Executive Representative*

[2] *U.S. Peace Corps Volunteer*

[3] *Cooperative Member*

[4] *Technical Assistant*

Action Sheet continues to next page

Contd

ACTIVITIES	TIME (MTH)	PERSON RESPONSIBLE	TIME LINE IN MONTHS
			11 12 13 14 15 16 17 18
contd Accounting	18	TA[4], CER[1]	
contd Purchase of Materials	14	TA, CER	
contd Construction	15	Contractor, CER, PCV[2]	
Print Guidelines, Posters, etc	1	CER	
Workshop 3	0.5	TA, CER, PCV	
Report to EFJ #3	0.5	CER	
Workshop 4	0.5	TA, CER, PCV	
Decommission pit latrines	6	TA, CER	
Project Audit	1	TA, CER	
Final Report	1	TA, PCV, CER	

[1] *Cooperative Executive Representative*
[2] *U.S. Peace Corps Volunteer*
[3] *Cooperative Member*
[4] *Technical Assistant*

8. Project Implementation and Management

The Cooperative Executive Committee will manage the project oversight and financing requirements. An Executive Member will be assigned to overseeing the day-to-day operations of the construction and project initiatives. The U.S. Peace Corps Volunteer, Ministry of Health/Environmental Health Unit Representative and Public Health Inspectors will provide technical assistance. The contractor will be a community member well familiarized with mason work and willing to work with the technical team. Two (2) labourers from the community will assist the contractor in constructing the facilities.

9. Project Financing Plan and Budget

See attached spreadsheet for details.

EFJ's Contribution	Cooperative Contribution	Other Contributors	Total
J$1,928,600.00	J$218,000	J$500,600	J$2,647,200

10. Budget Assumptions / Notes

The proposal budget for this project assumes the Jamaican dollar remains stable through present until project completion. Also, external resources will be utilised for printing, accounting, auditing and site plan surveying. The cost for the surveyor is per the availability of surveyor that provided estimate.

Budget for the workshops include an external technical assistant with a Cooperative Counterpart.

Also, the project budget considers a U.S. Peace Corps Volunteer will be available to work with the Cooperative throughout the duration of the project.

11. Counterpart Funding

U.S. Peace Corps/Jamaica programme is financially supporting the work contributed by the U.S. Peace Corps Volunteer.

12. Project Sustainability

To sustain the ETB toilet facilities the Cooperative will employ one (1) caretaker from 8:00 am until 5:00 pm every day. The person will be responsible for maintaining the toilet area and collecting the user fee. Another Cooperative member will be employed to monthly remove excess grass from the evapo-transpiration bed, check the septic tank status and other general plumbing requirements. A user fee will be charged to pay for the water usage and caretaker fees.

The Contractor and four (4) Labourers completing the construction phase of the project are from Half Moon Bay. In turn, they will be on-site to assist with troubleshooting immediate problems.

Workshops throughout the project duration will assist in sensitising community members.

13. Organisational Capacity

At present, the Cooperative has an active executive committee who are working with a U.S. Peace Corps Volunteer and the Ministry of Health to improve sanitary facilities at the beach.

The overall goal for the Cooperative is to fulfil the social and economic needs of its members. In order to facilitate this goal, the Cooperative must also actively promote the preservation of the beach environment through projects. This project will provide sanitary, environmentally appropriate toilets that will meet the needs of the people and preserve their surrounding environment. Also, this project will provide fishermen and other overnight guests an alternative to the current practice of defecated outdoors.

14. Project Evaluation

OUTCOMES	INDICATORS OF SUCCESS	HOW WILL INDICATOR BE MEASURED
Improve availability of public toilet facilities	Appropriate and approved toilet facilities Toilet facilities and primary caretakers are self-sustained through user fee Persons use facilities rather than bush or ocean	Acquire NEPA and MoH approved permit Financial review every month to evaluate user fee Keep a record of the number of toilet users and compare to daily visitors and beach staff
Improve access to domestic toilets	Fishermen understand the environmental consequences of constructing and using pit latrines All persons visiting the beach after 5:00pm have access to a toilet facility.	Fishermen and Cooperative work together to identify and decommission pit latrines. Also, cooperative members create and distribute sanitary guidelines for the beach VIDP toilets are constructed and maintained without closing at night.
Less potential for direct contamination of groundwater with excreta	Pit latrines are eliminated from beach. Development of sanitary guidelines, brochures and posters	All toilets constructed and maintained on beach are either of (1) tertiary treatment design or (2) dry pit sealed design - VIDP. All members are briefed on guidelines, member food shops display posters and have copies of brochures to distribute to visitors.
Accurate Site Plan drawings available	Site Plan Survey used to determine proposed toilets and locate future site Cooperative identifies environmental sensitive area	NEPA and MoH approves of toilet location. Areas are restricted for development,

15. Contact Information

PERSONS COMPLETING APPLICATION FORM:

NAME: Mr. Devon Malcolm

TEL: 404.0697

ADDRESS: Hellshire Park Estate, Hellshire P.A., St. Catherine

SIGNATURE: _____

Date: _____

NAME: Ms. Kelly Stanforth

TEL: 967.4762(office), 880.2682 (cell)

FAX: 967.1280

ADDRESS: 2 – 5 King Street, Kingston

SIGNATURE: _____

Date: _____

ENCLOSURES

- Most recent annual report
- Most recent financial statements

APPENDIX 2: Half Moon Bay Fishermen's Cooperative 10 acre land title

REGISTER BOOK
VOLUME 1150 FOLIO 468

ORIGINAL
NOT TO BE REMOVED FROM TITLES OFFICE
DO NOT FOLD

JAMAICA

Misc. 67891

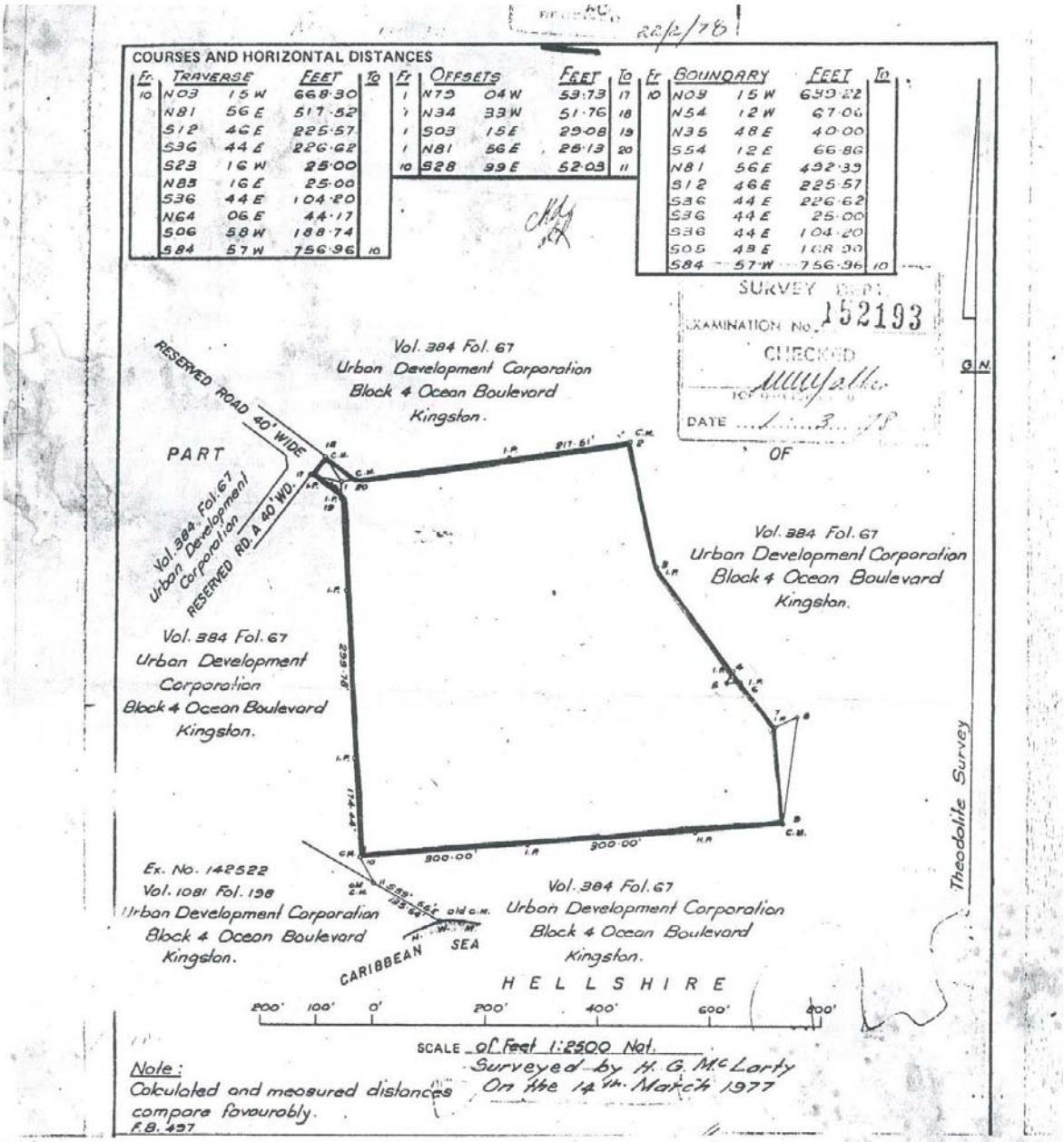
Certificate of Title under the Registration of Titles Act

URBAN DEVELOPMENT CORPORATION a Statutory Corporation established and existing under the Urban Development Corporation Act and having its registered office at 12 Ocean Boulevard Kingston Mall, in the City and Parish of Kingston is now the proprietor of an estate in fee simple subject to the incumbrances notified hereunder in ALL THAT parcel of land part of GREAT SALT POND called HELLSHIRE in the Parish of SAINT CATHERINE containing by suvery Four Hundred and Thirty-nine Thousand Two Hundred and Sixty-six Square Feet of the shape and dimensions and butting as appears by the Plan thereof hereunto annexed and being part of the land comprised in Certificate of Title registered at Volume 384 Folio 67.

DATED this 11th day of October One Thousand Nine Hundred and Seventy-eight.

Registrar of Titles.

Incumbrances above referred to:-



The above figure shaded red represents 439,266·0 square feet of land

part of Great Salt Pond called Hellshire in the parish of

Saint Catherine.

This is the plan referred to in the annexed.....

Certificate registered in the name of Urban Development Corporation

in Volume 1150 Folio 468

OFFICE OF TITLES

.....
for Registrar of Titles

APPENDIX 3: Rapid Assessment Survey (RAS) by the Greater Portmore Health Department

GREATER PORTMORE HEALTH CENTRE
Greater Portmore P.O.
St. Catherine

May 5, 2003

Chief Public Health Inspector
Thro' DCPHI (actg.)
St. Catherine

See below a narrative report of a survey that was carried out at Half Moon Bay. Hellshire on the 28th April and the 1st May respectively. All officers in the Portmore zone participated.

LOCATION

Hellshire is located in the South Eastern side of Greater Portmore along the shore line and consists of approximately ten (10) acres of land.

BUILDINGS

All buildings constructed on the bench are made from board and zinc with cement concrete foundation.

FOOD HANDLING ESTABILSHMENT

Because of the type of construction, most food handling establishment have no proper flooring. They are not licensed and need to be up graded to meet public health standard. Food handlers permits are invalid and some operators are without. Business goes on everyday but Sundays and Public Holidays are the best days where selling is concerned.

A lot of education is necessary and this process will be undertaken at the food handlers clinics to be scheduled.

SEWAGE DISPOSAL

Sanitary conveniences range from individual to communal. There are two communal toilets having one (1) water closet in each to suffice both the community and the patrons who come to the beach. These water closets are unsatisfactory/inadequate. The water closets tanks are defective and need replacement.

WATER SUPPLY

Water supply is potable and adequate and comes from the municipal system. Standpipes are strategically placed on the premises.

REFUSE DISPOSAL

There is a satisfactory refuse disposal system at Hellshire. A skip is placed at a strategic point for residents to place their refuse in and the truck collects it twice weekly.

HOUSING

Living conditions could be considered poor. Homes are unsatisfactorily ventilated. Leaking roofs, flooring and walls with holes are some of the

contributing factors. Some homes are poorly constructed and in case of a natural disaster such as hurricane lives are at risk.
The socio economic status depends mainly on the sale of fish by fisherman and the sale from the operation of food shop, bar and cook shops owned by some householders.

COMPOUND

Although Hellshire has a satisfactory refuse collection system, the compound of most householders unsatisfactory. Old tyres, old fishing equipment, old refrigerators and leaves fallen from trees all form harborage for the breeding of rodents and insects.

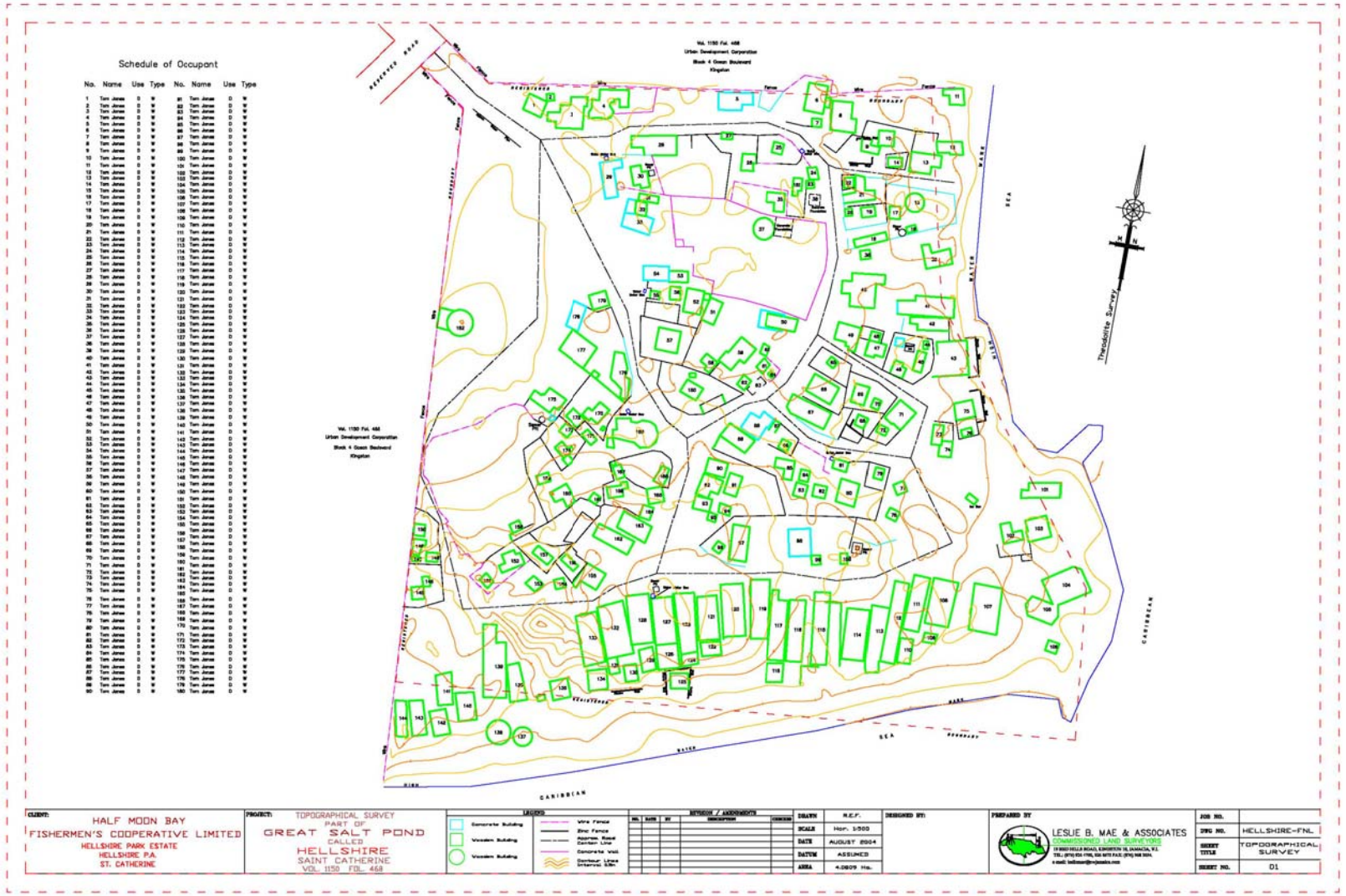
STATISTICAL REPORT

		STATUS	
		Satisfactory	Unsatisfactory
# Number Homes	– 62	16	44
# Food Shops	– 21	8	13
# Bars	– 9	5	4
# Restaurants	– 37	2	35
Other Premises	– 6	1	5

- No. of homes without sanitary conveniences 3. These have no access, they defecate in the bushes and in the sand.
- No. of homes that use communal system 54.
- No. of homes with pit latrine 1
- No. of homes with individual holding tank 4
- Total population that use communal system 181
- Total population residing on beach 194

for Idel Talbott
PHI 3

APPENDIX 4: Half Moon Bay, Hellshire Civil Site Survey Plan (August 2004)


Schedule of Occupant
No. Name Use Type No. Name Use Type
Vol. 1150 Fol. 468
Urban Development Corporation
Block 4 Ocean Boulevard
Kingston
Vol. 1150 Fol. 468
Urban Development Corporation
Block 4 Ocean Boulevard
Kingston
RESERVOIR ROAD
Theodolite Survey
SEA
CARIBBEAN
CLIENT:
HALF MOON BAY
FISHERMEN'S COOPERATIVE LIMITED
HELLSHIRE PARK ESTATE
HELLSHIRE P.A.
ST. CATHERINE
PROJECT:
TOPOGRAPHICAL SURVEY
PART OF
GREAT SALT POND
CALLED
HELLSHIRE
SAINT CATHERINE
VOL. 1150 FOL. 468
LEGEND
Concrete Building
Wooden Building
Wooden Building
Wire Fence
Zinc Fence
Concrete Wall
Contour Lines
REVISION / AMENDMENTS
DRAWN R.E.F.
SCALE Hor. 1:500
DATE AUGUST 2004
DATUM ASSUMED
AREA 4.0809 Ha.
DESIGNED BY:
PREPARED BY
LESLIE B. MAE & ASSOCIATES
COMMISSIONED LAND SURVEYORS
JOB NO.
DWG NO. HELLSHIRE-FNL
SHEET TITLE TOPOGRAPHICAL SURVEY
SHEET NO. 01

APPENDIX 5: Compilation of relevant Historical Documentation

REPORT ON FISHERMEN AT HALF MOON BAY

In 1968 when the Hellshire Hills Properties were vested in the UDC by Government, there were a number of fishermen scattered along the entire coast-line of Hellshire, including Half Moon Bay. The Forest Department was in charge of the area prior to its being handed over to the UDC and that department supplied a list of names of fishermen who were being granted annual permit to fish in the area. The number of fishermen at Half Moon Bay was then estimated at fourteen.

In 1970 and 1971 two seminars were held with government agencies to discuss development proposals for the area and at the 1971 seminar it was agreed that a joint survey would be undertaken by the Fisheries Division of the Ministry of Agriculture, Beach Control Authority and UDC to establish the number of fishermen residing in the area and how best they could be incorporated into the development proposals. At this seminar it was pointed out by Fisheries that Hellshire Hills was not considered as the best area for fishing and that there was no proposal by their department to establish the fishing industry in this area on a major scale.

The joint survey was carried out and indicated that all fishermen living in the area at that particular time had been interviewed and their length of stay, living pattern and family numbers had been established, also their preference for site location. Based on this report, it was generally agreed that Wreck Bay would be considered as an area to establish a fishing village with other facilities including housing, etc. This area, being more centrally located would, of course, facilitate not only the fishermen at Half Moon Bay, but the others along the coast.

It was also agreed that in addition to this Wreck Bay complex, an area at Half Moon Bay would be allocated to the fishermen for pulling up their boats, mending their nets, etc. The understanding at this time was that the proposals were agreeable to the fishermen. The only item on which agreement had not been reached was the exact area at Hellshire Bay that would be designated for their use.

In 1973 a further survey was undertaken, as the access roads had been constructed and the number of dwellers at Half Moon Bay was increasing considerably. At that time the number of fishermen had risen from an estimated fourteen to over forty.

In 1975 when the development plan for Hellshire was approved, UDC Planners made a comprehensive study to document the available facilities and economic condition of fishermen in the area. Based on this study and certain concerns expressed by the fishermen about Wreck Bay, proposals were drafted for a fisherman's complex at Hellshire Bay in close proximity and including sections of the beach now used by them. Financing of these proposals, including housing, was estimated in 1975 to cost about $.25M. At that time Fisheries indicated that the provision of facilities at Hellshire had not been included in their programme to 1977. It was considered necessary at the time to await the involvement of the Fisheries Division.

In January 1977 a deputation of fishermen visited the then Minister of Mobilisation. The main issues raised by the fishermen related to -

1. security of tenure

2. their being allowed to remain at Half Moon Bay and not be relocated to Wreck Bay.

Following on this, a Task Force was set up by the then Minister of State in the Ministry of Finance and Planning, Mr. Richard Fletcher, to solve the problems being experienced by the fishermen.

On April 21, 1977, the first meeting of the Task Force was held and agreement was on four basic issues:-

1. An approximate area of 10 acres on which the fishermen were presently living would be surveyed by the UDC;

2. The Commissioner of Lands would ensure security of tenure to the fishermen in accordance with the existing needs;

3. Fishermen would be organised on a Co-operative basis through a community council;

4. Fisheries Division would look into the provision of facilities including gear sheds and other equipment as soon as water became available.

The Task Force assumed responsibility for further dealing with the fishermen and this continued until March 22, 1978. At the end of this period three issues remained unresolved. UDC had surveyed the 10 acres of land but the fishermen had not been formed into a co-operative which could undertake lease of this land from the UDC. The Registrar of Co-operatives had refused to register Half Moon Bay fishermen as they were still illiterate and had no viable project.

On March 22, 1978, at a meeting of the St. Catherine Board, the question of the fishermen was extensively reviewed by the Board, and this meeting was attended by Richard Fletcher, Mr. A. B. Francis from Fisheries Division and Mr. Paul Vasciannia from the Co-operative Division. It was agreed at this meeting that the Task Force should now be considered as a sub-committee of the St. Catherine Re-development Company and assistance to the fishing community at Half Moon Bay would continue and include:-

a) Establishment of a viable fishing co-operative;

b) Making water available to the community;

c) Affording the fishermen security of tenure.

In June, 1979, in regard to (a), assistance was given the fishermen in obtaining from the Dutch Government six Evinrude Outdoor Motors. The handing over of this took place in June, and it was envisaged that this could form the basis of a viable fishing co-op. Assistance was given by Officers of the Hellshire Bay Development Company in the area of forming a pre-coop. group, helping with the Jamal classes.

Efforts have been frustrated by fishermen being absent for long periods engaged in fishing in other areas, the disappearance of one fishermen with an engine and the lack of interest displayed by most of them in the co-op. venture.

Regarding (b), water has been made available to the community with the assistance of the Hellshire Bay Company and the National Water Commission.

Regarding (c), the fishermen are adamant that they need the land to be given to them free and houses to be built at a very nominal cost.

Mr. Kooyman of the Ministry of Housing undertook to prepare a subdivision plan of the area, for discussion with the fishermen. In preparing this plan, he brought to attention the severe erosion which had taken place. The fishermen, being aware of this problem, had also requested that NRCD advise them on the matter. In view of this problem the St. Catherine Board considered it necessar to obtain a report from NRCD before giving any further consideration to the development of the area.

On May 21, 1980 the NRCD report was submitted to the St. Catherine Board and discussed at the 84th and 85th meetings, and it was generally agreed that a serious look would have to be taken at the report and recommendations as the practise of the fishermen had created havoc in the area. It was also agreed that NRCD would cost the proposal at which time the matter would be reviewed by the Board. To date costs have not been submitted by NRCD.

In October, 1981 the Property Manager of Hellshire Bay undertook a two-week survey of the Fisherman's Village , and his report is attached.

In view of the increasing number of fishermen, now estimated at 66 by Mr. Stewart, and the severe beach erosion problem, the matter was again reviewed by the St. Catherine Board at its 95th Meeting held on November 25, 1981. At this meeting it was agreed that the 10 acres would be made available to the fishermen in two sites:-

(1) Part of Lot 7 - Hellshire Bay (5 acres) - site originally offered to fishermen - for docking facilities, gear sheds, cold storages, etc.

(2) Part of Hellshire Park Estate - the area required for housing not exceeding 5 acres.

It was further agreed that the Ministry of Agriculture would be asked to liaise with the fishermen and UDC and be responsible for developing a fishing complex on the Half Moon Bay site, and that the Ministry of Construction (Housing) would be requested to liaise with the UDC and the fishermen and develop the housing site. UDC's responsibility would be to rehabilitate Half Moon Bay point and create a public beach in this area.

On 11th December, 1981, the Ministry of Agriculture and the Ministry of Construction (Housing) were written and requested to consider the matter and advise whether or not the respective Ministries would undertake the responsibilities requested.

In January, 1982 the Ministry of Agriculture agreed in principle at a meeting held with their Fisheries Division, to the construction of the fishing complex and undertook to hold preliminary discussions with the fishermen with a view to establishing their reaction to the recommendation.

On the 27th January, 1982, Mr. E. A. Royer, Director of the Fisheries Division, held a meeting with the fishermen and he has advised that about 20 fishermen were present and agreed in principle to the recommendation of a fishing complex. They, however, indicated their preference to being integrated into the community rather than having a specific area for housing designated for them. Mr. Royer has promised to submit a copy of the notes of the meeting held with the fishermen, together with his recommendations, so that a site meeting can be arranged between all the parties concerned.

To date, despite reminders, no reply has been received from the Ministry of Construction (Housing).

On the question of the erosion, NRCD has indicated the requirement of $21,000 to undertake a study on human use impact and wave fraction survey in regard to Half Moon Bay and Sandhills Bay. This study is to be submitted to the 99th Meeting of the Board to be held on April 21, 1982. This report will contain specific recommendations regarding rehabilitation of the Half Moon Bay Point.

Following on Mr. Royer's visit to the beach, the attached Petition has been circulated for beach users to sign. This is considered to be directly aimed at thwarting any attempt to remove the fishermen and rehabilitate the Point.

It is becoming increasingly urgent for the matter to be dealt with expeditiously, as land that has been eroded from Half Moon Point since 1975 is estimated at 800 feet. This is directly attributable to destruction of vegetation and sand dunes and intense human use. Dr. Wade has also indicated that the reefs are in a degraded state and portions have been destroyed by dynamiting.

It is urgent that agreement be reached between the Ministry of Agriculture, the Ministry of Construction (Housing) and UDC regarding the location of housing, the location of the fishing complex and the time frame for construction.

EHD:hr

5th April, 1982

Attach:

Half Moon Bay

In 1968 the Urban Development Corporation (UDC) was given the responsibility for developing the Hellshire Hills in South East St. Catherine.

Envisaged as Jamaica's first fully planned newtown, the development would contain residential, resort, commercial, light industrial, social and recreational facilities. The development of Hellshire it was felt, would absorb the population overflow from Kingston and prevent construction on agricultural lands.

The development plan also took into consideration Hellshire's rich history with every effort being made to protect historic sites. Two Sisters Cave is a case in point, where the discovery of a petroglyph, (a carving of an adult Awarak face) found on one of the walls of the Cave, has led to a proposal to reconstruct an Awarak Village on the site.

The vastness of the area - 27,000 acres, dictated development in three phases; Phase I, Hellshire Bay boasts five bays, among which is Half Moon Bay, popularly called Hellshire Beach.

The development of the bays was planned as follows:

i) Hellshire Bay was to be bordered to the north by Fort Clarence Beach; a proposed Workers Resort in the centre and the fishing village in the south. The entire beach was to be made easily accessible to the public.

ii) Halfmoon Bay was designated for resort uses, projected at the time to generate 700 jobs.

1

iii) Two Sisters Bay was also earmarked for resort development, generating 400-500 jobs.

iv) Sandhills Bay & Engine Head Bay - this stretch was to be bordered by a public beach park

When the UDC took over the lands, there were approximately 14 fishermen scattered along the Hellshire coastline. The names of these fishermen were given to the UDC by the Forestry Department, which had responsibility for the area, prior to the advent of the UDC. The fishermen had been issued annual permits by the Forestry Department to fish in the area.

A joint survey was conducted by the Fisheries Division of the Ministry of Agriculture, Beach Control Authority and the UDC to establish how best to incorporate the fishermen in the development proposals for Hellshire Hills.

Based on the survey, it was proposed to set up a fishing village with housing facilities at Wreck Bay. This was to facilitate not only the fishermen at Half Moon Bay, but also the fishermen along the entire coastline.

The fishermen subsequently expressed reservation about Wreck Bay. It was felt that the reefs would not allow them to dock their boats close enough to shore.

In 1977, the Government appointed a task force to investigate the position of the fishermen. The investigation revealed that the fishermen's demands had extended beyond security of tenure for the land occupied and their request not to be relocated to Wreck Bay, to include provision of housing, agricultural lands, water and gear sheds.

It was proposed that 10 acres of land be leased to the fishermen. Five acres at Hellshire Bay for a fishing complex in close proximity and including sections of the beach, already being used by them. An additional five acres to be allocated in Hellshire Park Estate for housing.

The responsibility for the development rested with the following Government Agencies:

- The Ministry of Agriculture - (Fisheries Division) would see to the development of the fishing complex.

- The Ministry of Housing would provide houses.

- UDC would rehabilitate the area and create a public beach.

- Social Development Commission would organize the fishermen on a community basis, to allow them to benefit from literacy classes, etc.

- National Water Commission would lay mains, to provide this utility.

- Co-operative Department would organize the fishermen into a co-operative. It was envisaged that the land would be leased to a co-operative, rather than to individuals.

Up to 1978, no aspect of the project had been implemented, due primarily to lack of financing. The estimated cost in 1975 was $.25M which should have been provided through budgetary allocation.

Additionally, the Co-operative Department indicated that the fishermen were not ready for the step of forming a co-operative.

Despite its lack of development, increasingly, people continued to use the beach over the years. A 1989 survey conducted by the UDC showed that 87 fishermen operated from the beach, which had a resident population of 206. Additionally, up to 3,000 beach users in 1,500 cars visited in one week.

A NRCA study in 1980 attributed the erosion of the beach to the unregulated use over the years, by human and vehicular traffic, as well as the presence of animals. This trampling at will, has led to the destruction of the vegetation, which left the sand dunes vulnerable to wind erosion, and the resultant loss of beach frontage.

The situation was aggravated by the practice of dynamite fishing, which damaged the reefs. Without this buffer, the shoreline was exposed to greater wave action and rapid erosion.

The UDC is currently preparing a development plan for Half Moon Bay, in an attempt to arrest the rapid erosion and destruction of the environment. As a first step a groyne has been constructed. Replanting of vegetation and the erection of wind barriers to prevent further loss of sand, will form part of the development plan.

The proposal includes - rehabilitation of the beach; development of a public and fishing beach in keeping with the requirements of the relevant authorities and housing to relocate the residents now living on the beach to Hellshire Park Estate.

The planned facilities for the public beach include vendor stalls, changing and shower blocks, lifeguard towers, parking facilities, landscaped picnic area and an administrative building, while the fishing beach will contain gear sheds, sanitary facilities, consumer goods store and office space for the cooperative.

The proposals are being developed in consultation with the Half Moon Bay community and the Member of Parliament for the area, Hon. Hugh Small, Q.C.

The project has now been accepted for inclusion in the Private Sector Investment Programme (PSIP). Funds are now being sought for the implementation process to begin if possible in the 1993/94 financial year.

October 15, 1992

5

APPENDIX 6: Proposed Sanitation Plan – Implementation Schedule
Implementation Schedule

START DATE: January 2004,
END DATE: March 2005

ACTIVITIES	TIME (MTH)	PERSON RESPONSIBLE	TIME LINE IN MONTHS
			1 2 3 4 5 6 7 8 9 10
Site Survey	1	Contracted Surveyor	
Permit for toilets	2	CER[1] and PCV[2]	
Accounting	18	TA[4], CER	
Purchase of Equipment	1	TA, CER	
Purchase of Materials	14	TA, CER	
Construction	15	Contractor, CER, PCV	
Workshop 1	0.5	TA, CER, PCV	
Report to EFJ #1	0.5	CER	
Workshop 2	0.5	TA, CER, PCV	
Develop Sanitary Guidelines	4	TA, CER, PCV	
Report to EFJ #2	0.5	CER	

[1] *Cooperative Executive Representative*
[2] *U.S. Peace Corps Volunteer*
[3] *Cooperative Member*
[4] *Technical Assistant*

Action Sheet continues to next page

Contd

ACTIVITIES	TIME (MTH)	PERSON RESPONSIBLE	TIME LINE IN MONTHS
			11 12 13 14 15 16 17 18
contd Accounting	18	TA[4], CER[1]	
contd Purchase of Materials	14	TA, CER	
contd Construction	15	Contractor, CER, PCV[2]	
Print Guidelines, Posters, etc	1	CER	
Workshop 3	0.5	TA, CER, PCV	
Report to EFJ #3	0.5	CER	
Workshop 4	0.5	TA, CER, PCV	
Decommission pit latrines	6	TA, CER	
Project Audit	1	TA, CER	
Final Report	1	TA, PCV, CER	

[1] *Cooperative Executive Representative*
[2] *U.S. Peace Corps Volunteer*
[3] *Cooperative Member*
[4] *Technical Assistant*

APPENDIX 7: Proposed Construction Materials for ET sanitation facility

1	V. Joint Door w/ Cross Bar 30" x 32"
2	Ultra Padlock
3	Yale Keyed Entrance Lockset
4	3.75" Sash Lift (Guard Security)
5	4" Hook and eye
6	Pipe Top Faucet (outdoor)
7	Flush Toilet
8	Urinal
9	Angle Valve
10	Flex Tube (16")
11	4" PVC Pipe (Solid)
12	Pond Liner (6 mil)
13	PVC Coupling (4")
14	1 x 3 x 14 RPP
15	2 x 4 x 14 WPP
16	5/8" Form Ply
17	5-gal 404 Berger White
18	Concrete Nail (2")
19	Wire Nail (2") (per pound)
20	1.5" Wood Bit (spade type)
21	0.5" VSR Drill/Driver (Black and Decker)
22	ASP and Staple
23	Hand Saw 26"/10 foot fine cut
24	Hammer
25	7.25" circular saw (Black and Decker)
26	Block Building - concrete (6")
27	clean gravel (0.5")
28	Sand wash
29	Sand granite (yard)
30	Cement - carib grey (bag)
31	Steel corrugated rod 12 mm x 9 mm
32	Wire B.I.#16 (kg)
33	Wire B.I.#4 (kg)

APPENDIX 8: MOH Report on ET Technology (Silvia, 1990)

Evapotranspiration Systems
Prepared by
Environmental Control Division, MOH

The environment in some areas of Jamaica has reached such level of deterioration that pollution problems appear more frequently and are impairing human health. Recent occurences such as the pollution of Kingston Harbour and Harbour View's water distribution system, the closure of several polluted water supply wells, the massive killing of fishes in Hunts Bay, the high bacterial content in coastal waters, are some examples.

Among the factors contributing to the above mentioned pollution problems is the inadequate treatment of some of the sewage generated by the general population and which is disposed of into soils and water bodies .

In Jamaica about 16% of the total population is served by sewerage systems. Sewers are an urban phenomenon, 21% of the urban population is served by sewerage systems which are to be found in parts of the Kingston Metropolitan Area, Montego Bay, Ocho Rios and Negril, as well as in other housing schemes built by the government. No rural area is sewered and this segment of the population relies on individual systems ranging from septic tanks to pit latrines, the latter being the principal facility for excreta disposal in the country as a whole.

Findings of a study funded by PAHO in 1987 indicate that the pit latrine is used in Jamaica by about 50 % of the total population. In Kingston and Montego Bay 47% and 46% of the population interviewed use pit latrines, and in the rural areas 68% use them. The same study reports that 6% of the population interviewed had no sanitary convenience at all. Lack of a toilet appears to be a problem only in the urban area, because no rural household surveyed was without one.

A conflict between people's desires and government capabilities exists. While 97% of Jamaicans desire a flush toilet, which involves a source of water, sewage collection, treatment and disposal, the government is unable to provide with the sewerage systems required for this. Water closets are viewed by Jamaicans as the highest form of sanitary facility -- technologically and culturally -- 97% of the sample across Jamaica identified water closets as the "most desirable" type of sanitary facility. Even if the Government were able to provide this service, people can't afford to pay for it.

Latrines are potential polluters of groundwater which can be rendered unacceptable for drinking purposes. Existing conditons of high groundwater level and weathered limestone as well as shallow bedrock make unacceptable the use of latrines in some of the areas. High groundwater level is common in several areas of Jamaica located close to beaches or rivers. Limestone formations exist in a good portion of Jamaica. Limestone aquifers are the best producers of water and are highly developed for drinking water purposes. Shallow bedrocks can be found in most of the hilly areas, there, laminar flow is the main mode of transport of applied sewage, which usually springs few feet downgradient of the point of disposal. This raw sewage is highly polluted with pathogens which can be the source of water related diseases such as hepatitis, cholera, typhoid, among others.

Marginal areas are usually located along river banks and subject to flooding. When flooding occurs excreta is carried out by flooding waters imposing risky conditions to human health, to the people living downstream and who use surface water as their sole source of water. There are some areas in Jamaica, such as around the Roaring River where because of these conditions, typhoid fever has become endemic.

The conventional pit latrine is not applicable in periurban areas because it imposes high demand on surface area - something not affordable for low-income families. This, in combination with the high cost of a latrine, forces households to share the facility with neighbors. Resulting in poor maintenance of facilities. This problem was observed to be worst in Kingston - rural households had cleaner and best kept sanitary conveniences. In rural areas availability of land is not a problem. However the potential return cost, the rocky soils, the shallow groundwater and the O&M problems, mainly odours and flies, are the main reason for its lack of acceptance.

In regard to treatment and disposal of sewage, 34% of the population uses latrines and 16% is connected to a central collection system.

Septic tanks provide primary treatment to the sewage before its disposal. Septic tanks remove about 30 to 40% of the organic matter and 50 to 60% of solids. The effluent of latrines is discharged into leach fields or percolation pits.. There are some instances where some other forms of disposal are used, such as mound systems, and evapotranspiration beds. Engineers and architects have some objection to these systems, mainly because these type of disposal systems are seen as new technologies.

Septic tanks produce effluents high in pathogens and nitrogen. Studies made in other countries indicate that fecal coliform contents in the effluent of septic tanks is of the order of 2,500,000 to 10,000,000 colonies per 100 ml, the concentration allowed in drinking water is 3 colonies per 100 ml. What makes it worst, is the findings of another research where salmonella and poliovirus were found to have survival times of 44 days and 170 days respectively.

The nitrogen effluent concentration ranges from 41 to 49 mg/l and the drinking water limit is 10 mg/l as nitrates. As it can be observed, the effluent of septic tanks can't be considered safe for disposal in certain areas, as the one mentioned in the case of latrines (shallow waters, limestone formations and shallow bedrock).

In the Kingston metropolitan area, the massive amount of septic tanks with percolation pits or leach fields installed in limestone formations have contaminated several water supply wells used by the National Water Commission. These wells have been found with a high content of nitrates and have been abandoned. This signifies an important economic loss for the NWC, because groundwater is the cheapest source for domestic uses.

As mentioned before, in order to protect the groundwater resources in those areas where a high potential for groundwater pollution exists due to the existing geological conditions or high groundwater table, other treatment and disposal methods available should be used. A list of some of them follows:

1. Aerobic systems with a sufficient retention time to allow for the removal of nitrates, the effluent may be chlorinated or sent to an intermittent filter. The effluent can be discharged into a well.

2. Septic tanks plus intermitent filters.

3. Septic Tanks and either a mound system or an evapotranspiration bed.

4. Total retention pond.

5. Septic tank and an overflow land system

All of these recommended treatment and disposal methods either eliminate or significantly reduce the pollution of groundwater.

Evapotranspiration Beds

Evapotranspiration (ET) beds consist of a sand bed with an impermeable liner and wastewater distribution piping (see Fig. 1). The surface of the sand bed may be planted with vegetation. Wastewater entering the bed is normally pretreated to remove settleable and floatable solids. An ET bed functions by raising the wastewater to the upper portion of the bed by capillary action in the sand, and then evaporating it to the atmosphere. In addition, vegetation transports water from the root zone to the leaves, where it is transpired.

ET beds are primarily utilized where geological limitations prevent the use of subsurface disposal, and where discharge to surface waters is not permitted or feasible. The geological conditions that tend to favor the use of ET systems include very shallow soil mantle, high groundwater, relatively impermeable soils, or fractured bedrock.

The following factors affect the performance of ET beds:

1. Climate
2. Hydraulic loading
3. Sand capillary rise characteristics
4. Depth of free water surface in the bed
5. Cover soil and vegetation
6. Construction techniques, and
7. Salt accumulation.

By far the most significant constraint on the use of ET systems is climatic conditions. The evaporation rate is controlled primarily by climatic factors such as precipitation, wind speed, humidity, solar radiation, and temperature. Recent studies indicate that essentiatily all of the precipitation that falls on an ET bed infiltrates into the bed and becomes part of the hydraulic load that requires evaporation. Provisions for long term storage of effluent and precipitation in ET systems during periods of negative net evaporation, and for subsequent evaporation during periods of positive evaporation, are expensive. In the case of Jamaica, the critical months are September through November (see Appendix 1). However, it is expected not to be a problem as in other countries such as United States. Therefore the year-around use of nondischarging ET systems appears to be feasible in Jamaica where evaporation exceeds precipitation during every month of operation, so that long term storage capacity is not required.

Design An ET bed system must be designed so that they are acceptable in performance and operation. Since the size (and thus the cost) of an ET system is dependent on the design hydraulic loading rate, any reduction in flow to those systems is beneficial. Therefore, flow reduction devices and techniques should be considered an integral part of an ET system.

The principal loading rate is the principal design feature affected by the acceptance criteria. The loading rate must be low enough to prevent the bed from filling completely. The hydraulic rate is determined by an analysis of the monthly net ET ([pan evaporation by a local factor] minus precipitation) experienced in the wettest year of a 10-year period. In addition to loading rates, the designer must also consider selection of fill material, cover soil, and vegetation.

According with information available from the meteorological Office, the loading rate can be as high as 0.06 gpd/s.f. If the design flow is assumed to be 40 gpcd and we assume an average of 5.5 persons/house, then an area of 3660 square feet are needed for an ET bed.

In order to reduce the size of the ET bed, it has been suggested the segregation of sanitary wastes and kitchen wastes from gray water. Gray water (shower and lavatory wastes) is proposed to be disposed of in a trench field and the sanitary wastes plus kitchen wastes will receive treatment by a septic tank and then be disposed of in the ET bed. This system is estimated to reduce the amount of waste going into an ET bed in 42%, therefore an ET bed area of 1540 square feet is needed.

Further reductions in area can be achieved by the use of low flow toilets which can reduce the amount of sewage generated by 3.7 gpcd, and by the use of restrictors and aerators in dishwahing basins. This should be further investigated.

The main concern is the quality of the grey water which will be disposed of in the trench field. Literature indicates that the quality of gray water may not be acceptable to be disposed of without treatment. The average quality of gray water is as follows:

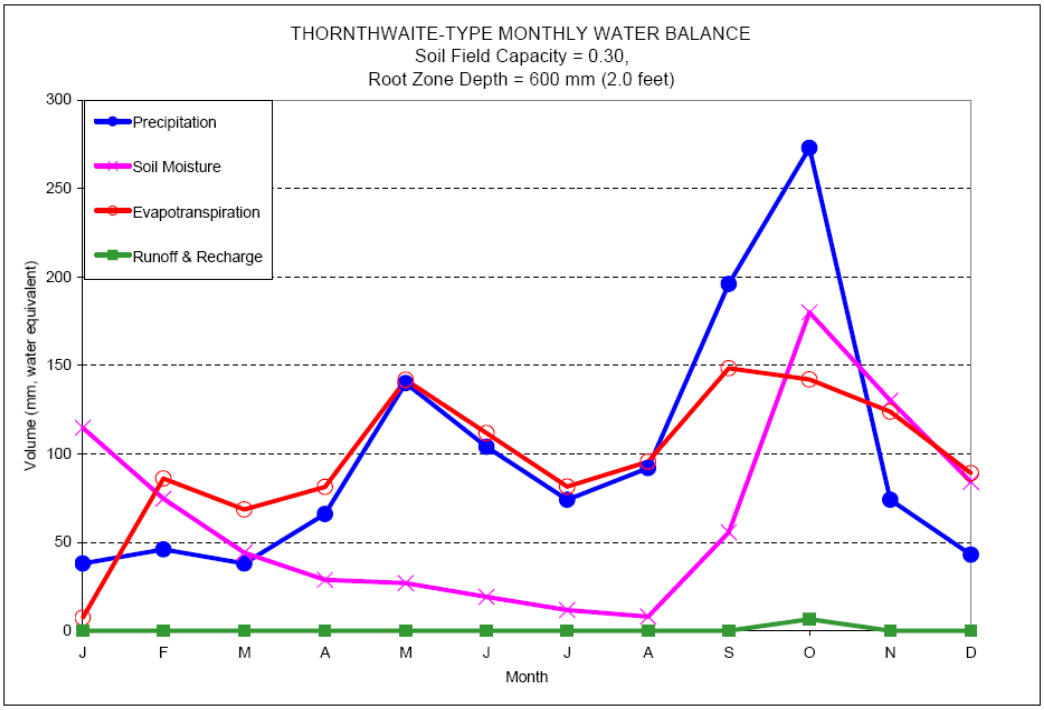
BOD5	260 mg/l
Suspended Solids	160 mg/l
Nitrogen	17 mg/l
Phosporous	26 mg/l

As it can be observed, the quality of the effluent does not meet the discharge limits imposed by ECD of 20 mg/l of BOD and 30 mg/l of Suspended Solids.

APPENDIX 9: Thornwaite-Type Monthly Water Balance Model

Calculation worksheet and background information provided by Dr. John Gierke, Department of Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, Michigan.

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL													
Based on a spreadsheet titled, "ThornEx.xls," by S.L. Dingman, Physical Hydrology, 2nd Ed.						See Box 7-3. PET computed via Hamon equation [Eqn.(7-63)].							
Cell Color Codes:	Input Data		Computed Values (Protected)			Titles, Labels, and Units (Protected)							
Data Source:	www.weather.com												
Year:	Average				Soil Field Capacity, θ_{fc}:	0.30		Root Zone Depth, Z_{rz}:			600	mm	
Location of Climate Data:	Old Harbour, St. Catherine				Latitude:	18.267	decimal degrees			$SOIL_{max}$:	180	mm	
Previous December Snowpack, $PACK_0$:	0 mm (water equivalent)					0.32	rad			$SOIL_0$:	180	mm	
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Average
Julian Day, J:	15	45	74.5	105	135.5	166	196.5	227.5	258	288.5	319	349.5	
Day Angle, Γ (radians):	0.241	0.757	1.265	1.790	2.315	2.840	3.365	3.899	4.424	4.949	5.474	5.999	
Declination, δ (radians):	-0.371	-0.232	-0.039	0.165	0.328	0.406	0.377	0.247	0.058	-0.147	-0.319	-0.406	
Day Length, D (hr):	11.0	11.4	11.9	12.4	12.9	13.1	13.0	12.6	12.1	11.6	11.2	10.9	12
WATER BALANCE Temperatures in degrees Celcius, Water-balance terms in mm water equivalent.													
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation, P:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Mean Monthly Temperature, T:	26.7	26.7	27.2	27.8	28.3	29.4	29.4	29.4	28.9	28.9	28.3	27.2	28
Melting Factor, F:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1
Precipitation as Rain, RAIN:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Precipitation as Snow, SNOW:	0	0	0	0	0	0	0	0	0	0	0	0	0
Snow Pack, PACK:	0	0	0	0	0	0	0	0	0	0	0	0	0
Snow Melt, MELT:	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Input, RAIN+MELT:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Potential Evapotranspiration, PET:	119	123	133	143	152	165	164	159	148	142	132	122	1702
Net Water Input, RAIN + MELT - PET	-81	-77	-95	-77	-12	-61	-90	-67	48	131	-58	-79	-518
Soil Moisture, SOIL:	115	75	44	29	27	19	12	8	56	180	130	84	65
Change in Soil Moisture, ΛSOIL:	31	-40	-31	-15	-2	-8	-8	-4	48	124	-50	-46	0
Actual Evapotranspiration, ET:	7	86	69	81	142	112	82	96	148	142	124	89	1177
Recharge & Runoff, RAIN+MELT-ET-ΛSOIL:	0	0	0	0	0	0	0	0	0	7	0	0	7
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation (inches):	1.4961	1.811	1.4961	2.5984	5.5118	4.0945	2.9134	3.622	7.7165	10.748	2.9134	1.6929	47
Mean Monthly Temperature (F):	80	80	81	82	83	85	85	85	84	84	83	81	83



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Snow Pack, PACK:	0	0	0	0	0	0	0	0	0	0	0	0	0
Snow Melt, MELT:	0	0	0	0	0	0	0	0	0	0	0	0	0
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Soil Moisture, SOIL:	0	0	0	0	0	0	0	0	15	15	0	0	3
Change in Soil Moisture, ΔSOIL:	0	0	0	0	0	0	0	0	15	0	-15	0	0
Actual Evapotranspiration, ET:	38	46	38	66	140	104	74	92	148	142	89	43	1020
Recharge & Runoff, RAIN+MELT-ET-ΔSOIL:	0	0	0	0	0	0	0	0	33	131	0	0	164
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
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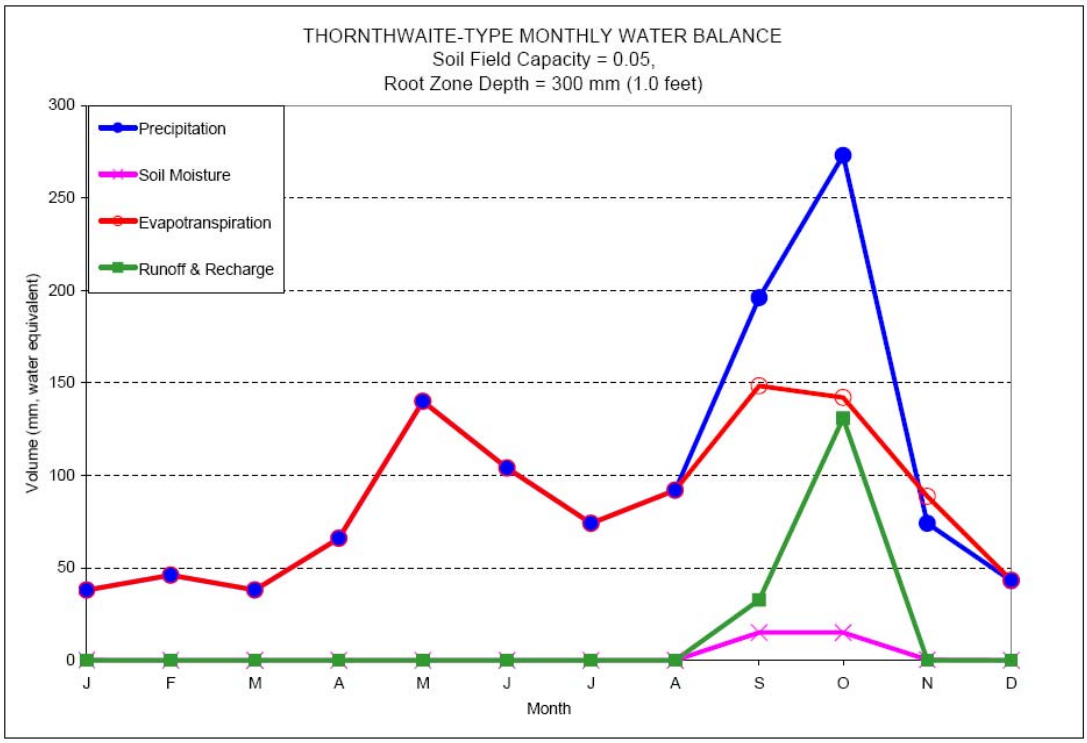

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL													
Based on a spreadsheet titled, "ThornEx.xls," by S.L. Dingman, Physical Hydrology, 2nd Ed.									See Box 7-3. PET computed via Hamon equation [Eqn.(7-63)].				
Cell Color Codes:	Input Data		Computed Values (Protected)						Titles, Labels, and Units (Protected)				
Data Source:	www.weather.com												
Year:	Average				Soil Field Capacity, θ_{fc}:		0.05		Root Zone Depth, Z_{rz}:		150	mm	
Location of Climate Data:	Old Harbour, St. Catherine				Latitude:	18.267	decimal degrees			$SOIL_{max}$:	8	mm	
Previous December Snowpack, $PACK_0$:	0 mm (water equivalent)					0.32	rad			$SOIL_0$:	8	mm	
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Average
Julian Day, J:	15	45	74.5	105	135.5	166	196.5	227.5	258	288.5	319	349.5	
Day Angle, Γ (radians):	0.241	0.757	1.265	1.790	2.315	2.840	3.365	3.899	4.424	4.949	5.474	5.999	
Declination, δ (radians):	-0.371	-0.232	-0.039	0.165	0.328	0.406	0.377	0.247	0.058	-0.147	-0.319	-0.406	
Day Length, D (hr):	11.0	11.4	11.9	12.4	12.9	13.1	13.0	12.6	12.1	11.6	11.2	10.9	12
WATER BALANCE													
Temperatures in degrees Celcius, Water-balance terms in mm water equivalent.													
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation, P:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Mean Monthly Temperature, T:	26.7	26.7	27.2	27.8	28.3	29.4	29.4	29.4	28.9	28.9	28.3	27.2	28
Melting Factor, F:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1
Precipitation as Rain, RAIN:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Precipitation as Snow, SNOW:	0	0	0	0	0	0	0	0	0	0	0	0	0
Snow Pack, PACK:	0	0	0	0	0	0	0	0	0	0	0	0	0
Snow Melt, MELT:	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Input, RAIN+MELT:	38	46	38	66	140	104	74	92	196	273	74	43	1184
Potential Evapotranspiration, PET:	119	123	133	143	152	165	164	159	148	142	132	122	1702
Net Water Input, RAIN + MELT - PET	-81	-77	-95	-77	-12	-61	-90	-67	48	131	-58	-79	-518
Soil Moisture, SOIL:	0	0	0	0	0	0	0	0	8	8	0	0	1
Change in Soil Moisture, ΛSOIL:	0	0	0	0	0	0	0	0	8	0	-7	0	0
Actual Evapotranspiration, ET:	38	46	38	66	140	104	74	92	148	142	81	43	1013
Recharge & Runoff, RAIN+MELT-ET-ΛSOIL:	0	0	0	0	0	0	0	0	40	131	0	0	171
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation (inches):	1.4961	1.811	1.4961	2.5984	5.5118	4.0945	2.9134	3.622	7.7165	10.748	2.9134	1.6929	47
Mean Monthly Temperature (F):	80	80	81	82	83	85	85	85	84	84	83	81	83