

## CHAPTER 4

### 4.0 WATER RESOURCES

#### 4.1 Overview

Water resources are a critical component in any development thus making it a top priority in the planning phase of any project conception. With this in mind, the developer of False Caye has studied the potential occupancy rate and its impact on the potable water demand. These two terms are important as the water sources will be evaluated to meet the demand with a preferred source or sources being discussed and/or explored.

In hindsight, the concept of water resources spans into the selection of a source with the eventual water conservation measures such as those proposed by the project. This will eventually lead to the monitoring of the water resources in order to protect the fragile ecosystem in which the project is found.

#### 4.2 Projected Occupancy

The planned development is a tourism based activity in which the general occupancy for the project is based on the different infrastructures and commodities that accompany the project and as described in the table below. Therefore the maximum daily number of persons that can possibly be accommodated into the project at any one time is 950 persons of which 774 persons are hotel and residential guests, 76 workers and 100 transient visitors. This in effect represents an occupancy rate of 100 % at full development and full operation. This percentage also considers the transient visitors that would visit the resort to utilize the various amenities and services.

**Table 4.1 Projected Occupancy Rate for the Proposed Project**

Series	Description	# of Units/Lots	Unit Prototype	# of Keys	Occupancy (persons)
1	Typical Hotel Unit	74	1 Bedroom	74	148
2	Type B Hotel Unit	32	2 Bd Lock Out	64	128
3	Villa Type A	19	3 Bd Lock-Out	57	114
4	Villa Type B	19	4 Bd Lock-Out	76	152
5	Villa Type C-1	6	4 Bd Lock-Out	24	48
6	Villa Type C-2	9	4 Bd Lock-Out	36	72
7	Special Lot	6	4 Bd Lock-Out	24	48
8	Over Water Cabanas	14	2 Bedroom	14	56
9	Special Estate	1	4 Bedroom	2	8
10	Employees	1	Workers	1	76
11	Transient Visitors	1	Guests	1	100
<b>Projected Occupancy</b>		<b>90</b>		<b>373</b>	<b>950</b>

As can be seen from Table 4.1, the anticipated occupancy rate at 100% is about 950 persons.

The standard hotel occupancy rate as per the Belize Tourism Industry is about 40 % or in the case of the development would be about 350 persons including the transient visitors. This percentage is low by environmental engineering calculation standards and would not show a true picture at full development. With this said, the consultants will utilize the 100 % occupation rate in assessing and calculating the project's water demand volume.

### 4.3 Water Resources

Water resources are sources of water that are useful or potentially useful to humans and their related activities. These can include agriculture, industrial, household, recreational and in our case tourism. Virtually most of these human uses require fresh water which is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing.

The project site is an undeveloped caye located just northeast of Seine Bight Village. This site is also about a mile away from any water source. Considering this fact, the proposed project will rely in finding its own source of potable water for both its construction and operation phase. Consideration will also be given for the possibility of any future connection to the Zeeboz potable water distribution main and use it in combination to the project water source. Piping will be facilitated by utilizing the beach access road reserve that is just south of Maya Playa Resort.

### 4.4 Potable Water Demand

Table 4.2 shows the estimated potable water demand that was calculated using an occupancy rate of 100 % for the project. This in effect should offset any advent water consumption that can occur in such projects. Nevertheless, the proposed undertaking will ensure that the water consumption is accounted for in the daily operation of the project.

**Table 4.2** Estimated Potable Water Demand for False Caye

Type	Unit Description	Maximum Occupancy	Water Demand	
			Units (gals/day)	Total Volume (gallons)
1	Typical Hotel Unit	148	50	7,400
2	Type B Hotel Unit	128	50	6,400
3	Villa Type A	114	50	5,700
4	Villa Type B	152	50	7,600
5	Villa Type C-1	48	50	2,400
6	Villa Type C-2	72	50	3,600
7	Special Lot	48	50	2,400
8	Over Water Cabanas	56	50	2,800
9	Special Estate	8	50	400
10	Employees	76	30	2,280
11	Transient Visitors	100	15	1,500
<b>Projected Occupancy</b>		<b>950</b>		<b>42,480</b>

As can be seen from the table above, the proposed project will be requiring an estimated water demand of 42,480 gallon of water a day at 100 % occupancy.

#### 4.5 Water Source Selection

As mentioned previously, the developer will rely on finding its own source of potable water to supply the proposed project. A number of potential water sources were discussed and analyzed by the consultant in order to meet the project’s water demand. Table 4.3 summarizes the various water sources analyzed considering that demand and also of the possibility of utilizing more than one source of potable water. This would eliminate the dependency of a single source, especially during the dry season.

**Table 4.3** Selection of the Preferred Source for False Caye

<b>OPTION</b>	<b>SOURCE</b>	<b>COMPONENT</b>	<b>TYPE OF TREATMENT</b>	<b>COMMENTS</b>
GROUND WATER	Wells dug on property	Pumps, storage tanks, transmission lines	chlorination	Excellent water source, easy to treat and stored for distribution. Dependent on aquifer supply and recovery rate.
RAIN WATER HARVESTING	Seasonal rains	Storage tanks, water transmission lines, gutters	Chlorination, Ozonation, UV	Excellent water source, easy to treat, but costly in terms of cistern construction and transportation mains.
WATER DE SALINIZATION	Wells,	Pumps, power line, treatment plant, water transmission line, storage tank	Reverse Osmosis, Coagulation, sedimentation, filtration, UV chlorination,	More expensive and complicated to operate, but highly dependable and reliable, good for dry season.
WATER RECYCLING	BESST Wastewater treatment or equivalent	Storage tanks, water transmission lines, dosing tanks	Chlorination, UV	Supplementary option exclusively used for restroom and Bathroom flushing
TRANSPORTATION OF POTABLE WATER TO THE SITE	Zeebox Water main/Big Creek Port	Water trucks, barge, pumps, storage tanks	None	Excellent for temporary use, ideal for construction purposes given adequate loading and offloading conditions

From the table of the preferred source, it can be seen that the project proponent chose to source their water from ground water. It is anticipated that fresh water can be obtained from a well that will be dug on site via telescopic drilling. This fresh water is from a confined aquifer that spans from the Maya Mountains eastwards towards the Caribbean Sea and along the plateau on which False Caye is located.

#### **4.5.1 Source Selection Description**

The project will require about 42,480 gallon of water a day at full development and operation. This volume of water demand from its onset is termed as the initial capital water volume and is likely to change due to the occupancy rate and the different conservation measures that will be implemented. The following summarizes the potable water sources that the project will be relying.

1- Option 1: Potable water for the operation of the resort will be gotten from a well that will be perforated on the property. See figure 4.1 for well cross section and figures 4.2 and 4.3 for well location and water supply plan. This well is expected to supply fresh water to the development. The project will utilize pumps, transmission lines and storage tanks to supply the development with potable water. This system is expected to be coupled to a disinfecting device capable of treating the water to an acceptable level before it will be used.

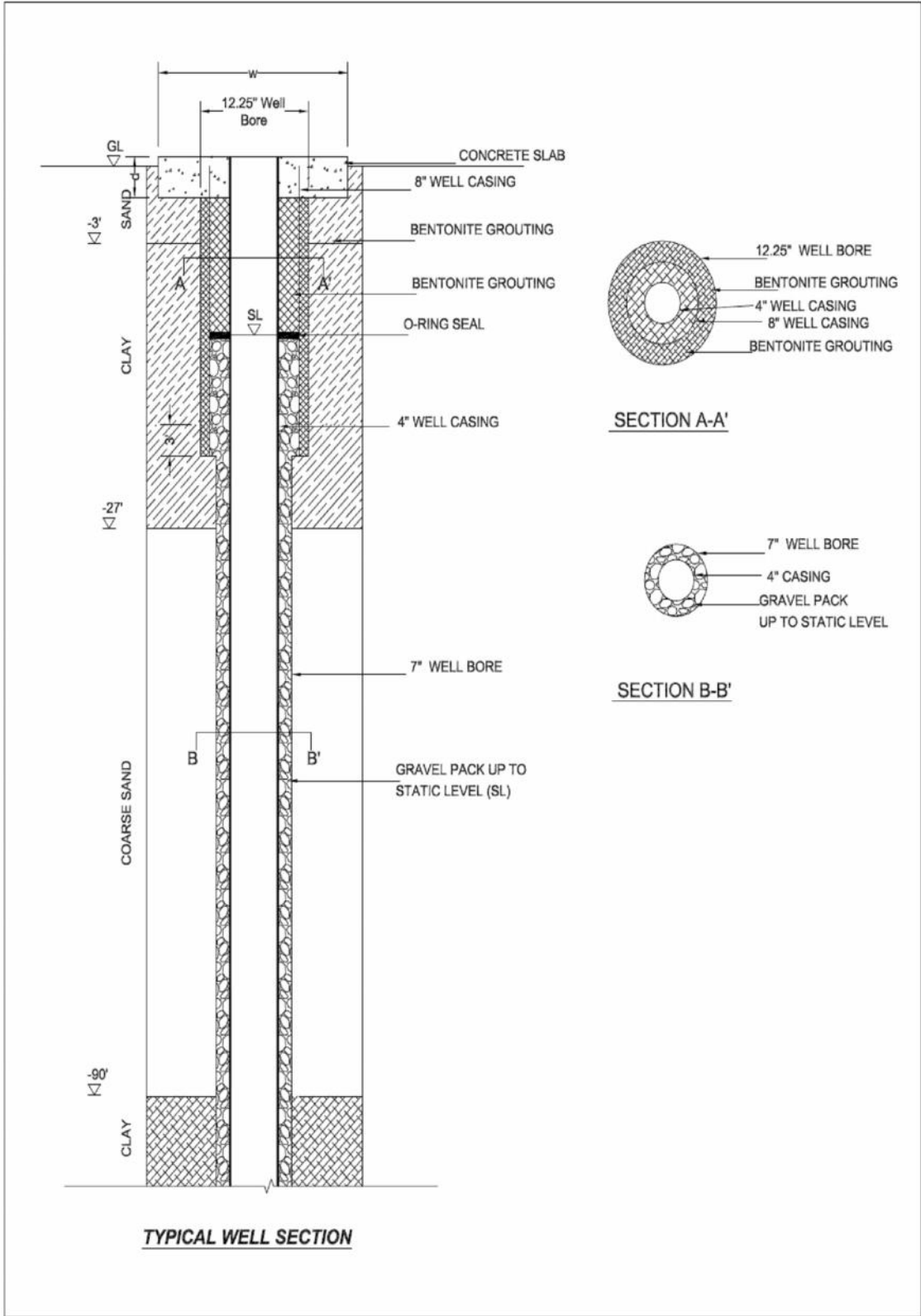
2- Option 2: In light of the above option, if proven unsuccessful, the proponent will install an underwater transmission lines that will send potable water from the Placencia Peninsula to the caye. Potable water will be gotten from the Zeeboz water distribution main, as shown in figure 4.3, and pumped to the caye. About a mile of 3 inch polyethylene pipe will be required for this process. The potable water will be received at the service pier and sent to a distribution tank.

3- Secondary Source: The proposed project plans to harvest some water for minimal use. The harvested water would be stored in drums and made potable by disinfection. This water may be used for some construction works or as a supplement in emergency cases such as drought, or fire.

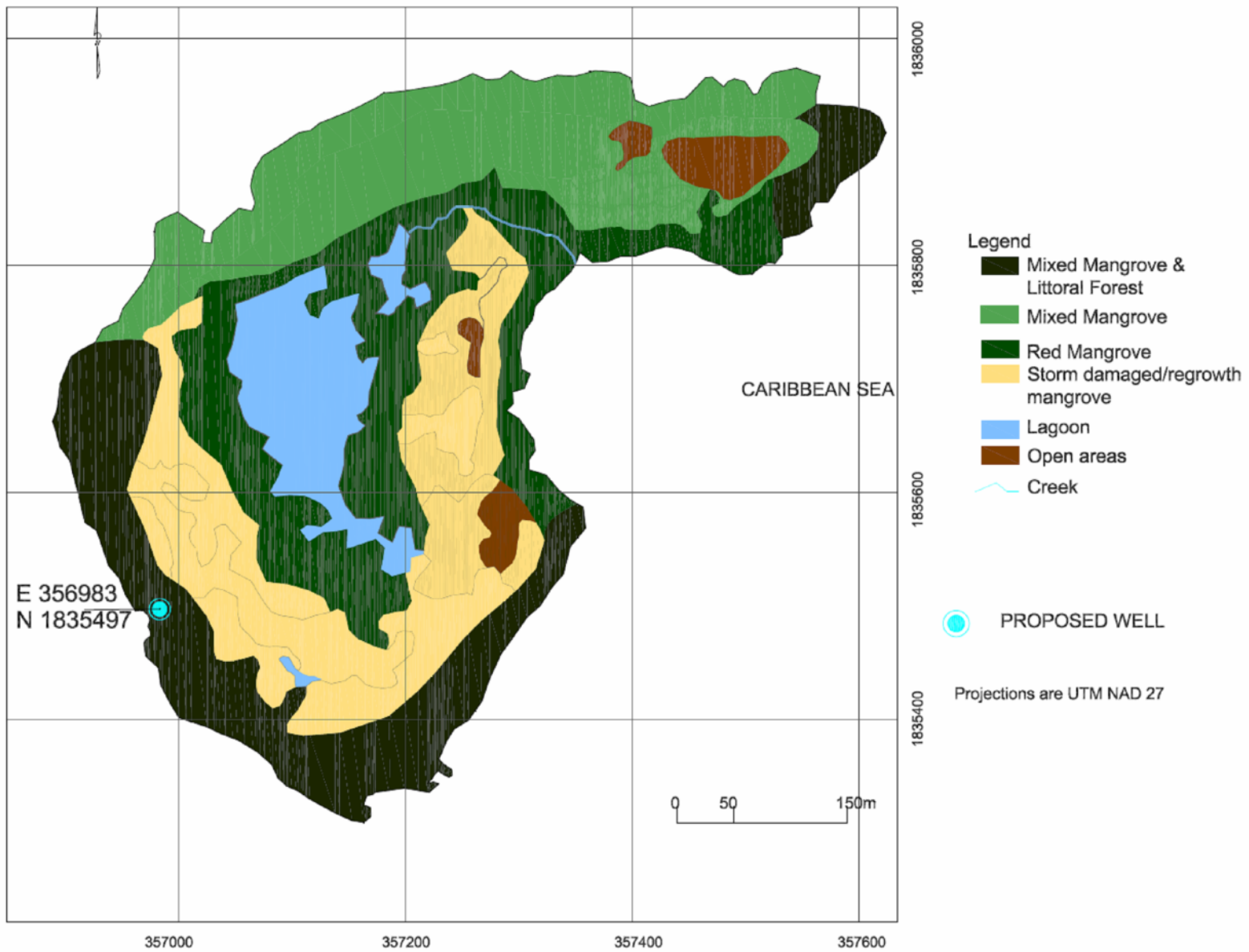
#### **4.5.2 Ground Water Distribution, Storage and Treatment Options**

Distribution will be facilitated by pumping with storage. This is the most desirable option if gravity distribution is not used. Excess water will be pumped into the storage tanks during periods of low consumption. During the periods of high consumption, the water will be drawn from the storage to augment the pumped water. In this fashion, more uniform pumping rates will result and the pumps will be able to run near their rated capacity most of the time.

Water will be stored to equalize the pumping rates, to equalize the supply and demand especially over periods of high consumption, and to furnish extraordinary volumes during emergencies such as fires. Between 30-50 % of the potable water will be required to be stored to equalize the pumping rates during the day, during maximum daily use.

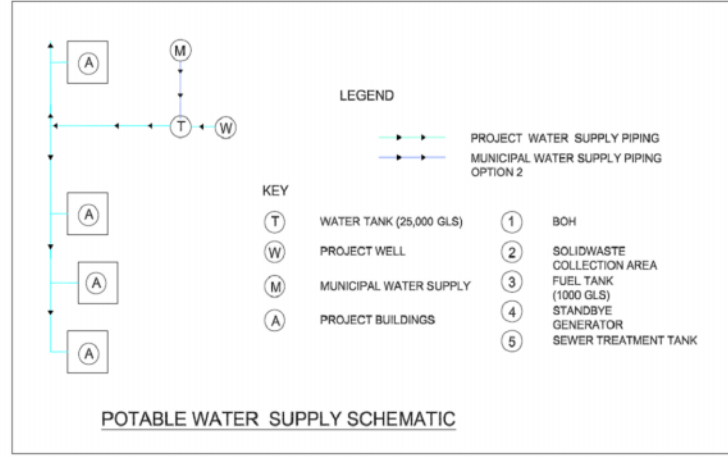
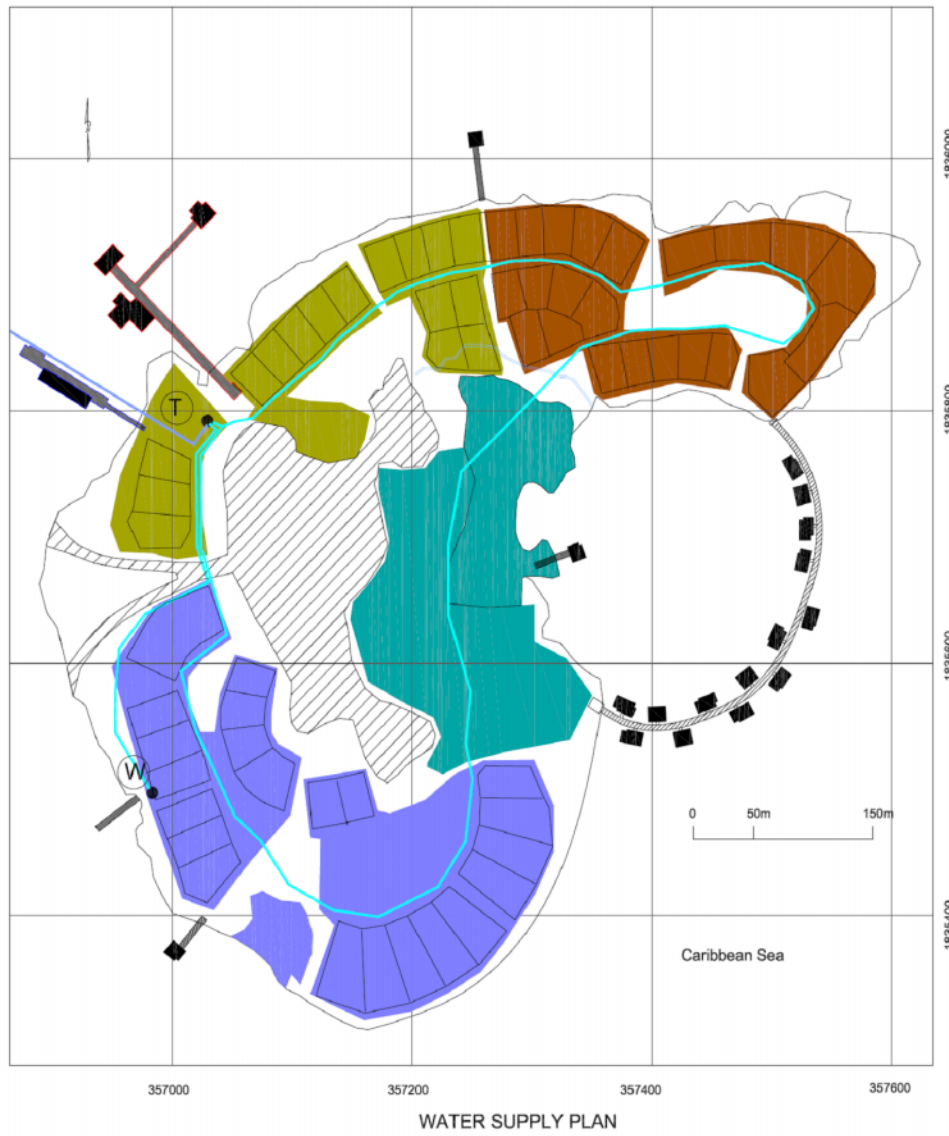


**Fig. 4.1** Cross Section of Proposed Well



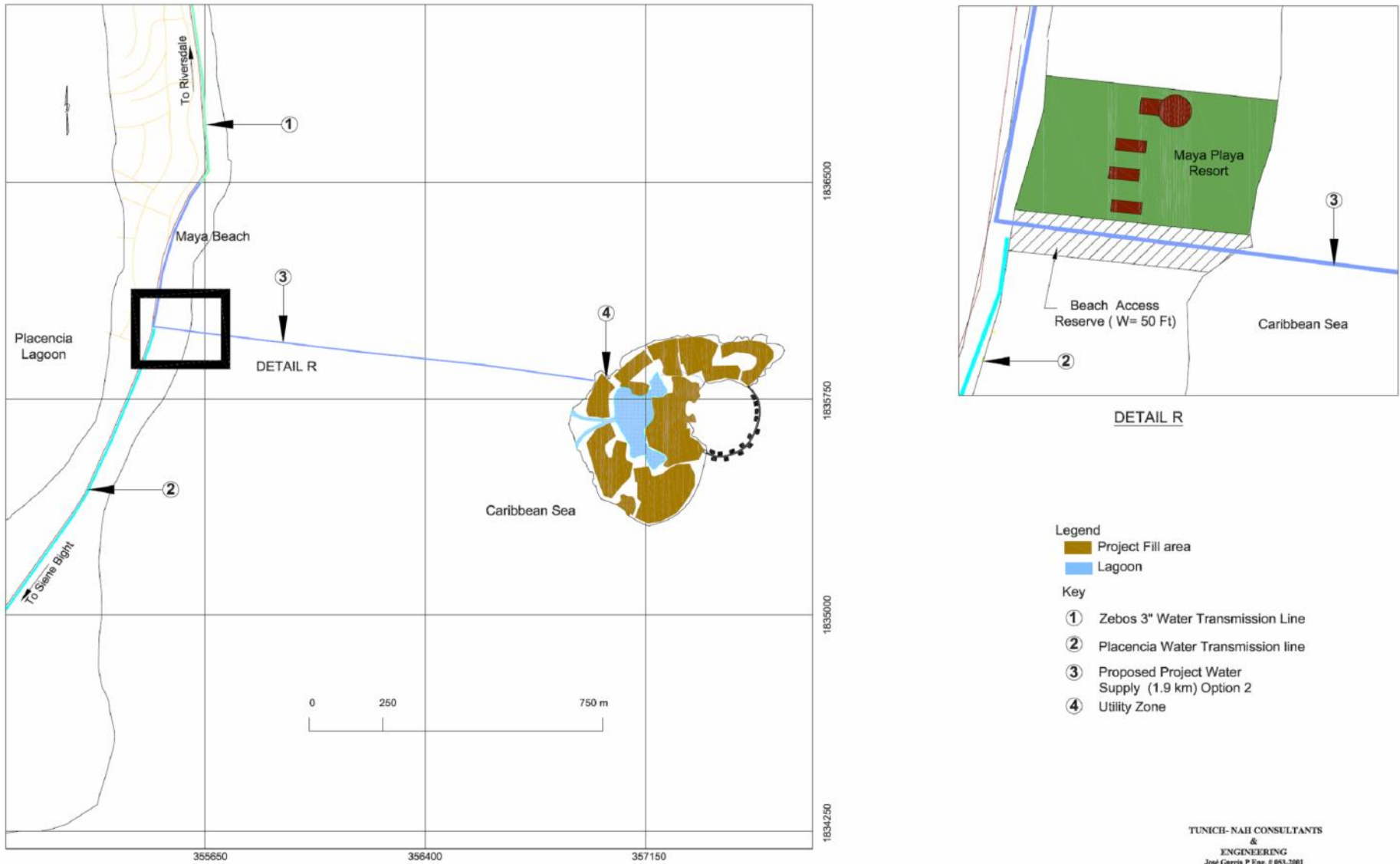
TUNICE-NAH CONSULTANTS  
&  
ENGINEERING  
Toni Garcia P. Eng. # 053-3001

Fig. 4.2 Proposed well location site



TUNICH-NAH CONSULTANTS  
&  
ENGINEERING  
José García P. Eng. # 053-2001

Fig. 4.3 False Caye Water Supply Plan



**Fig. 4.4** False Caye Development Second Option

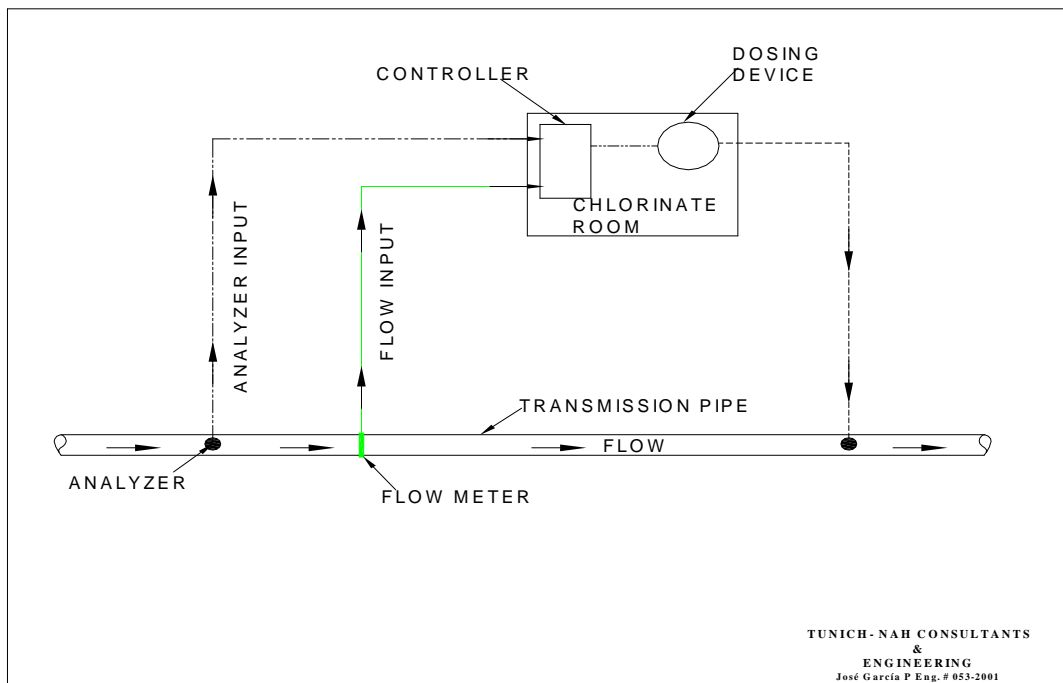
Storage for emergencies is more difficult to determine, and is dedicated by economic benefits to the developer. With this in mind, the developer plans to install two 15,000 gallon tank to store the treated water. This should offset any peak demand during the dry season. The reservoir's capacity is adequate for a day's demand.

A water distribution system consisting of mains and valves will be used to distribute the water to the different project areas for use. The project will eliminate the use of dead ends in the distribution system. Water for the cabanas will be obtained by placing the pipeline system under the piers for aesthetic purposes. All the distribution system will be pressurized for maximum yield.

The ground water is of excellent quality and will require little treatment. The project will entail two treatment options:

- Option 1: Calcium Hypochlorite (granulated or tablet form) can be used to remove any harmful pathogens, see figure 4.5. Residual chlorine will be monitored and additional tests will be carried out as part of the monitoring program. The treatment will meet the US EPA standards for potable water. Once treated, this water can be used for drinking purposes.
- Option 2: A small scale water treatment unit can be installed to further treat the water and remove any harmful pathogens. A domestic unit can also be installed at each facility for drinking purposes. This will include the use of micro screen filters, carbon filters and ultra violet light.

Option 1 is more feasible and will be the desired option for the project. Drinking water will be gotten from anyone of the above mentioned options or from a water bottling company along with the desired services.



**Fig 4.5** Proposed Potable Water Treatment Plan

#### **4.6 Zone of Influence**

The perforation of the well and the subsequent exploration of future wells will not have any negative impact on the other users in the zone of influence. It is projected that this zone belongs to the confined aquifer that will also supply Ara Macao with potable water. A proper pump testing will be done when the well has been perforated to see if there is any change in the hydrostatic pressure of the water.

The project in itself is located about a mile from mainland and thus far from any major development such as the Placencia Corridor, the shrimp farms, banana farms or citrus orchards. It is therefore expected that the supply of fresh water to the project will not influence any other development.

#### **4.7 Water Conservation**

Since the project is located some distance away from mainland, False Caye will develop and incorporate a strict water conservation code. These measures will include the education of the staff and guests on the importance of water conservation and by the installation of flow reduction devices. These procedures will be implemented to reduce water consumption and minimize water loss. These conservation strategies are important considering that the primary source is by harvesting rain water, where rain water is a premium. These conservation methods, should ultimately be beneficial on the long run as both resources and energy would be conserved.

#### **4.8 Surface Water Analysis**

Various water samples were collected for the proposed project site. These samples were analysed by an accredited DOE laboratory in view of the potential baseline data that can be obtained.

As can be seen from figure 4.6, there is not much range among the salinity values even though they seem to be higher than other nearby coastal areas. The salinity ranges are indicative of open waters such as oceans and seas. This also holds true for the conductivity values as well as the total hardness concentration. Both these parameters are indicative of the water environment. The TSS values for the site averaged about 23 ppm which is a fair indication that the water environment is not as clear as those encountered in the other uninhabited cayes closer to the reef.

The nutrient levels for the different sites were low and indicative of low induced impacts. These values however, varied from sample periods with the first being lower than the second. On the other hand, values for BOD were low but not as significant as compared to other uninhabited cayes. Reason for these could be numerous and therefore a monitoring program must be established in conjunction with the Department of the Environment.

Conversely, the microbiological analysis showed that there are no traces of E. Coli or Fecal Coliform bacteria at the different sites. Needless to say, these parameters are important to monitor considering the wastewater disposal options and its associated impacts to the recreational activity of the proposed project.

#### 4.9 Water Quality Monitoring Program

A complete water quality monitoring program will be developed for the entire project. Water samples will be collected and analyzed on a quarterly basis for the following parameters using the recommended protocol required by the *Effluent Limitations Regulations* (this regulation recommends the use of the Standard Methods for the Analysis of Water and Wastewater):

a) In situ Measurements

- Salinity
- Temperature
- Dissolved Oxygen
- Ph
- Turbidity
- Total Dissolved Solids
- Conductivity

b) Laboratory Analysis

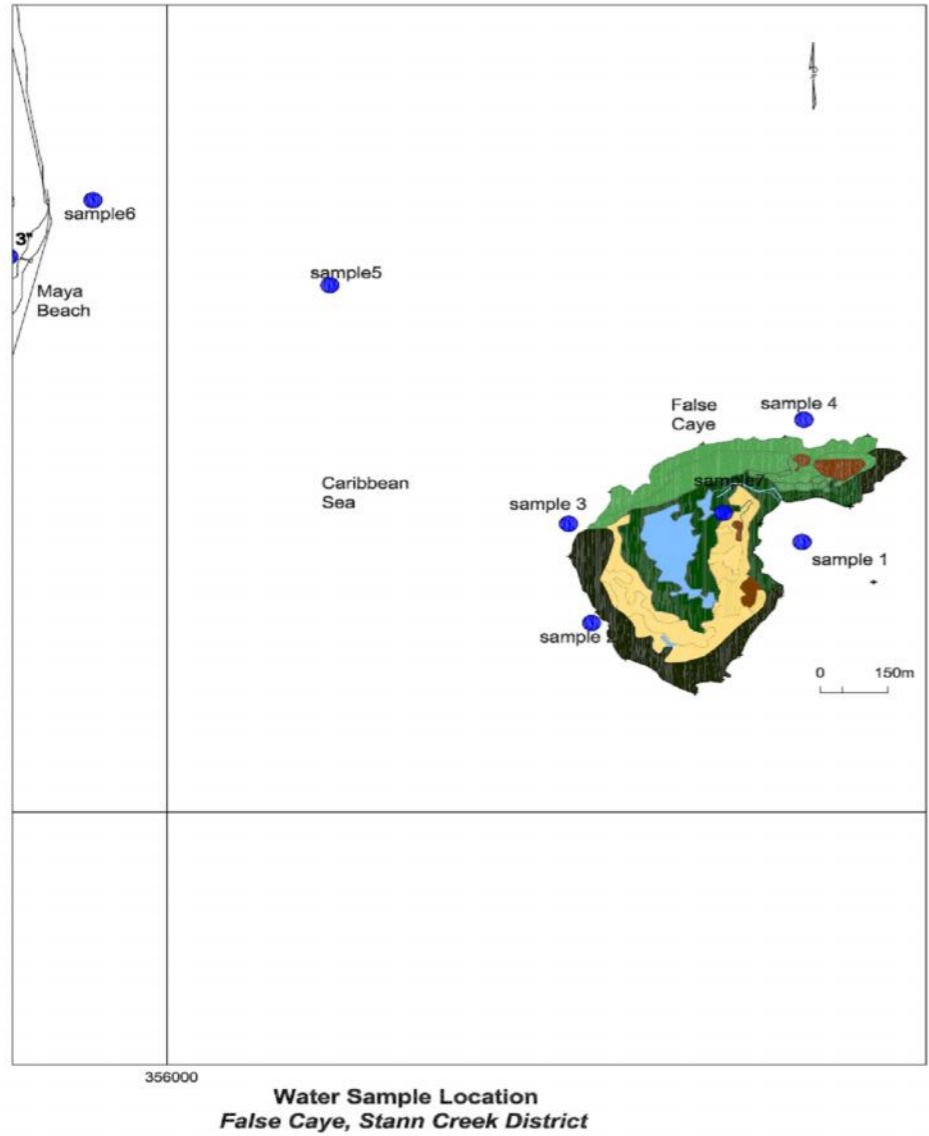
This will include the determination of

- Total Suspended Solids
- Total Nitrate
- Total Phosphate
- Total and Fecal Coliform
- E. Coli

The determination of Total suspended solids is necessary as increases may adversely affect aquatic life due to the reduction of light penetration.

c) Reporting Requirements

Reports on water quality monitoring will be submitted to the Department of Environment on a quarterly basis.



Sample	E	N
sample1	357395	1835702
sample2	358936	1835490
sample3	356885	1835747
sample4	357404	1838017
sample5	356361	1836375
sample6	356836	1836586
sample7	357224	1835774

Inorganic Chemistry			Water Sample Analysis						Date: 9 February, 2007	
Physical	Unit	Method	Results							
			1	2	3	4	5	6		
Conductivity	us/cm	CONDUCTIVITY (probe)	51,200	52,000	51,900	52,200	52,200	51,600		
pH	unit	pH/ISE meter (probe)	7.84	8.07	8.05	7.95	8.13	8.12		
Salinity	ppt	Mercuric Nitrate titration	34.2	35.1	34.8	34.9	34.3	34.8		
Total Suspended Solids (TSS)	ppm	Colorimeter	21	19	22	20	21	17		
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	25,800	26,000	25,900	26,100	26,100	25,800		
Dissolved oxygen (DO)	ppm	Probe	-	-	-	-	-	-		
Phosphate (PO <sub>4</sub> )	ppm	PhosVeri/Orthophosphate/ UV Vis Spectro	0.02	N/D	0.04	0.05	0.09	0.04		
Inorganic Compounds										
Total Hardness (as CaCO <sub>3</sub> )	ppm	Titration / UV VIS Spectro	5,810	6,120	6,200	6,100	5,890	6,010		
Total Nitrate (NO <sub>3</sub> )	ppm	Cadmium Reduction / UV VIS Spectro	0.6	0.6	0.6	0.5	0.6	0.6		
Sulphate (SO <sub>4</sub> )	ppm	Sulfa Ver 4/ UV Vis spectro	3,290	2,660	2,730	2,780	3,100	3,590		
Microbiological Analysis										
Total Coliform	count	m-ENDO Broth (MF)	-	-	-	-	-	-		
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml		
Fecal Coliform	count	m- FC/ROSILIC Broth (MF)	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml		

Inorganic Chemistry			Water Sample Analysis						Date: 20 April, 2007	
Physical	Unit	Method	Results							
			1	2	3	4	5	6	7	
Conductivity	us/cm	CONDUCTIVITY (probe)	54,200	54,300	54,100	53,900	54,000	53,600	55,200	
pH	unit	pH/ISE meter (probe)	8.47	7.96	8.31	8.41	8.15	8.4	7.36	
Salinity	ppt	Mercuric Nitrate titration	36.1	36	36	36	36.1	36	37.1	
Total Suspended Solids (TSS)	ppm	Colorimeter	39,360	41,800	39,620	39,720	39,900	40,140	40,920	
Total Dissolved Solids (TDS)	ppm	CONDUCTIVITY (probe)	27,100	27,200	27,000	27,000	27,000	26,800	27,600	
Dissolved oxygen (DO)	ppm	Probe	-	-	-	-	-	-	-	
Phosphate (PO <sub>4</sub> )	ppm	PhosVeri/Orthophosphate/ UV Vis Spectro	0.02	0.08	0.05	0.01	0.08	0.11	0.06	
Inorganic Compounds										
Total Hardness (as CaCO <sub>3</sub> )	ppm	Titration / UV VIS Spectro	6,345	6,415	6,380	6,230	6,280	6,370	6,750	
Total Nitrate (NO <sub>3</sub> )	ppm	Cadmium Reduction / UV VIS Spectro	3	3	2	3	3	3	4	
Sulphate (SO <sub>4</sub> )	ppm	Sulfa Ver 4/ UV Vis spectro	2,910	3,050	3,215	3,000	2,995	3,055	3,005	
Organic Chemistry										
Oxygen Demand Biochemical	count	BODTRAK /5days Digestion	4.6	8.2	10.2	14.4	16.8	15.2	21.8	
Microbiological Analysis										
Total Coliform	count	m-ENDO Broth (MF)	-	-	-	-	-	-	-	
Escheria Coli (E.coli)	count	m-ENDO Broth (MF)	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	-	
Fecal Coliform	count	m- FC/ROSILIC Broth (MF)	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	0/100 ml	-	

**Fig. 4.6** Water Sample Location for False Caye