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# TURNEFFE ATOLL MARINE RESERVE

CONTROL AND VIGILANCE SYSTEM DESIGN

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**WILDAID**



# ABOUT WILDAID

WildAid's mission is to end the illegal wildlife trade in our lifetimes by reducing demand through public awareness campaigns and providing comprehensive marine protection. We have successfully developed a comprehensive marine enforcement model that strengthens the key elements of the law enforcement chain: surveillance, interdiction, prosecution, and sanction in several Marine

Protected Areas (MPAs) throughout the developing world. We work with governments in the design of strategic control and vigilance strategies that use the power of technology to increase efficacy while lowering patrolling costs. Given weak judicial systems, we also work with partners to develop innovative fining mechanisms that ensure compliance. [www.wildaid.org](http://www.wildaid.org)

## INVESTIGATIVE LEAD AND REPORT WRITING

Marcel Bigue, *Marine Program Director*

Oswaldo Rosero, *Marine Operations Officer*

## COLLABORATORS

### FISHERIES DEPARTMENT

James Azueta, BSc.,  
*Fisheries Officer Ecosystems  
Management Unit Coordinator*  
Lyndon Rodney,  
*Fisheries Inspector and National Fisheries Prosecutor*  
Hampton Gamboa,  
*Supervisor Conservation Compliance Unit*  
Isaias Majil,  
*Fisheries Officer, Marine Protected Areas Coordinator*  
Ramon Carcamo Jr.,  
*Fisheries Officer*  
Charles Young,  
*Fisheries Mechanic*  
Roberto Carballo,  
*South Water Caye Marine Reserve*  
Adriel Enrique Castañeda (MSc.),

*Fisheries Officer*

### FLORA & FAUNA INTERNATIONAL

Robert Bensted Smith,  
*Regional Director*

### TURNEFFE ATOLL TRUST

Craig Hayes,  
*President*

### GRAPHIC DESIGNER

Hugo Ugaz

### PHOTOGRAPHY

Craig Hayes (*Pages 4, 12*)  
Marcel Bigue

# ASSESSMENT METHODOLOGY

This assessment represents the work of a multi-national team and was carried out in Belize over a 2-week period in March 2013. Research methods were developed and applied by WildAid in cooperation with the Belize Fisheries Department. Interviews were carried out with the following actors: Fishery officials, Belize Coastguard, Port Honduras MPA Administrators, TIDE, WCS, Belize Audubon Society,

OAK Foundation, members from both Northern and National Fishing Cooperatives, two Turneffe tourism operators, and Turneffe Atoll fishermen. The 2012–2017 Turneffe Atoll Management Plan proved invaluable as well. Despite both resource and time constraints, we are confident that sufficient information was collected to create a practical, yet versatile C&V system.

# ACRONYMS

AIS Automatic Identification System  
CAPEX Capital Expenses  
C&V Control and Vigilance  
EMS Electronic Monitoring System  
HP Horse Power  
MPA Marine Protected Area  
NM Nautical Miles  
NGO Non Governmental Organization  
NTZ No-Take Zone

IMO International Maritime Organization  
OPEX Operating Expenses  
RFMO Regional Fisheries Management Organization  
SOP Standard Operating Protocols  
TAMR Turneffe Atoll Marine Reserve  
TIDE Toledo Institute for Development and Environment  
WCS Wildlife Conservation Society  
VHF Very High Frequency

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# CONTROL & VIGILANCE SYSTEM DESIGN

## DESIGN OBJECTIVE

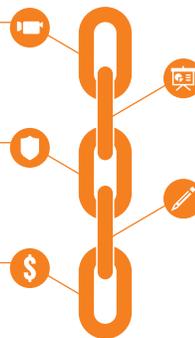
The main objective of this assessment is to design a cost effective control and vigilance system for the newly created Turneffe Atoll Marine Reserve (TAMR). The specific objectives are:

1. Develop a practical control and vigilance system for the TAMR based on interviews of local enforcement actors, analysis of existing co-management strategies, and a comprehensive site visit of the Turneffe Atoll.
2. Prioritize a series of recommendations to optimize patrol costs as well as increase detection efficacy using Electronic Monitoring Systems (EMS). The final recommendations will include the surveillance system design including potential electronic systems, patrol vessels, human resource requirements, energy supply needs, and overall cost estimate: Capital Expenses (CAPEX) and Operating Expenses (OPEX) for a five-year investment plan.

### SURVEILLANCE & INTERDICTION

### PROSECUTION & SANCTION

### SUSTAINABLE FINANCE



### SYSTEMATIC TRAINING

### EDUCATION & OUTREACH

WildAid focuses on the law enforcement chain, that encompasses the activities of detection, interdiction, prosecution, and the fining of lawbreakers. An effective law enforcement system should dissuade potential lawbreakers from committing illegal activities as the consequences/risks associated with apprehension outweigh economic gain. The law enforcement chain requires that each link function effectively and complementarily. Also critical, yet not part of the enforcement chain, is the vital role that outreach and stakeholder education plays in MPA acceptance and compliance. For the purpose of this project, we will focus primarily on the surveillance, interdiction, and systematic training components.

It is worth noting that Belize possesses a very unique regulatory framework that: 1) empowers Fishery officials with arrest authority and the right to bear firearms; 2) allows the Fisheries Department to delegate arrest authority to partner organizations including NGOs for the enforcement of MPAs; and 3) the Fisheries Department can directly litigate in a Belizean court of law. This is advantageous as the overall enforcement process from detection to sentencing is streamlined and enforcement officials are empowered with sufficient authority to apply the law.

# RELEVANT SITE INFORMATION

## LEGAL FOUNDATION:

The TAMR was created on December 1, 2012 via statutory instrument number 105 of 2012 as permitted under Section 14 of the Fisheries Act, Chapter 210 of the Substantive Laws of Belize.

## LOCATION & SIZE:

Turneffe Atoll is located 20 nautical miles east of Belize City and is surrounded by deep oceanic waters. The Atoll is roughly 30 miles long and 10 miles wide, within a proposed management area encompassing approximately 1,316.9Km<sup>2</sup>.

## BIODIVERSITY INFORMATION:

The Turneffe Atoll remains one of the most pristine and diverse marine protected areas in the Western Hemisphere despite overfishing and unregulated development. It is home to a diverse array of species that rely on the connectivity of the coral reefs, sea grass, mangrove, back reef flats and open sea ecosystems. Turneffe species include the American saltwater crocodiles, manatees, Nassau groupers, Queen conch, spiny lobster, sea turtles, great and scalloped hammerhead sharks, among others. There are a total of 260 marine species and three important spawning aggregation sites<sup>1</sup>.

## KEY MANAGEMENT AUTHORITY:

Fisheries Department, Coastguard & Turneffe Atoll Sustainability Authority (TASA).

## LICENSED ACTIVITIES:

- Commercial artisanal fishing: Lobster, conch, and fin fish.
- Sport fishing or recreational fishing: Tarpon, permit, and bonefish (Catch and Release)
- Tourism: Scuba diving and snorkeling. 4,000 divers annually at over 53 dive sites.
- Education & Research: A research station is located on Calabash Caye & Blackbird Caye.

## FISHER CHARACTERISTICS:

- There are an estimated 180 fishers and 20 fishing vessels.
- Belize fishers access Turneffe by 5-meter skiff using 40–60 HP outboard motors. About half of Turneffe fishers operate from fishing camps. They access the Atoll with a variety of boats, which mostly stay at their camps while they are at the Atoll. There is a third smaller group of fishers, mostly from Belize City, who fish the Atoll for a number of days at a time from a 5–9 meter panga with an ice storage box.
- Northern Fishers (Communities of Sarteneja, Copper Bank, and Chunox) access Turneffe using 8-meter sailboats & tow up to ten (10) small wooden canoes. Fishermen free dive.
- Fishing Gear: Hand lines, spear guns, lobster hook sticks, and lobster pots

## ISLAND INFRASTRUCTURE:

- There is no community located on the Atoll.
- Fishermen Camps: There are an estimated 25 fishing camps located within the Atoll (see map for specific locations).
- Tourism Operators: Three all-inclusive resorts: Turneffe Flats, Turneffe Island Resort, and Blackbird Caye Resort. A total of 15+ skiffs and VHF marine radio network. Two live-aboards and various dive operators from San Pedro, Caye Caulker, Placencia, Hopkins and Belize City visit weekly.
- Coastguard: Large base on Calabash Caye with two patrol vessel: one 10-meter vessel with three 275 HP Mercury outboard motors and one 6-meter vessel with a 90HP outboard for patrols in the lagoon. They possess a Harris radio, Garmin radar, two electrical generators, a large photovoltaic system, and three large reservoirs for fuel.
- University of Belize: Research station and former Fisheries office
- Oceanic Society: Station at Blackbird Caye
- Port Authority: Lighthouse on Mauger (completely oxidized) and Caye Bokel

1. The 2012–2017 Turneffe Atoll Management Plan

## TELECOMMUNICATIONS:

Currently there is no public cellular nor marine VHF services (fixed or relay for coordination purposes) on the Atoll. There are five private radio systems used by tourism operators, the Coastguard, and research stations. Internet is contracted directly via BTL (local cellular operator) and/or via a Hughes Network.

NATURE OF THREATS AND MANAGEMENT CONCERNS	
Illegal fishing	<ul style="list-style-type: none"> <li>• Unlicensed fishermen entering the TAMR</li> <li>• Overfishing once catch quotas are established</li> <li>• The targeting of undersized and out of season marine species</li> <li>• Illegal fishing gear: long lines, seine nets, or gill nets</li> </ul>
Tourism	<ul style="list-style-type: none"> <li>• Unlicensed tourism operators</li> <li>• Anchoring in sensitive areas and coral destruction</li> <li>• Water skiing and jet skiing</li> </ul>
Maritime shipping lanes	<ul style="list-style-type: none"> <li>• All Panama – Mexico traffic crosses Belize.</li> <li>• All traffic origin or destination in Honduras, Guatemala, or Belize must cross the coral reef.</li> </ul>
Drug trafficking	<ul style="list-style-type: none"> <li>• TAMR is within a drug trafficking route as can be demonstrated by the presence of the Coastguard and the 47.5 kilos seizure in August 2012</li> </ul>
Development	<ul style="list-style-type: none"> <li>• Dredging of sea grass, reef, and back-reef flats</li> <li>• Clearance of mangrove</li> <li>• Use of sand from beaches</li> <li>• Unregulated and unmonitored development</li> </ul>
Pollution/contamination	<ul style="list-style-type: none"> <li>• Lack of grey and black water treatment</li> <li>• Poor fuel management</li> </ul>
Invasive species	<ul style="list-style-type: none"> <li>• Lionfish</li> <li>• Palm trees</li> </ul>

Table No. 1: Nature of Threats and Management Concerns

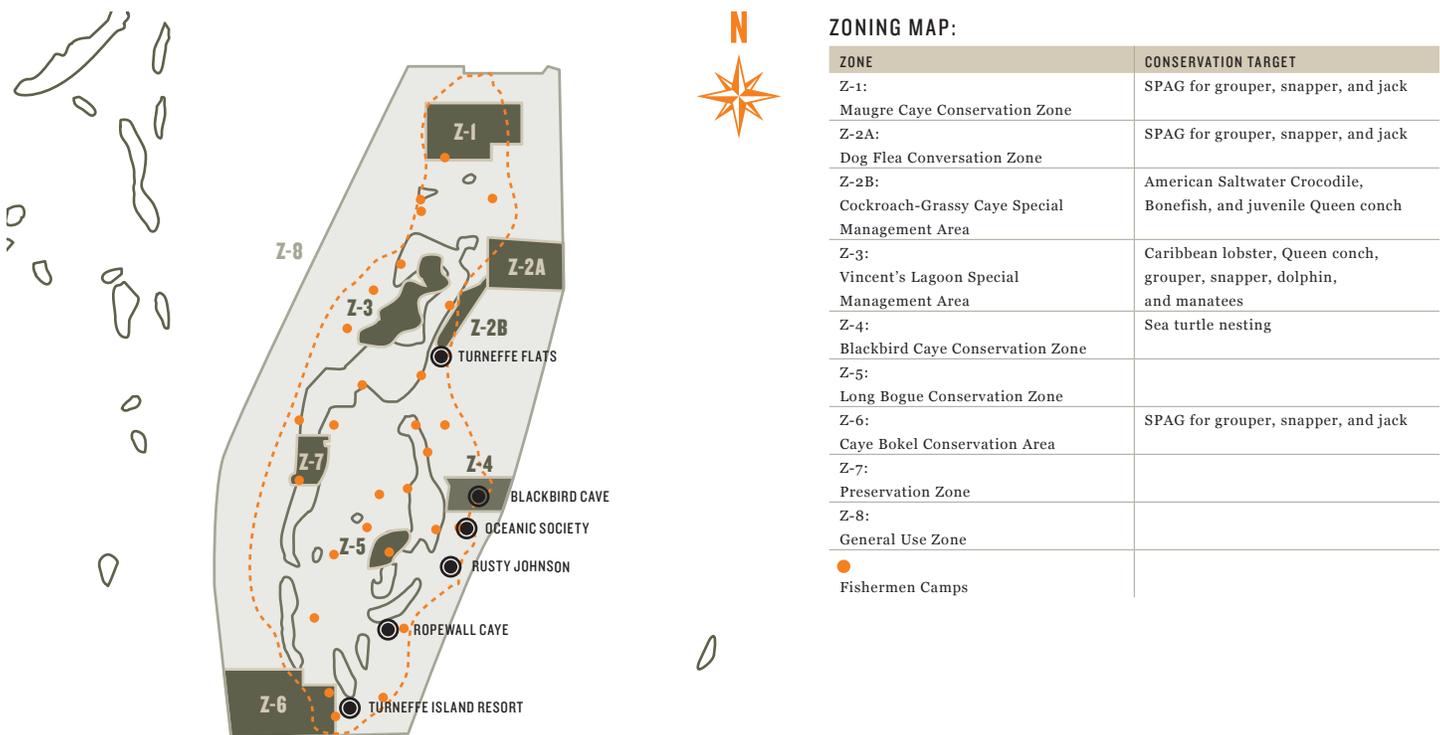


Figure No. 1: Turneffe Atoll Marine Reserve Maps which includes existing infrastructure and zonification plan

# TECHNOLOGY OPTIONS FOR SURVEILLANCE & INTERDICTION

WildAid carried out an exhaustive site inspection to determine the optimal combination of surveillance technology given site characteristics, the profile of stakeholders, use patterns, and capital and operating costs. In this section, we will briefly examine all surveillance technology options and

provide logic for final recommendations, which will be broken down into short term and medium term phases spanning 5 years. The surveillance system must cover the total area of the TAMR (1,316.9Km<sup>2</sup>) as well as a small buffer area beyond its boundaries. In terms of extension, this is a confined system,

however, the TAMR could be incorporated into a nationwide monitoring and control network of MPAs in the future. From a maritime point of view, this is a relatively “small” area. The TAMR extends 30 nautical miles from North-South and extends 10 nautical miles from East-West.

TECHNOLOGY ANALYSIS	
	<b>COLLABORATIVE</b> monitoring systems require location transceivers on-board vessels and require that the location device is active. Location messages include information such as: Vessel name, latitude, longitude, course, and speed. A specific regulatory law must be promulgated to obligate vessel owners to purchase and activate on board transceivers. If the location device is disconnected, clogged, or tampered with, the shore stations and control centers will not see the vessel’s position. As law violators tend to deactivate transceivers, regulations must impose stiff penalties for opportunistic tampering by stakeholders. A major drawback of these systems is that they will not detect fishers from other areas or countries who do not employ transceivers.
<i>Technology</i>	<b>VESSEL MONITORING SYSTEM (VMS)</b>
<i>Criteria</i>	VMS is a satellite based monitoring system that provides vessel positions around the world. As typical location intervals range from 1–6 hours, vms is more adequate for larger vessels and where sheer oceanic expanses need to be monitored. As the system is satellite based, position frequency implies a monthly cost to the user. Higher position intervals translate into a higher monthly cost. The Belize Fisheries Department currently operates a vms system and monitors 127 international fishing vessels. They do not operate within the Belizean Economic Exclusive Zone (EEZ), but throughout various Regional Fishery Management Organizations (RFMOS). The Fisheries Department currently uses Polestar and purplefinder.com to track vessels and vessel location is transmitted with 6-hour intervals.
<i>Recommendation</i>	VMS is not suitable for Turneffe as fisher vessels are too quick to monitor over 6-hour intervals and the recurring monthly costs are normally not feasible for artisanal fishers. Increase in location frequency to 1-hour intervals would only further raise costs for the end user with only limited benefit as fishers could deploy canoes and enter into conservation areas undetected.
<i>Technology</i>	<b>VHF-SAT AUTOMATIC IDENTIFICATION SYSTEM (AIS)</b>
<i>Criteria</i>	AIS is a “focalized” system that initially worked over VHF frequencies and required shore stations to receive the location messages. The use of shore stations limits the coverage to the “radio horizon” (usually between 15–80 nautical miles). Recent developments succeeded in putting AIS Base Stations on board satellites, allowing them to overcome range limitations. Shore based AIS has no cost to the user and provides vessels positions every 3–30 seconds depending on the type of beacon on board (Class A - merchant ships, and Class B - small vessels).
<i>Recommendation</i>	AIS could theoretically be employed to monitor Turneffe sailboat and skiff fishers, however, there are the following considerations: 1) the regulatory framework would need reforming in order to mandate their use; 2) solar powered transceivers cost US\$900–\$1,300 per unit and a financing scheme would be required; and 3) sailboat fishers deploy small canoes which could enter conservation areas undetected. AIS could be required for tourism vessels should management authorities want to monitor their activity over time.
<i>Technology</i>	<b>CELLULAR-GPRS</b>
<i>Criteria</i>	Cellular networks do offer location/monitoring services, but this would imply a US\$19–30 fee per month plus a costly smartphone for fishermen. This is not currently an option on the Turneffe Atoll as there is only very limited cellular service. Obviously the installation of a cellular base station would provide other beneficial services such as texting, internet access, and telecommunications, which are useful for any individual, however, our primary goal is automated control and vigilance.
<i>Recommendation</i>	We do not recommend a cellular network for monitoring services at Turneffe given the high cost of the smartphones and monthly service.

	<p><b>NON-COLLABORATIVE</b> monitoring systems are the best equipment option when detecting vessels that are intentionally carrying out illegal activities in a specific geographic areas or in the absence of collaborative systems. We often layer systems to make up for the deficiencies of one particular technology with the strengths of another. For example, radar systems often complement AIS systems in order to detect foreign vessels or vessels that have intentionally deactivated their transceivers. In this section, we will briefly examine different non-collaborative technologies and evaluate their appropriateness at Turneffe.</p>
<i>Technology</i>	<b>RADAR</b>
<i>Criteria</i>	<p>Radar is most useful for large and distant targets. Radars imply higher staffing levels for both operation and maintenance, which would further complicate logistics and staffing problems. During our assessment, we noted that the Belizean Coastguard possesses a X Band Garmin radar at Calabash Caye. From our evaluation, this equipment will not perform well as it is located too low (approximately 12–14m) and it has no digital processing capability. In short, detection of small targets will not be possible at ranges beyond 3–5 nautical miles.</p>
<i>Recommendation</i>	<p>Radar is not a cost effective option. Given the small size and boat materials (wood and fiberglass), the detection performance of a radar at Turneffe is extremely limited as target echoes are masked among the sea surface clutter. There is radar technology that could detect very small wooden or fiberglass targets, but it would cost between US\$250–500K and would not make for a cost-effective option.</p>
<i>Technology</i>	<b>VISUAL (FIXED FROM OUTLOOK POST &amp; WITH PORTABLE WITH BINOCULARS AND TELESCOPES)</b>
<i>Criteria</i>	<p>Given the relatively small size of the marine reserve and clear zonification of areas, the strategic placement of observation posts combined with the use of binoculars and/or telescopes can be extremely cost effective in detection. From field evaluations performed during the assessment, a patrol boat crew-member has a visual horizon of 4.5–5 miles. When lookout height is raised to 12–15 meters, visual horizon reaches 9–9.5 nautical miles. While visual horizon does not guarantee that small intruders will be detected at those same maximum ranges, maximum visual range data allows planning the outlook posts distribution within the reserve to maximize coverage over the most valuable areas and pathways.</p>
<i>Recommendation</i>	<p>WildAid recommends the use of portable binoculars and semi-portable telescopes since they are not expensive, are versatile, and can be used both on posts as well as on board vessels. For Turneffe, the recommended magnification for binoculars should be no less than 8X (preferably 10X) while telescopes should not be less than 20X-25X.</p>
<i>Technology</i>	<b>VIDEO CAMERA</b>
<i>Criteria</i>	<p>Visual detection can be enormously improved by the use of fixed cameras as they can perform automatic surveillance by using digital processing imaging algorithms and is highly recommended when staffing is an issue. Cameras require additional infrastructure and minimum conditions:</p> <ul style="list-style-type: none"> <li>• A permanent and stable electrical power supply;</li> <li>• A 48 meter 3–4 wind supported (Guyed) tower for elevation;</li> <li>• And an operator station to control Zooming, Azimuth (Pan) and Tilt.</li> </ul>
<i>Recommendation</i>	<p>We strongly recommended the use of at least one (1) high power video camera with daylight/lowlight and a video control station to be located in the main camp. Specifications can be found in Annex I.</p>
<i>Technology</i>	<b>NIGHT VISION DEVICES (NVDs) (FIXED AND PORTABLE)</b>
<i>Criteria</i>	<p>Night vision devices operate in a similar way as video cameras, however, they amplify the scarce light that could be found in the observed scenario, therefore improving the vision capacity of the observer. Various drawbacks can be noted regarding this technology:</p> <ul style="list-style-type: none"> <li>• The detector will not be able to generate an image when operating in all dark conditions or very poor residual light;</li> <li>• NVDs are expensive devices and with the advent of more efficient lowlight technology, common daylight/lowlight cameras are the first option from a cost-effective point of view;</li> <li>• And light amplification requires power, therefore, in portable devices, energy is an issue and normally continuous operation does not exceed 3–4 hours.</li> </ul>
<i>Recommendation</i>	<p>We do not recommend the use of NVDs at Turneffe.</p>

<i>Technology</i>	<b>THERMAL SURVEILLANCE DEVICES (FIXED AND PORTABLE)</b>
<i>Criteria</i>	The use of thermal radiation for marine surveillance revolutionized search and rescue since warm bodies could now be easily detected against colder backgrounds (such as the ocean water). Bodies even behind bushes or mangroves are now identifiable. Current thermal images are combined with powerful optical magnifying lenses, improved amplifying detectors, high digital resolution, and digital frame-to-frame processing that allows the creation of thermal cameras with applications similar to those performed by those that work on the “visual” spectrum. Performance has been enhanced by adapting Laser Illuminators, Laser Rangefinders, digital compass (for target azimuth reading), GPS (for knowing the camera location), and integration to IP networks (cameras could be networked).
<i>Recommendation</i>	Due to the small size of the area, staffing, and financial constrains, this technology would not be appropriate for Turneffe. Perhaps in a follow on phase, portable thermal binoculars could be considered for nighttime stealth patrols, but one must bear in mind that a thermal marine binocular costs an average of US\$4,500–\$7,000.

Table No. 2: Surveillance Technology Analysis

## CONTROL & VIGILANCE SYSTEM DESIGN SUMMARY

The following control and vigilance plan is designed with the following criteria:

1. Limit Capital Expenditures (CAPEX) by utilizing existing infrastructure and keeping the number of vigilance posts and equipment costs to a minimum.
2. Limit Operating Expenditures (OPEX) by strategic placement of vigilance posts, the use of fuel efficient 60 HP 4-stroke motors, the incorporation of Turneffe Atoll stakeholders into the vigilance system, the operation of floating barge, and the use of technology; namely the placement of high power video cameras.
3. The Managed Access framework allows for fisher and stakeholder incorporation into the control and vigilance system as we assume exclusive rights holders have a vested interest in ensuring the protection of fisheries and habitat and should be incorporated as “Surveillance Agents.”



Caption: Existing Infrastructure at Turneffe (Fisher Camps, Tourism Operators, & Coast Gaurd Base)

COMPONENT		RECOMMENDATIONS	
	IMMEDIATE – PHASE I	MEDIUM TERM – PHASE II	
<i>Surveillance</i>	<ol style="list-style-type: none"> <li>Three (3) strategically located Warden posts with lookout towers: <ol style="list-style-type: none"> <li>Stationary post in North;</li> <li>Floating barge in central lagoon;</li> <li>Headquarters located at Calabash Caye.</li> </ol> </li> <li>Visual surveillance equipment: Each post will be equipped with high power binoculars and telescopes.</li> <li>Install high tower at Calabash for placing VHF repeater, Video Camera, and AIS base station.</li> <li>Install Marine VHF Radio Network: 1 repeater at Calabash with base radios at each Warden post and handheld radios for patrol vessels.</li> <li>Install high power camera at Calabash Caye to cover southern and central regions.</li> <li>Install AIS base station for monitoring of local patrol vessels.</li> <li>Staffing: Total of 11 Wardens: 3 per post, 1 Supervisor, and 1 System Mechanic</li> <li>Establish local Ranger training: Basic IMO Courses and Boat Captain’s Course.</li> </ol>	<ol style="list-style-type: none"> <li>Incorporate local fishers into system as first alert aids.</li> <li>Paint authorized fishing vessels one color with unique markings per village.</li> <li>Installation of AIS transceiver aboard fisher and tourism vessels.</li> <li>Continuously monitor fuel once all networks are established to identify costs savings.</li> <li>Install cellular tower.</li> </ol>	
<i>Interdiction</i>	<ol style="list-style-type: none"> <li>Fast Patrol Vessels: The North post and Floating barge will each require one 17–19 foot fiberglass vessel with one 60HP outboard. Calabash HQ will require a 25–28 foot fiberglass vessel with two 115HP outboards. The larger vessel is required for logistics and outer Atoll patrols.</li> <li>Establish critical spare parts inventory, a series of 4-stroke maintenance workshops, and Maintenance SOPS.</li> <li>Elaboration of control center, patrolling, and boarding SOPS.</li> </ol>	<ol style="list-style-type: none"> <li>Improve Crime Scene Investigation and report writing.</li> </ol>	
<i>Prosecution &amp; Sanction</i>	<ol style="list-style-type: none"> <li>Establish an inter-institutional agreement between the TAMR patrol wardens and the Fisheries Department to ensure correct report writing and timely processing of both illegal fishing and tourism violations.</li> <li>Establish a practical database that allows for case monitoring and the recording of repeat offenders.</li> </ol>	<ol style="list-style-type: none"> <li>Ensure that fines for illegal fishing and tourism activities are effectively deterring lawbreakers.</li> </ol>	

Table No. 3: Control and Vigilance System Design Summary





# CONTROL & VIGILANCE PHASE I

## VIGILANCE POST: LOCATION & SURVEILLANCE COVERAGE

CHAPTER TWO  
17°20'9.30"N 87°52'3.60"W

The first step in establishing the TAMR C&V system requires selecting strategic posts where both surveillance coverage is guaranteed, as well as the timely interdiction of lawbreakers. As we will illustrate, the proposed vigilance posts and surveillance equipment provide an almost 90% permanent coverage of the TAMR with a high degree of overlap, which allows surveillance of critical zones with more than one post/sensor at a time. The primary visual equipment to be used at vigilance posts is binoculars and telescopes. We are also recommending the use of a high power video camera to be located at Calabash Caye to aid in the surveillance of both the central Lagoon and the southern area of the Atoll. Camera specifications can be found in Annex I. WildAid strongly recommends the deployment of a floating barge versus a fixed station for the Central Post as the barge allows flexibility in the surveillance system. The floating barge allows greater system flexibility as user patterns and the zoning areas may change over time. The barge can be moored at either primary entrance/exit waterways

on the Western side of the Atoll or at key conservation areas to serve as a deterrent, inspection point, and mobile surveillance platform. We have deployed floating barges in other marine reserves with great success. While you may have a greater initial capital cost, the investment will pay for itself over the long run. We are recommending the use of a concrete hull barge, which requires absolutely no hull maintenance thereby drastically reducing your maintenance costs over its useful life. Please find floating barge characteristics in Annex II. While technology may aid in the detection of fishers, a physical presence of inspectors is vital to ensure that conch and lobster caught meet minimum catch size. Only visual inspection of a law enforcement officer can guarantee compliance of key Turneffe fisheries.

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### CRITERIA FOR VIGILANCE POST LOCATION

Vigilance posts were located based on the following criteria:

- Coverage over the special protected areas
- Control over access waterways
- Monitor transit zones
- Control over fisheries zones
- Surveillance of buffer zones (external)
- Minimum response time (time to infraction)

We recommend locating the main base at Calabash Caye for the following reasons: 1) available land and former Fisheries office structure damaged by Hurricane; 2) existence of power sources; 3) central location within the TAMR; 4) guaranteed security with Coastguard presence; and 5) the existence of two docks. We attempted to identify an adequate location for a southern vigilance post as well, however, both CAPEX and OPEX would increase significantly with the addition of a fourth vigilance post, not to mention land tenure was an issue. Surveillance and interdiction of the southern end of the Atoll can be provided via the combination of the video camera at Calabash Caye, the floating barge, and respective patrol vessel.

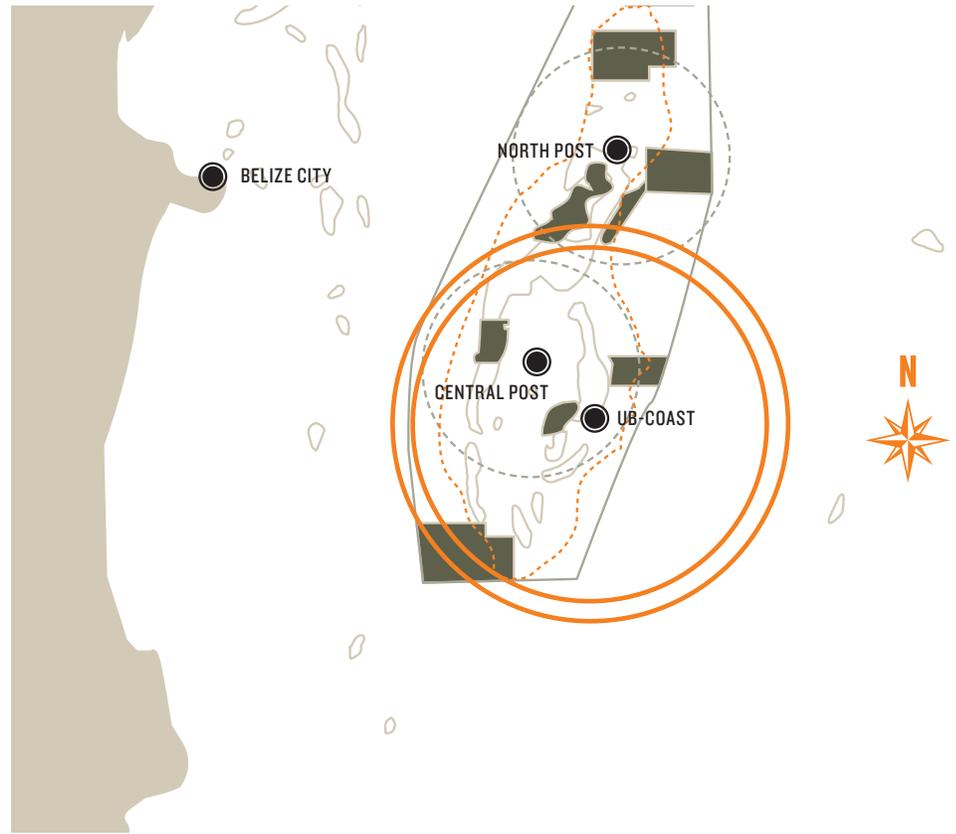


Figure No. 2: Surveillance Coverage with TAMR Management Zone Considerations

SITE	LAT	LONG	SITE HEIGHT (M)	TOWER HEIGHT (M)	TOTAL HEIGHT (M)
North Post	17°32'5.30"N	87°46'59.20"W	1.5	15	16.5
Central Post/Barge	17°20'9.30"N	87°52'3.80"W	1.5	15	16.5
UB-CB Post	17°17'0.05"N	87°48'37.00"W	2	48	50

Table No. 4: Vigilance Post Locations & Tower Height

## VIGILANCE POSTS: VISUAL HORIZON & COVERAGE

Visual horizon derives from a mathematical calculation that takes into account the shape of the earth as well as the height of the observer and target at their location.

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$$D_{\max} = 1.9276 \cdot (\sqrt{h_1} + \sqrt{h_2})$$

WHERE:

$D_{\max}$  = Maximum Visual Range (nautical miles)

$h_1$  = Observer height in meters

$h_2$  = Target height in meters (for small boats we assume 1m)

Under these mathematical conditions, visual horizon estimate for each post are as follows:

SITE	SITE HEIGHT (M)	TOWER HEIGHT (M)	TOTAL HEIGHT (M)	VISUAL HORIZON (NM)	COVERAGE SAILING BOATS (NM)	COVERAGE TOURISTIC BOATS (NM)
North Post	1.5	15	16.5	9.8	5-5.5	7.5
Central Post/Barge	1.5	15	16.5	9.8	5-5.5	7.5
UB-CB Post	2	48	50	15.6	8.5-9.5	10.5-11

Table No. 5: Vigilance Post Surveillance Horizon & Coverage

## MINIMUM SURVEILLANCE & SURVIVAL EQUIPMENT

The minimum equipment for boats and posts:

QTY	ON BOARD EQUIPMENT	LOCATION
3	Megaphone 25W with rechargeable batteries	All boats
3	Waterproof, shockproof, and portable GPS	All boats
4	First Aid Kit	On posts and 1 spare at main base
18	PFD, life saving jacket (flotation) yellow or orange	All boats
1	GPS w/ECDIS display and AIS interface	On board interceptor boat
3	Class B AIS transceiver: waterproof, fixed to boat, and connected to alternator	All boats
4	Marine waterproof binoculars 10X50 or up to 12X50	All posts and on boats while on patrol
3	Marine waterproof night vision devices with 5X zoom	All posts
6	LED search lights with rechargeable batteries	All boats
3	Waterproof and floatable handheld marine VHF radio 5–6W with built in GPS-DSC capability	
3	High performance antennas for handheld marine VHF radios	All boats
3	Extra batteries for handheld marine VHF radios	To remain on posts
3	Battery chargers for handheld marine VHF radios	To remain on posts
3	14.1 mega pixel shockproof/waterproof Digital Camera with Optical16x Zoom and built in GPS	All boats
3	Extra batteries for digital camera	All boats
3	16 GB SDHC flash memory cards for cameras	All boats
16	Leatherman multi tool	All wardens
4	Solar powered flashlights with battery backup	All boats (2 on main base)
12	Inflatable vinyl boat fender (8"x 24", white)	Smaller boats
6	Inflatable vinyl boat fender (12"x 36"), white)	Interceptor boat
9	Coastal locator flares kit	All boats (3 on each)
3	Digital camera storage bag	All boats
6	Pelican case 1620	All boats (2 on each)

Table No. 6: Vigilance Post & On Board Equipment Requirements

## RESPONSE TIME

Once identified by the surveillance system, a rapid response time for interdiction is critical. Consideration must be made for detection ranges, target speed/size of outboards, and fuel consumption. WildAid suggests that patrol vessel motors should not be less than 60HP. Assuming a 30K interception speed and that the suspicious target travels at a speed of 6Kt (*total relative interception speed of 36Kt*), the response times from the Posts to maximum ranges are the following:

SITE	TIME TO INTERCEPT (MINUTES)
North Post	16.26
Central Post/Barge	16.26
UB-CB Post	25.93

Table No. 7: Time to Intercept Calculation

## EQUIPMENT: PATROL VESSELS

Normal operations shall be performed within the boundaries of the TAMR with the occasional open ocean patrol & logistical trip to Belize city. The desired vessel fast response speed needed is 36 knots.

QTY	LENGTH	MOTOR	ACCESSORIES
02	18' fiberglass boat for internal Atoll patrol	01 60-HP 4 stroke Include remote control helm (02 motor total)	Include: <ul style="list-style-type: none"> <li>Fiberglass canopy</li> <li>Portable AIS Class B beacon</li> <li>Fixed to hull fuel tank</li> </ul>
01	24' fiberglass boat for external Atoll patrol and logistics	02 115-HP 4 stroke Include remote control helm	Include: <ul style="list-style-type: none"> <li>Fiberglass canopy</li> <li>GPS with electronic chart display</li> <li>Magnetic compass</li> <li>Fixed marine VHF radio w/antenna</li> <li>Fixed to hull fuel tank</li> </ul>

Table No. 8 Boats and Motor Characteristics

## CALCULATIONS FOR FUEL CONSUMPTION

Using Yamaha manufacturer technical information, we have calculated fuel consumption using Wide Open Throttle (WOT) calculations as our point of reference. Patrols/ Interdictions will be the responsibility of the smaller vessels while the larger vessel will be deployed for oceanic interdictions and logistical trips.

O/B MOTOR TYPE	QUANTITY	US\$/GAL	WOT CONSUMPTION GAL/H	OPERATION HOURS/MONTH	FUEL COST/MONTH
115HP	2	\$6.0	8.71	33.0	\$3,449.16
115HP floating base	2	\$6.0	8.71	4.4	\$459.89
60HP	2	\$6.0	4.544	55	\$2,999.04

Table No. 9: Fuel Cost Consumption Calculation

TOTAL FUEL CONSUMPTION PER MONTH:  
\$6,908 (1,151.33 GAL)

TOTAL FUEL CONSUMPTION PER YEAR:  
\$82,897 (13,816 GAL)



Caption: Belize Fishery Officials on Patrol at Turneffe

# INSTALLATION OF VHF RADIO NETWORK & AUTOMATIC IDENTIFICATION SYSTEM (AIS)

The core of enforcement operations is the VHF radio network. The network will link the base camps with patrol vessels and the main base, and hold potential for linking tourism operators and fishers into the control and vigilance system over time. At the Main Base, a Repeater Station is needed

in order to extend the communications range of all the stations on shore and at sea. Marine 25W VHF Base Stations are needed at the Main and remote bases and patrol vessels and individual rangers should be equipped with handheld marine radios operating with improved capabilities such

as higher power and high performance antennas. The communication system will require one Guyed 48m Radio communication tower, civil works for foundation and electrical power sources. A referential budget can be found in Annex III.

## LOCATION OF VHF NETWORK SITES & VIGILANCE POST EQUIPMENT

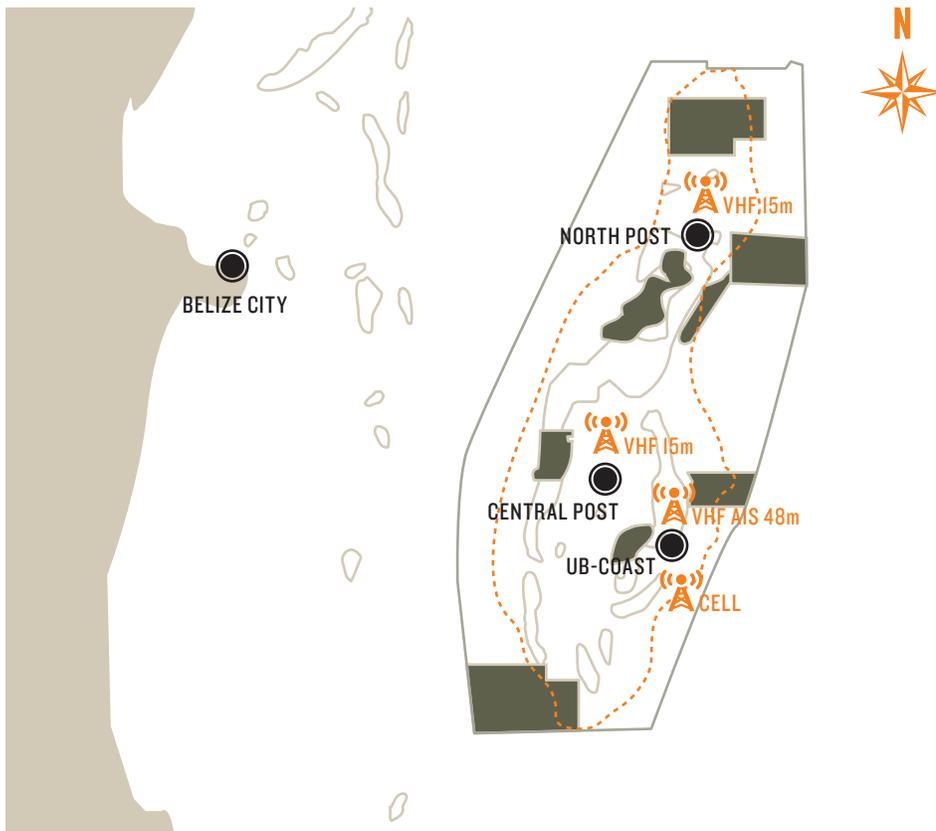


Figure No. 3: Location of the Telecommunications Towers

POST	AIS SHORE STATION	MARINE VHF REPEATER	MARINE VHF BASE STATION	MARINE VHF HANDHELD RADIO
North Post	–	1	1	–
Central Post	–	–	1	–
UB-CG	1	–	1	1
NP Patrol vessel	–	–	–	1
Central Post vessel	–	–	–	1
UB-CG Patrol vessel	–	–	–	1

Table No. 10: VHF Network & Vigilance Post Equipment Placement

## AUTOMATIC IDENTIFICATION SYSTEM (AIS)

We recommend placing one AIS base station at the University of Belize - Coast Guard Station given its central location on the Atoll and site security. An AIS base station would require a 48 meter tower, one 6dB antenna, its cable, and an in-house receiver and would provide 20 nm coverage, which would adequately cover the TAMR and beyond. In Phase I, we recommend installing the AIS shore station and equipping only patrol vessels with AIS transceivers as both a management and safety tool.

AIS for fisher and tourism monitoring is recommended for Phase II as currently there are no national laws that mandate the use of AIS for small vessels in Belize and warden training needs to be performed in advance for proper use of the system as a control and monitoring tool. Hence, the mandatory requirement of AIS for artisanal and tourism vessel monitoring within the TAMR would require a legal foundation and would most likely need to be promulgated via the Belizean Port Authority or perhaps the Department of Fisheries as a

pilot project for the TAMR. During Phase I, TAMR and Fisheries officials should explore potential legal reform scenarios and carry out consultations with key stakeholders to gauge feasibility, interest, and cost of AIS deployment on small vessels. The International Maritime Organization (IMO) possesses a blueprint of mandatory and recommended norms for all activities related to ships, ports, traffic, and activities related to the use of the sea.

## AIS COVERAGE CALCULATIONS

- AIS Base station will be placed at UB-CG site
- AIS Base station antenna will have a Gain of 6dB
- AIS Rx Antenna will utilize the 48m guyed tower that will be implemented at the base camp
- AIS Rx Antenna will receive monitoring signals from Class A and Class B AIS beacons
- Class A and Class B beacons are assumed to be installed at a height of 2.5m

UNDER THESE CONDITIONS, THE PREDICTED MAXIMUM DETECTED RANGES ARE:

SITE	SITE HEIGHT (M)	EXPECTED RANGE NM	
		TX POWER (WATT) AIS CLASS B	TX POWER (WATT) AIS CLASS A
UB-CB Post	50	16.94	26.79

Table No. 11: AIS Coverage for Class A & B Transceivers

AIS Class A coverage is depicted in dark green (outer circle), while Class B in light orange (inner circle). All physical approaches to the reserve waterways are covered therefore all boats entering the reserve with an active transceiver would be detected by the system. A small part of the northern cayes internal waters region falls outside the Class B maximum range, but is complemented by visual surveillance assuring 100% coverage.

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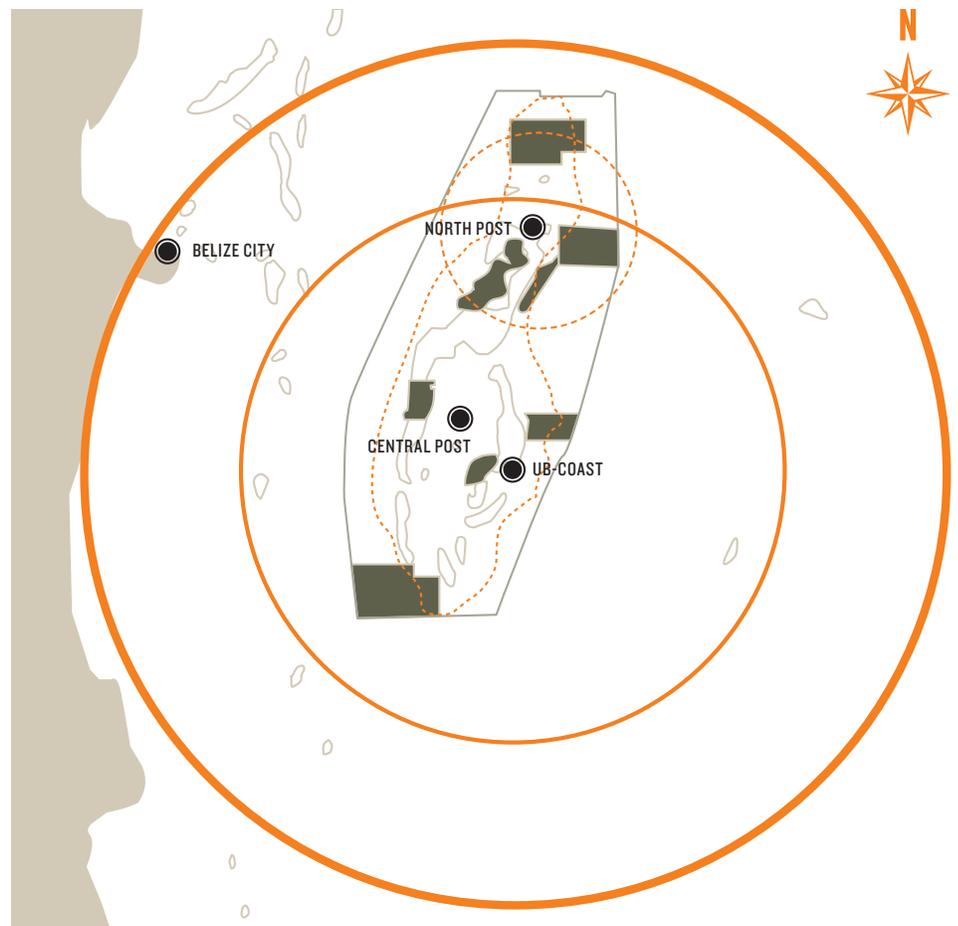


Figure No. 4: AIS Surveillance Coverage

# POWER SUPPLY

Given the energy requirement levels of the control and vigilance system outlined below, we are confident that all can be covered by solar power. The energy generation system will be comprised of the following: solar panels, charge control device, sealed maintenance free batteries with 10 years of operational life, distribution panel, and cable.

TYPE OF SITE	TOTAL POWER REQUIRED	REFERENTIAL EQUIPMENT SUPPORTED
Vigilance posts:	2.8–3.9 kW with 40% margin	6x15W light bulbs (LEDs or fluorescent) 2x400W laptop computers 1x25W VHF radio 1x600W small refrigerator 1x300W 24inch LED TV + DVD player 1x300W other electric appliances or charging devices
Control station (main base)	5.5–6.0 kW with 40% margin	12x15W light bulbs (LEDs or fluorescent) 4x400W laptop computers 1x500W printer 1x25W VHF radio 1x1000W medium sized refrigerator 1x300W 24inch LED TV + DVD player 1x800W camera and other electric appliances or charging devices

Table No. 12: Power Requirements for Vigilance Posts & Main Base  
 Caption: Artisanal Turneffe Fishers (Sailboat, Skiff, & Canoes)



# MINIMUM STAFFING & TRAINING REQUIREMENTS

## STAFF REQUIREMENTS

A minimum of 11 staff will be needed to operate the control and vigilance system at any given time. Additional personnel must be trained and available to operate the system on a rotating basis. Standard practice for field enforcement posts in Belize is 2 weeks on and 1 week off. This rotation will require at least three additional wardens for a TOTAL OF 14 STAFF.

POST & FAST LAUNCH	INTERDICTION TEAMS	POST OFFICER	WARDEN MECHANIC	C&V SYSTEM MANAGER	AUXILIARY	TOTAL STAFF
North Post	2	1	–	–	1	4
Central Post	2	1	–	–	1	4
UB-CG	2	1	1	1	1	6
Total	6	3	1	1	3	14

Table No. 13: Minimum Staffing Requirements

## TRAINING REQUIREMENTS

A comprehensive training program shall be carried out in order to build up the professional capacity of the newly hired management and enforcement team. Training programs must be executed by certified instructors and preferably provided by accredited entities such as the

California Maritime Academy among others. We highly recommend a combination of theory and practical exercises for improved retention of information and swift adoption of newly developed skills. We also recommend complementing workshops with the elaboration of Standard

Operating Protocols (SOPs) to institutionalize processes and prevent informal interpretation of best practices. Below please find the minimum suggested courses for the TAMR enforcement staff.

COURSE TOPIC	COURSE DESCRIPTION
Basic IMO training	<ul style="list-style-type: none"> <li>• First Aid</li> <li>• Survival at sea</li> <li>• Fire fighting</li> </ul>
Surveillance, detection, interdiction and boarding	<ul style="list-style-type: none"> <li>• Operations planning and preparation</li> <li>• Use of visual and electronic sensors in marine patrolling</li> <li>• Boarding procedures: performing inspections, documentation to request, what to look for, and documenting your inspection</li> <li>• Interviewing the suspect's boat crew</li> <li>• Crime Scene key practices/Evidence collection and handling</li> <li>• Operations/Felony Reports: information and itEMS that are typically in a "good" report</li> </ul>
Operations planning and control center management	<ul style="list-style-type: none"> <li>• Control Center functions including risk assessment (GAR model), asset use, reporting, communications procedures, surveillance procedures, and documentation</li> <li>• Telecommunications lines and coordination procedures with the Coast Guard</li> <li>• Situation escalation procedures and real time reporting</li> <li>• Terrestrial Charts interpretation and navigation</li> <li>• Nautical Charts interpretation and navigation</li> <li>• Search and rescue</li> <li>• First aid provided in the field</li> <li>• Personal safety issues for patrolling and boarding</li> </ul>
YAMAHA basic and advanced O/B service training course	<ul style="list-style-type: none"> <li>• All wardens must participate in an OEM basic outboard motor maintenance certification course</li> <li>• Two (2) of the wardens will be trained in second level maintenance: computerized diagnostic, critical spares replacement, and motor tuning</li> <li>• Overhauling shall be conducted at manufacturer' authorized workshops in Belize City</li> </ul>
SOPs	<ul style="list-style-type: none"> <li>• Maintenance</li> <li>• Control center</li> <li>• Patrolling</li> <li>• Boarding teams</li> </ul>

Table No. 14: Training Requirements





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# CONTROL & VIGILANCE PHASE II

## STAKEHOLDER SURVEILLANCE OF ILLEGAL FISHING & ILLEGAL TOURISM

CHAPTER THREE  
17°20' 9.30" N 87°52' 3.80" W

As mentioned earlier we would recommend incorporating key stakeholders into the TAMR surveillance system given the high costs associated with patrolling. Once under Managed Access, the TAMR will only be accessible to an exclusive number of fishers and registered fishing vessels. As such, we recommend the establishment of a practical visual detection system whereby all Turneffe registered fisher vessels are painted with a single color as well as the installation of a pole and TAMR flag on every fisher vessel. From an enforcement perspective, this will help in easily differentiating between local and foreign fishers. Illegal tourism is also a potential problem, which can be resolved through the incorporation of both licensed fishers and tourism operators into the surveillance system.

As the VHF radio network will be operational, select fishers and tourism operators could receive a marine VHF handheld radio and alert TAMR authorities about any unusual activity or unidentified boats entering the MPA. There are a few fishers who possess fishing camps near critical management zones who could be very useful in providing intelligence. During our visit to the Port Honduras Marine Reserve, we learned that TIDE carried out a fisher enforcement program with success, though they renamed the agents stewards versus

enforcement agents given reprisal risks to the fisher agents. In our interview of Turneffe fishers, they also expressed fear of reprisal from illegal fishers though they did express willingness to collaborate given illegal fishers complete disregard for respecting catch size minimum limits. The fisher and tourism surveillance program should be rolled out gradually and perhaps initially limited to only 3–5 strategic contacts. The Fisher Patrol Rangers would require minimum training and equipment at first, yet their inclusion may be cheaper than hiring “official” rangers over the long term. Radio property and responsibilities for their use must be clearly stated and resolved in advance. The VHF radio network will also allow better coordination between stakeholders and TAMR authorities in the event of a contingency (lost fishermen, wreckage, oil spill, etc.)

## INSTALLATION OF CELLULAR NETWORK

As there is no cellular infrastructure on the Turneffe Atoll, we strongly recommend that the Fishery Department lobby BTL (the local cellular operator) to construct a base station. Currently, the Turneffe Flats resort receives a very weak cellular signal from Belize City while the Turneffe Island Resort

(on the southern end of the Atoll) receives absolutely no signal. A cellular network could be incorporated into the TAMR surveillance system as stakeholders could report intruders, distress, or other information requirements via a 911 hot line (at no cost to the user). Given fear of reprisal,

many fishers would feel safer calling from a cell phone versus using a VHF marine radio. During our site visit, the Fisheries Department made initial consultations with BTL and apparently there is interest to extend coverage to the Turneffe Atoll.

## INTRODUCTION OF AIS FOR FISHER & TOURISM MANAGEMENT

Authorities will need to promulgate a regulation requiring the use of transceivers in order to monitor all vessels within the TAMR via AIS. We believe the Turneffe Atoll could serve as an important pilot study for their adoption by both the tourism and fisher stakeholders who possess exclusive rights to the TAMR. Some initial preparative steps include the following:

- A complete registration of Turneffe tourism and fisher licensed vessels: license numbers, ship-owner information, port of call, etc.
- A reliable departure and arrival control system must be set in place and must be coordinated with Port Authority. Currently Belize does not require embarkation permits when a vessel leaves port, however, we understand that this may change within the year.
- The proper Authority must promulgate a local regulation enforcing the mandatory use of AIS beacons.
- A local and national maritime control center must be established in advance.
- Staffing and training for supervisors and operators within the control centers need to follow a certification process.
- Inter-institutional operational procedures shall be agreed and set in force, particularly for surveillance and interdiction (Port Authority, Coast Guard, Fisheries, and Co-manager.)

Once the aforementioned steps are completed, we would suggest a phased roll out of the AIS system. We would recommend first requiring all tourism operators with the proper TAMR permit to purchase and install their respective AIS transceivers. AIS transceivers currently cost US\$900–\$1,300, which should not be a problem for tourism operators. Fishermen, on the other hand, may require a 5 to 10 year financing plan.

## RECOMMENDED PERFORMANCE INDICATORS

INDICATOR	DESCRIPTION	ASSUMPTION
Boat availability	Number of days each patrol vessel is available per month	On an annual basis, a vessel should be in operating condition at least 75% of the time.
Seizures	Monthly report of boats captured classified by the type of infraction, fishing gear, origin of fishers & resulting sanction	Seizures should decrease over time as local and foreign fishers become aware of constant enforcement presence.
Sightings	Monthly report of boats detected yet not interdicted	Base camps and small patrol vessels serve as a deterrent.
Total operational costs	Total monthly expenses on fuel and maintenance	Fuel and maintenance costs should decrease as radio communication network and base camps come on line. Monthly expenses will then stabilize at a lower reoccurring level.
Miles patrolled per month	Total sum of miles patrolled on a monthly basis per the patrol boat GPS and the log book	Average of 54 nautical miles per week per vessel.

Table No. 15: Recommended Performance Indicators

# BUDGET SUMMARY

## BUDGET SUMMARY FOR CONTROL AND VIGILANCE SYSTEM

TURNEFFE MARINE RESERVE LAW ENFORCEMENT PROGRAM DEFINITION // APRIL 2013

CONCEPT	REMARKS	YEAR 1	YEAR 2	YEAR 3	TOTAL
<b>CAPITAL EXPENSES</b>					
Maintenance workshop equipment	Compressor, hydraulic jacks, benches	\$6,500			\$6,500
On board equipment	Surveillance, first aid, Inspection, etc.	\$30,708		\$32,064	\$62,772
Infrastructures & main assets		\$681,535			\$681,535
<b>OPERATIONAL EXPENSES</b>					
Initial spare parts stock	List provided by YAMAHA distributor	\$54,610			\$54,610
Training		\$225,700	\$23,500	\$68,000	\$317,200
Broadband internet service	US\$600 per month	\$7,200	\$7,200	\$7,200	\$21,600
Cellular service	US\$100 per month	\$1,200	\$1,200	\$1,200	\$3,600
Fixed telephone service	N/A	\$600	\$600	\$600	\$1,800
Salaries	Check HR sheet	\$136,800	\$136,800	\$136,800	\$410,400
Fuel	Check Q-B motors	\$82,897	\$82,897	\$82,897	\$248,691
Maintenance	3% of assets cost/year		\$21,562	\$21,562	\$43,125
<b>TOTAL</b>		<b>\$1,227,750</b>	<b>\$273,759</b>	<b>\$350,323</b>	<b>\$1,851,833</b>

Budget in USD

# CRITICAL SPARE PART REQUIREMENTS

ITEM	QTY	UNITS	SPARES & MAINTENANCE EQUIPMENT	USD IN BELIZE (+35%)	TOTAL
1	1	U.	115 HP outboard motor (spare/backup)	\$18,000.00	\$18,000.00
2	1	U.	60HP outboard motor (spare/backup)	\$9,500.00	\$9,500.00
3	2	U.	20 to 25 HP outboard motor (spare/backup)	\$4,500.00	\$9,000.00
4	2	U.	Propellers for YAMAHA 115HP	\$222.00	\$444.00
5	2	U.	Propellers for YAMAHA 60HP	\$130.00	\$260.00
6	6	Box	Spark plugs for YAMAHA 115HP and 60HP	\$116.00	\$696.00
7	40	U.	Gas filters for YAMAHA 115HP and 60HP	\$10.00	\$400.00
8	8	U.	Batteries 12V 105Ah for YAMAHA 115HP and 60HP	\$225.00	\$1,800.00
9	4	U.	Remote command cables (Moorse)	\$75.00	\$300.00
10	1	U.	Panel switch	\$120.00	\$120.00
11	6	U.	Fuel rubber pumps	\$15.00	\$90.00
12	3	U.	Anchors 60 lbs	\$180.00	\$540.00
13	10	Tubes	Grease	\$18.00	\$180.00
14	2	U.	Yamaha tool set	\$140.00	\$280.00
15	1	U.	Yamaha compression testers	\$500.00	\$500.00
16	1	U.	Yamaha diagnostic computer set with PC	\$2,500.00	\$2,500.00
17	1	Set	Critical spare parts set (As manufacturer recommendation)  Fuel pump assembly, filter assembly, propeller shaft, ignition coil, pulser coil, carburetor set, pistons set, ring piston, crankshaft bearings, gasket kit, and cross joints  Carburetor repair kit, starting motor assembly, ignition coil assembly, bearing set, starter relay assembly, gear reverse, gear fwd, pinion gear, bearing reverse gear, bearing fwd gear, etc.	\$10,000.00	\$10,000.00
SUB-TOTAL					\$54,610.00

# SURVEILLANCE & SAFETY EQUIPMENT REQUIREMENTS

## ON BOARD EQUIPMENT

ITEM	QTY	UNITS	ON BOARD EQUIPMENT	USD IN BELIZE (+35%)	TOTAL
1	3	U.	Megaphone 25W with rechargeable batteries	\$60.35	\$181.04
2	3	U.	Waterproof/shockproof/portable GPS	\$513.00	\$1,539.00
3	4	U.	First Aid Kit	\$22.95	\$91.80
4	18	U.	PFDF, life saving jacket (flotation) yellow or orange	\$114.75	\$2,065.50
5	1	U.	GPS with ECDIS Display and AIS interface	\$4,725.00	\$4,725.00
6	3	U.	Class B AIS transceiver. Waterproof, fixed to boat, and connected to alternator	\$1,282.50	\$3,847.50
7	25	U.	Class B AIS transceiver. Waterproof, fixed to boat, and connected to alternator	\$1,282.50	\$32,064.00
8	4	U.	Marine waterproof binoculars 10X50 or up to 12X50	\$216.00	\$864.00
9	3	U.	Marine waterproof night vision devices with 5X zoom	\$2,160.00	\$6,480.00
10	6	U.	LED search lights with rechargeable batteries	\$174.70	\$1,048.22
11	3	U.	Waterproof & floatable handheld marine VHF Radio 5–6W with built in GPS-DSC capability	\$330.75	\$992.25

REMARKS	PHASE 1	PHASE 2
		\$18,000.00
		\$9,500.00
		\$9,000.00
	\$444.00	
	\$260.00	
	\$696.00	
	\$400.00	
	\$1,800.00	
	\$300.00	
	\$120.00	
	\$90.00	
	\$540.00	
	\$180.00	
	\$280.00	
		\$500.00
	\$2,500.00	
	\$10,000.00	
	\$17,610.00	\$37,000.00

REMARKS	PHASE 1	PHASE 2
One for each boat	\$181.04	
One for each boat	\$1,539.00	
1 for each remote base. 2 for main base	\$91.80	
6 per boat	\$2,065.50	
For the bigger boat	\$4,725.00	
One for each boat	\$3,847.50	
To be defined		\$32,064.00
1 for each remote base/2 for main base	\$864.00	
2 for remote bases/1 for main base	\$6,480.00	
1 per boat and 2 per base	\$1,048.22	
To be used by crew of each boat	\$992.25	

12	3	U.	High performance antennas for handheld marine VHF radios	\$51.30	\$153.90
13	3	U.	Extra batteries for handheld marine VHF radios	\$74.25	\$222.75
14	3	U.	Battery chargers for handheld marine VHF radios	\$60.75	\$182.25
15	3	U.	14.1 mega pixel shockproof/waterproof digital camera with optical 16X zoom and built in GPS	\$540.00	\$1620.00
16	3	U.	Extra batteries for digital camera	\$20.25	\$60.75
17	3	U.	16 GB SDHC flash memory cards for cameras	\$37.80	\$113.40
18	16	U.	Leatherman multi tool	\$94.50	\$1,512.00
19	4	U.	Solar powered flashlights with battery backup	\$81.00	\$324.00
20	12	U.	Inflatable vinyl boat fender (8" x 24", White)	\$94.96	\$1,139.51
21	6	U.	Inflatable vinyl boat fender (12" x 36", White)	\$128.71	\$772.25
22	9	U.	Coastal locator flares kit	\$81.00	\$729.00
23	3	U.	Digital camera storage bag	\$33.75	\$101.25
24	6	U.	Pelican case 1620	\$324.00	\$1,944.00

## MAIN CAMP, REMOTE & FLOATING BASE INVESTMENTS

ITEM	QTY	UNITS	CAMPS EQUIPMENT & ASSETS	USD IN BELIZE (+35%)	TOTAL
25	1	U.	Fiberglass 25–27 ft boat with fixed canopy, helm post and internal fuel tank	\$17,000.00	\$17,000.00
26	2	U.	Fiberglass 16–19 ft boat with fixed canopy, helm post and internal fuel tank	\$9,500.00	\$9,500.00
27	1	U.	Main camp 40'x 40' building (control room, quarters for 8, kitchen/dining room, and living room)	\$65,000.00	\$65,000.00
28	1	U.	Main camp maintenance shop with 1000 gal fuel storage	\$20,000.00	\$20,000.00
29	1	U.	Power generation room (for: generator, inverter and batteries)	\$15,000.00	\$15,000.00
30	1	U.	24m monopole tower (cellular)	\$40,000.00	\$40,000.00
31	1	U.	60m guyed tower (for AIS base station and camera)	\$10,000.00	\$10,000.00
32	1	U.	8m pole for remote base (antennas placement)	\$700.00	\$700.00
33	1	U.	Long Range daylight/lowlight CCD camera with local PTZ control	\$45,000.00	\$45,000.00
34	3	U.	Gray water sewage and treatment plant (no rust material)	\$3,500.00	\$10,500.00
35	3	U.	Black water sewage and treatment plant (no rust material)	\$3,500.00	\$10,500.00
			<b>FLOATING BASE</b>		
36	1	–	Concrete hull 20'x 46' (920sq ft). Freight to Belize included	\$85,000.00	\$85,000.00
37	1	–	Galley: Stove with 2 fires, blender, microwave, sink, garbage disposal	\$2,500.00	\$2,500.00
38	1	–	Water maker (40 gal/day capacity)	\$5,500.00	\$5,500.00
39	1	–	Refrigerator (with freezer)	\$1,800.00	\$1,800.00
40	1	–	Drinking water circuit and pump (no rust material)	\$2,000.00	\$2,000.00
41	1	–	Salt water circuit and pump (no rust material)	\$2,000.00	\$2,000.00
42	1	–	Superstructure: operation room, stateroom, galley and wardroom	\$18,000.00	\$18,000.00
43	1	–	Bathroom: 2 sinks, 2 urinals, 2 showers, 1 toilette	\$4,000.00	\$4,000.00
44	1	–	15 m mast with canopy on top	\$2,500.00	\$2,500.00
45	1	–	Manual water extraction pump with hoses	\$500.00	\$500.00
46	4	–	Navigation lights (bronze)	\$180.00	\$720.00

	Needed for increasing communication range	\$153.90	
		\$222.75	
		\$182.25	
	One camera per boat	\$1620.00	
		\$60.75	
	For the cameras	\$113.40	
	1 for each warden	\$1,512.00	
	1 for each remote base/1 for the main base	\$324.00	
	For the boats at the remote base	\$1,139.51	
	For the bigger boat	\$772.25	
	2 for the each boat and 1 for each base	\$729.00	
		\$101.25	
	2 for each boat to house surveillance and inspection equipment & on board logs/formats	\$1,944.00	

REMARKS		PHASE I	PHASE 2
		\$17,000.00	
		\$9,500.00	
		\$65,000.00	
		\$20,000.00	
		\$15,000.00	
		\$40,000.00	
		\$10,000.00	
		\$700.00	
		\$45,000.00	
	One for each base. Dependent on type of system (TBD)	\$10,500.00	
	One for each base. Dependent on type of system (TBD)	\$10,500.00	
		\$85,000.00	
		\$2,500.00	
		\$5,500.00	
		\$1,800.00	
		\$2,000.00	
		\$2,000.00	
		\$18,000.00	
		\$4,000.00	
		\$2,500.00	
		\$500.00	
		\$720.00	

47	2	U.	Anchors 70–100 lbs	\$300.00	\$600.00
48	10	U.	Portable fire extinguishers (10 pounds)	\$55.00	\$550.00
49	4	U.	115 HP 4 stroke out board motor with remote helm	\$18,000.00	\$72,000.00
50	2	U.	60 HP 4 stroke out board motor with remote helm	\$9,500.00	\$19,000.00
51	3	U.	Marine VHF 25W base station with power supply unit	\$675.00	\$2,025.00
52	3	U.	Marine VHF base station 6 dB antenna with cable and ancillary parts	\$607.50	\$1,822.50
53	1	U.	AIS base station antenna 6 dB. Fiberglass with cabin	\$1,620.00	\$1,620.00
54	1	U.	AIS base station receiver ITU M.1371–1, 12V	\$12,500.00	\$12,500.00
<b>MAIN CAMP POWER SUPPLY</b>					
55	24	U.	Solar panels 300 W, 30 VDC max., 3.5 Amp min.	\$675.00	\$16,200.00
56	1	U.	Charge controller 8–10A, 12/24 VDC	\$810.00	\$810.00
57	20	U.	Electrolyte gel batteries 12V, 115 Ah	\$877.50	\$17,550.00
58	1	U.	Aluminum/wooden base structure for S-panels	\$4,725.00	\$4,725.00
59	1	U.	Distribution panels and cabling	\$4,050.00	\$4,050.00
60	1	U.	6A 110VAC–60Hz inverter with 2hs with backup UPS	\$9,045.00	\$9,045.00
61	1	U.	8kW 110–120VAC 60Hz diesel Genset with transfer panel	\$10,800.00	\$10,800.00
<b>REMOTE BASE POWER SUPPLY</b>					
62	12	U.	Solar panels 300 W, 30 VDC max., 3.5 Amp min.	\$675.00	\$8,100.00
63	1	U.	Charge controller 4A, 12/24 VDC	\$607.50	\$607.50
64	10	U.	Electrolyte gel batteries 12V, 115 Ah	\$877.50	\$8,775.00
65	1	U.	Aluminum/wooden base structure for S-panels	\$1,620.00	\$1,620.00
66	1	U.	Distribution panels and cabling	\$810.00	\$810.00
67	1	U.	2kW, 3A 110VAC–60Hz inverter with 2hs backup UPS	\$6,480.00	\$6,480.00
68	1	U.	Marine 4kW 110–120VAC 60Hz diesel Genset (emergency generator) with sound attenuated enclosure	\$8,505.00	\$8,505.00
<b>FLOATING BASE POWER SUPPLY</b>					
69	12	U.	Solar panels 300 W, 30 VDC max., 3.5 Amp min.	\$675.00	\$8,100.00
70	1	U.	Charge controller 20–30A, 12/24 VDC	\$607.50	\$607.50
71	10	U.	Electrolyte gel batteries 12V, 115 Ah	\$877.50	\$8,775.00
72	1	U.	Aluminum/wooden base structure for S-panels	\$1,080.00	\$1,080.00
73	1	U.	Distribution panels and cabling	\$810.00	\$810.00
74	1	U.	2kW, 3A 110–120VAC–60Hz inverter with 2hs backup UPS	\$6,480.00	\$6,480.00
75	1	U.	Marine 4kW 110–120VAC 60Hz diesel Genset (emergency generator) with sound attenuated enclosure	\$8,505.00	\$8,505.00
76	2	U.	Laptop computers (main camp). One for operations control and one for administrative purposes	\$2,160.00	\$4,320.00
77	1	U.	AIS data viewer software	\$12,150.00	\$12,150.00
78	1	U.	LED 23 inch monitor	\$337.50	\$337.50
79	2	U.	Lightning Rod. Franklin type	\$2,025.00	\$4,050.00
80	2	U.	Grounding cooper rod and grounding mesh	\$2,565.00	\$5,130.00
81	2	U.	Civil works for antennas, grounding, solar panels installation	\$3,375.00	\$6,750.00
82	1	U.	Logistics, engineering and integration. AIS, VHF and Camera	\$16,875.00	\$16,875.00
83	1	U.	Logistics, engineering and integration. Electrical system	\$12,150.00	\$12,150.00
<b>SUB-TOTAL</b>					<b>\$702,744.40</b>

	4xmain camp, 4xfloating base, 2x remote base	\$550.00	
	2 for the floating base and 2 for the bigger boat	\$72,000.00	
	One for each small boat	\$19,000.00	
	Each to be installed at remote bases and main base	\$2,025.00	
	Each to be installed at remote bases and main base	\$1,822.50	
	To be installed at main base		\$1,620.00
	To be installed at main base		\$12,500.00
	To be installed at Calabash	\$16,200.00	
		\$810.00	
		\$17,550.00	
		\$4,725.00	
		\$4,050.00	
		\$9,045.00	
		\$10,800.00	
		\$8,100.00	
		\$607.50	
		\$8,775.00	
		\$1,620.00	
		\$810.00	
		\$6,480.00	
		\$8,505.00	
			\$8,100.00
			\$607.50
			\$8,775.00
		\$1,080.00	
		\$810.00	
		\$6,480.00	
		\$8,505.00	
	Xeon Quad Core W3520, 8GB RAM, 2.66MHz, HDD 2x600 GB, 7.2k SATA RAID. NVIDIA Quadro 290 with 246MB graphics card	\$4,320.00	
	Option such as SeaTraQ or MaxSEA-FURUNO		\$12,150.00
			\$337.50
	One for main camp and one for remote base	\$4,050.00	
	One for main camp and one for remote base	\$5,130.00	
		\$6,750.00	
	AIS base station and microwave links		\$16,875.00
	Includes solar generation, lightning protection and grounding installation	\$12,150.00	
		\$648,529.40	\$86,277.50

# FUEL CONSUMPTION CALCULATIONS

TURNEFFE ATOLL MARINE RESERVE LAW ENFORCEMENT PROGRAM DEFINITION // APRIL 2013

## NUMBER OF BOATS & MOTORS

LOCATION	NO. OF BOATS	O/B MOTOR TYPE	NO. OF MOTORS	MOTOR COST (EST.)	MOTOR INVESTMENT TOTAL
23' Boat	1	115 HP	2	\$18,000.00	\$36,000.00
16' Boat	2	60 HP	2	\$9,500.00	\$19,000.00
Floating base	1	115 HP	2	\$18,000.00	\$36,000.00
16' Boat	2	20 HP	2	\$4,500.00	\$9,000

NOTE: Data obtained from Yamaha web page

## FUEL CONSUMPTION CALCULATIONS

O/B MOTOR TYPE	QTY	US\$/GAL	WOT CONSUMPTION	OPERATION HOURS/ MONTH
115 HP	2	\$6.00	8.71	33.00
115 HP floating base	2	\$6.00	8.71	4.40
60 HP	2	\$6.00	4.544	55

NOTE: WOT = Wide open throttle (maximum speed/consumption)

TOTAL FUEL MONTHLY COST: US\$6,908.09

TOTAL GAL/MONTH OF FUEL: 1,151.33 GAL

FUEL YEARLY COST: US\$82,897.06

FUEL GAL/YEARLY: 13,816 GAL

# HUMAN RESOURCES REQUIREMENTS

TURNEFFE ATOLL MARINE RESERVE LAW ENFORCEMENT PROGRAM DEFINITION // APRIL 2013

POSITION	SALARY/MONTH	MONTHS				
		0	1	2	3	4
Supervisor	\$1,300.00	0	1	1	1	1
Control center operators (8 hours shift 24/24h)	\$750.00	0	3	3	3	3
Maintenance officer	\$850.00	0	1	1	1	1
Wardens (6+4 are needed for rotation purpose)	\$700.00	0	10	10	10	10
	\$0		\$11,400	\$11,400	\$11,400	\$11,400

NOTE: Salaries range and social benefits to be confirmed if within the figures shown.

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# TRAINING REQUIREMENTS

TURNEFFE MARINE RESERVE LAW ENFORCEMENT PROGRAM DEFINITION // APRIL 2013

ITEM	QTY	NAME OF COURSE OR PROCEDURE	UNIT COST	TOTAL
1	16	Yamaha basic O/B service training course	\$700.00	\$11,200.00
2	2	Yamaha advanced O/B service training course	\$3,500.00	\$7,000.00
3	1	Maintenance SOPS (on board and in workshop)	\$20,000.00	\$20,000.00
4	16	IMO Basic training certification (*). Firefighting, first aids, survival at sea	\$5,000.00	\$80,000.00
5	1	Boarding and CSI techniques (12 wardens). SOPS Control Center Operations. Planing and execution monitoring	\$50,000.00	\$50,000.00
6	4	Control Center Certification (*). 4 individuals	\$9,000.00	\$36,000.00
7	1	Control & Vigilance Plan. SOPS Patrol planning & techniques	\$25,000.00	\$25,000.00

NOTE: Courses marked with (\*) must be taken outside Belize. Shall consider air tickets, per times and lodging.

	FUEL COST/MONTH	OPS HOURS/DAY	OPS DAYS/MONTH	HS/MONTH	GAL/MONTH
	\$3,449.16	1.5	22	33.0	287.43
	\$459.89	0.2	22	4.4	38.32
	\$2,999.04	2.5	22	55.0	249.92

									YEAR
5	6	7	8	9	10	11	12		
1	1	1	1	1	1	1	1		
3	3	3	3	3	3	3	3		
1	1	1	1	1	1	1	1		
10	10	10	10	10	10	10	10		
\$11,400	\$11,400	\$11,400	\$11,400	\$11,400	\$11,400	\$11,400	\$11,400	\$136,800.00	

YEAR 1	YEAR 2	YEAR 3
16	-	-
1	1	-
1	-	-
16	4	-
1	-	1
4	-	2
1	-	-

# ANNEX I

## SURVEILLANCE VIDEO CAMERA REFERENTIAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS
	<b>OPTICAL CAMERA CCD DAYLIGHT/LOWLIGHT</b>
Minimum expected detection range for 15m vessel	>8.5 NM
Azimuth Range	360° Continuous
Elevation Range	±70° to ±90°
Spectral Range	Visual
Focus	Automatic
Digital Imaging	>10 mega pixel
Image enhancing	Automatic: Brightness, saturation, gamma, sharpness, exposure, white balance. Manual: image cropping, electronic zoom/pan/tilt, resolution windowing
Image Resolution	Variable & selectable by user among: 1920x1080 WUXGA / 1280x1080 HDTV / 1280x720 HDTV / 640x480 VGA
Field of View	Variable and continuous
Wide Angle	min 35° max 60° Horizontal
Narrow Angle	1.5° a 3° Horizontal
Image Frequency (Frames per Second - FPS)	>24FPS for 1920(H) x 1080(V) Lower resolutions shall operate > 30FPS
Data Rate	Selectable according to image resolution and FPS. Could be lower than 0.2Mbps but max 10Mbps
Digital Zoom	≥ 30X
Optical Zoom	≥ 10X
Residual Light	≤ 0.2 lux in day/night mode
Video output format	H.264 MPEG-4 part 10 o MJPEG
Video output connector	BNC, RS-232C/RS-485
Image capture formats	TIFF or JPEG
Programmable surveillance	Yes
Motion Detection	Yes
Video Tracking	Yes
Remote Control	Yes
Network connection /interface for remote control and transmission	Ethernet 100 MBps, TCP/IP. Protocols TFTP, HTTP, RTSP, RTP/TCP, RTP/UDP
Video Compatibility	Real Time streaming protocol (for media players): Apple Quick Time, Windows Media Player or any other commercial
BITE	Optional
Data Interfaces (optional)	RS-232 y/o RS-422 y/o RS-485
Geo positioning	Internal GPS coupled with digital compass
Magnetic Digital Magnetic Compass	Yes
Power Supply	12/24 VDC
Power consumption	10W
Timestamp over images and video on screen and on saved files)	Yes
Environmental	
Ingress Protection Rating (IP)	IP-64
Operational Temperature	0° to 55°
Humidity	0% to 90% non condensing

## ANNEX II

### FLOATING BASE SPECIFICATIONS

PARAMETER	SPECIFICATIONS
Dimensions	20' x 46' (total 920ft <sup>2</sup> )
Hull material	Concrete
Superstructure	Concrete, wood, and aluminum
Accommodation	4 men. 2x2 bunks
Mast	15m (50feet) height aluminum with lookout canopy on top
Galley and wardroom	Kitchen, refrigerators, sink with garbage disposal Dining area for 4 men Living room with 4 seats
Operational area	2 work stations. VHF Radio, plotting table
Additional equipment	Black and grey water treatment plant Fuel tank 2 o/b motors with remote helm on top of barge Power supply: solar panels Machinery room 1 small davit for a 15–18 ft fiberglass boat 2 IMO life rafts (8 persons each) Desalinization plant Emergency diesel generator

## ANNEX III

### METAL TOWERS SPECIFICATIONS

GUYED TOWER	
Structure Material:	Galvanized steel
Ancillary equipment (bolts, nuts, tensors, etc.)	Stainless steel
Height	48m
Equipment to hold	01 VHF-DSC repeater antenna 01 VHF-AIS antenna
SELF SUPPORTED TOWER	
Height	24m
Structure Material:	Galvanized steel
Ancillary equipment (bolts, nuts, tensors, etc.)	Stainless steel
Equipment to hold	Cellular base station (defined by BTL)



# WILDAID

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**BLUE MARINE FOUNDATION**

