IWEco

Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States

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LABORATORY ASSESSMENT REPORT FOR CARIBBEAN COUNTRIES PARTICIPATING IN THE GEF-IWEco PROJECT

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For:
The UNEP/ GEF Integrating Water, Land and Ecosystems Management in Small Island Developing States (IWEco) Project

Funded by:
Global Environment Facility (GEF)

ACKNOWLEDGEMENTS

Thank you to all who assisted in the laboratory survey activities undertaken. Special thanks to the IWEco Project Coordination Unit (PCU; Nicole Caesar) and to the IWEco National Project Coordinators for general support - assisting in the selection of suitable laboratories for assessment, and for providing the relevant contact information.

Gratitude is especially extended to the staff of participating laboratories who provided both the survey and follow up information needed. The time and effort taken to provide the requested detailed information is most appreciated.

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Acronyms and Abbreviations

BOD	Biochemical Oxygen Demand
CARPHA	Caribbean Public Health Agency
CEP	Caribbean Environment Programme
COD	Chemical Oxygen Demand
COP	Conference of Parties
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphorus
DO	Dissolved Oxygen
EHU	Environmental Health Unit
FAAS	Flame Atomic Absorption Spectrometry
GEF	Global Environment Facility
GFAAS	Graphite Furnace Atomic Absorption Spectrometry
HAB	Harmful Algal Blooms
IWCAM	Integrating Watershed and Coastal Areas Management in Small Island Developing States
IWEco	Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States

LBS	Land-Based Sources and Activities of Marine Pollution
NEPA	National Environment and Planning Agency
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management System
RAC	Regional Activity Centre
SIDS	Small Island Developing States
SOCAR	State of the Convention Area
SOMEE	State of the Marine Environment and Associated Economies
STAC	Scientific and Technical Advisory Committee
TSS	Total Suspended Solids
UNEP	United Nations Environment Programme
UNEP-CAR/RCU	Secretariat to the Cartagena Convention
WCR	Wider Caribbean Region

LABORATORY NAME ABBREVIATIONS

Country	Abbreviation of Name of Laboratory	Name of Laboratory
ANTIGUA	DAS	Department of Analytical Services
BARBADOS	GAS	Government Analytical Services
	PHL	Dos Santos Public Health Laboratory
CUBA	INRH	INRH - UEB Análisis y Servicios Técnicos, Cienfuegos
	CPHEM	Laboratorio de Química y Microbiología Sanitaria, Centro Provincial de Higiene, Epidemiología y Microbiología
	CIMAB	Laboratorio de Ensayos del CIMAB
	CEAC	Centro de Estudios Ambientales de Cienfuegos
DOMINICAN REPUBLIC	CAASD	Laboratorio de la Vigilancia de la Calidad del Agua de la Corporación del Acueducto y el Alcantarillado de Santo Domingo
	INTEC	Laboratorio de Servicios Analíticos Ambientales
	Lab. Amb.	Laboratorio Ambiental
	LAVECEN	Laboratorio Veterinario Central
GRENADA	GBS	Grenada Bureau of Standards Analytical Laboratory
	NAWASA	NAWASA Water Quality Laboratory
	PC	Produce Chemist Laboratory
JAMAICA	EHL	Environmental Health Laboratory
	NEPA	National Environment and Planning Agency (NEPA) Laboratory
	PRL	Pesticide Research Laboratory
SAINT LUCIA	WASCO	Thomas R. Theobalds Laboratory
	CARPHA	Environmental Health Laboratory of the Caribbean Public Health Agency
ST. KITTS & NEVIS	EHL	Environmental Health Water Quality Monitoring Laboratory
	NWD	Nevis Water Department Laboratory
SAINT VINCENT AND THE GRENADINES	SVGBS	The St. Vincent and the Grenadines Bureau of Standards
	FDL	The Fisheries Division Laboratory of the Ministry of Agriculture
TRINIDAD & TOBAGO	DoE, TOBAGO	The Department of Environment – Tobago
	IMA	The Institute of Marine Affairs – Environmental Quality Programme Laboratory
	CARIRI	Caribbean Industrial Research Institute – Analytical Chemistry Laboratory and the Environmental Microbiology Laboratory
	NQL	National Quarries Co. Ltd. Laboratory

1. EXECUTIVE SUMMARY

A laboratory capacity building exercise was carried out in 2006 – 2011 under the GEF-funded project: Integrating Watershed and Coastal Area Management (IWCAM), the purpose of which was to:

- increase the capacity of selected national and regional laboratories to perform environmental water quality monitoring by
    - providing laboratory and field equipment for basic water quality monitoring
    - training laboratory staff in quality assurance compliant with the requirements of ISO 17025 and quality control methods
- to provide reliable data and information for effective environmental management nationally and across the Region.

This report provides an update and expands the scope of the IWCAM exercise from the monitoring of water only to the inclusion of soils, sediments and biota.

A total of ten (10) Caribbean countries participated in the laboratory strengthening subcomponent of the IWEco Project

Ten (10) Caribbean countries participated in the laboratory strengthening subcomponent of the IWEco project:

- Antigua and Barbuda
- Barbados
- Cuba
- Dominican Republic
- Grenada
- Jamaica
- Saint Lucia
- St. Kitts and Nevis
- St. Vincent and the Grenadines
- Trinidad and Tobago

The overall objective of the laboratory capacity strengthening component of the Integrating Water, Land and Ecosystems Management in Small Island Developing States (IWEco) Project is to increase the capacity for monitoring environmental quality parameters and through reporting mechanisms such as SOCAR and SOMEE fulfil our legal obligations under the Protocol Concerning Pollution from Land-Based Sources and Activities (LBS Protocol) amongst others. Capacity strengthening of selected laboratories provides the tools for monitoring basic parameters and for a few laboratories, other specialised parameters such as pesticides and heavy metals. Among the tools provided is, through training, the know-how to provide accurate and reliable data, thereby strengthening the capacity of participating countries for effective decision making through the analysis of valid data.

Methods of Increasing Lab Capacity for Environmental Quality Monitoring

- Training of Lab Personnel
    - Technical – associated with equipment use
    - QA and QC
- Equipment Acquisition
- Repair of Existing Equipment

The assessment is intended to identify laboratory strengths and weaknesses in order to improve laboratory capacity for environmental monitoring resulting in improved national monitoring and assessment programmes, that in turn will inform ecosystem management and regional reporting across the Caribbean. This will be achieved by providing the tools for improvement through training and acquisition of needed equipment.

Priority areas for assessment included:

- an inventory of existing laboratory capacity to process water, soil, sediment, and biota monitoring samples,
- technical training required to utilize and maintain existing and newly acquired laboratory equipment under the IWEco Project; suitable labs to build capacity through the acquisition of equipment based on existing throughput and available manpower.

The overall assessment contributes to Component Two, Output 2.1.3. of the Project, namely, **strengthened field monitoring and assessment capabilities** - to strengthen participating countries' field monitoring and assessment capabilities and to inform project outputs on environmental monitoring and testing indicators.

Objectives of the Laboratory Assessments

- To identify the capacity of laboratories selected by each national IWEco focal point for assessment
- To identify the training and equipment needs to effectively support national IWEco projects and to support in the long term, the IWEco approach to environmental management
- To identify at least one laboratory in each participating country that would be strengthened by the GEF IWEco project through training and equipment acquisition/repair

The goal of the laboratory strengthening subcomponent of the Project is to support selected laboratories in the acquisition of field and laboratory equipment, and in personnel training in order for the laboratory to effectively provide reliable and accurate monitoring, surveillance and basic analytical services to support national IWEco practices and national environmental monitoring programmes.

It must be noted that in some countries the laboratories are challenged in terms of laboratory accommodation, manpower and equipment and subsequently carry out few tests. The suite of basic parameters for effective environmental monitoring is therefore incomplete. The needs of such laboratories can be easily met through the provision of instruments for basic monitoring and through training in use and necessary quality control measures. The challenges for other laboratories to implement training received in the past especially with respect to quality management system requirements include lack of manpower and top-down support. There are also challenges to implementing quality control where the cost of quality control standard solutions and materials is seen as prohibitive. In other countries, the laboratories perform a wide range of tests including pesticide and nutrient analyses. These laboratories often charge fees for conducting tests in order to recoup costs.

1.1 TRAINING

1.1.1 Laboratories Recommended for Support – General Training:

All laboratories that requested training in areas relevant to environmental monitoring of water, soil, sediments and biota that fell within the scope of recommended training and which were also involved in such monitoring, directly or indirectly, were recommended for training.

Of the four (4) laboratories that wished to carry out biota monitoring, three (3) requested training in identification of algal blooms, and indicator flora and fauna species, biota sampling techniques. Three (3) of the laboratories were in Trinidad and Tobago and the fourth was in Antigua.

The above-mentioned laboratories should receive the requested trainings to increase their knowledge base to fulfil their roles in environmental monitoring which may eventually be compiled at the national level for decision-making.

1.1.2 Recommended General Training

Training needs were assessed based on survey responses which were collated and compiled for different matrices and tests where possible. The most requested types of training were:

1. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control. It should also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

Summary - General Training Needs

- Current Methods of Lab Analysis and QC Requirements
- Methods of Sample Collection and Design of a Sampling Programme
- ISO 17025:2017 - Requirements and Implementation
- Use of Basic Lab & Field Equipment
- Nutrient Analysis Methodologies

2. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, Polychlorinated Biphenyls (PCB) analysis and herbicides analysis, nutrient analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, interpretation of the data and identification of trends in the data
3. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
4. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping.
5. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, cost of maintenance

1.2 REQUESTED EQUIPMENT and TECHNICAL TRAINING

1.2.1 Common Equipment Requests

The most common piece of field monitoring equipment requested was the multi-parameter meter with probes for the determination of pH, temperature, DO, salinity electrical conductivity. One (1) laboratory (CARIRI) also requested a multi-parameter meter with probes be able to test for TDS, TSS and turbidity. The most requested brand was the YSI. However, the Cuban labs preferred Hanna Instruments.

Almost all laboratories, with the exception of those already possessing such a meter, requested training in their use, calibration, and maintenance.

Common Technical Training Needs

- Use and Maintenance of Multi-Parameter Meter
- Use and maintenance of HACH DR 3900 spectrophotometer
- Use and Maintenance of Seal HR3 Nutrient Analyzer

1.2.2 Repairs and Servicing of In-house Equipment and Associated Training Needs

There three (3) major pieces of equipment are in need of servicing and re-training of staff in their use from two (2) laboratories, CARPHA (Saint Lucia) and the Environmental Health Laboratory in Jamaica. The instruments are the Seal HR3 Nutrient Analyzer (at CARPHA and the EHL) and the Teledyne Hydra II mercury analyzer (at EHL).

Servicing and training in the use of the HACH DR 3900 Spectrophotometer belonging to the Environmental Health Laboratory in St. Kitts is also required.

Two (2) laboratories in the Dominican Republic using multi-parameter meters are in need of sensors – replacement or new sensors to expand range of field monitoring.

1.3 INVENTORY OF TESTS PERFORMED

Most laboratories have the capacity to conduct basic monitoring of water. The exceptions are specialised laboratories such as the PHL in Barbados, which performs microbiological testing only, and the soil laboratory of the National Hydraulic Resource Institute (Spanish acronym INDRH). Laboratories that carry out routine monitoring of soils do so for agricultural purposes. Four (4) laboratories test sediments.

Few laboratories are equipped to carry out heavy metals testing. Most that have the capacity to test for metals in soil and water mainly test for trace metals to monitor the quality of soils for agricultural purposes, e.g., GAS; and potable water for fitness to drink. The Produce Chemist laboratory in Grenada may be the exception as it has stated that it is able to test for a wide variety of pesticides, PAHs and PCBs.

Similarly, for pesticide analysis, the emphasis is on food. Unless there is a project that requires testing of environmental samples, where the project provides support, environmental monitoring is generally not done. For this reason, laboratories in each country or region should have a designated testing laboratory, preferably one with a mandate for environmental monitoring, with suitable accommodation for the instruments and with financial support from the respective government for provision of consumables. In Jamaica for instance, both the Environmental Health Laboratory and NEPA would like to perform environmental monitoring of pesticides and heavy metals more frequently but lack the capacity to test in-house. It is felt that subcontracting is too

expensive, that other government laboratories that may be cheaper do not have the mandate to perform environmental monitoring and therefore their samples would not be given priority. The conundrum is that if subcontracting on a regular basis is too expensive, then how would they be able to afford the consumables and maintenance costs of the equipment. The only answer is for the government to provide financial support.

INVENTORY OF COMMON WATER QUALITY MONITORING TESTS

TEST	%	TEST	%	TEST	%	Test	%
pH	96	TC	81	NO3	73	BOD	65
Turbidity	88	FC	81	Sal. & T	73	E.coli	65
DO	81	Res. Cl	73	TSS	69	Enterococci	54

Detailed inventory of tests can be found in the chapter "Compiled Findings".

Testing for the full suite of tests comprising Dissolved Inorganic Nitrogen – Nitrates, Nitrites and Ammonia – are not done by any of the laboratories assessed. Some perform nitrates and nitrites but not ammonia. A few report total nitrogen and total phosphorus (12%) instead. Fifty-eight percent (58%) of laboratories test for dissolved inorganic phosphate. The laboratories that test nutrient content do so in wastewater and do not have the capacity to test marine waters. Those that test for nitrate only test potable water.

2 BACKGROUND TO ASSIGNMENT

2.1 INTEGRATING WATER, LAND AND ECOSYSTEMS MANAGEMENT IN CARIBBEAN SMALL ISLAND DEVELOPING STATES (IWEco PROJECT)

The Global Environment Facility (GEF)-funded project – Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States (IWEco Project) – is a five-year multi-focal area regional intervention that applies a "Ridge to Reef" approach integrating watershed and coastal areas management in small islands for addressing the multiple challenges of sustainable water, land (including forests) and biodiversity management and conservation within the spatial framework of the watershed unit.

The overall objective of the Project is to contribute to the preservation of Caribbean ecosystems that are of global significance, and the sustainability of livelihoods through the application of existing proven technologies and approaches that are appropriate for small island developing states. The Project seeks to strengthen the commitment and capacity to implement an integrated approach to the management of these ecosystems on a sustainable basis. A total of ten (10) Caribbean countries are participating in the project: Antigua and Barbuda, Barbados, Cuba, Dominican Republic, Grenada, Jamaica, St Kitts and Nevis, Saint Lucia, Trinidad and Tobago and St. Vincent and Grenadines.

The Project is co-implemented by the United Nations Environment Programme (UNEP) and United Nations Development Programme (UNDP), and co-executed by UNEP Caribbean Environment Programme (CEP)/Secretariat to the Cartagena Convention and the Caribbean Public Health Agency (CARPHA). The Project Coordinating Unit (PCU) is located at Cartagena Convention Secretariat in Kingston, Jamaica.

Under the CARICOM framework, CARPHA has the core mandate for environmental health and environmental management in provision of technical advisory services, conduct of environmental assessments, policy development and research on behalf of the countries in the areas of water, land/watershed resources management, wastewater, chemicals (pesticides and hazardous chemicals) and solid waste management. The Department is a training centre for environmental laboratory diagnostics services through its accredited laboratory facility.

2.2 THE LABORATORY STRENGTHING INITIATIVE

This assessment report updates and builds upon the laboratory assessment exercise conducted during the GEF-funded IWCAM project, Integrating Watershed and Coastal Area Management (IWCAM:2006 – 2011), where a laboratory capacity building exercise was carried out with the objective of strengthening environmental surveillance and monitoring capacity in the small island developing states (SIDS) participating in the IWCAM project. In order to meet this objective, it was recognized that there was a need to build laboratory capacity, not only nationally but regionally.

This assessment identifies laboratory strengths and weaknesses so that the IWEco Project can provide the tools for improvement through training and acquisition of needed equipment as recommended in the Report in order to strengthen the field monitoring and assessment capabilities. An updated laboratory capacity and training needs assessment will ultimately strengthen regional capacity to collect and interpret environmental monitoring data for effective environmental management across the region.

Priority areas for assessment included: (i) an inventory of existing laboratory capacity to process soil, sediment, water and biota monitoring samples, (ii) technical training required to utilize and maintain laboratory equipment, (iii) training in quality assurance and test method quality control to ensure the validity of data, and (iv) selection of suitable laboratories to build capacity (specifically, expand equipment) based on existing throughput, available manpower and capacity to perform basic tests.

The objectives and outputs of the laboratory capacity building activities directly related to the laboratory assessments planned were:

1. To survey environmental monitoring laboratories recommended by the IWEco focal point in each participating country in order to:
    a. inventory existing laboratory capacity, and
    b. assess the needs of these laboratories with respect to training and equipment with a view to enhancing or developing their capacity to perform basis analyses related to the LBS Protocol obligations and national environmental standards/guidelines.
2. To select suitable laboratories for capacity strengthening.
3. To assess and strengthen the capacity of laboratories that can act as laboratories within the Caribbean for more specialised tests, e.g., RAC's, in order to support national environmental laboratories, where necessary, in responding to the demands for environmental quality monitoring in participating SIDS.

2.3 LABORATORY CAPACITY BUILDING SURVEY ACTIVITIES

The laboratory surveys conducted sought to provide the following information:

1. National IWEco-related environmental quality monitoring needs, including the capacity in the laboratories assessed for responding to the needs of the country.
2. The capacity of regional laboratories and Regional Activity Centres to support national laboratories to respond to demands for environmental quality monitoring in participating SIDS.
3. An inventory of the analyses currently being performed to be compared with the needs of the national IWEco sub-project (if any) and minimum parameters to be monitored under the LBS Protocol.
4. By laboratory and hence country, the equipment needs and associated training, and other training needs identified by each laboratory

Outputs:

1. Compiled report containing country findings and recommendations regarding:
    a. the laboratories recommended to receive support from the Project
    b. the equipment recommended for acquisition and associated training in their use and preventive maintenance
    c. training for use and preventive maintenance of previously acquired equipment where needed
    d. general quality assurance (QA) and test method quality control (QC) training
    e. capacity building in regional and RAC laboratories to support national laboratories with respect to specialized testing and to act as reference laboratories

f. A summary of laboratories recommended for capacity building
    - common needs highlighted

2. PowerPoint presentation of key findings and recommendations

3 INTRODUCTION

3.1 ROLE OF ENVIRONMENTAL LABORATORIES IN MONITORING AND SURVEILLANCE OF THE STATE OF THE ENVIRONMENT FOR EFFECTIVE NATURAL RESOURCE MANAGEMENT

Small Island Developing States (SIDs) and territories are heavily dependent on marine-based economic sectors, such as tourism and fisheries that generate major revenues for most of these island states and territories. A healthy marine environment is therefore critical to the sustainability of these economies. Unfortunately, the marine environment is increasingly under pressure from land-based sources of marine pollution. Sewage pollution is, for example, among the most critical of the problems affecting the near shore and river environments in Caribbean SIDS. Industrial pollution from oil storage facilities, pollution from mining and quarrying, siltation from construction and nutrient loading from detergents, sewage and agricultural runoff are among the major problems in some of these states. Pollution of the environment affects not only livelihoods and economies but also threatens marine life and human health.

Environmental quality monitoring is an integral tool for effective natural resources management and is used to establish quantitative baselines and evaluate the effectiveness of mitigation measures. All the IWEco participating countries are signatories to the legally binding Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region; though, not all have ratified its three (3) protocols. One (1) of the three (3) supporting technical Protocols - Protocol Concerning Pollution from Land-Based Sources and Activities (LBS Protocol) – requires signatories to formulate and implement monitoring programmes. These programmes may be used for identifying and assessing patterns and trends in the environmental quality of the Convention area and to assess the effectiveness of mitigation measures.

In 2010, the Contracting Parties to the LBS Protocol produced the first State of the Convention Area Report (SOCAR) on land-based sources of marine pollution. Among the objectives of the report were the need to provide a quantitative baseline for monitoring and assessment of the state of the marine environment with respect to the land-based sources of pollution, and to help inform regional and country-level decisions on addressing land-based sources of pollution, including the development of a regional strategy and action plan for nutrient reduction in the Wider Caribbean Region (WCR). Eight (8) water quality indicators across the WCR were assessed based on relevance to the LBS Protocol, Sustainable Development Goal (SDG) 14.1, and Regional Seas indicators. The indicators used in the assessment were:

1. Dissolved inorganic nitrogen (DIN)
2. Dissolved inorganic phosphorus (DIP)
3. Chlorophyll-a
4. Dissolved oxygen
5. Turbidity
6. pH
7. *Escherichia coli*
8. Enterococci

Additionally, due to the increasing concern over the impacts of marine litter (especially plastics) and mercury on human health and the environment, a brief review was included in the report.

Other priority parameters not included in the SOCAR but which are necessary for monitoring the quality of inputs into river and coastal environments or for directly monitoring the marine environment are:

- Fats, oils and grease
- Biochemical oxygen demand – wastewater and ambient fresh water
- Floating plastic density
- Total suspended solids
- Salinity
- Temperature

In order to continue to provide objectively reliable data, the basis on which in-country and regional decisions should be made with regard to improving the state of the environment, laboratories responsible (or laboratories contracted by agencies responsible for monitoring the environment) for collecting and/or analysing samples must have the capacity to provide data that is reliable, using test methods that are appropriate for the parameters and their limits or acceptable ranges. Hence, there is a need for continued building of laboratory capacity, both nationally and regionally, to monitor and evaluate environmental quality in all participating SIDS. Building laboratory capacity involves the acquisition and use of suitable equipment and training of staff. Specifically, the need for building laboratory capacity is integral to the development and implementation of environmental monitoring and surveillance programmes seeking to use evidence-based laboratory data to establish baselines and to inform the results of amelioration efforts. Required training is mainly two-pronged: (i) use and routine maintenance of in-house/newly acquired equipment where applicable, and (ii) ensuring the validity of test results through the use of quality assurance and quality control measures.

The first step in building laboratory capacity is the assessment of laboratories that routinely perform environmental testing at the national level with a view to selecting one or two in each participating country for support, in terms of equipment and materials and training of personnel. Project support will enable these laboratories to not only perform the monitoring for any national sub-projects but in the medium- to long-term, enable them to support their country in the management of their freshwater and marine resources and ecosystems through monitoring and surveillance programmes that in turn support SOCAR and SOMEE reporting.

4 LABORATORY ASSESSMENT METHODOLOGY

A desk study, in the form of a survey instrument, was used to assess the capabilities of both regional and national laboratories to respond to requirements for environmental quality monitoring in participating IWEco SIDS and to national and international obligations. The purpose of the study was to update and build upon the laboratory assessment exercise conducted during the IWCAM Project.

Prior to the dissemination of the laboratory survey instrument, letters were sent to the Ministries/Ministry responsible for the Environment and Health and/or the IWEco focal point in each participating country informing them of the IWEco laboratory capacity building exercise, in particular the survey activity, with a request to identify suitable laboratories for assessment. Criteria for the selection of laboratories for assessment were also provided to guide the IWEco focal point. A briefing note on the Project and the laboratory capacity strengthening exercise was also included for dissemination to the laboratories selected by the focal point for their information. On provision of contact information by the focal point or the laboratory, the survey form was emailed to the participating laboratories for completion.

The questions in the survey sought to:

- capture information on the number of testing personnel, qualifications and experience of laboratory management and staff;
- equipment inventory and operational status;
- tests performed and methods used, testing volume;
- quality assurance and quality control procedures in use, and whether the laboratory was accredited;
- use of results for local and international reporting; and
- determine areas for capacity building or strengthening along with any existing strategic plans to fill the needs identified by them, as indicated by the laboratories.

The criteria used by the IWEco focal point to determine the most suitable laboratories for assessment (contained in the document: Criteria for the Selection of Laboratories for Assessment) were:

1. The laboratory must have a mandate for environmental management including ambient water quality monitoring and/or surveillance. If the laboratory's parent organization does not have a mandate for such monitoring, the laboratory must be contracted for testing by agencies/ministries responsible for environmental monitoring.

2. The organizational structure of the laboratory or institution should be sustainable.

The needs assessment was conducted using a combination of survey form information provided, interview/discussion with the head of the laboratory, and use of email for clarification purposes. Laboratories were required to submit samples of certificates of training where available/applicable, and samples of equipment servicing or maintenance (external or preventive in-house) records.

The criteria used for the suggested selection of the laboratory/laboratories for support by the Project were:

1. Laboratory is part of an organization having a mandate to perform environmental monitoring or if contracted, is contracted by ministry/agency responsible for environmental quality monitoring and surveillance.

2. Sufficient personnel with a knowledge base of environmental sampling and testing.

3. Greatest testing capability already in place for performing the tests required to support the national sub-project (where applicable), and any other priority parameters deemed necessary for basic environmental quality monitoring to support the obligations of the LBS Protocol and/or SOCAR reporting.

4. Quality assurance and test method quality control carried out to assure the validity of results generated.

5 COMPILED FINDINGS

5.1 INVENTORY OF TESTS PERFORMED BY ALL ASSESSED LABORATORIES

5.1.1 Matrix: Water

Twenty-six (26) of the thirty-four (34) laboratories approached, submitted completed survey forms. The results for all tests performed were compiled into groups of parameters (See Table 1) and by type of water tested as follows:

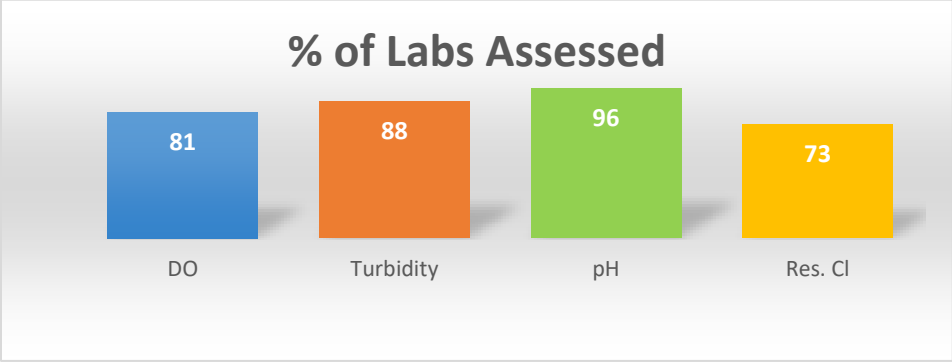
- Rivers/ponds,
- Seawater/coastal marine water,
- Wastewater and
- Potable (raw & processed) water inclusive of well water for drinking

Table 1: Grouping of Test Parameters

PARAMETERS TESTED BY GROUP	
GROUP	**PARAMETERS**
1	Dissolved oxygen, Turbidity, pH, Residual chlorine
2	Total coliform, Faecal coliform, E. coli, Enterococci
3	Nutrients: Nitrates, Nitrites, Ammonia, TKN, DIP, TN, TP
4	Parameters related to Nutrients: Chlorophyll a, Algal blooms location and identification
5	Fats, Oil and Grease, BOD, TSS, Salinity, Temperature
6	Floating plastic density and biota monitoring
7	Pesticides, PAHs, PCBs and heavy metals

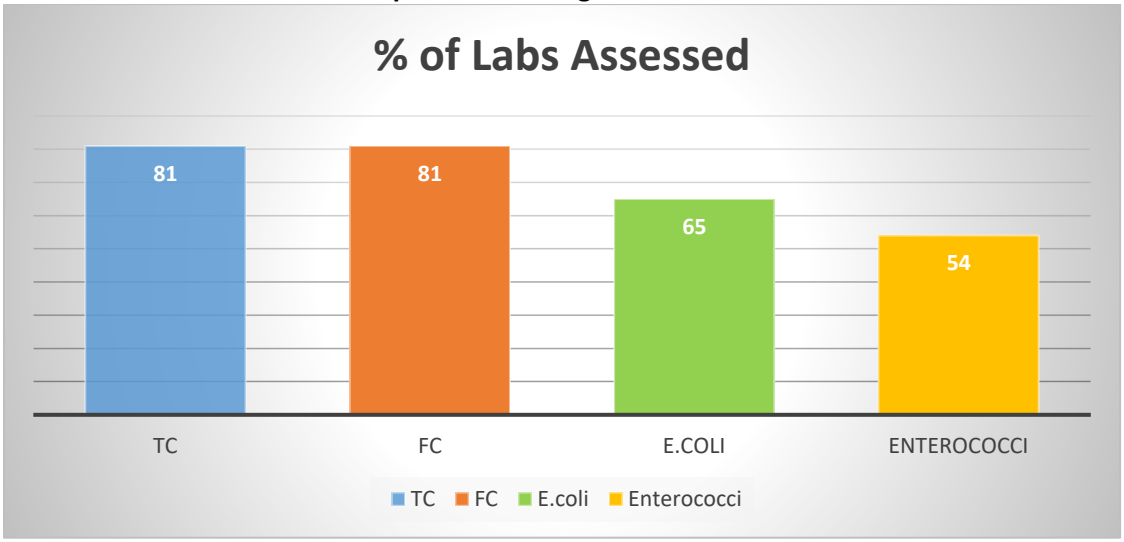
The percentage of laboratories that performed a particular test in water was determined by a positive response to the test parameter regardless of the type of water tested. See Appendix 1 for detailed tables by grouping and type of water tested. The following graphs relate to the analysis of water.

Group 1 – Basic Physico-Chemical Parameters



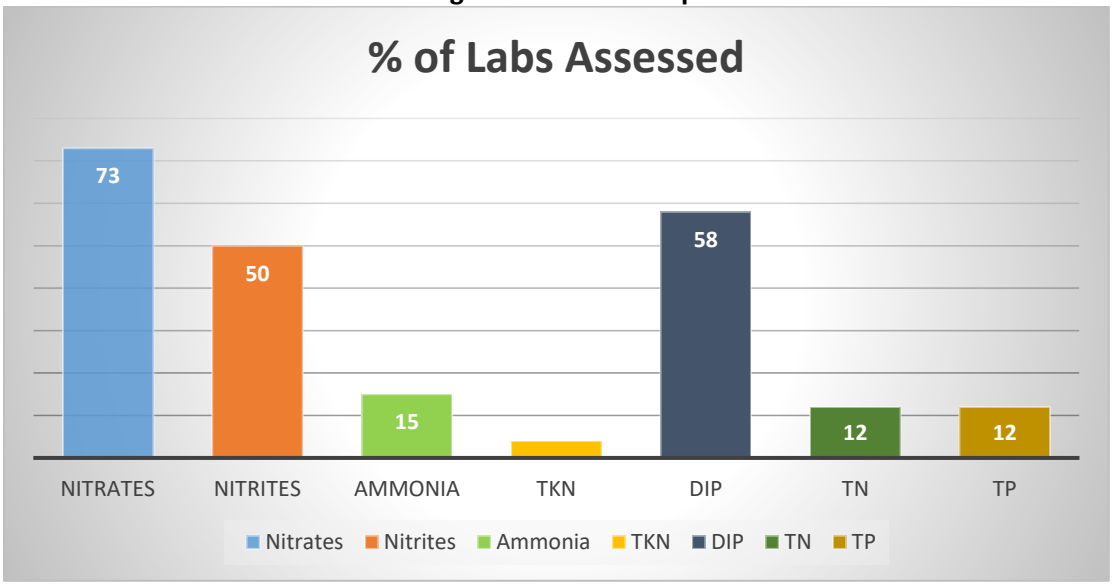
Graph 1 shows the vast majority of laboratories assessed were able to perform DO, Turbidity, pH and Residual chlorine with pH and turbidity being the most commonly assessed parameters.

Group 2: Microbiological Parameters



Group 2 results show that 81% of laboratories were able to test for both total and faecal coliforms. Only 65% and 54% respectively were able to test for *E. coli* and enterococci. Enterococci are the preferred indicators of faecal pollution in marine waters although *E. coli* is accepted.

Group 3 – Nutrients: Nitrates, nitrites, ammonia, TKN, Dissolved Inorganic Phosphate, Total Nitrogen and Total Phosphate

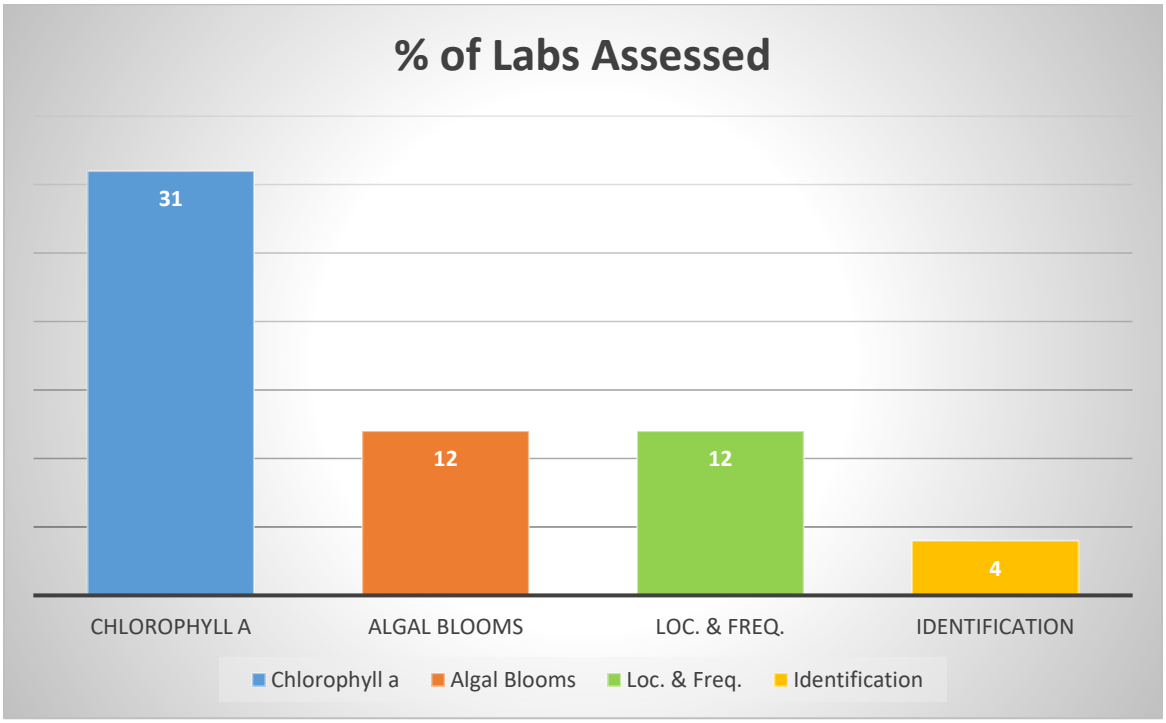


Of the twenty-six (26) laboratories assessed:

- Nitrates - 12 (46%) performed nitrates in wastewater, 10 (38%) in coastal water, 15 (58%) in surface water and 11 (42%) in potable water.
- Nitrites - 8 (31%) performed nitrites in wastewater, 9 (35%) in coastal water, 11 (42%) in surface water and 9 (35%) in potable water.
- Ammonia – Very few labs tested for Ammonia-N: 3 (12%) each tested in wastewater, surface and potable water and 8% in coastal water.
- TIP – 10 (38%) performed TIP in wastewater, 9 (35%) in coastal water, 11 (42%) in surface water and 8 (31%) in potable water.
- 1 laboratory tested for TKN in wastewater. 3 (12%) laboratories tested for TN and TP in wastewater and coastal water.

Although several laboratories have the capacity to test for various nutrients in coastal waters, few have the capacity to test for nitrates, nitrites and ammonia (Total Inorganic Nitrogen) in coastal water to facilitate the comparison of coastal water quality across the WCR as recommended in the SOCAR. Interference of ions in seawater appears to be a deterrent to performing these nutrient analyses as well as the lack of equipment and/or knowledge of test methods that can meet the required detection limits. Training is definitely needed and recommended in this area.

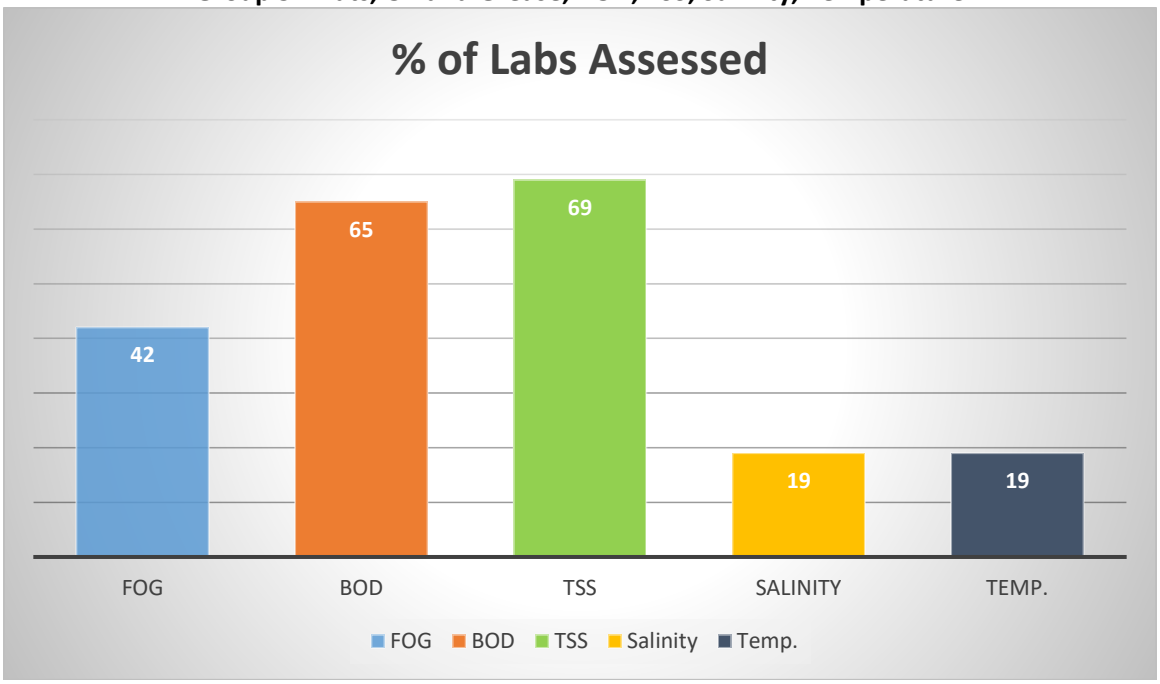
Group 4 – Parameters related to Nutrients: Chlorophyll a, Algal blooms location and identification



Chlorophyll a: Of the 8 (31%) laboratories that test for chlorophyll a, 7/8 perform the test in coastal waters while 5/8 perform the test in river or pond water. In addition to testing for chlorophyll a, the Department of Environment in Tobago also tested for blue-green algae using the YSI meter.

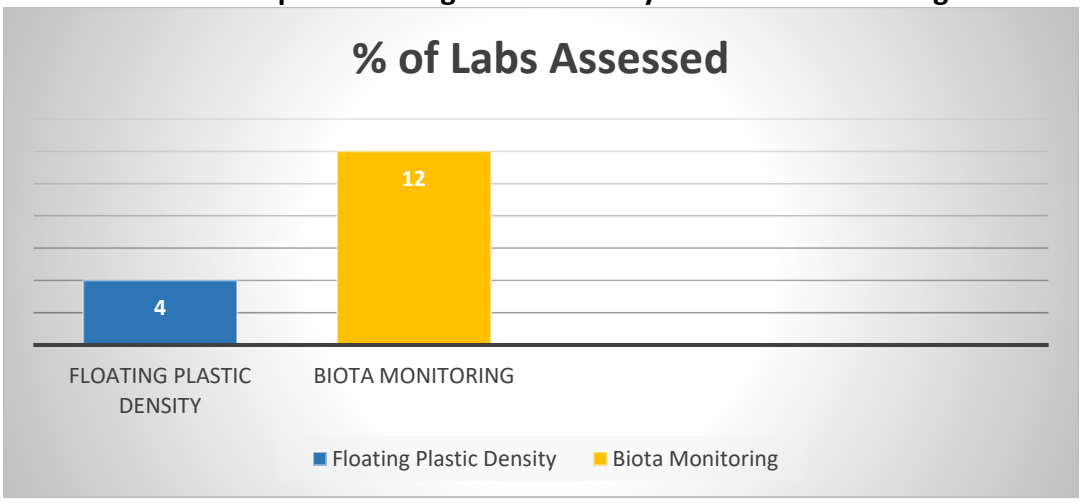
Algal Blooms: Only four (4) laboratories checked the location and frequency of algal blooms while only one (1) performed identification.

Group 5 – Fats, Oil and Grease, BOD, TSS, Salinity, Temperature



With the exception of a few laboratories, most laboratories that performed TSS also performed BOD – both important to wastewater discharged into surface or coastal water.

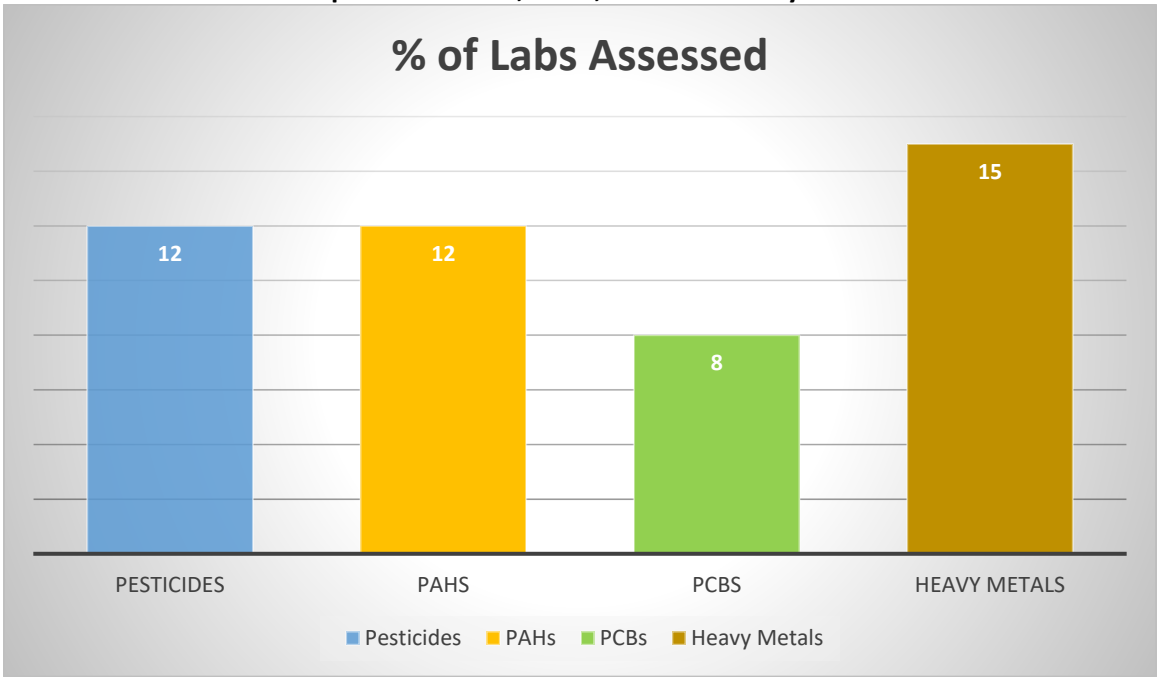
Group 6 – Floating Plastic Density and Biota Monitoring



Only one (1) laboratory, the Department of Environment in Tobago, checked floating plastic density in rivers and coastal waters.

Biota monitoring was rarely done. The Department of Environment tested for blue-green algae as well as chlorophyll a. The Department of Agricultural Services tested for POPs (organochlorine pesticides) in reef fish. The Government Analytical Services did identification of aquatic organisms and the Institute of Marine Affairs checked population diversity, density and richness of various indicator aquatic organisms. They also tested for PAHs and heavy metals in biota.

Group 7 – Pesticides, PAHs, PCBs and heavy metals



There are five (5) laboratories with the potential capacity to test for pesticides. Three (3) laboratories were able to test for pesticides – two (2) in Grenada and one (1) in Jamaica. Additionally, the GAS in Barbados was able to test for OPs and triazines in groundwater but were not currently able to do so due to equipment problems. Conversely at CARPHA in Saint Lucia, there is equipment with the capacity for testing pesticides, but staff require training. The PRL in Jamaica was able to test for the widest range of pesticides - OCs, OPs, carbamates and pyrethroids in wastewater, surface water and potable water. It was not able to test for pesticides in coastal waters.

The IMA in Trinidad, PRL in Jamaica and the Produce Chemist in Grenada test for PAHs in all types of water, with the exception of the PRL which does not test coastal water. Similarly, the PRL tests for PCBs in all aqueous matrices except coastal water. The Produce Chemist is the only other laboratory that also has the capacity to test for PCBs.

Miscellaneous Chemical Parameters

A number of other parameters were performed by a very small number of laboratories with the exception of COD. This was not included in the table with BOD as COD is mainly done in industrial waste or in coastal water where the salinity interferes with the BOD test. Few of the participating SIDS need to be concerned with industrial waste. Fifteen (15) of the laboratories or 58% had the capacity to perform this test in comparison to 65% for BOD.

Miscellaneous tests included solids other than suspended solids – dissolved, sedimentable, total; and anions such as chlorides, sulphides cyanides, sulphates. See Appendix 1, Table 8 for breakdown of tests by laboratory.

5.1.2 Matrix: Soil

COUNTRY	LAB	TEST											
		pH	**Sal.**	**NO_3**	**DIP**	**TKN**	**NO_2**	**FOG**	**Pest**	**PCB**	**PAH**	**HM**	**TM**
Antigua	DAS	✓		✓	✓				✓ OC				
Barbados	GAS	✓	✓			✓							✓
DR	INTEC											?	✓
Grenada	PC	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓
Jamaica	PRL							✓	✓				
TT	CARIRI	✓		✓			✓	✓				✓	

Sal. – Salinity Pest. – Pesticides TM – Trace Metals HM – Heavy Metals

5.1.3 Matrix: Sediment

COUNTRY	LAB	TEST											
		pH	Sal.	NO_3	DIP	TKN	NO_2	FOG	Pest	PCB	PAH	HM	TM
TT	IMA										✓	✓	
	CARIRI	✓		✓			✓	✓				✓	
Cuba	CIMAB										✓		
Antigua	DAS	✓		✓	✓								

- Personal communication with L. Christian of DAS, Antigua – Sediment testing is done from time to time – pH, Nitrates, ortho-phosphates.

As can be seen from the tables above, few of the laboratories test sediments and soil.

6 TRAINING

A wide range of training requests were made on a total of forty-nine (49) topics. The most common requests were for training in:

1. Current Laboratory Methods for the Chemical and Microbiological Analysis of Ambient Water inclusive of Test Method Quality Control and
2. The requirements and implementation of ISO17025:2017.
3. Sample Collection and Preparation of a Statistical Sampling Plan

Also received were requests for training in the analysis of coastal water. More advanced laboratories wanted training in the collection of sediment. A frequent request from laboratories performing basic chemical parameters was for training in the use, calibration, and maintenance of equipment. Many laboratories procure basic equipment and lack the training to properly calibrate the instrument before use.

Appendix 2 contains the list and frequency of training requests.

6.1 RECOMMENDED GENERAL TRAINING

The following courses can be recommended based on:

- Frequency of the request
- The importance to assuring the quality of test results
- The importance of increasing capacity to monitor particular parameters of significance to the environment where insufficiency exists

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, record-keeping (administrative and technical), etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods
3. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping.
4. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis:
    a. Design of a statistical sampling plan/programme

b. Data collection, Interpretation of the data and identification of trends in the data

5. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual methods and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, and cost of maintenance

This course is particularly recommended as many laboratories analyse nutrients in wastewater using HACH equipment (spectrophotometer) and reagents. However, the HACH test methods are not sensitive enough (MDLs for the methods are too high) for analysis of nutrients in coastal water. With almost all waste and agricultural runoff eventually emptying into the sea (or large bodies of surface water), it is important to be able to monitor seawater for both nutrients and chlorophyll a. Most personnel in laboratories are not aware of the test methods suitable for nutrient analysis (other than rapid methods utilising HACH) and seek to rely on HACH or think a nutrient analyser is the answer. Nutrient analysers are meant for laboratories with high sample throughputs on a regular basis, are expensive (USD 40,000 or more) and require annual external maintenance. Measurement methods for chlorophyll a, although requested by two (2) laboratories only, have been included due to its importance in supporting the results of nutrient analysis. Currently, only a third of the laboratories monitor this important parameter and with the multiple requests for multi-parameter meters the sensors required should be considered by laboratories performing field tests.

6.2 RECOMMENDED TECHNICAL TRAINING

The technical training associated with equipment recommended for acquisition by IWEco Project and for equipment already in house is wide and varied. Table 2 of Appendix 2 shows the technical training required for equipment already owned by the laboratory and for equipment that is recommended for procurement by the laboratory. Unfortunately, due to high cost, it is unlikely that all recommended equipment in this table can be procured, e.g., LC-MS for PRL, Jamaica, although its acquisition is recommended if possible. The table below shows the recommended technical training associated with equipment in order of priority for acquisition where applicable.

RECOMMENDED AREAS OF TECHNICAL TRAINING: IN ORDER OF PRIORITY

TECHNICAL TRAINING	ASSOCIATED EQUIPMENT	LABS MAKING REQUEST
1. Multi-parameter Meter - Use, calibration and maintenance	Multi-parameter Meter – YSI meter recommended. YSI ProDSS for consideration	1. CPHEM, Cuba 2. INRH, DR 3. NAWASA Grenada 4. CARIRI, Trinidad 5. EHL, St. Kitts 6. Fisheries Lab, SVG

TECHNICAL TRAINING	ASSOCIATED EQUIPMENT	LABS MAKING REQUEST
2. HACH DR 3900 - Use, calibration and maintenance	HACH DR 3900 spectrophotometer	1. EHL, St. Kitts 2. NWD, St. Kitts 3. PHL, Barbados
3. Use and in-house maintenance of Seal HR3 Nutrient Analyzer	Nutrient Analyzer - Seal HR3	1. CARPHA, Saint Lucia 2. EHL, Jamaica
4. A. Pesticide extraction from ambient waters, soil and sediments – LLE and SPE B. Analysis using GCMS	Trainer to recommend materials and solvents for acquisition prior to training or to bring materials to demonstrate – CARPHA to obtain solvents GCMS: Agilent 7890B/5977 GCMS – INHOUSE (CARPHA)	1. CARPHA, Saint Lucia 2. DAS, Antigua
5. Use of flow meter and application to water quality	Flow Meter	DoE, Tobago
6. Use of biota sampling kits	Biota Sampling kits	
7. Use of Membrane Filtration Test Kits	Membrane Filtration Test Kits	
8. Water purification system – on installation: use and maintenance	Water Purification System for type 2 water	INRH, Cuba
9. Use of Biochrom Libra S50PC	Biochrom Libra S50PC	

The most common piece of field monitoring equipment requested where training was also requested was the multi-parameter meter with probes for the determination of pH, temperature, DO, salinity electrical conductivity. The most requested brand was the YSI but with Cuban labs and some DR laboratories preferring Hanna Instruments. Almost all laboratories with the exception of those already possessing such a meter requested training in their use, calibration and maintenance.

The following strategy is recommended for the most commonly requested equipment:

I. Multi-parameter meter – one brand and model procured, and virtual training arranged – the YSI brand is recommended as the preferred brand.

II. Virtual training on HACH 3900 spectrophotometer and other HACH equipment –for those already in possession of the instrument and for those for whom procurement is recommended.

Other training, which is recommended due to its importance to the Region although highly specialised, are:

I. Use and in-house maintenance of Nutrient Analyser (after external maintenance performed by SEAL) – both the CARPHA lab and EHL in Jamaica already have the SEAL HR 3. These extremely expensive pieces of equipment have already been acquired – the one for the CARPHA lab under the IWCAM Project – and should be used. Very few laboratories have the capability to test for nutrients in marine waters.

II. Training in pesticide extraction from ambient waters, soil and sediments – theoretical training and demonstration of use of equipment/materials for extraction. This training is important as few laboratories in the Eastern Caribbean are able to test for pesticides. The area of weakness is not so much in the use of the instrument (GCMS, etc.) but in the methods of extraction. If practical, an attachment could be arranged with a laboratory that does both extraction and testing on a regular basis, e.g., PRL in Jamaica or other laboratory.

The CARPHA EHL has also requested re-training in the use of the instrument.

7 EQUIPMENT RECOMMENDATIONS

7.1 IN-HOUSE EQUIPMENT RECOMMENDED FOR REPAIR / SERVICING/PARTS

EQUIPMENT	LAB	COMMENTS
Nutrient Analyzer - Seal HR3 **NB. Servicing required**	1. CARPHA, Saint Lucia 2. EHL, Ja.	Both labs have the Seal HR3 analyser **in-house**. Both require maintenance due to lack of use
Teledyne Hydra II Mercury Analyzer **NB. Servicing required**	EHL, Ja.	Requires servicing due to lack of use. Quality of lab water caused problems with its operation.
GCMS	GBS	Part required – not specified
HACH DR 3900 Spectrophotometer	EHL, SKN	Servicing required
pH Meter [Hanna Instruments model HI3512]	CIMAB, Cuba	Electrode for pH meter Electrode part number HI1131B
Multi-parameter meter: YSI ProDSS	Lab. Amb., DR	Sensor for determination of chlorophyll a and pigments in freshwater blue green algae in ponds and reservoirs
Multi-parameter meter: Hanna Instruments model HI 9829		Sensors for pH and DO determinations

7.2 EQUIPMENT RECOMMENDED FOR ACQUISITION – NO ASSOCIATED TRAINING

Small pieces of equipment such as field monitoring meters and sampling equipment as well as laboratory items required to adequately perform basic tests such as incubators, thermometers and equipment for performing microbiological tests were requested. See Appendix 3 table 2 for details and specifications where applicable.

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
Antigua	DAS	1. HACH BODTrakII 2. 20º C incubator 3. Multi-parameter meter – pH, EC, salinity, DO (YSI ProDSS preferred) 4. Bacti-cinerator	1 1 1 1
Barbados	PHL and GAS	None	-
Cuba	CIMAB	Vacuum pump	1
		Liquid in glass thermometers • Environmental samples and work premises	• 10 units

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
		• Refrigerators and Freezers • Ovens and incubators	• 5 units • 5 units
		Digital burette	1
	CPHEM	Benchtop DO meter for BOD	1
		Analytical balance (0.1 mg)	2
		BOD bottles	1 case of 20
		20ºC incubator	1
	INRH	Buerkle Sampler propylene bottle holder	1
		15 mL conical tubes ø 16.4 mm for the Eppendorf 5804 centrifuge	8
		Analytical balance (0.1 mg readability)	1
Dominican Republic	Laboratorio Ambiental (Environmental Lab)	Sampler with extendable rod and bottle holder, e.g., Buerkle equipment	1
		HACH DR 300 pocket colorimeter	1
	INTEC (University Lab)	Hot plate	1
		Multiparameter meter	2
		Cole Parmer Water Sampler	1
	CAASD (part of Min of Health)	Refrigerated incubator for BOD	1
	LAVECEN (Vet. Lab)	-	-
Grenada	Grenada Bureau of Standards	Sample bottles – Nalgene, wide mouth, autoclavable, 500 mL	36
		pH meter	1
		Filter funnel with clamps (47 x 250 mL)	6
	National Water & Sewerage Authority	Sample bottles – Nalgene, wide mouth, autoclavable, 500 mL	36
		Membrane Filtration Equipment – manifold, filter funnels (12), 6 clamps	12
		Vacuum pump for membrane filtration	1
	Produce Chemist	Desktop Computer	1
		Analytical balance (readability 0.1mg)	1
Jamaica	Environmental Health Laboratory	Type1 water purification system	1
		Desktop Work stations for LIMS with wireless routers	4
		Multi-function printer for LIMS	1
		Headset with microphone	4

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
	NEPA	Water purification system – type 2 water	1
		UV-Visible Spectrophotometer, e.g., Genesys 50	1
		Multiparameter meter capable of measuring pH, Conductivity, Salinity, DO	3
St. Kitts & Nevis	EHL, St. Kitts	Turbidity meter	1
		pH meter	1
	NWD, Nevis	Bottle thermometer for refrigerator	1
		Thermometers for water bath incubators	2
Saint Lucia	CARPHA	None	-
	WASCO	HACH TL2360 Turbidimeter	1
		HACH DR 6000 Spectrophotometer	1
Saint Vincent and the Grenadines	SVGBS	High output vacuum pump	1
	Fisheries Div. Lab	Water purification system for type 2 water	1
		Incubator	1
Trinidad & Tobago	IMA	None	-
	CARIRI	Handheld UV lamp	1
	Nat'l Quarries Co. Lab	None	-
	Dept. of Environment, Tobago	None	-

8 RECOMMENDATIONS BY COUNTRY

8.1 ANTIGUA & BARBUDA

One (1) laboratory was recommended for assessment, the Department of Analytical Services, falling under the Ministry of Agriculture, Fisheries and Barbuda Affairs.

The laboratory is recommended for support by the IWEco Project.

Recommendations

Annex 1 contains the summary of findings and the actual survey response for reference.

A. ***Equipment for Acquisition by IWEco Project – No Training Required***

1. HACH BODTrakII and
2. Refrigerated incubator (20º C)
3. Multi-parameter meter (YSI ProDSS preferred)
4. Bacti-cinerator

B. Equipment for Acquisition - Training Required

Not applicable

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods
3. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data
4. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual methods and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, cost of maintenance

D. ***Equipment Training – Equipment In-house or to be Acquired Elsewhere***

1. Training in pesticide extraction for analysis by GC-MS
2. Training in metals extraction for analysis by GFAAS/FAAS

   Training in pesticide and metals analysis is not recommended as the equipment agent should provide training in the use of the instrument on installation. This training is instrument specific. However, methods of extraction of the analyte of interest from the sample are not included and analysts are often deficient in how best to extract the analyte before instrumental analysis.

E. NOT Recommended for Acquisition

1. ***Heating Block for COD analysis -*** the lab requested this equipment to digest samples for COD analysis but generally BOD is used in the SIDs to measure organic matter that is oxidizable by micro-organisms aerobically in wastewater and fresh water bodies. Certainly, in the Eastern Caribbean, there is little or no industrial waste being released into water bodies. Generally, there is little demand for the COD test, so acquisition of a COD digester is not recommended as a priority acquisition.
2. **Discrete Analyzer –** Although useful, this equipment is extremely expensive starting at USD40,000 for the Seal analyzer. The assumption is that the Thermo Scientific instrument requested would fall in this ball park. The CARPHA laboratory has found that, unless one is doing a large number of samples, it is easier to use a spectrophotometer after extraction. It requires annual maintenance with the supposition that the equipment is used for at least forty (40) hours per week. This instrument is more suitable for a research laboratory or an analytical laboratory with a high throughput of samples weekly.

8.2 BARBADOS

Two (2) laboratories were assessed:

(a) Public Health Laboratory
(b) Government Analytical Services (GAS)

RECOMMENDATIONS

It is recommended that both laboratories be supported by the IWEco Project, particularly in the area of general training.

Annex 2 contains the summary of the findings and the actual survey responses from the laboratories.

8.2.1 Best – Dos Santos Public Health Laboratory

The Best – Dos Santos Public Health Laboratory is primarily a medical laboratory with a Water Quality Laboratory responsible for microbiological testing of drinking water, coastal water and wastewater. It has a much higher capacity (10 fold compared to GAS based on samples tested for 2019) for analysing microbiological samples than the GAS. The ISO 17025 standard applies specifically to the Water Quality Laboratory while the ISO 15189, the standard for medical laboratories, applies to the rest of the PHL. There are and have been projects that are specifically aimed at the strengthening of medical laboratories and organizations like the CDC tend to support the medical aspects of the laboratory. Training in the requirements of the ISO 17025:2017 standard and its implementation will be needed by staff of the Water Quality Laboratory.

The Water Quality Laboratory has requested a HACH spectrophotometer and accessories to carry out basic chemical analyses with associated training which would allow for complete basic analyses of water. However, since the GAS already carry out wet chemistry analyses, this is not strictly necessary and would require training in water quality analyses already possessed by the GAS. In areas of general training, it is recommended that staff from the PHL be included. Nevertheless, it is also recommended that the IWEco Project consider the acquisition of HACH equipment as a backup for the GAS laboratory. Although HACH equipment is not suitable for testing marine waters due to the low-detection levels required by the limits set for TIN and TIP in marine waters, HACH water quality tests would be used by the Laboratory for monitoring the quality of wastewater, ground water and surface waters.

Recommendations

A. Equipment Recommended for Acquisition by IWEco Project – No Training Required

1. None – no equipment recommendation where training is not required

B. Equipment Recommended for Acquisition by IWEco Project - Training Required

1. HACH DR 3900 spectrophometer
2. HACH TNT plus test kits for spectrophotometric water analysis

Training in the use, care and maintenance of the spectrophotometer and in the use of the test kits are needed.

C. Recommended General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods
3. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

D. NOT Recommended for Acquisition

1. **ABI 7500 PCR Machine & associated accessories:**
    i. Fisherbrand™ accuSpin™ Micro 17 Microcentrifuge
    ii. Inspiron 14 5000 Laptop

This equipment is used for the quantification of pathogenic enteric viruses which can be present in the absence of faecal indicator organisms and which persists in the environment for several months – to be used for outbreak investigations. The acquisition of a PCR machine and associated training do not fall within the purview of this Project. The objective is to strengthen field monitoring and assessment capabilities in support of Integrated Water Resources Management (IWRM) Sustainable Land Management, Water Use Efficiency (WUE) and Ecosystems Monitoring and Indicators Framework. Unfortunately, acquisition of equipment for the investigation of public health outbreaks does not fall within any of these categories.

8.2.2 Government Analytical Services (GAS)

The Government Analytical Services (GAS) falls under the Ministry of Agriculture and is therefore an agricultural laboratory that provides testing services to other government agencies and to the public. Its goal is to be the leading provider of analytical services in the areas of Chemistry and Microbiology in Barbados and the region. The GAS performs both microbiological analyses of potable water, surface water, coastal water and wastewater and a wide range of chemical analyses for environmental monitoring purposes, have received training in the use of various instruments for a wide range of analytes and have experience in the use of all types of chemistry equipment including sophisticated analytical equipment.

The GAS equipment needs are for high-level sophisticated analytical equipment for highly specialized tests that may be outside the budget for the laboratory strengthening component of the Project and where, additionally the focus is on supporting laboratories to ensure that basic

field and laboratory testing is performed. It is therefore recommended that the laboratory be supported with training, as far as possible, in meeting its environmental laboratory strengthening needs.

Recommendations

A. Recommended Equipment for Acquisition by IWEco Project – No Training Required

1. None – no equipment recommendation where training is not required

B. Recommended Equipment for Acquisition - Training Required

1. Autoanalyzer for nutrient analysis of seawater, if within budget - Seal AA500 Autoanalyzer preferred. However, a specialist in auto-analyzers will need to be contacted to advise on the best instrument for their use. Cost of analyzer is US$40,000 – 50,000. Justification for acquisition given in Annex 2.

   Use and Preventive Maintenance of chosen nutrient analyzer on installation by agent.

C. Recommended General Training

1. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
   a. Design of a statistical sampling plan/programme
   b. Data collection, interpretation of the data and identification of trends in the data
2. Nutrient Analysis Methodologies for Water with a focus on Seawater – manual and automated methods and Methods for Determination of chlorophyll a.

D. NOT Recommended for Acquisition

1. **Cryptosporidium PCR kit or ELISA Cryptosporidium kit** for testing drinking water **-** The acquisition of such kits does not fall within the purview of the Project
2. **Spectrometer for soil analysis** - The tests for which this spectrophotometer is required are for agricultural purposes, for determining the quality of soil
3. **LC-MS/MS and GC-MS (triple quadrupole)** - for analysis of organic compounds including some pesticides. The LC-MS/MS would replace the non-functioning HPLC/MS used to monitor non-volatile pesticides. However, budgetary constraints would not allow for the acquisition of this instrument. With respect to the GC-MS (triple quadrupole), the laboratory has a working GC-MS, albeit not state of the art.

8.3 CUBA

A total of four (4) laboratories were recommended for assessment by various personnel involved in the Project.

Two (2) of these were recommended for assessment by the IWEco focal point. These were:

(i) the INRH - UEB Análisis y Servicios Técnicos, Cienfuegos and
(ii) Laboratorio de Química y Microbiología Sanitaria, Centro Provincial de Higiene, Epidemiología y Microbiología (CPHEM), Cienfuegos.

(iii) The Laboratorio de Ensayos del CIMAB was recommended for assessment by a UNEP programme officer.

(iv) The laboratories of the Centro de Estudios Ambientales de Cienfuegos (CEAC), were recommended for assessment by an IWEco Project programme officer as CEAC supports the work of the IWEco Project in its integrated approach to coastal area management. The laboratories were not formally assessed as survey information was not submitted. However, the list of tests for which the laboratories are accredited are included in annex 3. This information was downloaded from the website of the Cuban accreditation body (ONARC).

RECOMMENDATIONS

It is recommended that the following three (3) laboratories be supported by the Project. They are listed in order of priority.

1. CIMAB
2. INRH-UEB
3. CPHEM

Annex 3 contains a summary of the findings and the actual survey responses.

8.3.1 CIMAB Laboratory

CIMAB was designated as one of the two (2) Regional Activity Centres for the LBS Protocol. The mission of RAC/CIMAB is to improve the environmental quality of bays and coastal areas through the evaluation and control of pollutant discharges from land-based sources of marine pollution.

Its objectives are:

- Contribute to the promotion and application of the LBS Protocol by coordinating and supervising activities.
- Promote scientific-technical cooperation between specialized agencies of the United Nations (UN), intergovernmental and non-governmental organisations.
- Facilitate scientific and technical assistance, trainings, courses, seminars and workshops to governments and institutions in the region.
- Collect and apply innovative technologies for the implementation of programmes and activities related to the LBS Protocol.

The research lines of the organization include:

- Diagnosis and Monitoring of the Environmental Quality of Marine Coastal Ecosystems
- Management of Marine Debris and Domestic and Industrial Solid Waste

- Domestic and Industrial Wastewater Management
- Waste Management in Ports

The laboratories of CIMAB are therefore highly relevant in supporting the work of not only the Project but of UNEP as a whole.

Recommendations

A. ***Equipment for Acquisition by IWEco Project – No Training Required***

1. Vacuum pump
2. Liquid in glass thermometers – insufficient numbers in the laboratory. Needed for monitoring temperature of equipment requiring temperature control, e.g., incubators, ovens, refrigerators – see lab survey information in annex 3 for number and types
3. Electrode for pH meter – replacement for broken electrode
4. Digital burette

For more detailed information on equipment needs, e.g., numbers, types and model numbers, see Annex 3.

B. Equipment for Acquisition - Training Required

1. FTIR Spectroscope – to determine micro plastics in seawater – if budget allows
   Training would be required in "Determination of micro plastics in seawater" and in use and maintenance of the equipment, if acquired. As a RAC, this acquisition is highly recommended.

   Note: CEAC's website states that it is working on the development of analytical techniques for the evaluation and characterization of nano-plastics in coastal samples.

C. General Training

1. Training in test methods for determination of petroleum hydrocarbons in environmental samples
2. Training in test methods for the determination of chlorophylls in phytoplankton

D. <u>NOT Recommended</u> for Acquisition

1. Atomic absorption spectrophotometer – while the determination of heavy metals is relevant to the work of CIMAB and the Project, it may be outside the budget of the lab-strengthening component of the Project. However, as a RAC, its acquisition is important if heavy metal contamination from industry is significant.

8.3.2 INRH-UEB Laboratory

The UEB Analysis and Technical Services falls under the National Institute of Hydraulic Resources (INRH). The Institute is responsible for water quality at the national level; its main focus being protection of water resources. The Institute was set up to direct, execute and control the hydrological resources of Cuba. It organizes and directs the protection of surface water, watersheds, streams and hydrological installations, e.g., dams, against dangerous contamination and other forms of degradation and deterioration and controls the quality of the waters. The Institute also determines the necessary measures and standards to protect the economic, social, environmental and natural resources from the deleterious effects that could be produced by surface waters. It regulates and controls aqueduct, sewerage and river drainage. The INRH-UEB

Laboratory was recommended for equipment support under the laboratory-strengthening component of the IWCAM Project but did not receive any equipment. This laboratory has multiple valid equipment needs that should be met to be able to perform environmental monitoring efficiently. It is recommended that the laboratory be supported by the IWEco Project.

Recommendations

1. ***Equipment for Acquisition by IWEco Project – No Training Required***
    1. Analytical balance
    2. 15 mL conical tubes ø 16.4 mm x 8 for the Eppendorf 5804 centrifuge
    3. Buerkle ™ Samplers Polypropylene Bottle Holder

B. ***Equipment for Acquisition - Training Required***

1. U.V. Vis Spectrophotometer and quartz cuvettes x 4

   Note: The lab has requested a Biochrom Libra S50PC which is a spectrophotometer with a PC and remote-control software included as standard. The instrument is also available as the standalone S50 which would be more affordable and perhaps more rugged than the S50PC. The S50 is a rugged instrument with connectivity via USB, supporting connection to a Windows computer running optional remote-control software or export of data to PC via Ethernet or Wi-Fi or printing via USB, Ethernet or Wi-Fi.
   http://www.montreal-biotech.com/Brochures/Biochrom-Libra-brochure.pdf

   Another similar instrument that meets the requirements specified by the lab is the Genesis 50.
   https://assets.fishersci.com/TFS-Assets/MSD/brochures/BR52989-genesys-family-brochure.pdf

2. Multi-parameter meter (Hanna Instrument preferred) for field measurements
   Training in use and maintenance required.
3. Water purification system for type 2 water – training in use and maintenance on installation

C. ***General Training***

None.
The requested wastewater treatment systems training was more in keeping with training for an engineer rather than for laboratory staff.

D. ***NOT Recommended for Acquisition***

See Annex 3. Laboratory provided a list of 20 items – too numerous to include here. The items, while relevant to environmental monitoring, are too numerous for acquisition of all.

8.3.3 CPHEM Laboratory

CPHEM is a provincial public health laboratory, located in Cienfuegos, that reports to the Ministry of Health. It supported the national IWCAM Project in Cienfuegos by testing coastal waters. However, it did not receive equipment support from the IWCAM Project despite recommendations. Its equipment needs have remained largely unchanged. It is highly recommended that this laboratory be supported in its work if possible.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

1. DO meter. The lab uses titration to determine DO in BOD samples. A working meter gives the capacity to perform oxygen measurements more quickly.
2. Conductivity / Salinity meter – for rapid determination of salinity
3. pH meter
4. BOD bottles - 36
5. 20^{o} C incubator for BOD
6. 150mL, 250mL, 1L conical flasks – in short supply at lab
7. 150 mL, 250 mL, 1L beakers – in short supply
8. Graduated pipettes: 2, 5, 10, 25 mL – in short supply

B. Equipment for Acquisition - Training Required

None

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control. To also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods
3. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

D. NOT Recommended for Acquisition

1. Table top turbidimeter
2. Closed reflux COD digestor
3. Hot plates
4. Air compressor
5. Field comparators for residual chlorine determinations

The justifications given for acquisition are inadequate. With respect to the field comparators for residual chlorine determinations, the laboratory has stated in the survey that laboratory staff do not collect field samples.

8.3.4 CEAC Laboratory

No information was received from CEAC. CEAC collaborates with and is in sync with the work of the IWEco Project but cannot be supported under the laboratory strengthening component as no survey response was received[1].

[1] Cuba has received a substantial contribution under Component 1 of the IWEco Project which included a wide variety of laboratory equipment and materials.

8.4 DOMINICAN REPUBLIC

Survey responses were received from four (4) laboratories. They are:

1. Laboratorio de la Vigilancia de la Calidad Del Agua de la Corporación del Acueducto y el Alcantarillado de Santo Domingo (CAASD**)**
2. Observatorio de Cambio Climático y Resiliencia/Laboratorio de Servicios Analíticos Ambientales
3. Laboratorio Ambiental
4. Laboratorio Veterinario Central-LAVECEN

RECOMMENDATIONS

It is recommended that:

A. Laboratorio Ambiental be fully supported in meeting the recommended equipment and training needs.
B. CAASD be supported with respect to general training needs
C. INTEC be supported with respect to recommended equipment needs
D. LAVECEN be supported in meeting its general training needs if there is space available

Annex 4 contains the summary of findings and the actual survey responses for reference**.**

8.4.1 CAASD

The CAASD was created in 1973 as the first regional water and sewerage company in the Dominican Republic. It serves approximately four (4) million people in the capital, Santo Domingo, and three municipalities surrounding the province. The corporation falls under the Ministry of Health. The laboratory not only tests all types of water but also sediments. They do a wide range of basic parameters as well as location and frequency of algal blooms. They do have a working GC, but it is used to test for purgeable organic compounds (VOCs) – this group does not contain common pesticides in use. Although the survey indicated that sediments are tested, sediments were not included as a matrix in any of the tests performed. The laboratory is not accredited but staff has received extensive training in quality management systems including ISO 17025 and associated training such as internal audit training, verification of test methods and measurement uncertainty. Training records were provided but no examples of maintenance or service records. The tables for inventory of equipment and maintenance of equipment were not filled in and the promised Annex of equipment has not been sent.

Recommendations

A. ***Equipment for Acquisition***

There are no recommendations for equipment as the tests for which most of the equipment are being requested are done by the laboratory. With no inventory list and indication of working order of in-house equipment, this determination cannot be made.

Requests were also made for several specialised pieces of equipment such as an Electron Capture Detector (ECD) for the in-house GC in order to test for organochlorine pesticides, an ion chromatograph to test for anions and an AAS to test for heavy metals. These may be outside of the budget of the lab strengthening component of the Project.

Two (2) of the five (5) training requests were outside the purview of the Project. One was very general (interpretation of physico-chemical results), one for determination of heavy metals, and the last for the measurement of uncertainties.

B. General Training

1. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

8.4.2 Laboratorio de Servicios Analíticos Ambientales (INTEC)

The Laboratory of Analytical Services, located in the Technological Institute of Santo Domingo (INTEC), is a university laboratory that performs studies of air quality and carries out water and soil analyses. These analyses include physical-chemical and microbiological parameters. It also supports research and teaching by the university but also has private clients. It is ISO 9000:2015 certified.

The head of the laboratory has ten (10) years' experience and carries out or supervises all work in the laboratory and in the field. The laboratory is therefore research-focused and any environmental monitoring would be through the work of research students and their supervisors. The laboratory does not have a mandate to perform routine environmental monitoring and environmental research would be dependent on the research of students and professors.

With respect to testing of water samples, the laboratory is able to test wastewater, coastal water and river water. It also has the capacity to test sediments but has not indicated what tests are carried out. It has the capacity to test a wide range of basic water quality parameters and to test for metals. However, the metals were not specified as requested on the survey form.

The laboratory has indicated that it carries out in-house preventive maintenance and maintains records but has not provided any. The laboratory is ISO 9001 certified where the focus is on documentation and following the procedures set out. Competence is not evaluated. However, as a laboratory where maintenance and QA procedures are very important, it is expected that these are in fact carried out and documented.

Recommendations

A. *Equipment for Acquisition by IWEco Project – No Training Required*

1. Hot plate for acid digestion of samples for metals analysis
2. Multi-parameter meter x 2

B. General Training

The laboratory requested training in taking samples of hazardous materials and waste, as well as training in IR. Both of these requests are too specialised for the Project.

8.4.3 Laboratorio Ambiental

The laboratory is an internal water quality laboratory of the Water Quality Department which is a part of the Vice Ministry of Environmental Management. It does not provide services to third

parties. The laboratory provides analytical support to the Institution's programmes. Monitoring of rivers, beaches for recreational use, spas, lagoons, dams, streams, domestic and industrial wastewater treatment plants, and so on, is performed. A wide range of chemical tests are performed. Microbiological monitoring is done. The laboratory does not have the capacity to perform heavy metals, pesticides or biota monitoring.

It was noted under the IWCAM Project in 2009 that the use of quality control standards and certified reference material was limited in all the laboratories assessed due to financial constraints. Specifically, for this laboratory, it was noted that laboratory personnel were trained and carried out their duties competently although there were no written standard operating procedures (SOPs) and that staff were aware of quality control (QC) procedures. Based on the information contained in the survey for this laboratory, nothing with respect to QC procedures seems to have changed. The laboratory indicated in the survey that they do not perform QC, have no SOPs and do not participate in proficiency testing or inter-comparison laboratory exercises. However, through communication via email, the head of the laboratory has stated that the laboratory has completed several SOPs and associated forms with respect to sampling and field testing.

The IWEco Project can provide needed equipment and training but it does not have the capacity to address the root cause of lack of implementation of QA and QC measures to assure and directly verify the accuracy of test results produced by the laboratory.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

a. Sensor for multi-parameter meter, YSI ProDDD to test for chlorophyll a in the field
b. Field colorimeter for testing residual and total chlorine, e.g. HACH DR 900 since staff use HACH equipment
c. Sensors – pH and DO – for in-house Hanna multi-parameter meter
d. Piezometric tape
e. Sampler with extendable rod for sampling in hard to reach places

B. Equipment for Acquisition - Training Required

None

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping (administrative and technical), etc.
2. Current Methods for the Laboratory Analysis of Water and Associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

3. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping
4. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.4.4 Laboratorio Veterinario Central-LAVECEN

The laboratory is a veterinary one whose main clients are ranchers, Director General Livestock and the Ministry of Agriculture. The laboratory falls under the General Directorate for Livestock. The laboratory has given no indication of environmental samples tested or number of environmental tests for 2019. The laboratory does not function as an environmental monitoring laboratory. It is not recommended for support.

It is noted that the laboratory has the capacity to test for OCs, OPs and PCBs – matrix not specified – using an FDA method on its GC. The laboratory does perform some basic parameters for water – pH, total and faecal coliforms in water.

No equipment, parts or repair needs have been specified. They have requested training in a wide range of basic chemical parameters. However, they do not have the equipment to carry out the tests for which training is requested nor have they requested the equipment nor indicated that they intend to procure on their own. If possible, this request can be supported as a means of extending knowledge.

Recommendations:

This laboratory is generally not recommended for support by the Project.

A. Equipment for Acquisition by IWEco Project – No Training Required

None

B. Equipment for Acquisition - Training Required

None

C. General Training

However, if there is space, the following training is recommended.

1. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

8.5 GRENADA

Three (3) laboratories were recommended for assessment. They are:

1. Grenada Bureau of Standards Analytical Laboratory
2. NAWASA Water Quality Laboratory
3. Grenada Produce Chemist Laboratory

RECOMMENDATIONS

All are recommended for support by the IWEco Project with respect to training. It must be noted however that based on training records submitted, since 2009 the Produce Chemist has received Quality Management training three (3) times in addition to other related QMS training. The Produce Chemist has not responded to requests for equipment maintenance records.

Annex 5 contains the summary of findings and the actual survey responses for reference.

8.5.1 Grenada Bureau of Standards Analytical Laboratory

A. ***Equipment for Acquisition by IWEco Project – No Training Required***

1. Sample bottles x 36 – Nalgene, wide mouth, autoclavable, 500 mL
2. pH meter
3. Filter funnel with clamps x 6 (47 x 250 mL)

B. Equipment for Acquisition - Training Required

None

C. General Training

1. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

2. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

D. NOT Recommended for Acquisition

1. Various standards for different tests – due to short expiry dates
    a. Metal standards for AAS
    b. HACH reagents to perform Manganese and TPHs in water
    c. HACH soil extraction kit

These are consumables which do expire when annual test volume is low. The laboratory should be responsible for acquiring these as needed.

8.5.2 NAWASA Water Quality Laboratory

A. Equipment for Acquisition by IWEco Project – No Training Required

1. Sample bottles x 36 – Nalgene, wide mouth, autoclavable, 500 mL
2. Membrane Filtration Equipment – 3-place manifold, filter funnels x 12 & clamps x 6
3. Vacuum pump for membrane filtration

B. Equipment for Acquisition - Training Required

1. Multi-parameter meter with capability to perform conductivity, pH, DO and salinity (preferable YSI) – training in use and maintenance required

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control. To also include:
   a. Test Method Verification
   b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
   c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

D. NOT Recommended for Acquisition

Not applicable

8.5.3 Grenada Produce Chemist Laboratory

A. Equipment for Acquisition by IWEco Project – No Training Required

1. Analytical Balance
2. Desk top Computer

B. Equipment for Acquisition - Training Required

Not Applicable

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
   a. Test Method Verification
   b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
   c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

3. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, interpretation of the data and identification of trends in the data

D. NOT Recommended for Acquisition

1. Flame AAS
2. Ion Chromatograph
3. Biological Safety Cabinet

The above items may be outside of the budget. Additionally, despite repeated requests the laboratory has not submitted any equipment service records or in-house maintenance records.

8.6 JAMAICA

Three (3) laboratories were assessed. These are:

1. Environmental Health Laboratory (EHL)
2. National Environment and Planning Agency (NEPA) Laboratory
3. Pesticide Research Laboratory (PRL)

RECOMMENDATIONS

It is recommended that all three (3) laboratories be supported both in training and equipment acquisition, where possible, as all have a role in monitoring the health of the environment. While the Pesticides Research Laboratory does not have a mandate for environmental testing it does provide pesticide testing services for the NEPA (28% of all environmental samples tested by the PRL for 2019) and for the EHL from time to time.

Annex 6 contains the summary of findings and the actual survey responses for reference.

8.6.1 Environmental Health Laboratory

The Environmental Health Laboratory is a unit within the National Public Health Laboratory (NPHL) of the Ministry of Health that provides environmental monitoring and analytical services in conjunction with, and in cooperation with, the Environmental Health Units in each parish. The laboratory enjoys a close working relationship with the NEPA Laboratory.

Recommendations

A. ***Equipment for Acquisition by IWEco Project – No Training Required***

1. Type 1 Water Purification System
2. Laptop computers x 4 and wireless routers x 4 – specifications detailed in "Status of Equipment and Training Needs" attached
3. Multi-function Printer for LIMS
4. Headset with microphone x 4

B. Equipment for Acquisition by IWEco Project - Training Required

Not Applicable

C. In-house Equipment for External Servicing

1. Nutrient Analyzer – Seal HR 3
2. Teledyne Hydra II Mercury Analyzer

D. Training Associated with Equipment – In-house or to be Acquired

1. Retraining – in use of SEAL HR 3 Autoanalyzer
2. Determination of Nitrate and Phosphate using the Seal Autoanalyzer HR 3

E. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.

2. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

3. Nutrient Analysis Methodologies for Water with a focus on Seawater – manual and automated methods and Methods for Determination of chlorophyll a.

F. NOT Recommended for Acquisition

1. AAS
2. GC

Currently tests for pesticides are contracted to the Bureau of Standards or the Pesticide Research Laboratories.
Tests for heavy metals are also contracted, e.g., to the Mines and Geology Laboratory.

8.6.2 National Environment Planning Agency (NEPA) Laboratory

The vision of NEPA is that Jamaica's natural resources are being used in a sustainable way and that there is broad understanding of environment, planning and development issues, with extensive participation amongst citizens and a high level of compliance to relevant legislation.

Its mission is to promote sustainable development by ensuring protection of the environment and orderly development in Jamaica through highly motivated staff performing at the highest standard.

NEPA is the implementing agency for the national IWEco Project.

A. Equipment for Acquisition by IWEco Project – No Training Required

1. Type 2 Water Purification System
2. UV-Vis Spectrophotometer (conventional)
3. Multi-parameter meter x 3

B. Equipment for Acquisition by IWEco Project - Training Required

Not Applicable

C. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping (administrative and technical), etc.

2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

3. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

D. NOT Recommended for Acquisition

ICPMS and GCMS – Highly specialised instruments that exceed the laboratory strengthening sub-component of the budget.

8.6.3 Pesticide Research Laboratory

This laboratory is not a part of an organisation mandated to perform environmental monitoring. However, it performs tests for environmental organizations such as the NEPA. Its main routine work is in the support of food manufacturers. The laboratory is accredited to test for pesticide residues in fruits and vegetables.

A. Equipment for Acquisition by IWEco Project – No Training Required

None

B. Equipment for Acquisition by IWEco Project - Training Required

LC-MS - The laboratory is highly specialised and requires an LC-MS or LC-MS/MS to replace the instrument lost in a fire. However, this may be outside the budget. Training in use and in-house maintenance would be required on installation.

C. General Training

1. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.7 SAINT LUCIA

The names of four (4) laboratories were submitted by the IWEco focal point. However, the following laboratories were unsuitable for assessment:

1. The Gros Islet Polyclinic no longer provides microbiological testing services to the Ministry of Health and Wellness as the strategy is to focus on medical tests.
2. The Plant Research Laboratory where environmental quality monitoring tests are not conducted. The Head explained via email that the primary objective of the tests carried out at the Research and Development Division is to support farmers and provide plant quarantine regulatory functions in areas of soil health, Entomology, Pathology, Nematology with the goal of improving crop production, market access and meeting the requirements of phytosanitary international standards.

Consequently, two (2) laboratories were assessed:

1. The Thomas R. Theobalds Laboratory (the drinking water laboratory) of the Water and Sewerage Company (WASCO)
2. The Environmental Health Laboratory of the Caribbean Public Health Agency

RECOMMENDATIONS

It is recommended that the WASCO laboratory be supported with respect to training only. In-house maintenance does not seem to be recorded and QC is minimal. Its equipment needs are for ensuring redundancy rather than for meeting a deficiency in monitoring.

It is further recommended that the CARPHA EHL be supported as far as possible. This is a regional laboratory that already has the equipment capacity to perform nutrient analysis of seawater (nitrates only, the module for performing DIP was not purchased with the instrument) and analysis of organic contaminants by GCMS. The staff are in dire need of training not only in the use of the instruments themselves but in the extraction processes before reading on the instrument can be performed. The laboratory, although regional, acts as a local laboratory for the Environmental Health Department of the Ministry of Health and Wellness in the absence of a local laboratory with environmental testing capacity.

Annex 8 contains the summary of findings and the actual survey responses for reference.

8.7.1 Thomas R Theobalds Laboratory

WASCO has two (2) internal laboratories – one that tests primarily treated and raw drinking water (Thomas R Theobalds Laboratory) and the other is WASCO's sewage treatment plant that tests sewage. The main responsibility of WASCO, a government-owned entity, is "provision of potable water supplies and conservation, augmentation, distribution and proper use of water resources including preservation and protection of gathering grounds."

Recommendations

A. Equipment for Acquisition by IWEco Project

None

B. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping.
3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

C. NOT Recommended for Acquisition

1. Laboratory dishwasher – outside scope
2. Fume hood – outside scope
3. HACH DR 6000 UV/Vis Spectrophotometer – for redundancy purposes only
4. HACH TL2360 Turbidimeter – for redundancy purposes only

8.7.2 CARPHA Environmental Health Laboratory

The Environmental Health Laboratory (EHL), formerly the laboratory of the Caribbean Environmental Health Institute (CEHI), is a regional laboratory which also acts as a local laboratory for the Ministry of Health and Wellness. The Gros Islet Polyclinic laboratory used to perform microbiological environmental monitoring tests for the Ministry of Health and Wellness but no longer provides this service. The Caribbean Public Health Agency (CARPHA) is one of the co-executing agencies of the IWEco Project and therefore its laboratory is responsible for providing/ sourcing laboratory training for its member states throughout the Caribbean.

The laboratory has a GCMS but staff lack the capability to extract organic contaminants from soil and water samples. This was not recommended as a general training course because few laboratories made this request. However, it is very important if the equipment is to be used. CARPHA needs to source such training, perhaps through the use of a Caribbean laboratory network.

Recommendations

A. *Equipment for Acquisition by IWEco Project – No Training Required*

Not Applicable

B. Equipment for Acquisition by IWEco Project - Training Required

1. Module for performing Dissolved Inorganic Phosphate on Seal HR 3 nutrient analyzer

C. In-house Equipment for External Servicing

1. Nutrient Analyzer – Seal HR 3

D. Training Associated with Equipment – In-house Equipment

1. Retraining – in use of SEAL HR 3 Autoanalyzer
2. Determination of Nitrate and Phosphate using the Seal Autoanalyzer HR 3

E. General Training

1. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual methods and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, cost of maintenance
2. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.8 ST. KITTS AND NEVIS

Two (2) laboratories were assessed; they are:

1. Environmental Health Water Quality Monitoring Laboratory
2. Nevis Water Department Laboratory

RECOMMENDATIONS

Both laboratories are recommended for support by the Project. From interviews with laboratory heads, it is my considered opinion that the staff of both these laboratories would greatly benefit from practical training through an attachment to CARPHA PHL.

Annex 7 contains the summary of findings and the actual survey responses for reference.

8.8.1 Environmental Health Water Quality Monitoring Laboratory

Currently, the laboratory is only doing field testing on potable water as the laboratory was shut down from November – December 2020 for renovations. Additionally, the survey shows that most of the testing meters are non-functional. The meters that are being used to monitor the quality of potable water had been borrowed from the Bureau of Standards. However, the laboratory has indicated that it has the capability to test wastewater and coastal water. The laboratory also had difficulty accessing records as the laboratory was closed for renovations and everything was in storage.

The need to monitor coastal water quality has been recognised, as the IWEco focal point is working with CARPHA to fund part of project efforts to upgrade monitoring protocols for both potable and recreational waters.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

1. Turbidity meter
2. pH meter

B. Equipment for Acquisition by IWEco Project - Training Required

1. Multi-parameter meter with probes capable of measuring salinity/ conductivity and DO – for coastal water monitoring

C. In-house Equipment for External Servicing

1. HACH DR 3900 spectrophotometer gives message on start-up that it needs servicing. Staff also need training in its use and maintenance.

D. General Training

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping (administrative and technical), etc.
2. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping

3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

4. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.8.2 Nevis Water Department Laboratory

This laboratory is the internal laboratory of the Nevis Water Department which is a part of government. The laboratory is responsible for the testing of drinking water – raw well water and processed water to ensure safety for consumption. The laboratory also conducts testing for the Agriculture Department and for private clients.

Recommendations

A. ***Equipment for Acquisition by IWEco Project – No Training Required***

1. Humidity/Temperature Monitor (hygrometer)
2. Thermometers for Incubator x 2 and Refrigerator x 2

B. ***Equipment for Acquisition by IWEco Project - Training Required***

1. Bench top Spectrophotometer
2. Bench top Conductivity meter

C. ***General Training***

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.

2. Use, calibration, verification of accuracy and in-house maintenance of field and basic laboratory equipment with associated recordkeeping

3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

8.9 SAINT VINCENT AND THE GRENADINES

Two (2) laboratories were assessed. The third recommended laboratory, the Central Water and Sewerage Authority, did not respond. The laboratories assessed were:

1. The St. Vincent and the Grenadines Bureau of Standards
2. The Fisheries Division Laboratory of the Ministry of Agriculture

RECOMMENDATIONS

Both laboratories perform environmental monitoring to some extent although based on number of samples tested for 2019, neither carries out monitoring on a routine basis. It is, however, recommended that both be supported in the absence of a laboratory charged with routine environmental monitoring.

Annex 9 contains the summary of findings and the actual survey responses for reference.

8.9.1 St. Vincent and the Grenadines Bureau of Standards

The mandate of the Bureau of Standards is to ensure that all goods and services produced and/or used in the country are of consistently acceptable standards and quality. The Organisation is statutory and falls under the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation, Industry and Labour. The laboratory does, however, test on behalf of other government entities and statutory bodies and under Projects. Its main clients are manufacturers.

Very little environmental testing was done for 2019 (2 samples) although staff have received extensive training in environmental monitoring and in various aspects of the ISO 17025 Quality Management System.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

1. Millipore high output pump 220V/50Hz
2. Auto pipette: 0.1 – 1 mL

B. Equipment for Acquisition by IWEco Project - Training Required

None

***C.* General Training**

1. ISO 17025:2017 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping (administrative and technical), etc.

8.9.2 Fisheries Division Laboratory

The laboratory of the Fisheries Division mainly serves fish processors and fish processing establishments and some statutory bodies such as the National Park. Environmental monitoring is therefore mainly restricted to water monitoring for fish health.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

1 Incubator

B. **Equipment for Acquisition by IWEco Project - Training Required**

1 Multi-parameter with probes – demonstration of use
2 Still to produce Type 2 laboratory grade water use and maintenance on installation

C. **General Training**

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Use, calibration, verification of accuracy, and in-house maintenance of field and basic laboratory equipment with associated recordkeeping
3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

8.10 TRINIDAD AND TOBAGO

Of the six (6) laboratories contacted through the EMA, four (4) responded. These were:

1. The Department of Environment – Tobago
2. The Institute of Marine Affairs – Environmental Quality Programme Laboratory
3. Caribbean Industrial Research Institute – Analytical Chemistry Laboratory and the Environmental Microbiology Laboratory
4. National Quarries Co. Ltd. Laboratory

RECOMMENDATIONS

It is recommended that the Department of Environment, Tobago and the Institute of Marine Affairs as the RAC for the English-speaking Caribbean be supported both in terms of equipment and training needs where applicable.

Training for CARIRI should be accommodated where possible. Acquisition of equipment has not been recommended for CARIRI as the laboratory is able to support itself through the work it performs for its industrial and manufacturing clientele.

The National Quarries Laboratory supports the national IWEco quarry rehabilitation project through water testing of rivers adjacent to rehabilitation sites. The laboratory stated that in-house maintenance of equipment was not done but that service and repair records were kept. However, none were submitted on request. As the laboratory supporting the national project, it is recommended that the laboratory be supported in its water quality monitoring efforts.

Annex 10 contains the summary of findings and the actual survey responses for reference.

8.10.1 Department of Environment Laboratory – TOBAGO

This department does have a mandate to monitor the environment. The results are used locally in Tobago and nationally to determine compliance with the Ambient Water Quality Standards under the Water Pollution Rule, 2019. The laboratory staff use field kits for their work. No tests are carried out in the assigned laboratory space as this is not yet furnished and there is no set date for installation of furniture and equipment. The laboratory head has therefore requested field kits in lieu of laboratory equipment.

The density of floating plastic debris is recorded by laboratory staff as well as location and frequency of algal blooms.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

None

B. Equipment for Acquisition by IWEco Project - Training Required

1. Flow Meter – training in use and application to water quality
2. Biota sampling kits - training in use of kits
3. Membrane filtration test kits – training in use

C. **General Training**

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Use, calibration, verification of accuracy, and in-house maintenance of field and basic laboratory equipment with associated recordkeeping.
3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods
4. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.10.2 Institute of Marine Affairs

The Institute is a statutory body mandated to collect, analyse and disseminate information, including environmental developments, in marine affairs and to formulate and implement specific programmes/projects.

The IMA is recognized as a Regional Activity Centre (RAC) of the Caribbean Environment Programme (CEP) of the United Nations Environmental Programme (UNEP). It is the Regional Activity Centre (RAC) for the English-speaking islands of the Caribbean, undertaking activities aimed at implementing the Protocol on Land-Based Sources and Activities (LBS) of Marine Pollution at the regional level. The laboratory is not yet accredited but working towards it.

Based on the response with regard to maintenance and service records, the laboratory requires assistance with recordkeeping in particular; a common failing of non-accredited laboratories where in-house maintenance and external servicing may be carried out, but no records are kept.

A. Equipment for Acquisition by IWEco Project – No Training Required

1. None

B. Equipment for Acquisition by IWEco Project - Training Required

1. None

C. **General Training**

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping (administrative and technical), etc.

2. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

8.10.3 CARIRI – Analytical Chemistry and Environmental Microbiology Laboratories

CARIRI is a government-owned entity that was set up to provide various technical, engineering, industrial and advisory services to industrial enterprises and to the government regarding industrial processes and standards amongst others; all related to industrial enterprises.

The laboratories do have the capacity to perform environmental monitoring and CARIRI offers wastewater management services (that includes both chemical and microbiological monitoring) and recreational water quality monitoring. The labs have stated that they have a mandate to perform environmental monitoring.

The laboratories are accredited to perform a number of tests relevant to environmental monitoring as follows:
Chemistry – TDS, TSS, pH, COD
Microbiology – Enumeration by the MPN method – TC, FC and *E. coli*
In effluent – BOD, Enumeration by MF method - HPC, TC, FC, *E. coli*, Enterococcus

No records of equipment maintenance, repair, or servicing were submitted. However, as an accredited lab with a wide test scope routine maintenance and servicing of equipment associated with accredited tests would be performed as these are requirements of the ISO 17025 standard.

Recommendations

A. Equipment for Acquisition by IWEco Project – No Training Required

1. None

B. Equipment for Acquisition by IWEco Project - Training Required

1. None

C. General Training

1. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis.
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data
2. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual methods and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, cost of maintenance

8.10.4 National Quarries Company Ltd Laboratory

The laboratory is an internal one set up to ensure the state-owned entity's compliance with the EMA's requirements.

A. Equipment for Acquisition by IWEco Project – No Training Required

1. None

B. Equipment for Acquisition by IWEco Project - Training Required

1. None – the laboratory requested an air quality meter only

***C.* General Training**

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.
2. Use, calibration, verification of accuracy and In-house maintenance of field and basic laboratory equipment with associated recordkeeping
3. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control to also include:
    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

9 Conclusions

1. Due to the urgent need to improve the quality of data used for decision-making with respect to environmental management decisions at the higher levels, it is recommended, as far as possible, to support all laboratories with general training based on their needs. The results of most of the laboratories assessed are used for decision-making level to determine compliance with local standards or regulations or for showing compliance with international Protocols, e.g., LBS Protocol. As it is not possible to support all requests for training, the most requested training was recommended.
2. Acquisition of equipment to carry out basic testing, e.g., field monitoring equipment such as multi-parameter meters and field sampling equipment is a priority and has been recommended for support where requested. Additionally, equipment required for basic laboratory testing such as microbiological parameters and tests on wastewater, e.g., BOD, which can have a large impact on the quality of water bodies has also been recommended for acquisition. Each laboratory's needs are different.
3. Two laboratories requested automated Nutrient Analyzers. However, due to the high cost, these requests were not accommodated. Rather, it is recommended that laboratories that already have this equipment be supported with training in their use. One laboratory, in Jamaica, can be asked to support laboratories in the Western Caribbean at cost in exchange for support. The other laboratory, in Saint Lucia, can be asked to support the Eastern Caribbean under similar terms of support from the Project.

APPENDICES

APPENDIX 1 - INVENTORY OF TESTS PERFORMED BY ALL ASSESSED LABORATORIES

The test parameters have been divided into seven (7) groups for the matrices:

Rivers/ponds (R), Seawater/coastal marine water(C), Wastewater (W) and Potable (raw & processed) water inclusive of well water for drinking (P)

Group 1 – Dissolved oxygen, turbidity, pH, Res. Chlorine

Group 2 – Total coliform, Faecal coliform, E. coli, Enterococci

Group 3 – Nutrients: Nitrates, nitrites, ammonia, TKN, DIP

Group 4 – Parameters related to Nutrients: Chlorophyll a, Algal blooms location and identification

Group 5 – Fats, Oil and Grease, BOD, TSS, Salinity, Temperature

Group 6 – Floating plastic density and biota monitoring

Group 7 – Pesticides, PAHs, PCBs and heavy metals

Table 1: Group 1 – Basic Physico-Chemical Parameters - Water

Country	Lab	DO				Turbidity				pH				Res. Cl			
		W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P
Antigua	DAS	x	✓	x	x	x	✓	x	✓	✓	✓	x	✓	x	x	x	✓
Barbados	PHL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	GAS	✓	x	x	x	x	✓	x	✓	x	✓	x	✓	x	x	x	x
Cuba	CIMAB	✓	✓	✓	x	✓	x	✓	x	✓	✓	✓	x	x	x	x	X
	CPHEM	✓	✓	✓	x	x	x	x	✓	✓	✓	✓	✓	x	x	x	✓
	INRH	✓	x	✓	x	x	x	✓	✓	✓	x	✓	✓	x	x	x	✓
DR	Lab. Amb	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	INTEC	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x
	CAASD	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	LAVECEN	x	x	x	x	x	x	x	x	✓	x	x	✓	x	x	x	X
Grenada	GBS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NAWASA	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jamaica	EHL	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	NEPA	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	x	x	x
	PRL	x	x	x	x	x	x	x	x	✓	x	✓	✓	x	x	x	✓
SK&N	EHL	x	?	x	✓	x	?	x	✓	?	?	x	✓	?	x	x	✓
	NWD	x	x	x	✓	x	x	x	✓	x	x	x	✓	x	x	x	✓
SL	WASCO	x	x	✓	✓	x	x	✓	✓	x	x	✓	✓	x	x	✓	✓
	CARPHA	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓	✓	✓	x	x	✓
SVG	SVGBS	x	?	✓	?	x	?	?	✓	x	✓	✓	✓	x	x	x	✓
	FDL	x	x	x	x	x	✓	✓	✓	x	✓	✓	✓	x	x	x	✓
TT	IMA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	✓
	CARIRI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DoE Tobago	x	✓	✓	x	x	✓	✓	x	x	✓	✓	x	x	x	x	x
	NQL	x	x	x	x	✓	x	✓	x	✓	x	✓	x	x	x	x	x
	Total	21				23				25				19			
	%	81%				88%				96%				73%			

Table 2: Group 2 – Microbiological Parameters

Country	Lab	Total Coliform				Faecal Coliform				*D.* coli				Enterococci			
		W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P
Antigua	DAS	x	x	x	✓	✓	✓	x	✓	x	✓	x	✓	x	✓	x	✓
Barbados	PHL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	GAS	x	✓	✓	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓
Cuba	CIMAB	✓	✓	✓	x	✓	✓	✓	x	x	✓	x	x	x	✓	x	X
	CPHEM	x	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x	x	x	X
	INRH	✓	x	✓	✓	✓	x	✓	✓	x	x	✓	✓	x	x	x	X
DR	Lab. Amb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
	INTEC	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	x	x	x	X
	LAVECEN	x	x	x	✓	✓	x	x	✓	x	x	x	x	x	x	x	x
	CAASD	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	X
Grenada	GBS	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	✓	✓	✓	✓
	NAWASA	x	x	x	✓	✓	✓	✓	✓	x	x	x	✓	✓	✓	✓	✓
	PC	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓
Jamaica	EHL	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x	x	x
	NEPA	x	x	x	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	PRL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SK&N	EHL	?	?	x	✓	?	?	x	✓	?	✓	x	?	?	✓	x	x
	NWD	x	x	x	✓	x	x	x	✓	x	x	x	x	x	x	x	X
SL	WASCO	x	x	✓	✓	x	x	✓	✓	x	x	x	x	x	x	x	x
	CARPHA	x	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	x	✓	✓	x
SVG	SVGBS	x	x	?	✓	x	x	?	✓	x	✓	?	?	x	✓	?	?
	FDL	x	x	x	x	x	x	x	x	x	✓	✓	✓	x	✓	✓	✓
TT	IMA	x	x	x	✓	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	CARIRI	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DoE Tobago	x	✓	✓	x	x	x	x	x	x	✓	✓	x	x	x	x	x
	NQL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Total	21				21				17				14			
	%	81%				81%				65%				54%			

Table 3: Group 3 – Nutrients: Nitrates, nitrites, ammonia, TKN, Dissolved Inorganic Phosphate, Total Nitrogen and Total Phosphate

Country	Lab	Nitrates				Nitrites				Ammonia				TKN				DIP			
		W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P
Antigua	DAS	✓	✓	x	x	x	x	x	✓	x	x	x	x	x	x	x	x	✓	x	x	x
Barbados	PHL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X	x	x	x
	GAS	x	x	x	✓	x	x	x	✓	✓	x	x	✓	✓	x	x	x	X	x	x	✓
Cuba	CIMAB	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	X	✓	x	x
	CPHEM	x	x	✓	✓	x	✓	✓	✓	x	x	x	x	x	x	x	x	X	x	x	x
	INRH	x	x	✓	✓	x	x	✓	✓	x	x	x	x	x	x	x	x	X	x	✓	x
DR	Lab. Amb	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x	✓	✓	✓	x
	INTEC	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	X
	LAVECEN	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CAASD	✓	x	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	✓	X	✓	✓
Grenada	GBS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	NAWASA	x	x	✓	✓	x	x	✓	✓	x	x	x	x	x	x	x	x	x	✓	✓	✓
	PC	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x	x	x	✓	✓	✓	✓
Jamaica	EHL	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x	x	x	✓	✓	✓	✓
	NEPA	✓	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓	✓	x
	PRL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SK&N	EHL	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	✓	?	x	?
	NWD	x	x	x	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SL	WASCO	x	x	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓
	CARPHA	✓	✓	✓	x	✓	✓	✓	x	x	x	x	x	x	x	x	x	✓	✓	✓	x
SVG	SVGBS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	FDL	x	x	x	x	x	x	x	x	x	x	✓	✓	x	x	x	x	x	x	x	x
TT	IMA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	✓	✓	✓	✓
	CARIRI	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x	x	x	✓	✓	✓	✓
	DoE Tobago	x	x	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	NQL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Total	19				13				4				1				15			
	%	73%				50%				15%				4%				58%			

Country	Lab	Total Nitrogen				Total Phosphorus/Phosphates			
		W	C	R	P	W	C	R	P
Barbados	GAS	✓	✓	x	✓	✓	✓	x	✓
DR	Lab. Amb	✓	✓	✓	x	✓	✓	✓	x
Jamaica	NEPA	✓	x	x	x	X	x	x	x
TT	IMA	x	x	x	x	✓	✓	✓	✓
	Total	3				3			
	%	12%				12%			

Table 4: Group 4 – Parameters related to Nutrients: Chlorophyll a, Algal blooms location and identification

Country	Lab	Chlorophyll a		Algal Blooms			
		C	R	C	R	Location & Freq.	Identification
Antigua	DAS	✓	x	✓	✓	✓	X
Barbados	PHL	x	x	x	x	x	X
	GAS	x	x	x	x	x	X
Cuba	CIMAB	✓	x	x	x	x	X
	CPHEM	x	x	x	x	x	X
	INRH	x	x	x	x	x	X
DR	Lab. Amb	✓	✓	x	x	x	X
	INTEC	x	x	x	x	x	X
	LAVECEN	x	x	x	x	x	x
	CAASD	x	✓	x	x	✓	✓
Grenada	GBS	✓	✓	x	x	x	X
	NAWASA	x	x	x	x	x	x
	PC	✓	✓	x	x	x	x
Jamaica	EHL	x	x	x	x	x	x
	NEPA	x	x	x	x	x	x
	PRL	x	x	x	x	x	x
SK&N	EHL	x	x	x	x	x	x
	NWD	x	x	x	x	x	x
SL	WASCO	x	x	x	x	x	x
	CARPHA	x	x	x	x	x	x
SVG	SVGBS	x	x	x	x	x	x
	FDL	x	x	x	x	x	x
TT	IMA	✓	✓	✓	✓	✓	?
	CARIRI	X	x	x	x	x	x
	Doe Tobago	✓	x	✓	✓	✓	x
	NQL	x	x	x	x	x	x
	Total	8		3		4	1
	%	31%		12%		12%	4%

Table 5: Group 5 – Fats, Oil and Grease, BOD, TSS, Salinity, Temperature

Country	Lab	FOG				BOD				TSS				Salinity				Temperature			
		W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P
Antigua	DAS	x	x	x	x	✓	x	x	x	✓	x	x	x	x	✓	✓	x	x	✓	x	x
Barbados	PHL	x	x	x	x	x	x	x	x	x	x	x	x	x	X	x	x	x	x	x	x
	GAS	✓	x	x	x	✓	x	x	x	✓	✓	x	✓	x	x	x	✓	x	x	x	x
Cuba	CIMAB	✓	x	✓	x	✓	✓	✓	x	✓	✓	✓	x	x	✓	✓	x	✓	✓	✓	x
	CPHEM	x	x	x	x	✓	✓	✓	x	✓	x	x	x	x	✓	x	x	✓	✓	✓	✓
	INRH	✓	x	✓	x	✓	x	✓	x	✓	x	✓	x	x	x	x	x	✓	x	x	x
DR	Lab. Amb	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	INTEC	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	LAVECEN	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CAASD	x	x	x	x	✓	x	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grenada	GBS	x	x	x	x	✓	✓	✓	✓	x	x	x	x	✓	✓	✓	✓	✓	✓	✓	✓
	NAWASA	x	x	x	x	✓	x	x	x	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓	✓
	PC	✓	✓	✓	x	x	x	x	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jamaica	EHL	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	x	x	✓	✓	✓	✓	✓	✓	✓
	NEPA	x	x	x	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	✓	x
	PRL	✓	X	✓	✓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SK&N	EHL	x	x	x	x	✓	?	x	?	x	x	x	x	?	✓	x	?	✓	✓	x	✓
	NWD	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	✓	x	x	x	✓
SL	WASCO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CARPHA	✓	✓	x	x	✓	x	x	x	✓	x	✓	✓	✓	✓	✓	x	✓	✓	✓	✓
SVG	SVGBS	x	x	x	x	x	?	✓	?	x	?	✓	?	x	✓	?	?	x	✓	✓	✓
	FDL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TT	IMA	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CARIRI	✓	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	DoE Tobago	x	x	x	x	x	x	x	x	x	✓	✓	x	x	✓	✓	x	x	✓	✓	x
	NQL	x	x	x	x	x	x	x	x	✓	x	✓	x	x	x	x	x	x	x	x	x
	Total	11				17				18				19				19			
	%	42%				65%				69%				73%				73%			

Table 6: Group 6 – Floating plastic density and biota monitoring

Country	Lab	Floating Plastic Density		Biota Monitoring		
		Coastal	River	Yes	No	Description
Antigua	DAS	x	x	✓	-	Monitoring of POPs in fish species General scan of metals in fish species
Barbados	PHL	x	x	-	x	-
	GAS	x	x	✓	-	Identification of aquatic organisms
Cuba	CIMAB	x	x	-	x	-
	CPHEM	x	x	-	x	-
	INRH	x	x	-	x	-
	CEAC*					
DR	Lab. Amb	x	x	-	x	-
	INTEC	x	x	-	x	-
	LAVECEN	x	x	-	x	-
	CAASD	x	x	-	x	-
Grenada	GBS	x	x	-	x	-
	NAWASA	x	x	-	x	-
	PC	x	x	-	x	-
Jamaica	EHL	x	x	-	x	-
	NEPA	x	x	-	x	-
	PRL	x	x	-	x	-
SK&N	EHL	x	x	-	x	-
	NWD	x	x	-	x	-
SL	WASCO	x	x	-	x	-
	CARPHA	x	x	-	x	-
SVG	SVGBS	x	x	-	x	-
	FDL	x	x	-	x	-
TT	IMA	x	x	✓	-	Population diversity, density and richness of polychaetes, amphipods, bivalves. Tests for PAHs and heavy metals in biota.
	CARIRI	x	x	-	x	-
	DoE Tobago	✓	✓	-	x	-
	NQL	x	x	-	x	-
	Total	1		3		-
	%	4%		12%		-

Table 7: Group 7 – Pesticides, PAHs, PCBs and Heavy Metals

Country	Lab	Pesticides				PAH				PCB				Heavy Metals			
		W	C	R	P	W	C	R	P	W	C	R	P	W	C	R	P
Antigua	DAS	x	x	x	x	x	x	X	x	x	x	x	x	x	x	x	x
Barbados	PHL	x	x	x	x	x	x	X	x	x	x	x	x	x	x	x	x
	GAS*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cuba	CIMAB	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CPHEM	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	INRH	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CEAC																
DR	Lab. Amb	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	INTEC	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	LAVECEN	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CAASD	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Grenada	GBS	✓	✓	✓	✓	x	x	x	x	x	x	x	x	✓	✓	✓	✓
	NAWASA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	PC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x
Jamaica	EHL	x	x	x	x	x	x	x	x	x	x	x	x	** ✓	** ✓	** ✓	** ✓
	NEPA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	PRL#	✓	x	✓	✓	✓	x	✓	✓	✓	x	✓	✓	x	x	x	x
SK&N	EHL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	NWD	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SL	WASCO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	CARPHA ^	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SVG	SVGBS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	FDL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
TT	IMA	x	x	x	x	✓	✓	✓	✓	x	x	x	x	✓	✓	✓	✓
	CARIRI	x	x	x	x	x	x	x	x	x	x	x	x	✓	✓	✓	✓
	DoE Tobago	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	NQL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Total	3				3				2				4			
	%	12%				12%				8%				15%			

*GAS: Can do OP and triazine pesticides in groundwater when equipment is working.

**EHL: Mercury only when analyzer is working

PRL: Tests for OC, OP, Carbamates, pyrethroids

^CARPHA: Pesticides not done due to lack of training

Table 8: Miscellaneous Chemical Parameters

Parameter	P	C	W	R	Lab	Country
Conductivity	X	✓	✓	✓	Lab. Amb	DR
Sulphates	X	✓	✓	✓		
Total dissolved solids	X	✓	✓	✓		
Sedimentable solids	X	✓	✓	✓		
Total chlorine	X	✓	✓	✓		
Sulphides	X	✓	✓	✓		
Cyanides	X	✓	✓	✓		
Total alkalinity	X	✓	✓	✓		
Real colour	X	✓	✓	✓		
Apparent colour	X	✓	✓	✓		
Total hardness	X	✓	✓	✓		
	✓	x	x	x	NWD	SK&N
Chlorides	X	✓	✓	✓	Lab .Amb	DR
	✓	x	x	x	NWD	SK&N
	✓	x	x	x	FDL	SVG
COD	x	✓	✓	✓	Lab. Amb	
	x	x	✓	✓	INTEC	DR
	✓	x	✓	✓	CAASD	
	x	x	✓	x	NAWASA	Grenada
	x	✓	✓	✓	PC	
	✓	✓	✓	✓	EHL	Jamaica
	x	x	✓	x	NEPA	
	x	x	✓	x	CARPHA	SL
	✓	x	✓	✓	IMA	TT
	✓	✓	✓	✓	CARIRI	
Total solids	x	✓	✓	✓	L.Amb	
Presence/absence Pseudomonas	✓	✓	✓	✓	CAASD	DR
Volatile Organic Compounds	?	?	?	?	CAASD	
Acidity	X	X	✓	X	NAWASA	Grenada
	✓	✓	✓	✓	PC	
	✓	x	✓	✓	PRL	Jamaica
Blue Green Algae	x	✓	x	✓	DoE Tobago	T&T

NOTES – Tests Performed in Soil or Sediment, Foods

- Antigua
  - DAS – pH, NO_3 in soil/sediment, DIP in soil/sediment, Pesticides (OCs) in soil
- Barbados
  - GAS – pH in soil, salinity in soil, TKN in soil, trace metal in soil, Identification of aquatic organisms and organisms in soil
- Cuba –
  - CIMAB – PAHs in sediment
  - CEAC: Did not fill out survey, see Accredited Tests attached
- Dominican Republic
  - INTEC – Performs metal testing but have not specified which ones
  - LAVECEN – Pesticides tested in foods
- Grenada
  - GBS – Performs tests for *E. coli* in foods
  - Produce Chemist – Does pH, salinity, nitrates, nitrites, FOG, pesticides (OP, OC, pyrethroids, carbamates, carbonyls, chlorinated hydrocarbons), PAHs, PCBs, metals for soil quality
- Jamaica
  - PRL - FOG and pesticides in soil and food
- Trinidad and Tobago
  - CARIRI – Tests for nitrates, nitrites, pH, FOG, total coliform, faecal coliform, *E. coli*, enterococci, heavy metals, and bacteria identification to species level in soils and sediments.
  - IMA – PAHs, & HM in sediment

APPENDIX 2 – TRAINING NEEDS

Summation of general training needs identified by all laboratories that responded to survey

TABLE 1: TRAINING NEEDS IDENTIFIED BY ASSESSED LABORATORIES

TRAINING IDENTIFIED	LABORATORY MAKING REQUEST	Comments	% OF ALL LABS ASSESSED MAKING REQUEST
1. ISO 17025 Requirements and its Implementation	1. Dept of Analytical Services (DAS), Antigua 2. PHL, Barbados 3. GAS, Barbados 4. NAWASA, Grenada 5. PC, Grenada 6. EHL, Jamaica 7. EHL, SKN 8. DoE, Tobago 9. Lab Amb. DR 10. WASCO, SL 11. SVGBS, SVG 12. Fisheries Lab, SVG		46%
2. Current Laboratory Methods for the Microbiological and Chemical Analysis of Ambient Waters, Soil and Marine Sediments with Analytical and Microbiological Test Method Quality Control. To also include - Test Method Verification - Laboratory Statistical Analysis of QC Results including Control Charting to detect trends in analysis - Determination of Measurement Uncertainty for Analytical and Microbiological Laboratories - Proficiency Testing	1. DAS, Antigua 2. PHL, Barbados 3. NAWASA, Grenada 4. PC, Grenada 5. NEPA, Jamaica 6. EHL, SKN 7. NWD, SKN 8. IMA, TT 9. DoE, Tobago 10. Lab Amb. DR 11. CAASD, DR 12. LAVECEN, DR 13. WASCO, SL 14. CPHE, Cuba 15. GBS, Grenada (sp. MF & 3M Petrifilm) 16. CARIRI (sp. MPN & HM) 17. Fisheries Lab, SVG		65%
3. Sample Collection, preservation and transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical	1. DAS 2. GAS, Barbados 3. CPHE, Cuba 4. GBS, Grenada 5. EHL, Jamaica 6. PRL, Jamaica 7. EHL, SKN		54%

TRAINING IDENTIFIED	LABORATORY MAKING REQUEST	Comments	% OF ALL LABS ASSESSED MAKING REQUEST
analysis – to include for pesticide analysis, PCB analysis and herbicides analysis - Design of a statistical sampling plan/programme - Data collection, Interpretation of the data and identification of trends	8. NWD, SKN 9. IMA, TT 10. CARIRI, TT 11. DoE, Tobago 12. CAASD, DR 13. CARPHA, SL 14. Lab. Amb., DR		
4. Use, calibration and In-house maintenance of field and basic laboratory equipment, e.g., pH meter, Conductivity meter, turbidimeter,	1. EHL, SKN 2. NWD, SKN 3. NQL, TT 4. Lab. Amb., DR 5. WASCO, SL 6. Fisheries Lab, SVG		23%
5. Nutrient Analysis methodologies with a focus on seawater	1. DAS, Antigua 2. GAS, Barbados 3. CARPHA, SL 4. EHL, Jamaica	Equipment available in-house: – not in use due to lack of training in nutrient analysis using SEAL HR 3 for CARPHA and EHL	15%
6. Internal Auditing Training	1. IMA, TT 2. SVGBS, SVG 3. Fisheries Lab, SVG		12%
7. Risk Assessment and Management in accordance with ISO 17025:2017	1. EHL, Jamaica 2. IMA, TT 3. SVGBS, SVG 4. Fisheries Lab, SVG		15%
8. Biota Monitoring • Identification of algal blooms • Biota sampling techniques • Benthic Surveys – sample collection, sample prep, analysis and interpretation of data • Identification of indicator flora and fauna species in riverine, brackish and coastal environments	1. DAS, Antigua 2. CARIRI, TT 3. DoE, Tobago		12%
9. Measurement methods for chlorophyll a and other phytopigments of env. Significance	1. DAS, Antigua 2. CIMAB, Cuba		8%

TRAINING IDENTIFIED	LABORATORY MAKING REQUEST	Comments	% OF ALL LABS ASSESSED MAKING REQUEST
10. Soil analysis techniques	GAS, Barbados	N/A	4%
11. Soil analysis using spectroscopy	GAS, Barbados	N/A	4%
12. Training in ways to improve efficiency with reduced analysts	GAS, Barbados	N/A	4%
13. Analysis of pesticides by GC/MS/MS and LC/MS/MS	GAS, Barbados	No equipment available	4%
14. Extraction of Pesticides from Ambient Water – surface and marine, Soil and Sediment	DAS, Antigua CARPHA, SL	GCMS available	8%
15. Analysis of Pesticides using GC-MS	1. DAS, Antigua 2. CARPHA, SL	GCMS available	8%
16. Analysis of organic contaminants by LC/MS/MS	GAS, Barbados	No equipment available	4%
17. Extraction of metals from ambient water – surface and marine	1. DAS, Antigua 2. CAASD, DR	No equipment available - theoretical	8%
18. Analysis of metals using AASGF and hydride generator for mercury 19. Spectroscopic techniques for the determination of metals in environmental samples	1. DAS, Antigua 2. CIMAB, Cuba 3. CAASD, DR	No equipment yet available	12%
20. Training in test methods for determination of petroleum hydrocarbons in environmental samples Analysis of soil samples for total petroleum hydrocarbons, ammonia and Mn (using kits)	1. CIMAB, Cuba 2. Fisheries Lab, SVG 3. GBS, Grenada	No equipment available – theoretical Too specialised	8% 4%
21. Techniques for the determination of micro plastics in seawater Update related to plastic waste in water and its effect on the environment and health	1. CIMAB, Cuba 2. IMA, TT 3. CPHE, Cuba		8% 4%
22. Wastewater treatment systems: - types, classification, structure, operation and efficiency - interpretation of results from such systems	1. INRH, Cuba 2. Lab. Amb., DR		8%

TRAINING IDENTIFIED	LABORATORY MAKING REQUEST	Comments	% OF ALL LABS ASSESSED MAKING REQUEST
- methods of measurement of flows in such systems - measurement of pollutant load			
23. Use of in-house BOD and COD meters	GBS, Grenada	Training in use of existing meters - Request too specialised	4%
24. Proficiency Testing	Produce Chemist, Grenada	Included in Methods of Lab Analysis and Test Method QC	
25. Analytical techniques, including in-field treatment of water samples where necessary	1. PRL, Ja. 2. EHL, SKN 3. Lab Amb., DR	Included in Methods of Lab Analysis and Test Method QC	
26. BOD Testing a. 5-day BOD (std.) method - water b. BOD of soil/sediment samples	1. EHL, Jamaica 2. CARIRI, TT		8%
27. Microscopy – polarised light phase contrast	EHL, Jamaica	Too specialised	4%
28. Laboratory Safety including management (handling, storage and disposal) of chemicals	1. NEPA, Jamaica 2. WASCO, SL		8%
29. Training in air sampling for volatile organic compounds (VOCs) – to include actual sampling techniques, treatment of samples, storage of samples and analysis of samples	PRL, Ja.	N/A to IWEco Project	4%
30. Writing SOPs	NWD, SKN	Included in Requirements & implementation of ISO/IEC17025:2017	
31. Maintenance of Records and submission of records for official use Data collection and record keeping	NWD, SKN NQL, TT	Included in Requirements & implementation of ISO/IEC17025:2017	
32. The study of ocean acidification	IMA, TT	Too specialised N.B. This course may still be available through the IAEA	4%

TRAINING IDENTIFIED	LABORATORY MAKING REQUEST	Comments	% OF ALL LABS ASSESSED MAKING REQUEST
33. Use of PCR in microbial analysis	IMA, TT	Too specialised	4%
34. Detection and Enumeration of Cyanobacteria, Cryptosporidium and Giardia	CARIRI, TT	Outside of scope of IWEco Project	
35. Design of remote testing facilities, delayed incubation techniques and extended sample preservation for microbiological samples	CARIRI, TT	Outside of scope of IWEco Project	
36. Development and interpretation of topography maps	CARIRI, TT	Outside of scope of IWEco Project	
37. Assessment of impacts and effectiveness of mitigation techniques in rehabilitation	NQL, TT	Outside of scope of IWEco Project	
38. EM Act of TT and role of Nat'l Quarries	NQL, TT	Outside of scope of IWEco Project	
39. Groundwater Monitoring	Lab Amb., DR	Too specialised	
40. Monitoring of waterbodies	Lab Amb., DR	Too specialised	
41. Integrated watershed management	Lab Amb., DR	Outside of scope of IWEco lab strengthening component	
42. Geographic Information Systems	Lab Amb., DR	Too specialised	
43. Training in IR	INTEC, DR	Too specialised	
44. Collection of samples of hazardous materials or waste	INTEC, DR	Too specialised	
45. Determination and identification of parasites, protozoa and viruses	CAASD, DR	N/A to IWEco Project	
46. First Aid, CPR, Fire drills	WASCO, SL	Not directly applicable to Lab Strengthening	
47. ISO 9001 & Process Improvement	SVGBS, SVG	N/A to IWEco Lab Strengthening	
48. Parasitology Analysis of Seafood	Fisheries Lab, SVG	N/A to IWEco Project	
49. Techniques for the analysis of PAHs, PCBs, H.M.s, and pesticides	Fisheries Lab, SVG	Lab does not have the equipment – theoretical only	

RECOMMENDED GENERAL TRAINING

1. ISO 17025 Requirements and its Implementation – to include detailed implementation requirements such as how to write the Quality Manual, standard operating procedures, equipment inventory and identification, recordkeeping – administrative and technical, etc.

2. Current Methods for the Laboratory Analysis of Water and associated Analytical and Microbiological Test Method Quality Control. To also include

    a. Test Method Verification
    b. Laboratory Statistical Analysis of Results (Test and QC results) to include trends in data
    c. Determination of Measurement Uncertainty for Analytical and Microbiological Test Methods

3. Use, calibration, verification of accuracy and In-house maintenance of field and basic laboratory equipment with associated recordkeeping

4. Sample Collection, Preservation and Transport Techniques for soil, sediment and water (surface waters, coastal water and groundwater) for microbiological, and chemical analysis – to include samples for pesticide analysis, PCB analysis and herbicides analysis
    a. Design of a statistical sampling plan/programme
    b. Data collection, Interpretation of the data and identification of trends in the data

5. Nutrient Analysis Methodologies for Water including Seawater and Determination of chlorophyll a – manual methods and automated methods. Training must include:
    a. Sample preparation and extraction methods based on test
    b. Appropriate technologies based on type of water, sample throughput, cost of maintenance

TABLE 2: RECOMMENDED TECHNICAL TRAINING ASSOCIATED WITH EQUIPMENT - INHOUSE AND REQUESTED

TRAINING NEED	EQUIPMENT	LAB MAKING REQUEST	STATUS OF EQUIPMENT
1 & 2: • Training in pesticide extraction from ambient waters, soil and sediments • Analysis using GCMS	GCMS	1. CARPHA Saint Lucia 2. DAS, Antigua	1. **In-house** GCMS: Agilent 7890B/5977 GCMS 2. **To be acquired through another project**
• Extraction of metals from ambient water and sediments • Analysis of metals using FAAS & AAS-GF	• GFAAS and /or FAAS • Hydride generator	DAS, Antigua	**To be acquired through another project** In-house equipment
• Analysis of mercury using hydride generator and Hydra II Mercury Analyzer	• Hydra II Mercury Analyzer	EHL, Jamaica	• Analysis of mercury using hydride generator and Hydra II Mercury Analyzer

TRAINING NEED	EQUIPMENT	LAB MAKING REQUEST	STATUS OF EQUIPMENT
Training in in-house maintenance and use **after maintenance inspection**	Nutrient Analyzer - Seal HR3 **NB. Maintenance required**	1. CARPHA, Saint Lucia 2. EHL, Ja.	Both labs have the Seal HR3 analyser **in-house** which is not in use due to lack of training. Both first require maintenance due to lack of use
Use and maintenance of HACH DR 3900 and use of associated test kits	HACH DR 3900 Spectrophotometer and TNT Plus Test Kits for determination of nutrients in wastewater – NO_3^-, $NO_2^-$and DIP	PHL - Barbados	To be acquired through IWEco
Use and in-house maintenance of Seal AA500	Seal AA500 Autoanalyzer	GAS - Barbados	Recommended for acquisition through IWEco but may be too costly. About USD 50,000 for 3 parameters, USD 40,000 for 2 parameters
Operator training in use and maintenance of multi-parameter meter	Multi-parameter meter with capability to perform conductivity, pH, DO and salinity	CPHE, Cuba	Recommended for acquisition through IWEco
Operator training in use and maintenance of multi-parameter meter	Multi-parameter field meter (preferably HI 9829)	INRH, DR	Recommended for acquisition through IWEco
Operator training in use and maintenance of multi-parameter meter	Multi-parameter meter with capability to perform conductivity, pH, DO and salinity (preferable YSI)	NAWASA, Grenada	
Operator training after installation in use and maintenance	Water purification system / deionizer capable of producing type 2 water UV/Vis spectrophotometer: Biochrom Libra S50PC with PC and remote control software as standard with 4 additional cuvettes or Biochrom S50	INRH, Cuba	Recommended for acquisition through IWEco
Operator training		Recommended for acquisition through IWEco	Recommended for acquisition through IWEco

TRAINING NEED	EQUIPMENT	LAB MAKING REQUEST	STATUS OF EQUIPMENT
	/Genesis 50 depending on budget available + Windows computer with optional remote control software for purchase		
Use of software and hardware in the operation and minor maintenance of these instruments (done on installation)	LC-MS with included computer hardware and software – Agilent recommended	Pesticide Research Lab, Jamaica	Recommended for acquisition through IWEco
Use and maintenance	HACH DR 3900 Spectrophotometer Multi-parameter meter capable of measuring salinity, conductivity, DO	EHL, St. Kitts	In-house Servicing required
Use and maintenance		Recommended for acquisition through IWEco	Recommended for acquisition through IWEco
Use and maintenance	HACH Spectrophotometer for nitrates in well water and other ions specific to raw and treated water for drinking Conductivity meter	NWD, Nevis	Recommended for acquisition through IWEco
Use and maintenance	Multiparameter meter and probes	Fisheries Lab, SVG	Recommended for acquisition through IWEco
Use, calibration and maintenance	Multiparameter meter, preferably YSI Sonde (pH, Temp., TDS, TSS, Salinity, DO, Turbidity)	CARIRI, TT	Recommended for acquisition through IWEco
Use of flow meter and application to water quality	Flow Meter Biota sampling kits	Dept. of Environment, Tobago Dept. of Environment	Recommended for acquisition through IWEco
Use of kit for sampling			Use of kit for sampling
Use of test kits	Membrane filtration test kits		Use of test kits

TABLE 3: RECOMMENDED AREAS OF TECHNICAL TRAINING: IN ORDER OF PRIORITY

TECHNICAL TRAINING	ASSOCIATED EQUIPMENT	LABS MAKING REQUEST
7. Multi-parameter Meter - Use, calibration and maintenance	Multi-parameter Meter – YSI meter recommended. YSI ProDSS for consideration	CPHEM, Cuba INRH, DR NAWASA Grenada CARIRI, Trinidad EHL, St. Kitts Fisheries Lab, SVG
8. HACH DR 3900 - Use, calibration and maintenance	HACH DR 3900 spectrophotometer	EHL, St. Kitts NWD, St. Kitts PHL, Barbados
9. Use and in-house maintenance of Seal HR3 Nutrient Analyzer	Nutrient Analyzer - Seal HR3	CARPHA, Saint Lucia EHL, Jamaica
10. Pesticide extraction from ambient waters, soil and sediments – LLE and SPE Analysis using GCMS	Trainer to recommend materials and solvents for acquisition prior to training or to bring materials to demonstrate – CARPHA to obtain solvents GCMS: Agilent 7890B/5977 GCMS – INHOUSE CARPHA	CARPHA, Saint Lucia DAS, Antigua
11. Use of flow meter and application to water quality	Flow Meter	DoE, Tobago
12. Use of biota sampling kits	Biota Sampling kits	
13. Use of Membrane Filtration Test Kits	Membrane Filtration Test Kits	
14. Water purification system – on installation: use and maintenance	Water Purification System for type 2 water	INRH, Cuba
15. Use of Biochrom Libra S50PC	Biochrom Libra S50PC	

APPENDIX 3 – EQUIPMENT AND REPAIR NEEDS

TABLE 1: In-house Equipment Recommended for Repair / Servicing / Maintenance

EQUIPMENT	LAB	COMMENTS
Nutrient Analyzer - Seal HR3 **NB. Servicing required**	3. CARPHA, Saint Lucia 4. EHL, Ja.	Both labs have the Seal HR3 analyser **in-house**. Both require maintenance due to lack of use
Teledyne Hydra II Mercury Analyzer **NB. Servicing required**	EHL, Ja.	Requires servicing due to lack of use. Quality of lab water caused problems with its operation.
GCMS	GBS	Part required – not specified
HACH DR 3900 Spectrophotometer	EHL, SKN	Servicing required
pH Meter [Hanna Instruments model HI3512]	CIMAB, Cuba	Electrode for pH meter Electrode part number HI1131B
Multi-parameter meter: YSI ProDSS	Lab. Amb., DR	Sensor for determination of chlorophyll a and pigments in freshwater blue green algae in ponds and reservoirs
Multi-parameter meter: Hanna Instruments model HI 9829		Sensors for pH and DO determinations

TABLE 2: EQUIPMENT RECOMMENDED FOR ACQUISITION – NO ASSOCIATED TRAINING

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
Antigua	DAS	5. HACH BODTrakII 6. 20º C incubator 7. Multi-parameter meter – pH, EC, salinity, DO (YSI ProDSS preferred) 8. Bacti-cinerator	1 1 1 1
Barbados	PHL and GAS	None	-
Cuba	CIMAB	Vacuum pump	1
		Liquid in glass thermometers for monitoring temps: • Environmental samples and work premises Measuring range: 0-100ºC Accuracy: 0.1ºC Quantity: 10 units • Refrigerators and Freezers Measurement range: -30 to 20ºC Accuracy: 0.5 ºC Quantity: 5 units • Ovens and incubators Measurement range: 0-200ºC Accuracy: 0.5ºC Quantity: 5 units	• 10 units • 5 units • 5 units

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
		Digital burette	1
	CPHEM	Benchtop DO meter for BOD	1
		Analytical balance (0.1 mg)	2
		BOD bottles	1 case of 20
		20ºC incubator	1
	INRH	Buerkle Sampler propylene bottle holder	1
		15 mL conical tubes ø 16.4 mm for the Eppendorf 5804 centrifuge	8
		Analytical balance (0.1 mg readability)	1
Dominican Republic	Laboratorio Ambiental (Environmental Lab)	Sampler with extendable rod and bottle holder, e.g., Buerkle equipment	1
		HACH DR 300 pocket colorimeter	1
	INTEC (University Lab)	Hot plate	1
		Multiparameter meter	2
		Cole Parmer Water Sampler	1
	CAASD (part of Min of Health)	Refrigerated incubator for BOD	1
	LAVECEN (Vet. Lab)	-	-
Grenada	Grenada Bureau of Standards	Sample bottles – Nalgene, wide mouth, autoclavable, 500 mL	36
		pH meter	1
		Filter funnel with clamps (47 x 250 mL)	6
	National Water & Sewerage Authority	Sample bottles – Nalgene, wide mouth, autoclavable, 500 mL	36
		Membrane Filtration Equipment – manifold, filter funnels (12), 6 clamps	12
		Vacuum pump for membrane filtration	1
	Produce Chemist	Desktop Computer	1
		Analytical balance (readability 0.1mg)	1
Jamaica	Environmental Health Laboratory	Type1 water purification system	1
		Desktop Work stations for LIMS with wireless routers 8th Generation Intel® Core™ i5-8265U (4-Core, 6MB Cache, 1.6GHz to 3.9GHz, 25W) Windows 10 Pro 64bit English	4

COUNTRY	LABORATORY	EQUIPMENT	NUMBER OF PIECES
		8GB, 1X8GB, DDR4 non-ECC Memory 2.5 inch 1TB 7200rpm SATA Hard Disk Drive HD Camera Headphones and microphone Ports 1 RJ-45 port 10/100/1000 Mbps 4 USB (rear) 2 USB (front or side) 1 Universal Audio Jack Slots 1 Kensington lock slot 1 DC-in 1 M.2 2230 slot for Wi-Fi and Bluetooth card 1 M.2 2230 slot for PCIe solid-state drive 1 SATA 3.0 FFC connector for hard drive Intel AX200 wireless card Microsoft Office Professional License for 3 years Security software for 3 years Warranty 3 Years Hardware Service with Onsite/In-Home Service After Remote Diagnosis, LA	
		Multi-function printer for LIMS	1
		Headset with microphone	4
	NEPA	Water purification system – type 2 water	1
		UV-Visible Spectrophotometer, e.g., Genesys 50	1
		Multiparameter meter capable of measuring pH, Conductivity, Salinity, DO	3
St. Kitts & Nevis	EHL, St. Kitts	Turbidity meter	1
		pH meter	1
	NWD, Nevis	Bottle thermometer for refrigerator	1
		Thermometers for water bath incubators	2
Saint Lucia	CARPHA	None	-
	WASCO	HACH TL2360 Turbidimeter	1
		HACH DR 6000 Spectrophotometer	1
Saint Vincent and the Grenadines	SVGBS	High output vacuum pump	1
	Fisheries Div. Lab	Water purification system for type 2 water	1
		Incubator	1
Trinidad & Tobago	IMA	None	-
	CARIRI	Handheld UV lamp	1
	Nat'l Quarries Co. Lab	None	-
	Dept. of Environment, Tobago	None	