Fisheries Reference Laboratory in Kiribati

FEASIBILITY STUDY

November 2023

INFOPESCA

ABBREVIATIONS

AAS	Atomic Absorption Photometer
AUD	Australian Dollars
CA	Competent Authority
CAC	CODEX Alimentarius Committee (FAO)
EHD	Environmental Health Division
EPA	Economic Partnership Agreement
EU	European Union
FAO	Food and Agriculture Organization (United Nations)
FPA	Fisheries Partnership Agreement
FS	Food Safety
GC	Gas Chromatograph
GDP	Gross Domestic Product
GNI	Gross National Income
HACCP	Hazard Analysis and Critical Control Points
HPLC	High-Performance Liquid Chromatography
IAS	Institute of Applied Sciences
IUU	Illegal, unreported and unregulated
KCAE	Kiribati Customs Administration and Enforcement
KDP	Kiribati Development Plan (5 years)
KFL	Kiribati Fish Limited
KIS	Kiribati Industry Standard
KPA	Kiribati Port Authority
KSVA	Kiribati Seafood Verification Authority (MFMRD)
KV20	Kiribati Vision 2016-2036
LDC	Least Developed Countries
MCIC	Ministry of Commerce, Industry and Cooperatives
MELAD	Ministry of Land, Environment and Agriculture Development
MFMRD	Ministry of Fisheries and Marine Resource Development
MHMS	Ministry of Health and Medical Services
MRL	Maximum residues levels
NCC	National CODEX Committee
NCD	Non-communicable diseases
OIE	International World Organisation for Animal Health
PPP	Private-Public Partnership
PNA	Parties to the Nauru Agreement
PROP	Pacific Islands Regional Oceanscape Program
ROI	Return on Investment
SDG	Sustainable Development Goal
SIDS	Small Island Developing State
SPC	Secretariat of the Pacific Community
SPS	Sanitary and Phyto-Sanitary
TBT	Technical Barriers to Trade
USA	United States of America
USD	United States Dollars
USP	University of the South Pacific
VAT	Value Added Tax

EXECUTIVE SUMMARY

The Kiribati Vision 2016-2036 (KV20) is the long-term development blueprint for Kiribati, The contribution of fisheries and tourism sectors to the country's development aspirations is expected to directly contribute to achieving the Sustainable Development Goals (SDGs) for Kiribati by 2036. Development of natural capital will include implementing measures aimed at maximising revenue from fisheries and marine resources, and implementing strategies to support the development of an inclusive trade and private sector. Fisheries are one of the priority sectors to stimulate economic growth and development during the life span of the KV20. Fisheries have been the main source of revenue in addition to others attributed to an improved revenue base through the implementation of Value Added Tax (VAT). The sector has contributed to a significant increase in the revenue from fishing licenses.

Kiribati Fish Ltd (KFL) is the only fishing company engaged in processing and exporting of fresh and frozen fish. The key export markets for KFL fish products include Australia, Japan, the United States of America (USA) and the European Union (EU). Government will continue to improve market access opportunities for its fisheries products through implementation of the Trade Policy Framework. This will ensure that the potential trade opportunities in new markets especially the EU are satisfied and maintained through improved investment in higher value added fisheries products. However, this will require improvement in economic and social infrastructure to support the investment in the fisheries sector.

The quality and safety of products are crucial for developing fisheries sectors. Thereare also strong dependencies between the environment, fish health, food safety, and human health. Maintainingor developing fishing and aquaculture resources is closely linked to maintaining the water quality in the lagoon and the ocean. While the level of environmental and health monitoring has increased, the lack of resources and the quality of data are recurrent issues that limit the effect of official controls. Besides, food consumption patterns are changing in Kiribati: a surge of food imports originating from Asia, and the development of locally processed food, are generating increased interest from regulators. Here also, the lack of resource and the absence of testing capability have prevented so far the competent authorities for food to enforce regulations.

The proposal for a reference laboratory for fisheries products' analyses is an integral part of the Pacific Islands Regional Oceanscape Program (PROP) project in Kiribati. The reference laboratory would undertake food and water analyses to support the export market of tuna. The laboratory would also analyse reef fish for the domestic market, especially with regard to ciguatera.

There are several conditions necessary for the successful financial operation of the laboratory. These include substantial growth in the domestic fish processing industry. and the number of samples to be tested and their prices. If these conditions are met, the findings of the feasibility study are positive and in year 4 the laboratory would start making income.

Overall, developing a reference laboratory for fishery products represents a significant investment. Based on the calculations, the total investment will a new one-storey building with a footprint of 160 square meters (approx. 16 m.*10 m.), with estimated costs for buildings at AUD 340 000 and for systems, fixtures, and finishing at AUD 140 000. The laboratory should be equipped with furniture and basic and intermediate analytical equipment amounting to a total of AUD 165 000. The facility and equipment would thus represent an investment of about AUD 645 000. In the first years of the project, the operational costs would be much higher than income and would generate an operating loss, which should be financed. After year 4, the laboratory becomes profitable and generates a profit of about AUD 200 000, with a turnover of about AUD 520 000 (capacity development and amortization costs included). The laboratory would employ 6 persons. The laboratory is thus feasible, provided that the private industry pays for all the tests to be carried out, in order to export mainly the tuna to foreign countries, namely the EU.

The success conditions and institutional arrangements have been fully developed (see chapter 6). The study considers that given the limited volume of samples and tests involved, having a reference laboratory installed is justified on the grounds of the reliability of results, the synergies in the use of resources (staff, power, reagents), and the impossibility to expand services based on outsourced tests, which incur intractable logistics issues. In terms of the institutional setup discussed in chapter 6, the need for impartiality and risk assessment can be best fulfilled in the configuration of an autonomous public body. The idea is to have a phased start up that is less ambitious as onshore processing is built up, with increased investment occurring as the tuna processing facilities expand. This phased start up will be describe in more details in the structural concept design.

The capacity development plan linked to the laboratory and other Sanitary and Phytosanitary (SPS) functions is detailed in the activities of the PROP project. The foreseen amount of money is in the range of USD 100 000.

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1. ANALYSIS OF THE CURRENT SITUATION

Kiribati consists of a collection of thirty-three islands and atolls in the Pacific, laid in three sub-groups namely the Gilbert, Line, and Phoenix groups. The atolls are scattered across the equator over three and half million square kilometres of water. Kiribati is a Small Island Developing State (SIDS), categorized as Lower Middle Income Country. The economy is mainly driven by public spending – particularly on infrastructure – but also relies on fishing license fees as a source of government income.

1.1. Political and economic background

Kiribati has now reached the Gross Domestic Product (GDP) of a lower middle-income nation, and would have graduated from the UN Least Developed Countries (LDC) group a while ago. Notwithstanding the UN assessment that graduating would not have had negative consequences, Kiribati advocated successfully for remaining in the LDC group, on grounds of economic remoteness and vulnerability to internal factors and external shocks. Sustainable development has thus become a priority objective in recent years due to the increased risk of flooding – all islands but one rise no higher than a few meters above sea level. This objective requires delicate balancing of public investment between infrastructure (protection, water, etc.) and productive facilities.

The population of Kiribati was 128 870 in 2021. In the same year, its GDP per capita estimates were USD 1 606 while the Gross National Income (GNI) was USD 3 884, the GNI includes external revenues sources which substantially complement the GDP. Kiribati GDP was estimated at about USD 207 million. Kiribati's economy is based primarily on the sale of fishing licenses, oceanic fishing and coastal fishing.

Economic development is constrained by a small and limited production capacity, weak infrastructure, insufficient skilled human resources, insufficient of energy sources and natural resources, and the country's spatial spread and remoteness from international markets. These are constraints of Small Island Developing States (SIDS), which have been well identified and documented by several aid agencies. Mitigation solutions have remained scarce.

The political context relates to the globalization of trade in the Pacific region. Regional trade agreements with Australia and New Zealand (PACER Plus) was signed. PACER Plus has key components related to enhancing Technical Barriers to Trade (TBT), SPS-related capacities, and to Trade Development. The Government intends to use such linkages to get trade-related support from Australia and New Zealand.

Kiribati's exports to the EU market are limited mainly to fish and copra. It could export all its products to the EU free of tariffs or quotas under the 'Everything But Arms' (EBA) scheme until graduating from its classification as a Least Developed Country (LDC). Kiribati can accede to the EU-Pacific Economic Partnership Agreement (EPA), currently applied between the EU and Fiji, Papua New Guinea, Samoa and Solomon Islands. The EPA would give all of Kiribati's products duty-free, quota-free access to the EU market — the world's largest single market. Kiribati is a party to the Parties to the Nauru Agreement (PNA) fisheries management scheme and has a Sustainable Fisheries Partnership Agreement (SFPA) with the EU, and a Protocol which is currently under renewal negotiations.

The social context reflects growing difficulties to cope with reduced opportunities and increasing costs of life. Under- and unemployment levels are high in Kiribati. Unemployment rate in Kiribati is about 11 percent, which compares to 4.3 percent in Fiji, 8.9 percent in Micronesia, and 10 percent in Marshall Islands. Unemployment of youth (15-24 years) is also extremely high in Kiribati: about 27 percent, which compares to 15.6 percent in Fiji, 18.9 percent in Micronesia, and 25.7 percent in Marshall Islands. These figures show that unemployment is higher in Kiribati than in other Pacific Island countries.

1.2. Economic policy

The economic development policy is reflected in the Kiribati Vision 2016-2036 (KV20) that describesfour Pillars as Wealth (incl. Nature and Human resources development), Peace and Security, Infrastructure, and Governance. The KV20 implementation is done in the frame of Kiribati Development Plan (KDP, 5 years) through the Ministries Development Plans with the assistance of development partners. The Government is eager to rationalize investment and to channel spending to those streams that point directly to the KV20 and KDP indicators. In addition to the KDP, Kiribati has a number of national policies such as Trade Policy Framework and National Quality Policy, Fisheries Policy, and other sectoral policies. The government has adopted a Private Sector Development Strategy that aims at fostering a more conducive business environment for enterprises. An example on action under this plan is the setup of a public-private partnership to operate a major hotel in Tarawa.

Improving economic opportunities for the population remains the central focus. The Government is viewing human resource development, infrastructure and good governance as critical enablers; employment abroad is still seen as important.

The Government is also focused on employment creation, in Kiribati and abroad. However, population growth still exceeds employment growth. The Kiribati Government faces difficulties in generating sufficient domestic revenues to provide all people with access to basic services. Kiribati has also gradually been tapping more of the potential of its tuna resources: the returns from tuna fishing licenses are important for the national economy.

1.3. Kiribati's Trade Integration and SPS-related needs

Kiribati trade remains heavily unbalanced, with a yearly deficit in the range of USD 70 million. Exports destinations vary year by year because of opportunistic behaviour by traders and the absence of high-volume supply. Kiribati imports include processed foodstuffs incl. sugar; tobacco; canned meat & vegetables, animal meats; rice, flours and other vegetal products and the like. The imports are mainly sourced China (22 percent), from Fiji (16 percent), and Australia (10 percent).

Table 1: Kiribati exports of all good and services (in million USD)

	2017	2018	2019	2020	2021	2022
Thailand	111.0	93.7	82.5	75.7	63.0	69.5
Philippines	9.5	8.2	14.6	11.2	9.4	17.2
Mexico	19.2	20.7	5.1	1.4	3.4	0.0
Japan	9.7	8.5	8.0	4.5	5.5	12.0
Vietnam (preliminary)	0.0	0.0	15.9	1.9	5.9	5.9
Rep of Korea	3.7	3.8	8.7	3.2	3.4	4.5
Others	12.3	11.6	9.1	8.3	21.6	14.4
_Total	165.5	146.4	143.9	106.2	112.4	123.5

Source: TDM 2023

Table 2: Kiribati imports of all goods and services (in million USD)

	2017	2018	2019	2020	2021	2022
China	15.4	17.8	20.2	24.4	38.9	41.9
Fiji	23.4	19.2	18.6	19.4	25.9	24.8
Australia	18.7	15.3	13.3	16.1	21.9	19.4
Taiwan	3.0	2.0	10.7	5.2	26.1	46.3
South Korea	11.3	13.0	10.5	8.8	10.3	12.9
Japan	11.9	6.2	5.0	7.5	10.1	9.5
New Zealand	11.6	8.4	7.2	5.4	7.2	7.2
Brazil	0.1	0.1	0.3	36.3	0.2	0.4
Vietnam (preliminary)	0.0	0.0	4.0	21.1	1.3	0.0
Singapore	2.9	2.5	4.4	2.3	4.2	4.6
Others	18.9	17.4	15.3	15.3	21.5	25.5
_Total	117.1	101.8	109.4	161.8	167.5	192.7

Source: TDM 2023

1.3.1. Kiribati's fishery products trade relationships

Total capture fisheries production in Kiribati increased from 63 000 tonnes in 2011 to 238 000 tonnes in 2019, representing a significant increase over previous years. Production fell in 2020 and 2021 as a result of the impact of COVID-19 on tuna export logistics.

Export earnings increased in line with increased tuna production, reaching USD 153 million in 2017. In line with reduced production fishery products declined to USD 94 million in 2021. Tuna exports represent about 80 percent of total export earnings. The main export item is frozen tuna, with skipjack accounting for USD 60 million and frozen yellowfin accounting for USD 18 million in 2021. Thailand is by far the most important fish-importing country from Kiribati, accounting for 70 percent of total sales. During the COVID-19 years, imports declined slightly, in 2021 this was also because of high transport costs. Similarly, exports of tuna to The Philippines declined in 2020 and 2021. This country buys an additional 10 percent of Kiribati's exports. The exports to Mexico declined due to disinterest of this country in recent years, reflecting the opportunistic trading behaviour of Kiribati exporters.

Kiribati is allowed to export to the EU since 2016. Three countries from the EU imported during that period, namely Germany, Italy, and France. Germany was the pioneer in importing fishery products from Kiribati, but stopped in 2021. Italy imported in 2020 and 2021, but stopped in 2022. France imported in 2017 and 2022. Overall the importance of the EU in total exports of fishery products from Kiribati is limited, at 0.4 percent in 2020, which had been the year of highest exports to the EU. The pattern of trade to the EU member countries shows the rather opportunistic attitude of Kiribati's fish exporter, who do not maintain a continuous relationship with importers.

Table 3: Kiribati exports of fishery and aquaculture products (in USD million)

Country	2016	2017	2018	2019	2020	2021
Thailand	91.90	111.0	93.40	82.50	75.70	63.00
Mexico	4.80	19.20	20.70	5.10	1.30	3.40
Philippines	2.20	5.30	8.10	14.60	11.20	9.40
Japan	7.40	9.70	8.40	7.70	4.50	5.50
Viet Nam	na	na	na	15.90	1.90	5.90
Republic of Korea	1.20	3.70	3.80	3.80	3.10	3.40
United States of America	2.90	3.30	2.50	2.40	1.00	0.90
Ecuador	1.00	1.10	3.50	0.80	3.90	2.50
China	9.50	0.30	0.10	0.90	0.00	0.00
EU	0.03	0.05	0.2	0.06	0.4	0.2
Others	0.77	0.05	0.28	0.14	0	0
Total	**121.80**	**153.60**	**140.70**	**133.90**	**102.90**	**94.30**

Source: TDM 2023

A study of the island's vulnerability to climate change discovered that the country has become overly reliant on revenue from offshore foreign-flagged purse seine tuna fishing vessels. Fees charged to tuna companies accessing its 3.5 million square kilometre exclusive economic zone account for roughly 80 percent of the country's government revenue. Outside of the tuna business, Kiribati has enormous potential for developing alternative sources of revenue from the fisheries sector. Aquaculture is one option, but other types of fish, such as demersal fish species, may also be profitable. The country could also try to obtain permission to export fisheries and aquaculture products to the European Union, which could be a good source of foreign currency earnings.

1.3.2. Overall framework for complying with trade requirements

1.3.2.1. Roles of the Kiribati Port Authority and the Kiribati Customs

The Kiribati Port Authority (KPA) mandate is to manage and develop seaport infrastructure; this includes the physical handling of cargoes until clearance and release by the various inspection services. KPA thus interacts with customs, quarantine, and health services, which are availed access or basic facilities to carry out their inspections. KPA is also ensuring the collection of all handling and clearance related fees.

The Kiribati Customs Administration and Enforcement (KCAE) ensures the functions of revenue collection, border control and the movement of goods across the border, mostly at Tarawa seaport and to a limited extent at the Bonriki airport, as well as in the Kiritimati seaport. KCAE maintains a close cooperation with the Biosecurity Section of Ministry of Environment, Land, and

Agriculture Development (MELAD), which has quarantine officers posted in the port buildings.

1.3.2.2. Animal Quarantine

Kiribati is not a member of the International World Organisation for Animal Health (OIE); and has no immediate plans to join. Usually, the country would submit a national report on live animals (aquatic and terrestrial) using OIE template, through the Pacific Community (SPC). The Director of Agriculture is the Kiribati focal point vis-à-vis SPC, for OIE. While Kiribati has thus a linkage to OIE, the absence of direct relationship is restricting the ability of exporters to send live fish to Australia.

1.3.2.3. Food Safety

Food safety is important for health reasons as well as for the development of tourism. Imported fooditems present a concern to authorities, including issues such as composition, labelling, date markingand adulteration. National food standards are under the auspices of the Ministry of Health and Medical Services (MHMS), which has started in 2018 conducting border inspections (while previously ad hoc inspections were triggered by KCAE call). Officers from MHMS are based at KPA for food container inspection and clearance. Kiribati has been a member of FAO Codex since 1990 and has a National Food Safety and CODEX Committee (CAC), which serves as a multi-sectorial forum onmatters related to food standards; to advise the government and recommend priorities on food issues and standards implementation.

1.3.2.4. Overview of Legislation for SPS issues

The following Laws and Regulations have been considered in assessing the current Kiribati SPS legislative framework:

- Consumer protection Act 2001 and Consumer Protection Regulation 2004
- Food Safety Act (2006) and Food Regulation and Standards (2014)
- Fisheries Act 2010 with amendments (2014), Fish Export Regulation 2012 and Kiribati Industry Standard (2016)
- Quarantine and Importation of Animals Ordinances (1977 ed.) and the Biosecurity Act of2011.

The collection of texts administering the SPS issues appears complete, especially considering the recent updates in regulations (local fisheries products, food...). The Laws are based on modern legal writing and account sufficiently for international practice. The regulations are also effective, even if some modern approaches to regulation (user pay policy, impact assessment) are not alwaysmentioned or used).

These regulations now require the concerned Ministries to develop specific action plans to enforce the dispositions. Implementation has been unequal so far: the most advanced in term of practice and capacity would be the Competent Authority (CA) Fisheries, followed by MELAD, while MHMS has only recently started mobilizing resources for enforcing the Food Safety dispositions.

1.3.2.5. Consumer Protection

The Consumer Protection Act 2001 defines the tasks, competence and powers of inspectors. The Act also provides for the remedies and sanctions for which initiation the Minister of Commerce, Industry and Cooperatives is responsible.

The Act empowers the Minster to prescribe by regulation, product safety or quality standards for anyspecified kind of goods and prohibits the supply or trade in goods in relation to which there is an approved standard, unless the goods comply with the standard. The Act also includes provisions onfair-trading and statutory warranties.

The Consumer Protection Regulation 2004 importantly specifies two standards in Product Safety and Labelling. There are concerns about the adequacy and practicability of the current sanctions and the capacity to deal with highly technical issues.

1.3.2.6. Biosecurity

Biosecurity Act, 2011 (No. 2 of 2011) is intended to prevent the entry of animal and plant, pests and diseases into Kiribati; to control their establishment and spread in regulate the movement of animal and plant pests and diseases and of animals and plants and their products; to facilitate international cooperation in respect of animal and plant diseases; and to make ancillary and related provisions.

This Act provides for biosecurity measures in relation with importation and exportation of animals and plants and related materials conducted by persons present in the Kiribati. The Act also provides with respect to administration of biosecurity control and deals with biosecurity emergencies.

The Act shall apply to any "regulated article": (a) any animal or animal product; (b) any plant or plant product; (c) any living organism, whether modified or not; (d) soil, sand gravel and aggregate; (e) any genetic material; (f) human remains; (g) any host material; (h) a regulated pest or disease; (i) any clothing, machinery or other article that contains or has adhering to it anything mentioned in paragraph (a), (b), (c) or (d); j) garbage; (k) any other article, substance, goods or thing declared by the Minister by order under subsection (2) to be a regulated article for the purposes of this Act. The Minister who is responsible for the administration of this Act may, on the advice of the Director of Biosecurity, declare, by Order in the Gazette, any article, substance, goods or thing to be a regulated article for the purposes of this Act. The Minister shall responsible for the overall administration of this Act. The Act establishes the positions of: (a) the Director of Biosecurity; (b) the Deputy Director of Biosecurity; (c) biosecurity officers, and define duties and powers of such public officers.

The Act concerns, among other things: biosecurity border control; biosecurity import and export procedures (including quarantine and issue of sanitary and phytosanitary certificates; and biosecurity internal control. The Act defines offences and penalties.

The Director must maintain a biosecurity register and other records needed for the administration of this Act and the performance of the biosecurity functions of the Government. The Director may enter into compliance agreements with importers, exporters or procedures or any other purposes for purposes of application of particular biosecurity measures. As for biosecurity emergencies, they may be declared in respect of the whole of or that part of Kiribati by the Minister in accordance with the advice of the Cabinet.

1.3.2.7. Agri-food processed products

The Food Safety Act 2006 puts in place the basic requirements and prohibitions as well as the powers and functions for official control of food. It also prescribes the sanctions and mechanism fortheir enforcement, which is the responsibility of Ministry of Health and Medical Services.

The Food Regulations and Standards (2014), fully harmonized with Codex Guidelines and Standards, further details requirements for domestic food businesses as well as for imports and for so-called designated products whilst prescribing horizontal chemical and microbiological parameters. In addition, there are mandatory quality parameters for key food groups included in so- called standards attached as schedules.

1.3.2.8. Fisheries

The Fisheries Act of 2010 concerns protection, management and development of fish stocks as wellas the licensing of foreign vessels. It was amended in 2015, amongst other things to create the Kiribati Seafood Verification Agency (KSVA) as the CA to verify the import and exportof seafood. The Act requires the certification of exports with certain requirements, provides sanctions and the mechanism for enforcement, and provides for the Minister to set standards.

The Fish Export Regulations 2012 brings the Agency into being and specify procedural as well as provide for the appointment of inspectors, the mandatory certification requirements (establishment and product) and the powers to define standards.

Further to this regulation, in 2016 the Kiribati Industry Standard (KIS) was adopted pursuant to the Regulation, which specifies and details the requirements for the establishment, for personnel as well as for production processes.

Transhipment is important for the Kiribati economy. The majority of transshipment activities conducted in port carried out between licensed fishing vessels and carrier boats. Transshipment is high when fishing favours Kiribati waters, particularly during El Niño periods. Since Kiribati does not have a canning factory fish from purse seiners is normally transshipped to overseas destinations. In recent years, the Government imposed on licensed vessels a requirement to offload a certain portion of high-grade tuna species to KFL. This is an additional catch besides catch landed by KFL vessels to ensure sufficient raw materials needed for processing is maintained. All landing and export data are currently held at KFL.

2. OFFICIAL CONTROLS FOR SPS IN KIRIBATI

2.1. Controls in the Fisheries sector: the Competent Authority

The fisheries sector includes local traditional fishing, aquaculture, and industrial fishing and fish processing. Kiribati has adopted the modern food safety approach whereby the operators are primary responsible for ensuring safe and hygienic food; the competent authority carrying out verifications and sectorial planning.

The KSVA is the CA for ensuring seafood safety. It is a section under Ministry of Fisheries and

Maritime Resources Development (MFMRD). Established with EU support, the CA has a staff of seven people. They carry out inspection of vessels and processing plants, sensory evaluation of catch, and sampling and testing of fish landed. The CA is now using a risk-based approach for their residue monitoring plans and for planning the inspection of fish processing plants and vessels. These dispositions are fully detailed in the Fisheries National Control Plan. The KSVA received support from the Forum of Fisheries Authorities, which provided capacity building on food safety techniques & inspection methods.

The analyses of process water and fish are needed to ensure residue monitoring plans and the verification of establishment compliance. The CA is outsourcing all the tests for a total cost of about USD 15 000 per year, which corresponds to about 20 samples per year.

Heavy metals and Histamine in fish (2 times/year), as well as all water and ice tests by the Institute of Applied Sciences (IAS) laboratory of the University of the South Pacific (USP) in Fiji

- PCB & dioxins (1 times/ year) at Asure Quality lab (Australia)
- Histamine by High-Performance Liquid Chromatography (HPLC) at Cawthron laboratory (New Zealand)

The competent authority is facing the following constraints:

- Equipment limited to basic controls (pH, sampling tools, temperature)
- Insufficient space to organize a proper laboratory
- Absence of testing capability: the tests are sub-contracted in laboratories in Fiji andin New Zealand.

The KSVA would thus need capacity development on fish inspection, on fish sampling methodology, and on the development and verification of Hazard Analysis and Critical Control Points (HACCP) plans for fisheries operators; as well as developing testing capabilities.

2.2. Controls by the Ministry of Health: safety of water and processed food

2.2.1. Official control dispositions

The KV20, the Kiribati Development Plan and other national level documents have highlighted the significance of non-communicable diseases such as diabetes and diarrhoea, linked to safety and nutrition. While the quality and safety of water and food are often pointed at, especially for imported food, the situation results from interaction of several aspects such as lack of information, nutritional habits, and food safety.

Kiribati is a member of FAO's CODEX Alimentarius Committee; a sub-committee of the National CODEX Committee (NCC) has been set up with representatives from the main ministries. The sub-committee meets regularly to exchange information and discuss on-going issues and needs.

Food safety is gradually becoming a priority with the implementation on the Food Safety Regulation; this represents a growing part of the workload of the division. The official controlsfor food have remained at a minimal level, including some initial assessment of food businesses and investigation of imported shipments. However, the implementation of the food safety regulation now requires strengthening of the monitoring and testing capabilities.

2.2.2. Capacity to analyse water and food hygiene and safety

The MHMS has two labs, the medical laboratory and the public health laboratory. The medical lab ensures microbiological analysis of water aside from medical testing; while the public health laboratory analyses the chemical and physical parameter of water. Ten officers have been trained for analytical work; the microbiology section has a staff of four, and the chemistry section has two technicians.

The laboratory for medical testing is used for the needs of the public hospital: biology, serology, and immunology tests are carried out; in addition, this lab carries out water microbiology tests. The chemistry section ensures testing to monitor the quality of water. The only tests carried out are the measurement of nitrates and nitrites in water samples, which are usual contaminants and indicate the level of water quality. The tests are carried out by colorimetry (benchtop colorimeter). This method is valid, but known to be relatively imprecise: to produce reliable results, it would require regular calibration and quality control (QC) procedures. The lab has also two hand-held water testers used to determine basic physical characteristics during on-site visits. Similarly, these could need re-calibration. The chemistry section operates with standard operating procedures; however, the quality assurance and quality control arrangements are still being prepared with the assistance of an external laboratory.

The microbiology laboratory analyses both the samples of human health (medical tests) and environmental health (food-water). For the latter samples, it identifies and measures the contamination for aerobicflora (TPC), Total Coliforms, E. coli, and Enterococci for shellfish (local consumption). The lab consists in two small rooms, one for sample reception and preparation and one for inoculation, incubation and determination. The tests are carried out on small petri dishes (mostly). The equipment is very limited (one incubator, one mixer, one water bath, autoclave...).

The laboratory is practically a small room, and the setting of the lab (floor area and number of rooms) does not allow for following thegood laboratory practices. The instruments seemed poorly maintained and ongoing work, due the lack of space, seemed poorly organized. In addition, the laboratory seemed operating without set procedures and without any disposition to ensure the quality and reliability of results. In addition, serious concerns are the proximity of patient consultation in the same lobby, the free access to the incubation rooms (no airlock), the overlap of activities and lack of space and fixtures to properly store, manage and dispose properly of instruments and reagents. These current settings create a significant risk for the health of workers and visitors, not to mentiona risk of cross contamination.

2.3. Ministry of Commerce, Industry and Cooperatives

Kiribati has no formal standards organization, and is not a member of the ISO. At Ministry of Commerce, Industry and Cooperatives, the Trade Promotion Division oversees export developmentand the related Aid for Trade, the Quality Promotion Division is responsible for facilitating the implementation of the National Quality Policy and ensuring access to relevant standards, and the Consumer Protection Division deals with issue related to fairness in trade and legal metrology (use of metric system).

3. POTENTIAL FOR DEVELOPING TRADE IN FISHERIES PRODUCTS

3.1. Local Traditional Fishing

This sub-sector is of limited size, but important to livelihoods. About 60 to 70 percent of coastal fisheries production in Kiribati is for subsistence purposes, with the remainder comprising artisanal and small- scale commercial fisheries.

The MFMRD has set up small fish plants with gutting tables, freezers, ice production on 22 islands (Gilbert group), and ensured training of operators on Good Hygienic Practices. The fish is sold fresh on local markets; small volumes are dried or marinated and sold locally. MFMRD has issued regulations extending the mandate of the competent authority for the local fisheries products; however, the hygiene and safety practices are evolving slowly.

The official controls for hygiene and food safety are not yet in place: there is some action in terms of awareness rising rather than enforcement. Currently KSVA has no mandate under the fisheries laws to carry out official controls for locally sold seafood products. KSVA is awaiting the regulation to be developed in this area to accommodate this gap.

Reef fish is a small percentage of the local traditional catch; however, there seem to be some problems with ciguatera poisoning. A laboratory is needed to check reef fish for this problem.

3.2. Aquaculture

Initiatives such as aquarium clam production (Atoll Beauties Co Ltd), live ornamental fish, and milkfish raising have been reported; at time of writing, another investment project (for milkfish production) is being assessed by MFMRD. While at early stages, aquaculture has a potential to relay local traditional fishing both for subsistence and for commercial purpose. However, as highlighted in the national fisheries policy, a specific regulatory framework is missing (Good Aquaculture Practices, zoning). As well, export of live fish (as food to Hong Kong, and ornamental fish to Australia) is regulated on the grounds of conservation (CITES), quarantine (parasites), and safety (contaminants). Because Kiribati is not a member of the CITES or OIE agreements, export initiativeshave been limited by the lack of certificates for sanitary condition or for conservation status.

3.3. Industry

The sector is of limited size at the moment, as Kiribati operations entail one landing point, the Kiribati Fish Limited (KFL) plant and cold store, and about twenty fishing vessels (3 vessels for KFL). The total volume ofcatch landed amounts to about 1 000 tonnes/ month, which compares to the total yearly catch of about140 000 tonnes caught by licensed international fishing vessels under the Vessel Days Scheme.

The Kiritimati Integrated fisheries master plan 2014–2017 foresaw the construction of fish processing facilities, in order to establish the Island as a hub for the tuna industry, however, these ideas are still to materialize.

Other processing factories are of smaller size e.g. CPPL, (not yet approved to export seafood products to the international markets only selling domestically).) and Pacific Fish (freezing local catch for sales in the villages of south Tarawa).

Only the KFL plant holds a food safety management system (KiribatiS) certification; the factory laboratory is using rapid tests methods for analyses of bacteria and histamine.
KFL is facing a few trade constraints, as follows:

USA, Australia and New-Zealand based importers (fresh and frozen fish) increasingly demand sustainable catch and eco-friendly certification.

Table 4: Approved companies/vessels from Kiribati for exports to the EU

Approval number	Name	Street	City	Region	Activities
KIR-KFL-EU-01	Kiribati Fish Limited	Betio Wharf, Tarawa	Betio	Betio	Processing Plant
KIR-ZV-MKN-EU-02	Moakona (Kirikore Fisheries Company Limited)	Kiribati	Bairiki	South Tarawa	Freezer Vessel
KIR-ZV-MMI-EU-04	Moamari (Kirikore Fisheries Company Limited)	Kiribati	Bairiki	South Tarawa	Freezer Vessel

Source: Traces EU

In 2023 the list of approved establishments was published by the EU. Allowed to export to the EU are the KFL fish processing plant in Betio and two freezer vessels of the Moamari (Kirikore Fisheries Company Limited).

In addition to maintaining food safety (FS) certification, the KFL factory must also carry out tests in accredited laboratories to verify their own routine checks. The overall budget for testing is in the tune of AUD 150 000 /year. To maintain their FS system, KFL currently carries out:

- Microbiological tests (hygiene monitoring) in fish meat, water and ice: with daily in- house analysis of about 25 swab samples for Total Plate Count, Total Coliforms, Escherichia coli, Salmonella spp, Staphylococcus aureus, Listeria monocytogenes.
- Routine detection of histamine with rapid test kits (cost of about AUD 20,000 /year)
- Water quality tests with rapid reaction chlorine strips
- External tests in accredited laboratories (verification of KiribatiS) include histamine by HPLC (4 times/yr.), polychloro-biphenyls (PCB14) once a year, heavy metals in water samples (4 times/ year)

The constraints for the above tests include:

- The high costs of subcontracted tests, of rapid kits, and of logistics;

- The unpredictability of freight, since even the courier operator face limitations and some flights are full or cancelled;
- Waste of working time to process paperwork and administration procedures to sort out cross-border issues when sending samples.

During the fact finding mission of Dr. Urbani, the KFL management welcomed the idea of having a local testing capacity within a reference laboratory. In their view, it is imperative to seek good quality of services and reach accreditation as soon as possible. KFL would be open to consider contracting part of their tests or even to operate jointly certain tests in the laboratory (microbiology). This means the KFL could sub-contract analysis tothe reference laboratory, or even carry out their analysis with their staff in the premises of the laboratory under a cost-sharing arrangement.

3.4. Development of new markets

3.4.1. Aquaculture

Whilst the aquaculture sub-sector is still under-developed in Kiribati, there are a few enterprises already involved in seaweed collecting and farming; this sub-sector has benefitted from support projects funded by Australia and the Government. Other aquaculture entrepreneurs have developed hatchery and production of juveniles of sea cucumber (beche de mer). They use imported species; the live animals are sent for further growth in Abaiang and eventually exported to Hong Kong. A local company, Atoll Beauties, is also producing and exporting ornamental bivalves.

Milkfish collecting and farming takes place at artisanal scale for domestic markets, although milkfish is not the main fish consumed in Kiribati. KFL has plans to develop aquaculture for producing of milkfish for export to SE Asia countries, where it is in demand.

The development of aquaculture, whilst in its initial stage, could require additional testing capacity, since certain contaminants e.g. antibiotics residues are specific to aquaculture.

3.4.2. Local processed fish products

Beside the industrial, large-scale operations described above, processing takes place at household level with sun-dried, marinating, or smoking operations. Such local processed fish specialties are sold on local markets and to Australia and New Zealand for a small extent. In these countries, and to some extent in the USA, there is a niche market for dry or marinated fish or fish 'jerky'. The idea to export on a regular and official basis has been looming in Kiribati for a while: both MFMRD (CA)and Ministry of Commerce, Industry and Cooperatives (MCIC) have received repeated requests to support and facilitate development and trade in theselocally prepared fish products.

There is a CODEX standard for smoked fish (CAC-RCP 311-2013); the Australia and New Zealand food code reflects this standard and has additional specifications. Exporting fish products prepared locally by fishing communities will require compliance with destination regulations; and the CA fisheries will be in the front line to ensure that exports are properly regulated and controlled.

This new trade opportunity may not concern large volumes, but would certainly boost incomes for the families involved; therefore, it is significant for the national economy. In order to develop trade in locally processed fish products, the concerned Government department should consider:

- Developing local food safety guidelines / regulations based on the CODEX standard for smoked fish;
- Organizing local small-size collect and/or processing centres where basic quality control and proper packaging could be ensured on a cost-recovery basis;
- Building capacities of producers' groups[17] (or civil society networks) to market and export such products.
- Engage with the producers' groups to develop their knowledge on hygiene, process, and finally capacity to produce safe (exportable) prepared fish products.

For fish that is consumed locally, incur additional testing needs as follows:

- Benzo(a) pyrene at ppm level for smoked fish and fish meat,
- Benzoic acid in cured fish,
- Formaldehyde and benzoic acid for marinated products (0.1 percent MRL)
- Total Volatile Basic Nitrogen and Total Methyl Amines that indicate degradation of fishmeat,
- Cigatoxin, a toxin cumulating in the meat of reef fish (local consumption)
- Salt and moisture contents,
- Microbial load,
- Heavy metals (50 ppm MRL in Australia).

It is important to be noted that for domestic fish the cost of the samples needs to be paid by the public authority.

The preparation of the CODEX standard on methyl mercury in major predatory fish would not bring new requirements for the industry. The CODEX Commission simply adopts and harmonizes various maximum residues levels (MRL) into an international standard. The ongoing works aim at evolving the current Guideline into an international standard. The MRL requirements in the guideline are similar to those found in regulations in the EU, Australia, or USA; Kiribati fisheries operators are already familiar and compliant with these. Nevertheless, the fact that such residue levels are stated in an international standard would in the future induce importers to increasingly referring these in trade deals; hence, a necessity for exporters as Kiribati to be able to demonstrate routinely conformance to such MRLs. This in turn would be much easier if a local laboratory had the capacity to analyse these heavy metals.

3.4.3. Attract foreign (EU) operators to Kiribati

Experience from other Pacific countries show that it is opportune to attract foreign investor, in order to increase the local processing and export of fishery products. The Government of Kiribati would need to create an enabling environment for investments, such as tax holidays. It would be opportune to exempt for a certain period the export from taxes, grant duty free imports of equipment for building the factory, special licencing conditions for building land, etc. In order to attract EU investors, Kiribati would need to accede to the EU-Pacific Economic Partnership Agreement (EPA), which is currently applied between the EU and Fiji, Papua New Guinea, Samoa, and Solomon Islands. The EPA would give all of Kiribati's products duty-free, quota-free access to the EU market — the world's largest single market. This would create the right environment for investors from the EU, especially Spanish tuna canners, which have invested in countries with EPA status. This would avoid the 24 percent duty on tuna loins imports from Kiribati. Obviously there is a challenge of establishing such a facility on a remote atoll, but with a good will by both the private and the public counterpart these challenges can be overcome.

3.4.4. Tests for ciguatera in domestic fish products

Reportedly there are cases of ciguatera poisioning in Kiribati. This problem mainly occurs with reef fish such as barracuda, grouper, jacks, snapper, amberjack, kingfish, moray eel, parrotfish, triggerfish, It is important to note that the risk of ciguatera fish poisoning varies depending on the location where the fish was caught, as well as the size and the age of the fish. These types of tests will be completely at the cost of the Government, but the benefits to the health of the population can be fundamental.

4. ENHANCING KIRIBATI SPS CAPABILITY

4.1. Legislative corpus for SPS matters

Based on the document review and interviews with key informants, the legislative texts are deemed complete and adequate to organize a framework to ensure food safety.

4.2. Official Controls

4.2.1. Kiribati Seafood Verification Authority (MFMRD)

The official controls are well organized and staffed, but as described before, the competent authority testing capacity is very limited. There is a need to access to the range of tests requested by export destinations regulators, in good conditions of timing and cost. However, the CA might prefer not to operate the laboratory directly; because when foodsafety agencies own and operate a laboratory, they are '*de facto*' in a situation allowing conflicts of interest. To avoid this situation, most food safety agencies in developed economies donot own and operate a laboratory; they either 'isolate' the public laboratory by adequate administrative set up or completely outsource the testing services to suitable (read: accredited) private laboratories. In Kiribati, it is recommended that the KSVA do not invest in and operate a laboratory section, but delegate the tests to a suitable structure e.g. the proposed reference laboratory.

In addition, the CA has indicated their desire to assist outer islands that wish to export smoked fish,salted fish, and tuna jerky to the Pacific communities in Australia and/or New Zealand. This will require the capacity to test salt, moisture and contaminants in the products.

Finally, the CA fisheries would need support to improve their fish sampling methods when inspecting fishing vessels, and would need the support of an external team (local service provider orconsultancy) to develop capability of seafood operators to conceive and implement properly HACCPsystems.

4.2.2. Food Controls through MHMS

While the control of water used for human consumption is well organized, the official controls for food are not yet sufficiently developed. The Environmental Health Division (EHD) is responsible for several other components of public health and therefore has no specific officers. Food safety issuesare supposed to be dealt with by public health officers in each district, as part of the range of duties in public health. The EHD has not yet carried out a systematic analysis of the food risks prevalence and of their impact on public health, or developed a national contaminants monitoring plan. While the significance of non-communicable diseases (NCD) is recognized, it seems that an important cause of illness remains the food consumption habits.

4.3. Analytical Capacity

Basically, there is no capacity to analyse the chemical characteristics and possible chemical contaminants of fishery products in Kiribati. The only chemical tests available locally,with a limited accuracy, are the measurement of nitrates and nitrites in waters. The capacity to determine and enumerate bacteria, yeasts and moulds in water and food could be sharply constrained by the lack of space, equipment, and proper work methods.

The fact that Kiribati is starting from a very low capacity level should be seen rather as an opportunity than as a challenge. Against the immediate perception that the lack of existing resources will challenge the realization of a competent reference laboratory, one should recognize that starting from an almost blank page allows adopting from the onset, in an adequate facility, good laboratory practices and a management system, and allows shaping up the team and resources to the objectives set.

5. OPTIONS TO INCREASE ACCESS TO LABORATORY TESTS

At present, most of the tests required by regulators or the industry (exports) are outsourced: only a few microbiology tests are done locally. The central question is whether it would be possible for Kiribati to develop the national testing capacities for fishery products. The options are thus either to continue and increase outsourcing of tests, or to develop the local capacities to ensure testing locally; in the latter case the ways for the delivery of services should be appraised.

In this assessment, a time span of five years has been considered. Five years is a usual lifetime for laboratory equipment; hence, it is practical to consider a first phase for capacity development with the same duration.

5.1. Outsourcing of the tests to other laboratories in the region

Outsourcing is currently the default option for all tests (except microbiology analyses). Most of the samples for testing heavy metals in water and fish are sent to the chemistry laboratory of the University of South Pacific in Suva, Fiji. Currently, the volume of 'complex' tests represents less than 50 samples a year.

5.1.1. Advantages of outsourcing

The main advantage consists of getting reliable results, since the laboratories involved are accredited for the outsourced tests. Specialized laboratories are able to use complex equipment with a large throughput, which allow providing a reasonable cost for the tests.

For Kiribati's economy, another advantage could be seen in the fact the Government needs not immobilizing funds for investment and for recurrent operational and overhead costs. The tests are purchased at market prices; and this requires only specific (and flexible) budget allocation. However, such flexibility and low budget footprint come as a trade-off with effective regulation enforcement.

5.1.2. Disadvantages of outsourcing

5.1.2.1. Limitations to the range of testing

Some samples cannot be sent abroad, since they must be analysed within a set time after sampling. In general, any sample will evolve during handling and this determines changes in the presence or relative concentration of the molecules of interest. These requirements are particularly stringent in the case of microbiology sample and most of the samples including organic contaminants, which must be stored under low temperature and analysed within 24 hours. These types of analysis are presently been carried out in the laboratory of the KFL company.

5.1.2.2. Heavy logistical constraints

The use of courier services is not straightforward in Kiribati. Courier services cannot provide delivery services to doors of perishable goods like fish. Therefore, this one of the challenge faced by Industries and KSVA especially in sending fish and water samples to IAS in Fiji and Asure Quality in New Zealand.

In addition, frequent changes in flights, and the limited space for cargo, lead sometimes the courier company to cancel or delay the shipment. In addition, forwarding samples abroad involve significant administrative procedures (customs, quarantine, etc.), abundant paperwork, and consumes time. As a whole, the handling of samples up to the laboratory abroad remains unpredictable. Following proper procedures for handling and forwarding samples is yet a crucial part of successful analysis. Because the duration of transport and reception, and the temperature storage canvary considerably between series of samples sent to a same lab abroad, this would affect the quality of analytical data and cause difficulty to compare the test results. This situation was experienced in the Cook Island, were the results of water samples for environmental monitoring were found to be heterogeneous within similar series and prevented useful exploitation of data.

5.1.2.3. Longer time to results

Even once the samples are successfully forwarded, the time to result can be very long. Kiribati clients have little or no leverage to demand a quick processing, given the limited number of samples sent.

5.1.2.4. Overall costs of testing

The cost of courier service (AUD 150 per shipment), as well as the staff time linked to prepare documents, add to the quality control costs. This extra cost acts also as a limitation to increase the frequency of sampling and testing, since large shipments would not be cheaper. Since volumes remain comparatively modest, there seems to be no possibility to enter into an agreement with the forwarders or airlines to accommodate regular shipping and/or lower rates; in this context, the costs of shipping would remain in proportion to the volume of samples sent.

5.1.2.5. Weak investment environment

The present climate for foreign investors is not very positive. This has to change as described in chapter 3.4.3. above. The absence of a testing capacity in country acts as an additional disincentive for investors. Companies seeking to develop fish processing factories near the catch location, or food production for local or regional markets, have to accommodate the inconvenience and extra costs for getting their quality control analyses done.

5.1.2.6. Absence of in-country capacity building

Finally, the most serious inconvenience of outsourcing is the hindrance to capacity development in Kiribati. Because there is no proximity between the laboratory and the clients, the latter receive neither information on the analytical techniques and their scope and limitations, nor advice on how to interpret the test results or on how possibly improve sampling or sample handling. This limits both the value of the results for users, and their capacity to understand the results, to enhance SPS controls, and to improve their SPS- related knowledge. In theory, any accredited laboratory should avail themselves to providing assistance to the customers to understand the results; nevertheless, such exchanges are greatly hampered by distance. Having the lab 'next door' allows more frequent formal or informal meetings, and greatly improves the interactions and learning process.

In addition, analytical theory and practice is a keen intellectual exercise, one that produces smart technicians and professionals. The absence of laboratories in Kiribati means such opportunities for personal development are lacking. Lab work or apprenticeship would be valuable in many trades e.g. marine industries, catering, food industry, and would even offer youth the possibility to work abroad as qualified professionals.

In summary, outsourcing of testing consists of the 'default' option. The costs of testing abroad are marginally higher than in-country testing. It has the convenience of avoiding significant investment in capital and human resources; but conversely brings in hidden costs and significant limitations that prevent regulatory agencies to discharge their mandate effectively. This could be seen as hampering both the growth of the economy and the knowledge base of the people. Alternatives to outsourcing would consist in developing a sufficient analytical platform locally; this may be achieved faster and more efficiently under a public-private partnership lab development model.

5.2. Developing analytical services in-country

5.2.1. SWOT Analysis of the strengths, weaknesses, opportunities and threats

5.2.1.1. Strengths

- The Ministry of Fisheries is well managed and the staff is dedicated
- Through the PROP programme funding is available
- The tuna resources of the country are strong and can be further exploited
- The CA is well trained and dedicated

5.2.1.2. Weaknesses

- No reference laboratory existing
- Investment needed is substantial
- No specific knowledge for laboratory staff exists in the country

5.2.1.3. Opportunities

- Kiribati is authorized to export to the European Union
- With a reference laboratory in place, additional investors could become interested in building factories in Kiribati
- Laboratory staff will receive plenty of training, including travel to foreign laboratories, which makes the job attractive
- Neighbouring countries could use Kiribati as reference laboratory
- It is fundamental to embed ISO/IEC 17025 requirements in the institutional setup
- Training of CA staff in fundamental issues of sanitary controls

5.2.1.4. Threats

- Procurement can be an issue, especially as the set up will be under the Ministry of Fisheries, so it is essential that procurement of regents and other consumables is made unbureaucratic
- Few staff available, already trained and ready to start working
- The scarcity of candidates with suitable profiles to staff the key positions would lead to difficulties in managing the laboratories, especially to demonstrate their competence.
- Poor cost tracking may lead to a deficient pricing structure (too high or too low prices) that would hinder the sustainability of the laboratory business;
- Unsatisfactory linkages could prevail between the laboratory and ministries, which would trigger disinterest and/or the development of individual labs in the future;
- There is little synergy and possible work sharing between biology, microbiology and chemistry analyses. The only rationale to couple these sections is the cost reduction for investment and utilities (energy, water, air conditioning).

- One major risk is the EU policy with regard to IUU fisheries (the EU's IUU regulation[1])

5.2.2. Lessons learnt from other countries and critical success factors

From other similar projects the following issues emerged:

Procurement can be an issue. This public service lab sought to reach low unit costs by purchasing large quantities; however, this generated overstock while the limited rates of consumption lead to obsolescence and waste of reagents.

The laboratory mandate and organization can be an issue to reach sustainability. Staffing of the laboratory is a key to success. Recruiting of new additional microbiologists is essential, which can lead to more samples processed by the laboratory. It is important for success to have personnel with the qualification and experience adequate to the range of tests. If personnel are not available in country, regional professional will be sought after and local competence will be built up gradually. Staff training at various levels is planned to be delivered over a 12 months period, with WB funding, in order to build up from very low level of knowledge laboratory analysts.

It is important to consider that staff training and hands-on capacity building required lots of practice and hence additional reagent during the growth period.

t is fundamental to embed ISO/IEC 17025 requirements in the institutional setup and in the physical design of the laboratory. This needs to be done in an early stage of the laboratory roadmap. Accreditation means the lab management system is effective, and henceforth, that the lab provides reliable results and would remain sustainable.

It is essential to have a facility that is secure, large enough to accommodate work, and can minimize the environment variations affecting the tests.

The independency or large autonomy from parent ministry is essential so that the laboratory head has sufficient authority on budget matters to sustain the activities. The increasing income as forecast will also need an experienced accountant to carry out the book keeping.

The Kiribati-based reference laboratory should aim at ensuring only tests of intermediate complexity that will be most in demand in the next 5 years. Some more specific tests would need to be still outsourced. While a management system will cover all activities, accreditation could be sought after first for specific tests (export-related) and gradually extended to the whole range.

Laboratories are business units that produce and sell services to clients. The fact that public laboratories do not always 'charge' for the tests, does not mean that these services have no costs. Rather, their costs are hidden and covered by the Government budget. However, good laboratory management suggests tracking the costs associated to inputs (staff, reagents, energy, etc.), and to

[1] 'Council Regulation (EC) No. 1005/2008 Establishing a Community System to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) Fishing, Amending Regulations (EEC) No. 2847/93, (EC) No. 1936/2001 and (EC) No. 601/2004 and Repealing Regulations (EC) No. 1093/94 and (EC) No. 1447/1999. | FAOLEX', accessed 4 June 2023, https://www.fao.org/faolex/results/details/en/c/LEX-FAOC090889/.

use business planning with a costing structure that allow cost recovery when feasible. This is seen as a mean to measure the value-to-cost ratio of the services offered, and to ensure sustainability.

Considering the broader SPS system, local laboratories can play an important role in assisting regulators to understand better the interactions between the environment and plant, animal, and human health. There is a need to facilitate interactions between laboratory and enforcement or monitoring sections, in particular to improve monitoring plans, sampling methods, or HACCP implementation. Therefore, it would be worth if the reference lab facility would also include a meeting room and office setup allowing to host on a temporary or permanent base the activities from other institutions.

6. FEASIBILITY

6.1. Overview of project

The main aim of this project component is, initially, to prepare Kiribati for the setting up a Reference Laboratory, including a thorough analysis of whether this is feasible from an economic point of view, or whether it is more feasible to send samples to reference laboratories in the region, such as Fiji. Following the results of the feasibility, the program will seek to build and equip the Reference Laboratory.

The EU obliges countries that want to supply the EU market with seafood products to carry out certain chemical and microbiological analysis. These analyses do not need to be carried out in reference laboratories within the country that is exporting the product.

The possibility to export tuna to the EU is widely beneficial to Kiribati's population, example, through increased product flow to the EU market, generating higher revenues and profit margins. Additionally, in the future there is the potential for processing plants to be built, particular for tuna loins, which could enter the EU market tariff free. At the moment, exports are rather small, between 5 and 140 tonnes, since the country was approved to export to the EU in 2017.

6.2. Technical feasibility

The technical feasibility of the proposed program of work will depend to some degree on the support from the industry and from the administration alike, and will be assessed as part of the program of work. It will be very important to inform the private industry of the costs (fees to enable operation) and benefits involved in the setting up and operations of a Reference Laboratory, assessing whether the industry is willing to pay for sample analysis in an Kiribati-based Laboratory, reducing the need for export of samples (which is complex, time consuming, and costly).

A small laboratory currently exists in Tarawa, however, the structure and the technical capabilities are insufficient for becoming a fully comprehensive Reference Laboratory with capabilities as required by the EU.

New technology and trainings will need to be acquired and undertaken as part of the program of work, in-line with the sampling requirements specified by the EU at the Reference Laboratory.

The main technical challenges or constraints are the availability of trained laboratory staff available in Kiribati. Currently, there are insufficient resources/personnel readily available to execute the project effectively. New skills need to be acquired, and above all, new staff needs to be hired, trained, and retained. The primary milestone is the feasibility study, which will show whether it is economically and technically feasible to create a new reference laboratory within Kiribati.

6.3. Financial and economic feasibility

The estimated costs (broadly) associated with the project, including initial investment, are in the order of AUD 650 000. The running of the facility will be around AUD 280 000 per year, including training courses for staff and the maintenance of equipment. The initial costs are within the PROP funding. The running costs, however, will be in part covered by the payments for samples by private industry. The source of revenue generation is clear. The expected return on investment (ROI) is approximately AUD 180 000 per year, so the initial investment will be refunded, considering also the losses made in the first three years, after 9 years.

One major risk is the EU policy with regard to IUU fisheries (the EU's IUU regulation[2]); in fact in the list of authorized establishments there is a reference to the risk of being excluded from export authorization in case the IUU policy is not strictly followed by the country. This policy requires stringent controls to mitigate against and reduce IUU fishing activity via various means. The best way that Kiribati can plan for this is to improve its internal processes to mitigate against potential IUU activity, both of its own Kiribati-flagged vessels and those of foreign flags that operate within Kiribati waters and land to Kiribati ports. Improved traceability of all tuna products from Kiribati will go a long way in ensuring the Kiribati can meet the standards of the EU IUU regulation. For tuna, the IUU fishing is well managed, due to the control by FFA and other regional mechanism, however the IUU regulation of the EU also covers small-scale fisheries, which could represent a problem.

This Regulation lies down that the trade with the EU of fishery products obtained from IUU fishing will be prohibited. To ensure the effectiveness of this prohibition, consignments of fishery products shall only be imported into the EU when accompanied by a catch certificate. Through this instrument, the competent authorities of flag State of the vessel catching the fish will certify that the export consignment of catches have been taken in accordance with applicable laws, regulations and international conservation and management measures. This certificate shall be validated by the competent authority of the flag State, and if necessary, other documents envisaged by the certification scheme in the event of an indirect import after transhipment, transit or processing of the products in another third country. The catch certificate is available in Annex II of the IUU Regulation. In order to ensure that smaller vessels can continue to export to the EU, the Commission has introduced a simplified catch certificate. For vessels meeting the criteria of small vessels as laid down in article 6 of Regulation 1010/2009 the master of these vessels need not to be identified. Instead, an exporter trading fish stemming from several small vessels only need to list the vessels which he has bought fish from hence the master or his representative do not need to sign the catch certificate. The simplified catch certificate is laid down in Annex IV of Regulation 1010/2009. Catches by EU vessels are submitted to strict control mechanisms, which is reinforced by the new Control Regulation (EC) No 1224/2009 which also entered into force on 1 January 2010. More information

[2] 'Council Regulation (EC) No. 1005/2008 Establishing a Community System to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, Amending Regulations (EEC) No. 2847/93, (EC) No. 1936/2001 and (EC) No. 601/2004 and Repealing Regulations (EC) No. 1093/94 and (EC) No. 1447/1999. | FAOLEX', accessed 4 June 2023, https://www.fao.org/faolex/results/details/en/c/LEX-FAOC090889/.

on the Control Regulation is available on: http://ec.europa.eu/fisheries/cfp/control/index_en.htm

The catch certification scheme will apply to all unprocessed or processed catches, except for freshwater fish, ornamental fish, aquaculture products obtained from fry or larvae or certain molluscs, contained in Annex I of the Regulation. The list of excluded products has been updated in Commission Regulation 86/2010. By ensuring product-traceability from the fishing net to the plate, including processing operations, the certification scheme aims to strengthen compliance with management and conservation rules and to support international cooperation in the fight against IUU fishing.

6.4. Environmental and socio-cultural feasibility

The setting up of a reference laboratory will help to control the environment and minimize health risk associated with consuming fishery products. The reference laboratory will be planned to ensure good working controls which will avoid any unnecessary environmental impact from its operations. The laboratory will also have a proper resource usage and waste management system. The laboratory will create some marginal employment opportunities with increase CA inspector and laboratory technician numbers. Overall, the reference laboratory is environmentally and socio-culturally feasible.

6.5. Institutional and management feasibility

The CA is under the Ministry of fisheries and marine resources development. The present staffing are 4 professionals, but additional staff is likely to be hired soon. The reference laboratory needs to guarantee a certain independence from the CA.

The institutional set up of the reference laboratory must allow three conditions to be met:

- Be independent from undue influences potentially affecting test results
- Have a secure operational budget with funds regularly/timely allocated
- Receive a sufficient number of samples.

Both the ownership and management structure may either support or hinder the above requisites. These issues are critical success factors for the reference laboratory. A range of options to set up the reference lab can be considered by combining the choices for ownership and management.

International practices increasingly favour private ownership and management of laboratories, on the rationale that in most cases, private ownership and management tend to optimize efficiency and sustainability in response to markets signals. In such an option, the public offices can select and approve those laboratories offering accredited services at competitive prices. Selected laboratories are then offered multi-year service contracts to carry out the tests necessary to achieve public regulations.

However, the model indicated above is mostly found in developed or emerging economies, where sizeable demand for testing services exists. Such is not the case in Kiribati where the limited demand for tests in the industry would not allow full profitability for a laboratory owned by a private company. Consequently, in order to sustain the production of reliable data used for regulatory decisions and policy-making (public goods) the Government should be prepared to secure recurrentoperational funding over the first years of services; this would yet be on a decreasing basis as the reference laboratory would gain progressively more private and external clients to generate revenue.

6.5.1. Reference laboratory as the technical arm of MFMRD

This option will require particular arrangements allowing it to be managed in wide independence from the rest of the ministry. This may require the technical section to be attached directly at the top level of the Ministry, rather than down in the hierarchical lines This is crucial to guarantee independence of the testing, security of resources (avoiding possible intra-ministry budget re-allocation), and equal treatment for any sample received. The budget would need to cover all direct operational expenses (labour, consumables, chemicals, repairs and maintenance).

While this option has the advantage to build upon existing administrative and technical capacities, it brings significant risks as follows:

- Inappropriate hierarchical arrangements could lead to insufficient independence of the lab Manager.
- The allocated budget could be not separate enough, which would lead to re-allocationwithin the Ministry and compromise effectiveness of the laboratory.
- The ministry's administrative procedures used for selection, recruitment, managementand training of personnel could be inadequate and limit the efficiency and capability ofthe laboratory.

6.5.2. Reference laboratory as part of an existing statutory body

The Government of Kiribati has developed a range of state-owned enterprises and statutory authorities for ensuring the production of goods and services. Under this option, the development, ownership and operations of the reference laboratory would be put under the MFMRD.

This entity would become responsible for the investment and operational budgets of the laboratory, as well as for generating revenue to cover the costs of testing services provided. The reference laboratory could be seen as an adjacent business unit working under the umbrella of the existing entity; for the sake of avoiding creating yet another independent state enterprise.

The advantages of this option consist in a fit with the commercial and operational orientation of the entity, and in the independence of the laboratory management with any other client. It may yet be uneasy to 'graft' a new, specific activity into an existing structure: the reference laboratory activity would have to be 'hosted' within the structure while having a full operational and managerial autonomy.

The disadvantages of this option include the fact that Ministries are sometimes very bureaucratic in addressing issues and short/time equipment needs. In addition, there is a potential conflict of interest, as the Ministry is also interested in increasing revenues, while the reference laboratory must guarantee a certain independence of judgement.

6.5.3. Reference laboratory created as a new stand-alone public entity (Statutory Body)

This option aims at creating a new stand-alone entity, tailored and fit for the purposes of the reference laboratory. The new body would have its own strategy, budget and programmes. Besides delivering specific microbiology and chemistry testing services to regulators, the new body may seek other private sector clients and/or become the recipient of projects or partnerships for increasing SPS capacities in the country, or for research activities.

A new independent statutory body may prove an ideal situation to allow participation of Kiribati private sector and/or external operators into the capital and operations. The main advantages of this option are the full independence of the reference laboratory from any customer, the full control on the budgets, and a greater focus on service delivery.

It would also facilitate the development of new services as Kiribati needs, as well as receiving any possible external support from Development partners.

There could be some disadvantages with this option, such as the time required to create such a new body and secure the budget arrangements. The MFMRD will be the main contributor to the development of such a statutory body.

6.5.4. Reference laboratory created as a private company

This option would require the Government to attract one or more private operator to invest in Kiribati in the aim to develop and operate the reference laboratory. The private operator may be sought after among existing accredited laboratory in the region, as well as with international companies specializing in conformity assessment. Taking into account the small size of the market for services in Kiribati, private players would require commitment from the Government to facilitate the investment for the laboratory, as well as securing a volume of tests for public purposes. Such support could be formalized through a public-private partnership and the creation of a local joint- venture company with a minority public share, for the single purpose of creating and operating the reference laboratory.

Nevertheless, the requirements of each partner will need to be duly accounted for. In such situation, the private sector partners usually take on the responsibility for operating the laboratory; they expect to have a large freedom to run the operations. The Government may have requisites in terms of local capacity building and the priority given to samples for official controls.

For Kiribati government, the advantages of this option would be found in access to the private operator resources, knowledge, and experience such as available technical staff, established management system and methods, training infrastructure, etc. Overall, this option would be the faster way to reach the state of a fully functioning, accredited reference laboratory. The benefits for the private partner, beyond the financial income stream, may consist of increased footprint in the region, enhanced reputation, and access to additional funding for research purposes.

The disadvantages of this option are chiefly the lesser government control on the reference laboratory and the need to enter in substantive MOUs with each ministry to secure the full load of samples. Another inconvenience is that if the new local venture priorities do not match government ones, tension may arise for managing the operation. The risks include the somewhat higher costs of tests due to the profit margin applied by the private operator, the possibility to see monopolistic practices, and the difficulty for Government department to organize research. Finally, there is a risk that the private company could cease operations and disinvest after a few years, leaving the management of the reference laboratory to the Government. Overall this option seems to be not very viable.

6.5.5. The optimal configuration

There is no 'best option' and each of the solutions mentioned above has its pros and cons. The reasoning would thus be to assess how the success factors can be met and the risks could be best mitigated.

- The need for impartiality and risk assessment can be best fulfilled in the configuration of an independent entity (joint-venture or private company), or by dispositions included in the statutes of an autonomous public body.
- The presence of the public sector in the oversight structure of the reference laboratory is deemed necessary to maintain alignment with the country objectives and to foster and facilitate linkages with the ministries.
- The need for large operational independence can be reached through the position of Institute director, granted with full power to run the operation within the mandate, with some control by the Government
- The requirements to secure recurring resources can be met through adopting a multi-year budget framework integrated to national budget, in addition to the capability to generate own resource (user-pay policy).

In summary, the institutional set- up, which would best enable the successful operation of a reference laboratory, is an autonomous enterprise or agency,

As indicated above the fisheries industry in Kiribati consists of one large processing company and half a dozen of smaller ventures. The leader, Kiribati Fish Limited, carries out routine microbiology basic chemistry tests on-site and those analysis that need to be done within 24 hours, and outsources the detection of histamine and heavy metals (regulatory requirements) to the USP laboratory in Fiji. The management recognized that developing local capacities is necessary; however, a local lab should rapidly secure accreditation.

KFL may be willing to consider using the services of a reference laboratory for routine tests in complement or in substitution of their factory QC laboratory. The two factors into consideration here will be the cost of the tests and the time to results. If tests prices are higher than the costs of the internal lab, or if the results cannot be delivered in real time, the industry would not use the reference laboratory services. Regarding the tests currently outsourced, shifting from USP to the local laboratory would be considered once accreditation is secured and provided the costs be at the same level.

The KFL management was open to continue the discussion and to consider possible collaboration with a reference laboratory. Nevertheless, the prospects of a public-private partnership for the fisheries sector remain uncertain, because of the low number of enterprises involved and the significant risk involved. Furthermore, the industry could not possibly control a laboratory that provides tests for the use of the competent authority for fisheries. The involvement of KFL would thus probably remain limited below the Private-Public Partnership (PPP) level, for example through an observer position in the board and through service purchasing agreements.

Due to the highly specialized testing services, seeking a partner laboratory that may co- invest in the reference laboratory makes sense. Such partner could easily provide support services (training, assistance) as an external supplier. However, the Government's aim will be that the lab become fully operational and reliable and quickly get an accreditation without any delays. Securing one or more private laboratories as co-investors in Kiribati's reference laboratory would greatly facilitate achieving this objective. In addition, the participation of private investors may generate opportunities for mobilizing support funding from the investors' countries.

Several laboratories could be approached for partnership, including:

- In New Zealand: the Cawthron Institute (already involved in the discussion of a PPPin Cook Islands), ESR, RJ Hill, Asure, EnviroLab-MSL, Eurofins, etc.
- In Australia: SGS (PPP developed in Cambodia and Indonesia), OMIC, ACS Lab,Symbio alliance, Eurofins, Envirolab;
- In Fiji: the laboratory of the University of the South Pacific.

The above is merely an indication of possible support. Most labs would rather be cautious to involvein a PPP for the small operation in Kiribati with limited market. Thus, Donor support would be necessary to 'incentivize' the investment and to provide operational support over the first years. A New Zealand laboratory could be the favourite (with NZAid support). Alternatively, the USP lab could be convinced to step in, on the grounds of regionalism and given USP has campuses in almost all countries of the Pacific. That option could or 'may' be linked with the COE (Regional SPSproject). The USP would probably request same level on incentives to step in.

7. OPERATIONAL AND TECHNICAL FEASIBILITY

7.1. Nature of the facility

The building hosting the laboratory and other offices either could be considered as an integrated facility which actually manages operations for all parties and would offer a single contact point for enquires about analyses and results. It would have an experienced laboratory director in charge of implementing the management system and quality assurance and control disciplines. The staff carrying out a higher number of tests would quickly gain proficiency, and reach a high standard of service.

7.2. Location

The issue of the location of the reference laboratory is significant for the timeframe for having the laboratory built. The MFMRD has already designated an area where the reference laboratory will be built, namely in Amboo.

7.3. Infrastructure

7.3.1. Building layout and realization

7.3.1.1. Considerations for layout

The preferred option for a laboratory building is a stand-alone facility. A laboratory environment includes or generates hazardous chemicals and waste, potential noise, vibration, smells and fumes...all presenting risks or inconveniences for the public. Integrating a laboratory in a general use building (hospital, offices...) would incur additional costs e.g. for better protection of environment and safety systems. Finally, a stand-alone facility allows expanding the laboratory building in the future.

The facility should include the following:

- Reference laboratory building;
    - Offices, board & meeting rooms, canteen and break rooms, either a separate unit or integrated to the lab building, possibly as a second floor;
    - Separate technical building (45-50m^2) to host the storage for chemicals and gases; the generator and fuel tanks, the air compressor, the power regulation, the water filtration unit;
    - Hangar or shed (80 m^2) to accommodate the fumigation and incineration activities.

It is possible to design multi-storey labs, or to host laboratory section into a multi-storey building. Nevertheless, there is little economic gain as the reduction of structural costs is almost offset by the additional access (stairs), extra materials used to withstand weight, and the need to extend reticulation, power lines, ducts etc. Furthermore, single-floor labs provide better security (access for rescue teams, evacuation, etc).

Laboratories are usually designed and built so as to minimize potential impact of any external factors on the environment and operations of the laboratory. When variations are kept to a minimum, the laboratory is in good condition to work regularly and produce reliable results. The standard ISO/IEC17025 describes in details which factors should be controlled (or monitored), including:

- Security: access to most areas is restricted by keys or locks. This contributes both tosecurity and to protection of confidentiality.
- Reducing the possibility of air-borne contamination (bacteria, solvents, fumes...) by maintaining a negative pressure in work areas; this is achieved by extraction of the airvolume and replacement by external air.
- Absence of physical contamination in the incoming and circulating air. Contaminants include insects, dust, particulates, bacteria, etc. The lab building must be insect-, bird-, rodent- and
    - vermin-proof. Preventing contamination also requires the use of air filtration systems, anddetermines dispositions to avoid cross-contamination.
- Control of temperature and humidity of the circulating air where these could affect the results of operations.
- Environmental protection with control of effluents (test solutions) and waste (sample, matrices)
- Ease of cleaning and sanitation (especially for microbiology), which requires all surfaces to be smooth, easily washable, and acid- and solvent-resistant.
- Adequate lighting to ensure easy reading of colours and instruments indications.

In addition, it is also recommended to consider

- Reducing the area of windows and using fixed window panes with tinted glass
- Using an external, separate building for storing chemicals
- Restricting access to chemicals and laboratory equipment to trained personnel
- Stabilizing electrical power (voltage and wave when needed)
- Using a pre-filtration and reverse osmosis unit to filter the water supplied to labs.
- Keeping the gas cylinders and pressure equipment in external enclosures with concrete or

cinder blocks walls.

- Using a fire protection system with smoke detectors and temperature alarms.

The size of the proposed laboratory is determined by the scope of services, the number of samples and tests, the land space available, and finally by the target budget. Based on the designs and information gathered, it is proposed to consider a building with a footprint of 160 m^2, respectively.

The laboratory would need the following work areas:

- Office & general purpose rooms
  - Offices for administrative staff
  - Toilets (1 for men, 1 for women)
  - Showers (1 for men, 1 for women)
  - Changing room
  - Cleaning and decontamination room with post-rooms for autoclave
  - Small reception area (info counter) to receive queries and samples and sample holding (refrigerators, freezer, shelves etc.)
  - bench for test items preparation
  - One ambient store for generic, dry reagents and miscellaneous supplies
  - One controlled store room for sensitive media
- Microbiology Laboratory
  - media preparation room (including adjacent media storage)
  - room for incubators
  - reference culture storage and maintenance room (could be fitted at later stage)
- Chemical/physical laboratory
  - Digestion/ extraction area
  - A 'wet' chemistry area for the methods involving titration, spectrometry, conductivity...
  - Instrument rooms hosting the Atomic Absorption Photometer (AAS), Gas Chromatograph (GC), and HPLC instruments

7.3.1.2. Construction

A few options may be considered for building the facility premises, depending on the nature and characteristics of the underlying soil. A traditional option consists of a cinder blocks structure built on concrete foundations, pillars and slab; it must be entirely heat-insulated by proper lining.

Alternatively, the laboratory could be built as a metallic structure with insulated sandwich panels walls and ceilings. This would require equipping the lab rooms with mobile benches and cabinets, since the walls would not be fit to bear masonry benches.

All floor surfaces must be covered with materials suitable for laboratory use: PVC tiles, high-grade ceramic tiles, epoxy-resins...and the angles with floor and ceilings must be rounded to allow easy cleaning.

All windows and doorframes should be high quality, durable PVC assembly; windows should be in small dimension with fixed tinted, dual- or triple insulated glass reducing heat and UV transfer.

The construction project for the building should be tendered under one of the two options below.

a. Design-Build tender allowing selecting a consortium of firms offering the best cost-to-value project; or

b. Preparation services commissioned to various experts, resulting in the production of the Building Plans, Schematic Design, Construction Documents and Specifications; followed by Tendering of the works, building materials and project management services,based on the documents prepared.

7.3.2. Functional Systems

The definition and set-up of all the functional systems should be part of the construction project (either option a. or b.).

7.3.2.1. Ventilation and Air Conditioning (VAC)

This represents a crucial system for the laboratory, since it determines the security and stability of the operational environment, as well as well-being of staff. The lab has three kinds of zones requiring different atmospheres:

- Areas/ rooms for generic work, dry stores, and office areas where simple air extraction and air conditioning is sufficient.
- Rooms where temperature and humidity must be maintained within set limits (25± 1.5ºC and 55±2 percent HR),
- Rooms with controlled ambiance, and supply of filtered air with very low levels of particulates or bacteria.

The requirements to control humidity and temperature combined with the need to renew the air volumes can lead rapidly to significant power consumption. The VAC system should thus include a combination of individual air conditioners, and a unit for supplying de-humidified and filtered air in replacement of the extracted volumes in controlled rooms.

7.3.2.2. Power

The importance of high quality power cannot be emphasized enough. Most technical representatives and equipment suppliers fail to understand the extent of power issues in developing countries.

- Voltage typically can vary from 180 to 240 volts.
- Outages are frequent and unpredictable
- Spikes are frequent; they are caused by load variation, network imbalance, start ofnearby generators, lightning...The structure of the alternative current wave may vary in shape and amplitude
- The start-up of certain instruments generate currents five time higher than the nominal (current usage load)

These conditions can generate variations in the instruments, and cause premature aging. Across brands, instruments have very different built-in protection and stabilization features. Certain brands are better than others, but in any case, there is a need for high-quality protection at two levels: a general unit and some units dedicated to the AAS, HPLC, and GC instruments. Cheaper or entry-level uninterruptible power systems (UPS) just turn on below a pre-set voltage, but do not stabilize or redress the power wave. Even the best UPS equipment does not have good surge protection. Hence, the lab's main power board must be fitted with a high-grade surge protector, capable of withstanding lightning and other network spikes. The AVR capability is essential in high precision work, since variable mains load can affect results especially in cheaper instruments with weak internal regulation. Furthermore, the reference laboratory must have either:

- Top-range UPS that transforms incoming AC voltage/current to a battery and then generate astabilized sinusoid AC voltage calibrated at 240 Volts 50 hertz; or
- Basic UPS combined with separate automatic voltage regulator (AVR) to lock in 240 Volts.

Another aspect to take into account is the quality of the realization of the laboratory power lines, which must be well balanced over 3 phases and prevent resonance effects. All electrical works should be professionally designed and validated beforehand, use certified materials, switches, relays...adequate to a lab power grid, and be carried out by certified technicians according to Australian safety and performance standards.

Finally, given the very high cost of electricity, there will be a need to realize an energy diagnostic study, to find the most economical way of powering the lab. It is proposed to equip the reference laboratory with solar panels for supplying part of the power used in the lab during the day for lightning, hot water, small amperage plugs..., and the basic functions used during night time (security, low power ventilation, fridges and freezers). This would require also a set of batteries, aninverter and a controller unit. The investment comes at an extra cost: it should be evaluated as part of the detailed preparation of the investment project. There will be a need of professional advice anddesign services to define a stable and regular power supply and distribution grid, as well as balancing the use of fossil- and solar-based energy sources.

The infrastructure foresees a set of UPS systems, capable of keeping all machinery working in the laboratory, even during periods of long power cuts.

7.3.2.3. Water

The laboratory should have a single medium-size unit to filter, de-ionize and purify the water supplied by the Public Utility Board. In first estimation, the unit should process about 100 litres/ day, which means a nominal output capacity of 20 litres/ hour (water 'type 335'). The lab should have input and output buffer tanks of half to one m^3 to store incoming water in a sufficient quantity for feeding the washing machine, sterilizers and water stills or ultra-purifiers for a couple of days.

7.3.2.4. Waste

The laboratory must have a system to process waste. One option is to store in separate bins biological waste (after decontamination) and physical waste (paper, plastic, glass etc.). The containers would be taken away by the public waste collection service. However, autoclave decontamination is for laboratory waste, but not adequate for quarantine samples. Therefore, there is an opportunity for the new facility to accept waste from various sources and to burn it properly in a medium-sized incinerator. Modern incinerators have dual combustion and gas cleaning system that reduce their environmental impact.

The liquid waste (solvents and acids) should neither be burned nor released in the environment. Instead, it must be stored in ad hoc containers and shipped away to the nearest recycling centre.

The waste resulting from fumigation (spent phosgene pellets and other solids) must be collected, stored securely, and sent away for recycling.

7.3.2.5. Internet access

Access to a broadband service provider is a necessity for the laboratory. Beyond mundane search and exchange of technical information, the cloud-based transmission and storage of data, access to online database of tests, distributed (cloud-based) Laboratory Information Management Systems (LIMS), and online hook-up for maintenance of equipment...are now of common use in laboratories.

7.3.3. Equipment

The necessary equipment is based on the main tests needed. The equipment can be divided into general equipment (which includes fridges, tables, scales, PC, printers, etc.), chemical equipment, and micro-biological equipment. The total cost of equipment can be identified in AUD 165 000.

7.3.3.1. Chemical Equipment

Table 5: Chemical equipment to be bought (bought (costs in AUD)

NB	COST	INSTRUMENT
1	40,000	Atomic Absorption Spectrometer
1	750	Balance (precision)
1	1,200	Balance, analytical 4 digit
1	2,200	BOD Incubator
1	4,000	Centrifuge (refrigerated)
1	600	Desiccator
1	9,000	Fridge, explosion proof for chemistry
1	1,500	Homogenizer, overhead with stand
1	35,000	HPLC + ECD, UV, FID detectors
1	6,250	Misc. items
1	3,500	Muffle furnace
1	2,000	Orbital Shaker
1	2,000	Oven, drying
1	2,140	pH Meter +conductivity (benchtop)
1	700	Reagent dispenser, digital
1	2,000	Reversing Mixer, overhead with stand
1	3,000	Rotary vacuum evaporator
1	2,500	Soxhlet/Soxtec apparatus
1	6,000	Thermoreactor (digestor)+temp control
4	2,400	Working tables
1	1,200	Turbidity meter
1	5,000	UV-Vis spectrophotometer
1	1,000	Vacuum pump
1	1,500	Vortex mixer
1	2,500	Water bath, shaking

NB	COST	INSTRUMENT
1	3,500	Water ultrafiltration and RO/ion exchange
TOTAL	101,440	

7.3.3.2. Micro biological equipment

Table 6: Micro-biological equipment to be bought (costs in AUD)

NB	COST	INSTRUMENT	DETAILS
1	450	Balance (2 digits)	0 - 200g, readibility= 1mg
1	650	Balance (precision)	Capacity max. approx. 210g, readibility= 0.1mg; Repeatability ~ 0.1 mg;
1	750	Benchtop pH-meter with probes, connections	Range pH –2.00 to 16.00; Temp: –20.0 ºC to 120.0 ºC; Resolution: 0.01 pH
1	750	Binocular magnifier	0 - 3X
1	5,000	Bio-safety cabinet (laminar flow hood)	Protection ISO Class 5; Separate flows blowers, ULPA filters; low velocity
1	1,500	Colony Counter	
2	500	Electronic hot plate	Ceramic top; Surface temp up to 350 oC
1	1,435	Freezer	Type Chest; CFC free; Climate Class N; Capacity: 100 liters; Cooling perf. -4
1	1,500	Fridge for microbio	professional model, climate class N, with regulator & external temp dial
2	4,200	Incubator	Stainless steel, Temp. up to +60°C, dual door, regulated, calibrated
2	800	Manifold filter holder & funnels+clamps	autoclavable
1	5,000	Media dispenser	
1	200	Membrane filters for water microb.	diam 47mm, pore 0.45micrometer, meets EPA and APHA standards for w
1	2,500	Microscope	10 - 100X
1	250	Microwave oven (basic)	power 1000W; High-performance vent system with standard output +hos
1	1,027	Multiposition heating stirrer	3 positions each adjustable temp and speed; 700W; plates 160x160 mm.
1	2,235	Oven sterilization - hot air	Capacity 105 l, Temp: min. 10°C above ambient up to +250°C, digital contr
3	2,000	Pipette filler	electric
2	1,500	Pipette washer	
7	7,500	Pipettors	
2	700	Portable Digital Reference Thermometer	With Pt100 probe (according to EN 60751); ~ 15 cm; Range : -30°C to +200
1	7,500	Set of misc lab tools & glassware	Autoclavable Disposable 'red' bags ; Pipette graduated (0.1, 1, 2.5, 5ml); e

NB	COST	INSTRUMENT	DETAILS
1	3,833	Set of reagents	pH buffers (4,8,10); EC broth ; EMB Agar for coliform, E.coli testing; Indol
1	6,000	Steam Sterilizer ~80l + accessories	sterilization ISO 17665-1:2006, Safety: IEC/EN 61010-1, IEC 61010-2-040,
3	1,500	UV Hand lamps	254nm - 365nm
1	1,000	Vacuum pump	air displacement ~ 30l/min; depression ~720 mmHg
1	1,500	Vortex mixer	110mm
2	2,500	Water Bath, regulated	10-12 liters, Temp range: 10 °C to 95 °C plus boiling stage, regulated,
1	3,050	Water still (or UF+ion exchange)	for producing Type 1 laboratory water
3	1500	Working Precision LIG Thermometers	Length ~305 mm, partial immersion (approx 75mm); Range : 0°C to 110°C
Total	29083		

8. STAFFING AND CAPACITY DEVELOPMENT PLAN

8.1. Human Resources

The laboratory will have a simple structure with regard to Human Resources. The minimum number of staff of the laboratory is 4 technicians, of whom one will act as the coordinator of the laboratory. The latter will receive a slightly higher salary for this coordination function. This coordinator will have a chemistry background. The 3 analysts should have a degree in the microbiology or chemistry, and have previous practice in a testing laboratory. They shall undergo a trial period of no less than 6 months to assess their fitness to the job. The administrative staff is supposed to include 2 persons, taking care of the invoices, acceptance of samples, etc. The laboratory technicians should have successfully completed the cycle of secondary education. Once recruited, they shall receive training for the tasks under their responsibility. They shall undergo a trial period of no less than 6 months to demonstrate their fitness to the job.

The laboratory must also employ one cleaner who will be responsible for maintaining overall order and cleanliness inside and around the building.

The ability to recruit and retain qualified and experienced staff is a crucial success factor for a reference laboratory with a large testing scope, aiming at accreditation. While the volume of tests may remain low in the first years, the reference laboratory will need to fill up all positions at the onset, so that staffs may operate any instrument and on-the-job training and transmission of skills may take place. Once in full use when the analyst will be familiar with several instruments, the laboratory would have ten positions, which could be staffed by ten or more persons in case of part-time work.

In order to jump-start the laboratory and reach quickly accreditation, the use of foreign specialists should be considered at least for the executive and managerial positions.

9. IMPACT AND ECONOMIC VIABILITY

In developing countries, many official controls or applied research laboratories are government units that receive investment and operation funds from the national budget. Most of the time, the public laboratories are not charging for the services they ensure. When public laboratories have a 100 percent user pay policy, they often do not collect the moneys from their tests, as payments are done to a separate administration/ finance department. Only semi-autonomous or statutory bodies may be entitled to keep the proceeding of the sales of their services.

In Kiribati, the small size of the economy and the limited demand for tests would probably prevent topursue a 100 percent user-pay policy. The recovery of the costs of tests would therefore be shared by theGovernment and by users.

9.1. Economic Assessment

9.1.1. Benefits of the laboratory

In general, laboratory testing is used for the following purposes:

- to contribute to regulatory compliance, when goods placed on the markets have mandatoryspecifications ;
- to help ascertaining production processes and the level of desired characteristics inproducts;
- to produce information used as a basis for managing risks in a number of areas (food safety,tourism, waste management, environmental crises, etc.

In the specific case of a reference laboratory for fisheries products, the laboratory will look at the mercury and histamine testing of tuna for the export market. These tests are likely to increase over time, similarly to what happened in Papua New Guinea. These tests will be paid for by the industry. At present the industry sends samples to Fiji. The costs are as following: -cost of transport by plane AUD 150 per sample, cost paid for histamine tests AUD 800 per sample, cost paid for mercury tests AUD 700-800 per sample. In case the development of the industry is slower than anticipated, some slower phasing of the laboratory function should be built in, only slowing increasing the number of staff, etc.

In addition to the industrial products, some ciguatera testing for reef fish will be carried out, in order to guarantee public health. The latter will all be paid by the public administration.

Once the reference laboratory is working well and shows its strength there might be clients from other food sectors that will carry out their analysis in the reference laboratory. In the following cost table this additional potential source of income has not been taken into account, but could become with time quite substantial.

9.1.2. Anticipated testing needs

The assumption is made that in a few years ahead, all testing required by regulatory agencies will be enforced, and samples are analyzed by the reference laboratory. At the moment some 8 000 tests are needed for fish to increase to some 11 000 in year 5.

The number of samples that the laboratory would receive is likely to be much higher than at present, because of the progressive implementation of the food safety regulation, the increase of samples from fisheries sector. It must be noted that import requirements are changing in the USA and in Asian countries, moving closer to EU standards. In view of this, it is likely to additional samples for the laboratory are needed.

9.2. Expenditures for the reference laboratory

9.2.1. Investments

The general infrastructure needed will be about 160 m^2, with proper fencing and parking lots, for a total space of 350 m^2. The building including permits, architecture feeds, etc is estimated at AUD 340 000, plus utilities which amount to AUD 140 000. The total investment for the infrastructure is thus just below AUD 500 000.

The total cost of the equipment is around AUD 165 00, for a total amount of AUD 645 000 for the full laboratory, construction and equipment included.

Table 7: Cost of investment (AUD)

Infrastructure general	**340800**
Fencing, drains, utility connection, carpark	40800
Building foundation, mainframe, walls, roofing	130000
Buildings: insulation, doors, fittings, ducts...	120000
Fumigation hangar	45000
Registration, permits and publication costs	5000
Infrastructure utilities	**139000**
Fixtures & furniture	30000
Electricity generator & fuel storage	40000
Ventilation and Climatisation systems	40000
Water treatment & purification unit	16000
Security systems: CCTV, cardlocks, etc	13000
Equipment	**165000**
Chemistry Instruments	100000
Microbiology instruments	30000
small equipment	35000
Total	**644,800**

9.2.2. Operational costs

Table 8: Cost of investment (AUD)

All cost in AUD	Year 0	Year 1	Year 2	Year 3	Year 4	----	Year 8
OPERATIONS	**160,500**	**184,190**	**208,280**	**201,590**	**197,972**		**195,600**
Operating costs	**95,000**	**106,500**	**119,000**	**124,000**	**129,500**		**130,500**
Reagents, chemicals, test kits	10,000	10,000	15,000	20,000	25,000		25,000
Calibration	0	5,000	7,500	7,500	7,500		7,500
QA services+ cert. standards	0	5,000	10,000	10,000	10,000		10,000
Salaries, technical staff	66,000	66,000	66,000	66,000	66,000		66,000
Utilities : power, fuel, water	19,000	19,000	19,000	19,000	19,000		19,000
Waste disposal		1,500	1,500	1,500	2,000		3,000
Non-operating costs	**65,500**	**77,690**	**89,280**	**77,590**	**68,472**		**65,100**
Salaries, admin staff	25,000	25,000	25,000	25,000	25,000		25,000
Utilities : power, water	1,000	950	1,000	1,050	1,100		1,050
Communication fees (phone, Internet, mail)	1,200	1,500	2,000	2,060	2,122		2,500
Membership fees in organisations	500	1,500	1,600	1,700	1,800		1,900
Accreditation	0	10,780	21,560	9,500	10,000		10,500
Training of staff	30000	30000	30000	30000	20000		15000
Security costs	7,800	7,960	8,120	8,280	8,450		9,150
Indirect costs (overhead)	**55,575**	**78,275**	**80,150**	**80,526**	**81,650**		**85,275**
Amortization of building	30,075	30,075	30,075	30,075	30,075		30,075
Amortization of equipment	0	16,500	16,500	16,500	16,500		16,500
Consulting fees & advisory	20,000	20,000	20,000	20,000	20,000		20,250
Accounting & Auditing	1,000	4,500	4,750	5,000	5,250		6,500
Insurance	2,500	2,500	2,500	2,500	2,750		2,750
Travels in region	1,000	2,000	3,500	3,500	4,000		5,000
Financial costs	500	2,200	2,300	2,400	2,475		3,000
Other costs (meetings & publications)	500	500	525	551	600		1,200
Total Costs	**216,075**	**262,465**	**288,430**	**282,116**	**279,622**		**280,875**

9.2.2.1. Direct operating costs

The bulk of the operating costs will be labour. Total operating costs will be AUD 84 200 on year 1 to go up to AUD 130 000 in the course of the implementation.

9.2.2.2. Non-operating costs

These costs are not directly linked to the production of test results, including e.g. the salaries of administrative and ancillary staff, the costs of utilities for office & canteen, communications, accreditation-related expenditures, and training.

Total non-operating costs amount to about AUD 75 000 in a year.

9.2.2.3. Indirect Costs

In this group, are the costs linked to use of capital invested (amortization of infrastructure and equipment, financial charges), the costs aimed at covering risks (insurance, business consulting and advisory), and those related to corporate communication (accounting, publications, registrations). Indirect costs are estimated to about AUD 85 000 a year, with three quarters of this amount for amortization. To note, amortization costs are not cash expenditures; since they contribute to a provision that is cumulated into a line of the balance sheet. This practice allow factoring the use of physical capital into the costs of testing, and thus replacing equipment or renovating buildings when need arise.

9.3. Sustainability of the reference laboratory

9.3.1. Funding needs

To sustain the reference laboratory, the following funding needs must be secured:

- Capital funding to build the laboratory covering the investment in land, building, functionalsystems, and training and assistance (human capital development);
- Operational funding on a yearly basis, which includes:
  - Operating expenditures (linked to delivering test services)
  - Non-operating expenditures, or costs linked to support services
  - Indirect costs such as building amortization, insurance, financial services, etc.
- Development funding, when the Government would carry out research projects or the development of a new service (analysis or sampling).

These types of funding may be provided independently of each other. While the initial investment may be sufficient to set-up a laboratory and get equipment, it can be difficult in successive years to get sufficient funds to ensure the maintenance and to replace equipment. Those expenditures are part of indirect costs that have to be included when determining the prices of tests. When the revenue from the sales of services is insufficient, ongoing financial contribution tosustain the laboratory operations would be required. Therefore, it is strongly recommended that the future budget estimates include a separate and well-identified provision towards the capital and operational costs of the reference laboratory.

For the building some AUD 500 000 are needed, while the equipment of the laboratory is in the range of AUD 165 000. The funding capital for this investment is already earmarked in the MFMRD.

Funding for operations will depend on the management structure adopted. The operational costs are estimated at AUD 220 000 for year one, and then AUD 370 000.

Meanwhile, purchasing timely the reagents and services implies the laboratory has sufficient working capital to pay such purchases upfront. Hence, for the laboratory to operate efficiently, it should receive guaranteed funding (budget allocation) to cover overheads, non- operating costs, and a part of the operating costs.

9.3.2. Earnings

Table 9: Earnings (AUD)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
EARNINGS	**29,750**	**165,250**	**269,500**	**450,750**	**484,200**	**524,800**	**527,500**	**533,000**
Sales of tests	10,000	125,000	200,000	375,000	405,000	440,000	440,000	440,000
nb of tests	200	2,500	4,000	7,500	9,000	11,000	11,000	11,000
average unit price of test	50	50	50	50	45	40	40	40
Sales of outsourced tests	17,250	25,250	50,000	50,000	50,000	50,000	50,000	50,000
nb of ext. test	138	202	400	400	400	400	400	400
average unit price ext. test	125	125	125	125	125	125	125	125
Other sales (fumigation, training)	2,500	15,000	19,500	25,750	29,200	34,800	37,500	43,000

9.3.3. Income

Sales of services will increase over the years, and already in year 3, the sales of services will amount to AUD 270 000, thus close to the operating costs. From year 4 onwards the laboratory would be running at a net gain, between AUD 170 000 and AUD 243 000. These numbers are mainly coming from histamine and mercury checks, which will be carried out for each container, some 5 500 tests, which would correspond to about 100 000 tonnes of tuna exported. With these high numbers of samples, maybe some increase in staffing might be consider in year 4 and following.

Table 10: Cost of investment (AUD)

all cost in AUD	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Running costs	216,075	262,465	288,430	282,116	279,622	300,000	280,875	350,000
Revenue		29,750	165,250	269,500	450,750	484,200	524,800	527,500
Income		-232,715	-123,180	-12,616	171,128	184,200	243,925	177,500

ANNEXES

Tests required in the food safety regulation (MHMS)

Minerals
Sodium in canned fish; limit: 430 mg/100g

Metals
Cadmium in sardine; tuna, bonito; limit 0.1 mg/kg
Cadmium in other fish; limit: 0.05 mg/kg
Cadmium in crustaceans; limit: 0.5 mg/kg

Lead
Lead in cephalopods; limit: 1 ppm
Lead in meat of crustaceans; limit: 0.5 ppm
Lead in meat of sardine, tuna, bonito, seabass; limit: 0.4 ppm
Lead in meat of fish; limit: 0.2 ppm

Mercury
Mercury (total) in meat of scombridae; limit: 1 ppm.
Mercury (total) in meat of other fish; limit: 0.5 ppm

Formaldehyde
Formaldehyde in smoked fish and meats; limit: 5 ppm

Histamine
Histamine in fish and frozen fish; limit: 10 or 20 mg/100g

Microbiology
Total *coliforms* & *E. Coli*
Salmonella ssp
B. Cereus
Coagulase positive Staphylococci
Vibrio parahaemolyticus
Staphylococcal enterotoxins

Summary of limits of contaminants in fisheries product for some export destinations

COUNTRY	Antimony	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Tin: can/	Selenium	Zinc	Fluorine	Asc.acid	Phosphates	Histamine	TVA/TVBN	PCB/138	POP/OC	Mgreen	Hormones
India																			
Hong Kong	1	6	2	1		6	0.5	230/-											forbidden
EU			0.1			0.3	1	200/-						9,2,100,200					
Indonesia																			
Israel							1							200	2.5/300				
Japan																0.5			
Rep. of Korea																			
Malaysia																			
Mexico			0.5			1	1	100/-							-/300				
Australia	1.5	1	0.2		10	1.5	0.5	150/50	1	150		400 (frzn)	1,300			0.5			
China		0.1	0.1			0.5	1									2/0.5			
New Zealand		2				0.5	1		2	40	10					4^-12		0.001	
Philippines		3				0.5	0.5	200/-											
Russia							0.5												
Taiwan																			
Thailand		2			20	1	0.5	100/250									0.1-0.6_		
Vietnam			0.05			0.3	0.5							9,2,200,400					
ALL	1ppm	0.1ppm	0.05ppm	1ppm	10ppm	0.3ppm	0.5ppm	50ppm	1ppm	40ppm	10ppm	400ppm	1300ppm	100ppm	2.5/300ppm	0.5ppm	0.1ppm		

Main analyses required for the official controls of seafood (EU EXPORTS[3])

Test	No. of samples	Maximum levels	Performance criteria
Lead	1 sample per species per company biannually	0.3 ppm	LOD less than a tenth of the permissible limit LOQ less than one fifth of the permissible level
Cadmium	1 sample per species per company biannually	0.1 ppm tunas - 0.25 ppm swordfish 0.05 ppm other species	LOD less than a tenth of the permissible limit LOQ less than one fifth of the permissible level
Mercury	1 sample per species per company biannually	1.0 ppm tuna and swordfish - 0.5 ppm other species	LOD less than a tenth of the permissible limit LOQ less than one fifth of the permissible level
Inorganic Tin (ONLY FOR CANNED PRODUCT)	Canned tuna: 10 cans per lot per year	200 ppm canned tuna	LOD less than 5 mg/kg LOQ less than 10 mg/kg
Dioxins and PCBs	1 sample per species per year	3.5 pg./g dioxins (sum of dioxin) 6.5 pg./g wet weight dioxins and PCBs (sum of dioxins and dioxins alike PCBs) 75 ng/g wet weight (sum of PCB 28/52/101/138/153/180)	Not specified
Benzo(a) pyrene , (ONLY FOR SMOKED FISH PRODUCTS)	1 sample per species per year	50 µg/kg smoked fish benzo(a)pyrene and 12.0 µg/kg sum of benzo(a) pyrene/ benz(a)anthracene/ benzo(b)fluoranthene and chrysene	LOD less than 0.3 µg/kg LOQ less than 0.9 µg/kg
Histamine	9 samples every 6 months per establishment	No more than 2 samples with results between 100 and 200 ppm and no results over 200 ppm	HPLC
Microbiology	1 sample per year	TPC 22oC No abnormal change; E. coli nil per 100 ml; Enterococci Nil per 100 ml	ISO 9308-1; ISO 7899-2
Acrylamide	1 sample per year	0.1 µg/l	Control by product specification
Antimony	1 sample per year	5.0 µg/l	Trueness, limit of detection and precision all 25 percent
Arsenic	1 sample per year	10 µg/l	Trueness, limit of detection and precision all 10 percent
Benzene	1 sample per year	1.0 µg/l	Trueness, limit of detection and precision all 25 percent
Benzo(a)pyrene	1 sample per year	0.01 µg/l	Trueness, limit of detection and precision all 25 percent
Boron	1 sample per year	1.0 mg/l	Trueness, limit of detection and precision all 10 percent
Bromate	1 sample per year	10 µg/l	Trueness, limit of detection and precision all 25 percent
Cadmium	1 sample per year	5.0 µg/l	Trueness, limit of detection and precision all 10 percent
Chromium	1 sample per year	50 µg/l	Trueness, limit of detection and precision all 10 percent

Copper	1 sample per year	2.0 mg/l	Trueness, limit of detection and precision all 10 percent
Cyanide	1 sample per year	50 µg/l	Trueness, limit of detection and precision all 10 percent
1,2-dichloroethane	1 sample per year	3.0 µg/l	Trueness, limit of detection both 25 percent and precision 10 percent
Epichlorohydrin	1 sample per year	0.1 µg/l	Controlled by product specification
Fluoride	1 sample per year	1.5 mg/l	Trueness, limit of detection and precision all 10 percent
Lead	1 sample per year	10 µg/l	Trueness, limit of detection and precision all 10 percent

[3] Commission Regulation 333/2007, 589/2014, & 1441/2007, Regulation 1881/2006, 1259/2011, Council Directive 98/83

Test	No. of samples	Maximum levels	Performance criteria
Mercury	1 sample per year	1.0 µg/l	Trueness 20 percent, limit of detection 20 percent and precision 10 percent
Nickel	1 sample per year	20 µg/l	Trueness, limit of detection and precision all 10 percent
Nitrate	1 sample per year	50 mg/l	Trueness, limit of detection and precision all 10 percent
Nitrite	1 sample per year	0.5 mg/l	Trueness, limit of detection and precision all 10 percent
Pesticides	1 sample per year	0.1 µg/l	Trueness, limit of detection and precision all 25 percent
Pesticides – total	1 sample per year	0.5 µg/l	Trueness, limit of detection and precision all 25 percent
Polycyclic aromatic hydrocarbons	1 sample per year	0.1 µg/l	Trueness, limit of detection and precision all 25 percent
Selenium	1 sample per year	10 µg/l	Trueness, limit of detection and precision all 10 percent
Tetrachloroethene and trichloroethene	1 sample per year	10 µg/l	Trueness 25 percent, limit of detection 10 percent and precision 25 percent
Trihalomethanes	1 sample per year	100 µg/l	Trueness 25 percent, limit of detection 10 percent and precision 25 percent
Vinyl chloride	1 sample per year	0.5 µg/l	Controlled by product specification
Chloride (as Cl)	1 sample per year	250 mg/l	Trueness, limit of detection and precision all 10 percent
Manganese	1 sample per year	50ug/l	Trueness, limit of detection and precision all 10 percent
Sulphate	1 sample per year	250 mg/l	Trueness, limit of detection and precision all 10 percent
Sodium	1 sample per year	200 mg/l	Trueness, limit of detection and precision all 10 percent
Ammonium	4 samples per year	<0.5 ppm	Trueness, limit of detection and precision all 10 percent
Colour	4 samples per year	Typical	Not specified
Conductivity	4 samples per year	2500 Us cm-1	Trueness, limit of detection and precision all 10 percent
pH	4 samples per year	6.5 to 9.5	Capable of measuring concentrations equal to the parametric value with a trueness of 0.2 pH unit and a precision of 0.2 pH unit.
Odour	4 samples per year	Typical	Not specified
Taste	4 samples per year	Typical	Not specified
Turbidity	4 samples per year	<5 NTU	Not specified
Aluminium	4 samples per year	200 µg/l	Trueness, limit of detection and precision all 10 percent
Escherichia coli	4 samples per year	Nil	Not specified
Total Coliforms	4 samples per year	Nil	Not specified