



## IHO Capacity Building Programme

# The State of Hydrography and Nautical Charting in The Republic of Kiribati



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## Abbreviations

AHS	Australian Hydrographic Service
ALB	Airborne Laser Bathymetry
AtoN	Aids to Navigation
BA	British Admiralty (Chart)
dwt	Dead Weight Tonnage
EEZ	Exclusive Economic Zone
ENC	Electronic Navigational Chart
EU	European Union
fm	fathom
ICZM	Integrated Coastal Zone Management
IHB	International Hydrographic Bureau
IHO	International Hydrographic Organization
KPA	Kiribati Ports Authority
Lidar	Light Detection and Ranging
LINZ	Land Information New Zealand
LOA	Length overall
MBES	Multi Beam Echo Sounder
MSDI	Marine Spatial Data infrastructure
MSI	Maritime Safety Information
MSP	Maritime Spatial Planning
NC	New chart
NM	Nautical mile
NtoM	Notice to Mariners
PCA	Primary Charting Authority
PD	Position Doubtful
RHC	Regional Hydrographic Commission
RNC	Raster Navigational Chart
SBES	Single Beam Echo Sounder
SOLAS	United Nations Convention on the Safety of Life at Sea
SOPAC	The marine geoscience division of the SPC
SPC	Secretariat of the Pacific Community
SWPHC	South West Pacific Hydrographic Commission
ToR	Terms of Reference
TTW	Territorial Waters
UKHO	United Kingdom Hydrographic Office
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environmental Programme
WMO	United Nations World Meteorological Organization



# Executive Summary

## Status of Charting

The IHO-sponsored technical assessment visit to Kiribati marks the first evaluation of the hydrographic needs of Kiribati's maritime community and international shipping for over 50 years. It is hardly surprising; therefore, that chart modernization is required. The only coherent nautical chart coverage for the three island groups and Banaba that comprise the Republic of Kiribati is through 14 nautical charts published by the United Kingdom Hydrographic Office (UKHO) at varying scales and all except one are referenced to old datums and show depths in fathoms.

Nautical charting of Kiribati is, for historical reasons, still produced by the UKHO as the Primary Charting Authority (PCA). The majority of the current published charts were originally published in the 1950s and 1960s from surveys conducted by the British navy and historical data from 1943 and earlier. One existing chart was published in 1898 and the latest and only modern-style chart was published in 1994 (BA731 Gilbert Group). The chart scheme covering Kiribati requires urgent modernization.

The findings and recommendations of the IHO technical assessment propose that the existing chart coverage be reduced to approximately six or seven modern metric charts, depending on scales and limits, referenced to satellite datum and thus compatible with modern electronic navigation systems. Once completed, the new charts would also form the foundation of documentation for the nation's maritime boundary delimitation.

## New Data Required

There has been an almost total lack of any chart correcting information being passed to the PCA (UKHO) for decades. This means that little or no new or revised information has been added to the existing charts and further accounts for the poor state of the existing charts. This situation must be addressed urgently. Establishing a local programme whereby mariners and other stakeholders provide updated information directly to the PCA is of paramount importance in this regard.

An extensive chart modernization programme for Kiribati can only be conducted effectively by obtaining recent or new hydrographic data. Some relatively recent data has been identified from three sources; the governments of Australia and the United States of America and SPC-SOPAC. Additional data will be required not only to achieve a modernization programme but also to maintain new charts to acceptable standards.

A programme of targeted hydrographic surveying and data collection is proposed in this report to improve specific charting requirements. It is estimated that at least £1.82M would be required to conduct the necessary hydrographic surveys.

Improvement of the charts of the following ports, harbours and approaches requires new hydrographic data to support emerging and growing commercial activities:

- Port Betio, Tarawa
- Butaritari
- English Harbour, Tabuaeran (Fanning) Island
- Port London, Kiritimati Island
- Kanton Island

## Capacity Building and Assistance

The IHO sets down three key phases of hydrographic capacity building to help States to develop capabilities to meet their obligations under SOLAS with regard to ensuring the provision of appropriate hydrographic and nautical charting services for the country. These are:

- maintaining a maritime safety information (MSI) infrastructure,
- conducting hydrographic surveying, and
- producing nautical charts.

Kiribati, like all Coastal States can and should aspire to reach the Phase One level – provision of MSI – by forwarding information on maritime changes and developments to the PCA and the regional radio navigational

warnings coordinator. This work is vital for safe and efficient navigation in Kiribati's waters and for the long-term sustainability of charting.

Given the nature and the very limited infrastructure and resources available in Kiribati, Kiribati should rely primarily on regional organisations (SPC-SOPAC) or foreign governments for most of its Phase 2 (conducting hydrographic surveys) and for all of its Phase 3 (production of nautical charts) requirements and obligations. This can best be achieved through strengthening bi-lateral and regional arrangements with other national hydrographic authorities and through an active local programme that ensures that new and changing information is forwarded to the relevant charting authorities.

### **Principal Conclusions**

The following principal conclusions were reached:

- The current state of nautical charting and the lack of coherent MSI services are probably having a significant adverse impact on the Kiribati economy as well as putting the safety of life at sea and protection of the marine environment at significant risk.
- The modernization of charts covering Kiribati should be a matter of particular concern to the national government. Every effort should be made to work with the PCA to enable an effective modernization programme.
- The release of existing but hitherto unused bathymetric data to the PCA is a possible basis for the immediate improvement some charts.
- The establishment of a recognised, albeit limited, in-country hydrographic capability that can provide local input to the UKHO or other charting authority is important to enable the maintenance of nautical charts of Kiribati to continue.
- Kiribati, as a State Party to the SOLAS Convention must recognise and act upon its obligations to ensure that appropriate paper charts and ENCs are available in accordance with the government obligations set out under Regulations 9 and 4 of Chapter V of that Convention. In this regard, Kiribati does not appear currently to be meeting its international treaty obligations to ensure that appropriate hydrographic services are in place. This is because there is no infrastructure or capability in place to provide information to the PCA so that the relevant charts can be kept up to date.
- The absence of up to date charts, apparently poorly maintained and documented aids to navigation and no formal arrangements in place to satisfy the requirements of the SOLAS Convention, are likely to lead to Kiribati failing the hydrography section of the voluntary IMO Member State audit scheme which is likely to become mandatory around 2015.

### **Recommended Actions**

This report provides a list of recommended actions for the government of Kiribati and other relevant stakeholders to consider and support in order to ensure the improvement and maintenance of appropriate nautical charting coverage of its waters. For ease of reference, these recommended actions are also listed as Annex A to this report.



## 1. Introduction

The International Hydrographic Organization (IHO) is an intergovernmental technical organization, currently comprising 80 Member States. The IHO seeks to ensure that all States with coastlines and maritime interests provide adequate and timely hydrographic data, products and services, thereby advancing maritime safety and efficiency in support of the protection and sustainable use of the marine environment. The IHO is the recognised competent authority of the United Nations for hydrography and nautical charting. The International Hydrographic Bureau (IHB), based in Monaco, is the secretariat of the IHO.

Mr Moote KABURE, of the Kiribati Marine Division, represented Kiribati at the 9<sup>th</sup> meeting of the South West Pacific Hydrographic Commission (SWPHC). The SWPHC comprises all IHO Member States and a growing number of observer States from the South West Pacific region. The purpose of the Commission is to fulfil the objectives of the IHO through hydrographic cooperation and assistance between all the States and relevant authorities in the region.

At the 9<sup>th</sup> meeting of the SWPHC, Mr KABURE requested a technical and advisory visit to Kiribati to help assess the current status of charting and hydrography in the country and to provide advice to the government and to stakeholders on a way ahead. As a result the SWPHC recommended that an IHO technical visit to Kiribati be made to assess the current status of hydrography and to raise awareness in the country of the importance of hydrography and nautical charting. This request was subsequently approved by the IHO Capacity Building Sub Committee.

Director Robert Ward from the IHB and Mr Bob Wilson, seconded from the United Kingdom Hydrographic Office (UKHO) carried out a hydrographic awareness and technical assessment visit to Kiribati between 17 and 24 November 2011 as part of the IHO Capacity Building Programme.

This resulting report has been written with the express intention of assisting the government of Kiribati to arrange and strengthen its hydrographic effort to meet its current and future needs and in turn, to meet its international maritime obligations under the UN Convention on the Safety of Life at Sea (SOLAS). The report comprises a description of the visit, major conclusions and a number of recommended actions for consideration by the relevant organisations.

The report is supported by various Annexes and Appendices providing detailed information including the dependence on hydrography and nautical charting of various sectors in Kiribati, an analysis of the current survey state, an analysis of the existing charting situation and a proposed programme for modern hydrography surveys in Kiribati.

## 2. Background

The Republic of Kiribati is a remote oceanic country of 33 coral atolls scattered over an area of 3.5 million square kilometres. Kiribati has few natural resources and is one of the least developed Pacific Island states. It has few natural resources, no manufacturing industry or commercial agriculture. Copra and fish represent the bulk of production and exports. Tourism provides more than 20% of GDP. Every item required to sustain life in the country is imported by sea. Port Betio, Tarawa, is the sole port of entry for imports. Imports are redistributed around the atolls forming Kiribati by local trading vessels that return to Port Betio with copra for export in bulk. Foreign fishing vessels operating under licence in Kiribati's EEZ transfer catches for export at Port Betio; this procedure is due to be relocated to Butaritari in 2012. Effective sea communications are pivotal to Kiribati's very survival.

As well as having an obvious and overwhelming dependence on maritime communications, Kiribati has an obligation to ensure that both paper charts and electronic navigational charts (ENCs) are available in accordance

with the government obligations set out under Regulation 9 (*hydrographic services*) and Regulation 4 (*navigational warnings*) of Chapter V of SOLAS. This obligation helps to ensure that all vessels operating in the world's seas and oceans can do so safely and efficiently, thereby preventing loss of life and protecting the marine environment. The SOLAS convention is administered and regulated by the International Maritime Organization (IMO), a specialised agency of the United Nations Organization. Kiribati is a Member State of the IMO and a State Party to SOLAS. At present, there do not appear to be any formal arrangements in place in Kiribati to ensure that the SOLAS obligations for hydrographic services and navigational warnings are being satisfied.

There have been few maritime developments in Kiribati over the past decades other than the termination of military interest in some of the atolls. However, this situation is changing. Starting in 2012, Port Betio is to be upgraded to provide the port with an alongside berth and eliminate the need for the time consuming transfer of goods by barges from ships at anchor off the port. This work is needed not only to improve cargo handling but to allow for the expected increase in goods handled, given that Tarawa's population is forecast to double in the next 20 years. Concurrent with this upgrade the fish transfer arrangements at Port Betio will move to Butaritari thus easing congestion at Port Betio. Tourism is also set to play an important part in the nation's income generation with upgraded terminals and facilities at Kiritimati Island and Tabuaeran (Fanning) Island.

### **3. Technical Visit Programme**

The IHO Technical Team that visited Kiribati in November 2011 comprised Director Robert Ward (IHB) and Mr Bob Wilson (UKHO). The principal host officer for the visit was Ms Teboranga TIOTI, Deputy Secretary, Department of Communications, Transport and Tourism Development and acting Officer in Charge - Marine Division. Meetings, in the form of both workshops and individual discussions, were arranged with as many hydrographic and nautical charting stakeholders as possible. The details of those attending the various meetings are shown in Annex B - List of Contacts.

The national economic benefits of reliable charting and hydrography were presented at each meeting together with discussions on the current status of hydrography and charting in Kiribati. From these meetings various options to improve the current situation were identified and considered.

A concluding meeting of stakeholders was used to develop an initial list of charting priorities for Kiribati. Stakeholders were invited to provide details of those areas in Kiribati where the provision of adequate charts was a vital requirement to support current or anticipated activities.

Unfortunately, due to the impending election of a new President of Kiribati, and the consequent uncertainty of the composition of the next government, all relevant Kiribati government ministers were unavailable during the period of the visit. In the circumstances, the Secretary to the President's Office was briefed instead. A variety of other commitments prevented meetings with the Departmental Secretaries to the Cabinet Office, the Ministry of Foreign Affairs and the Ministry of Communications, Transport and Tourism Development.

### **4. General Assessment**

The following general assessment, discussion of available options, conclusions and recommended actions are supported by a number of Annexes and Appendices. These provide the summary of recommended actions (see Annex A), together with additional detailed information including an identification of the dependence on hydrography and nautical charting of various sectors in Kiribati (see Annex D), an analysis of the existing charting situation (see Annex F), and a proposed programme for modern hydrographic surveys in Kiribati (see Annex G).

#### **4.1. National Hydrographic Awareness**

The Government and its Administration appear to be largely unaware of the fundamental importance and benefits of hydrography and nautical charting to a country such as Kiribati that has such a total dependence for its survival on maritime trade. There is also little awareness of the State obligations under SOLAS V Regulations 9 and 4 to ensure that appropriate hydrographic and charting services are made available. The only organization that appears to appreciate fully the importance of hydrography and nautical charting services is the Marine Department and its Departmental Secretary. There is no mechanism in place to determine local priorities for charting or for surveys.

## 4.2. Maritime Safety Information

There is no clearly established Maritime Safety Information (MSI) infrastructure that coordinates its activities with the Worldwide Navigation Warning service (WWNWS) implemented globally by the IMO, IHO and WMO. There is no national MSI coordinator appointed to collate and promulgate new and important navigation information through the relevant regional and worldwide maritime communications channels. The Marine Department does promulgate coastal warnings and information in an ad hoc fashion. There is very limited liaison between the maritime authorities in Kiribati and the UKHO's chart compilers and maintainers in Regional Team 5 – the section responsible for producing and maintaining the existing charts of Kiribati.

The current state of the charts of Kiribati is made worse by the limited amount of maritime safety information flowing from the Republic of Kiribati to the PCA (UKHO). It is clear from a cursory glance in the Port Betio area that a number of charted features no longer exist. The routine maintenance of charts and publications to include changes in buoyage and wrecks for example, is as important as new survey data if charts are to be maintained to the standard required for safe navigation. This information has to come from the nation State and be passed to the PCA for action.

The following table shows the current publication date of charts covering the Republic of Kiribati, the reference of the last notice to mariners (NtoM) and the total number of NtoM affecting the chart since publication.

BA Chart	Title	Published (Last NtoM/Year)	NtoMs issued since Publication
102	Plans in the Central Pacific, Malden Island and Malden Island Anchorage	21 Feb 1964 4445/06	2
184	Pacific Ocean, Plans of the Phoenix Islands	19 May 1950 2382/80	15
700	Pacific Ocean, Gilbert Islands, Maiana to Marakei	17 Jul 1964 4445/06	10
731	Gilbert Group	22 Apr 1994 Nil	0
743	Pacific Ocean, Gilbert Islands, Abemama	12 Apr 1963 1153/85	1
755	Pacific Ocean, Gilbert Islands, Abaiang	17 Jul 1964 1153/85	1
767	Pacific Ocean, Gilbert Islands, Tabiteuea South Lagoon.	6 Jan 1966 4445/06	3
768	Pacific Ocean, Plans in the Gilbert Islands	27 Oct 1967 4445/06	2
1451	South Pacific Ocean, Phoenix Islands, Canton Island Lagoon Entrance	2 Apr 1954 4445/06	2
2867	Plans in the North Pacific Ocean	28 Mar 1959 5694/07	23
2971	North Pacific Ocean, Fanning Island	23 Apr 1898 4445/06	21
2993	Central Pacific Ocean, Plans in Christmas Island	20 Sep 1963 4445/06	5
2995	Pacific Ocean, Christmas Island, Approaches to Port London	31 Jan 1964 4445/06	6
3269	Pacific Ocean, Plans in the Gilbert Islands	13 Nov 1964 5249/09	28

The government of Kiribati is strongly urged to organise a review all the current charts of Kiribati and relay to the PCA all differences from that charted as soon as possible. The UKHO produces a Code of Practice giving guidance on the information required and the format in which it should be sent to UKHO. Digital and hard copies of the Code of Practice have been passed to the relevant Kiribati authorities.

### 4.3. Hydrographic Surveying

Following independence, and the subsequent withdrawal of UK surveying operations from the region in the mid 1970's, there has been no significant level of hydrographic input to any charts covering Kiribati. The reliability of those charts has therefore declined steadily. Today, it is questionable whether most of the charts remain fit for purpose.

There is no in-country hydrographic surveying or chart updating capability. This means that the existing charts published and maintained by the UKHO do not contain the latest navigationally significant information, nor are mariners arriving from overseas aware of any recent navigationally significant information before they arrive in Kiribati. The Department of Lands and Surveys employs a number of land surveyors that are familiar with digital data manipulation, map making and geographic information systems (GIS). These surveyors could easily learn additional skills in hydrographic data collection thereby providing a cost-effective, minimal level of in-country hydrographic data gathering expertise.

SOPAC, the marine geoscience division of the Secretariat to the Pacific Community (SPC), has been conducting multibeam echosounder (MBES) surveys in support of scientific and environmental activities in many of the islands of the Pacific over the last ten years or more, including Kiribati. While not achieving the IHO S-44 standards of survey accuracy, much of the data is, most likely, suitable for inclusion in charts. Currently, there is no formal mechanism in place to ensure that this data is brought to the attention and made available to the relevant chart producers. However, the recent conclusion of a Memorandum of Understanding between the IHO and SPC will be able to address this, assisted by a proposed Cooperation Arrangement between SPC and UKHO to allow routine access to and use of data gathered by SOPAC.

Several other organisations, notably the US Department of Defense and the Australian Department of Defence, have conducted hydrographic surveys in a number of locations in the Pacific, including Kiribati. This data has not been forwarded to the PCA (UKHO). The Naval Mobile Construction Battalion (NMCB) organisation, the US Navy Oceanographic Office (NAVO) and the Australian Navy Deployable Geospatial Support Team (DGST) are all thought likely to be holding bathymetric data applicable to the existing charts of Kiribati.

### 4.4. Nautical Charting

The utility of the nautical charts of Kiribati published and maintained by the UKHO on behalf of the government of Kiribati are in many if not most cases limited because little or no new information has been provided by local authorities for many years. In many cases, especially in the outer islands and atolls, the existing charts show little useful bathymetric information to allow safe and controlled navigation. While some new detail, such as the causeway, built over 10 years ago between Bairiki and Betio, is shown on the relevant chart, the continued existence of aids to navigation and changes in the shape of the coastline have not been reported and, therefore, not included in revisions to the charts.

None of the existing larger scale charts and plans can be used with global navigation satellite systems (GNSS). The difference between GNSS derived positions and those plotted on some of the charts is likely to be significant and could lead ships into dangerous situations. Despite warnings placed on the relevant charts mariners are increasingly relying heavily on GNSS for positioning in all parts of the world. In these circumstances, it is inevitable that an increasing number of incidents will occur in the future unless the Kiribati charts are redrawn to be compatible with GNSS. Specific topographic survey work will be required to achieve this. This could be done by the Kiribati Department of Lands and Survey in close liaison with the PCA (UKHO).

Nautical charts of Kiribati cannot be purchased locally because there is no recognised chart agent in the country. Charts must be obtained from agents in Fiji or elsewhere in the world.

It is apparent that some of the existing charts and plans of Kiribati have been published for historical reasons and may not be of areas used by modern shipping; indeed they may even tempt ships to enter areas that it would be wiser to avoid. These charts and plans should be withdrawn and replaced with more general, but modern charts that would still allow for the safe conduct of inter-island traffic, the safe passage of cruise ships in and around the atolls particularly in areas such as Carondelet Reef, and provide charting for the Phoenix Islands Protection Area.

Stated briefly, an urgent chart modernization programme is required if the existing chart coverage is to meet national needs and remain in circulation. The modernization of existing charts and plans will require re-scheming to cover modern requirements and to incorporate modern data. The identification of the dependence on hydrography and nautical charting of the various users and stakeholders is important in this context. The dependence on hydrography and nautical charting by various sectors is covered in Annex D to this report.

These improvements and the retention of relevant nautical charts for Kiribati should allow for:

- the safe conduct of inter-island traffic;
- the safe passage of cruise ships in and around the atolls particularly in areas such as Carondelet Reef;
- charting for the Phoenix Islands Protection Area; and
- general charting coverage of other areas at appropriate smaller scales, referenced to the WGS84 datum following the withdrawal of the low priority, unsafe, inadequate and out of date plans currently being published.

The process of chart modernization to meet contemporary requirements relies on the availability of new and revised information. Some of this information can be obtained by local authorities, stakeholder organizations and individuals and be forwarded to the PCA (UKHO). Other information exists that could be included in revised charts. Dedicated surveys will nevertheless be required for key areas.

The emerging technology of satellite bathymetry may offer a very cost effective way of providing at least reconnaissance level data to be used in those areas not critical for navigation. Satellite bathymetry may be able to provide at least indicative depths, together with suitable cautions, to be included on charts.

A comprehensive analysis of the existing charting situation is contained in Annex F - Charting Analysis of Kiribati Waters.

## 5. Consequences and Options

### 5.1. The Consequences of Doing Nothing

Unless action is taken soon, Kiribati will have no medium or large scale charts for navigation into its main ports of entry. In addition, there will be no medium or large scale charts covering the significant islands and atolls that depend on inter-island traffic.

A lack of appropriate charts for the navigation of foreign-going vessels into the main ports of entry would appear to breach the State's obligations set out in SOLAS Chapter V Regulations 9 and 4. In effect, this means that the hydrographic and nautical charting services being made available by Kiribati do not meet international requirements. This, in turn, may lead to Kiribati failing to successfully pass its IMO audit, when audits are likely to become mandatory in about 2015. A consequence of failing an IMO Member State audit could result in the State being considered substandard in relation to meeting its SOLAS obligations.

The absence of any in-country point of focus for the collection, assessment and dissemination of new navigationally significant information means that charts will not be kept up to date.

The lack of appropriate charting for foreign-going vessels may expose the Kiribati government to financial liability in the event of a navigational incident – especially under pilotage conditions – essential to provide local knowledge in the absence of good charts. In such circumstances, the Master of a vessel involved in any navigational mishap might contest that he was unable to appropriately monitor the performance and advice of the Pilot because no appropriate charts were available. In the case of any resultant pollution, salvage or other remedial action, the Kiribati government might then find itself solely responsible.

The lack of appropriate charting in Kiribati increases operating risks for ship owners, thereby resulting in less valuable (and inherently less efficient and robust) ships being used. This further increases the risk of incidents because of the state of those ships, as well as resulting in more costly freight charges through using inefficient ships. It also reduces the number of shippers prepared to operate their vessels, thereby inhibiting competition and curbing excessive charges.

Any navigational mishap occurring in an entry to a port or anchorage may result in widespread pollution. Kiribati has little resources to combat such an incident. Furthermore, the port may be closed or blocked for some time. This should be an unacceptable risk given the vital role that sea trade plays in sustaining Kiribati.

Cruise ships are most reluctant to operate vessels in areas where charting is poor. This is not only because of the risks to the ship and the passengers but also the risk to the reputation of the operating company.

## 5.2. Options for the Way Ahead

### Urgent Chart Modernization Programme

It follows that a chart modernization programme is required most urgently. It is the only way to ensure the long term availability of large and medium scale chart coverage in Kiribati. As soon as possible, the most important ports, anchorages, refuges and coastal passage must be surveyed to verify or update the existing charted information. In the first instance, and in the interests of economy and time, these surveys should be limited to covering only the charted approach routes and anchorages and any supporting navigational marks and aids required by commercial shipping. Provision of this information to the UKHO may result in the most important charts being updated instead of being withdrawn.

As there is no in-country capability to undertake a programme of surveys for chart modernization purposes, urgent assistance should be sought from regional neighbours or by engaging contract survey assistance. Both the Australian and New Zealand navies have deployable survey teams that could undertake such work, subject to authorisation. There are also a number of smaller hydrographic surveying companies based in Australia and New Zealand that could undertake the work under contract. A prioritized surveying programme that would support a chart remediation programme is set out in Annex G - Proposals for Hydrographic Surveys in Kiribati.

In the meantime, a national programme should be started that encourages all mariners and other interested parties to report any discrepancies in the existing charts and to provide as much information as possible on what should actually be shown on the chart. This information should be forwarded to the national coordinator for hydrography and charting for submission to the UKHO.

Arrangements should be put in place to enable existing data held by regional organisations such as SPC-SOPAC and various overseas military organisations to be made available to the PCA (UKHO).

### Appoint a National Coordinator for Hydrography and Charting

A national coordinator for hydrography and charting is required. The role of the coordinator would be to act on behalf of the government to ensure that Kiribati meets its international obligations that proper nautical charting services are available to mariners. The coordinator would be the first point of contact for in-country stakeholders and for maintaining relations with relevant international organisations such as the IHO, SWPHC, SPC-SOPAC, and other countries and agencies that might support hydrographic development and assistance in Kiribati.

Designating the Marine Department as the national coordinator for hydrography and charting is the most logical appointment. This arrangement would be similar to that most recently put in place in Papua New Guinea and planned for the Solomon Islands, whereby the national Maritime Safety Authority has responsibility for the development and coordination of the provision of nautical charting services in the respective countries.

### Appoint a National MSI Coordinator

A national MSI coordinator is required. The Marine Department should be appointed as the national MSI coordinator. The MSI role should include a limited hydrographic surveying/reconnaissance capability. These two measures would enable navigationally significant information to be *collected* and subsequently *promulgated*; both through immediate warnings to shipping when warranted, and through the incorporation of new or revised information in existing published charts.

### Develop a Minimal Capability for Hydrographic Information Gathering

A limited but sustainable in-country hydrographic information gathering capability could be created as a mobile hydrographic surveying capability. It would allow reported dangers to be confirmed, as well as enabling the collection of relevant new or changed hydrographic information and even allow the survey of some previously unsurveyed areas. The existing surveyors in the Kiribati Department of Land and Surveys could easily learn the additional skills required. Suitable short courses are available through the IHO Capacity Building Programme.

A relatively simple and unsophisticated outfit of equipment could be purchased for use by the Department of Lands and Surveys surveyors for approximately \$100K - \$150K plus maintenance. Although some surveys may take longer using such equipment, the use of a single beam echo sounder and side scan sonar can be as equally effective as much more sophisticated and expensive technology such as multibeam echo sounders (MBES). This is especially true in shallow water, such as is the case for Kiribati and its many atolls and islands. Using portable equipment in craft of opportunity avoids the capital cost of dedicated boats and significantly reduces deployment/mobilisation expenses. Under such an arrangement, all hydrographic data collected would then be forwarded to the PCA (UKHO) for charting action.

### **Recruit a Temporary Hydrographic Adviser**

There is currently little or no indigenous hydrographic expertise in Kiribati. The participation of hydrographic advisers from overseas would therefore assist in establishing an in-country hydrographic capability and would help foster close liaison and potential assistance from recognized hydrographic services in other regional countries. The support of advisers will require the allocation of suitable funding. Such advisers could be engaged under contract. Alternatively, established hydrographic offices in the region may be able to provide seconded officers for limited periods of time.

### **Actively Participate in Bilateral Arrangements for Production of Kiribati Charts**

It is unrealistic to consider establishing an in-country chart production or maintenance facility. Subject to the continuing agreement of the UKHO, Kiribati should rely on the UKHO to publish charts; however, there is a fundamental obligation on Kiribati to ensure that the UKHO is provided with all the relevant information required for inclusion in those charts. Currently, this is not happening.

Because of the state of the underlying survey data for many of the existing charts and plans covering outer islands and atolls, there will be cases where neither the UKHO nor any other established hydrographic offices will be willing to publish these charts in their current form. In such cases, where Kiribati considers such charts are required for local purposes, it will need to consider alternative arrangements. This might be achieved through engaging contract support. However, the Kiribati government must still be able to verify any contractors' work and authorise the charts for subsequent public use. Other established hydrographic offices in the region, such as the Australian Hydrographic Service (AHS) or Land Information New Zealand (LINZ) may be prepared to adopt some important charts and take on the maintenance task, provided Kiribati was able to arrange for the regular supply of reliable updated information. The SWPHC is the appropriate forum in which to seek such assistance.

### **Establish National Charting Priorities**

All hydrographic stakeholders need to be involved in contributing to a Kiribati national hydrographic program. This is not only to identify and prioritise national requirements, but also to contribute to the execution of the programme. This could be through help in-kind, such as the provision of boats, or personnel or through contributions to enlist contract support – for example for surveys of areas targeted for development and even the compilation of local charts, in areas where the PCA has not assigned a priority. A key role for the stakeholders is to educate and encourage everyone to forward all relevant new or changed hydrographic information to the national coordinator for hydrography and charting.

## **6. Technical Visit Conclusions**

Based on discussions and the facts obtained, the following principal conclusions were reached:

- (1) The current state of nautical charting and the lack of coherent MSI services are most likely having a significant adverse impact on the Kiribati economy as well as putting the safety of life at sea and protection of the marine environment at significant risk.
- (2) The modernization of charts covering Kiribati should be a matter of particular concern to the national government. Every effort should be made to work with the primary charting authority to enable an effective modernization programme.
- (3) The release of existing but hitherto unused bathymetric data to the primary charting authority is a possible basis for the immediate improvement of some charts.
- (4) The establishment of a recognised, albeit limited, in-country hydrographic capability to provide local input to the UKHO to assist in the maintenance of the existing charts is important to enable the maintenance of nautical charts of Kiribati to continue.
- (5) Kiribati, as a State Party to the SOLAS Convention must recognise and act upon its obligations to ensure that appropriate paper charts and ENCs are available in accordance with the government obligations set out under Regulations 9 and 4 of Chapter V of that Convention. In this regard, Kiribati does not appear currently to be meeting its international treaty obligations to ensure that appropriate hydrographic services are in place. This is because there is no infrastructure or capability in place to provide information to the UKHO so that the relevant charts can be kept up to date.
- (6) The absence of up to date charts, apparently poorly maintained and documented aids to navigation and no formal arrangements in place to satisfy the requirements of the SOLAS Convention, are likely to lead

to Kiribati failing the hydrography section of the mandatory IMO Member State audit scheme which is likely to become mandatory around 2015.

## 7. Recommended Actions

It is recommended that the relevant authorities consider the following actions:

- (1) **The Kiribati government** should formally designate a **national coordinator for hydrography and charting**, such as the Marine Department, to be responsible for ensuring the provision of appropriate nautical charting services for Kiribati in accordance with the international Convention on Safety of Life at Sea (SOLAS).
- (2) **The Kiribati government** should seek urgent assistance from regional neighbours such as Australia and New Zealand or from relevant international agencies, such as SPC-SOPAC, to carry out chart modernization surveys for the following areas:
  - a. Tarawa and Port Betio (BA3269, BA700)
  - b. Kiritimati Atoll (Christmas Island) (BA2867, BA2995)
  - c. Tabuaeran Atoll, formerly called Fanning Island (BA2971)
  - d. Aba-Riringa Island (Kanton) (BA184, BA1451)
- (3) **The Kiribati government** should authorise SPC-SOPAC and any other organisations holding bathymetric or other relevant data covering Kiribati, such as overseas military organisations, to provide that data to the charting authority (UKHO) for use in the compilation or revision of the existing charts.
- (4) **The Kiribati government** through the **national coordinator for hydrography and charting**, should start a national programme that encourages all mariners and other interested parties to report discrepancies on existing charts together with as much information as possible on what should appear on the chart.
- (5) **The Kiribati government** should ensure that the **national coordinator for hydrography and charting** establishes at least:
  - a. An MSI Coordinator position to fulfil Kiribati obligations under SOLAS V/4 (navigational warnings);
  - b. The MSI Coordinator position should be combined with the role of a survey technician, to assist in gathering and forwarding new and updated information to the charting authority (currently the UKHO) to enable existing charts to be kept up to date.
- (6) The **national coordinator for hydrography and charting** should establish relations with the SWPHC, the IHO, the UKHO and SPC-SOPAC and represent Kiribati in all relevant hydrographic activities and discussions.
- (7) **The Kiribati government** should ensure regular funding and travel support for the **national coordinator for hydrography and charting** to attend relevant meetings of the SWPHC and SPC-SOPAC.
- (8) The **national coordinator for hydrography and charting** should apply, through the SWPHC, for MSI training under the IHO Capacity Building Program.
- (9) The **national coordinator for hydrography and charting** should liaise with the UKHO's Regional Team 5B to ensure new navigationally significant information is forwarded and included in existing charts of Kiribati.
- (10) **The Kiribati government** should provide the **national coordinator for hydrography and charting** with at least one outfit of portable hydrographic surveying equipment. An estimated breakdown of cost is shown in Annex C - Typical Costs of Portable Surveying Equipment. Funding will also be required for the regular maintenance of this equipment and for the training and requalification of operators;
- (11) The **national coordinator for hydrography and charting** should seek appropriate training for a hydrographic surveying technician. Short courses can be provided through the IHO Capacity Building programme;

- (12) **The national coordinator for hydrography and charting** should establish and chair a national hydrographic consultative committee or forum that coordinates national hydrographic requirements including input to a National Charting Plan, a National Hydrographic Survey Plan and a National Maritime Safety Information Plan. This group should include representatives from all stakeholders, including but not limited to: maritime police, ship operators, port authorities, maritime education authorities, provincial representatives, tourism operators, fisheries, geology and coastal survey, and SPC-SOPAC and other potential assistance agencies;
- (13) **The Kiribati government** should ensure the development and execution of:
- a. **A National Charting Plan** – by endorsing and proposing the chart modernization plan detailed in this report to the PCA (UKHO);
  - b. **A National Hydrographic Survey Plan** – by seeking resources through foreign funding or assistance to complete the surveys listed and prioritised in the National Hydrographic Survey Plan in support of the National Charting Plan.
  - c. **A National Maritime Safety Information Plan** – by ensuring that field checks are carried out on the current charts and publications and the results are forwarded promptly to the PCA.
- (14) **The Kiribati government** should engage an overseas hydrographic adviser to guide and assist the **national coordinator for hydrography and charting** during the establishment of an in-country hydrographic data gathering capability and to foster close liaison and possible support from recognized national hydrographic authorities in other countries.
- (15) **The SWPHC and the IHO** should monitor the further development of satellite bathymetry as a possible emerging technology that could help address the type of chart modernization issues being faced by Kiribati.
- (16) **The Kiribati government** should apply for membership of the IHO (details available in IHO publication M-2), including allocating on-going funding for the annual subscription (about €8,000 per annum) and travel support for Kiribati delegates to attend relevant meetings.



## Annex A – List of Recommendations

It is recommended that the relevant authorities consider the following actions:

- (1) **The Kiribati government** should formally designate a **national coordinator for hydrography and charting**, such as the Marine Department, to be responsible for ensuring the provision of appropriate nautical charting services for Kiribati in accordance with the international Convention on Safety of Life at Sea (SOLAS).
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- (12) **The national coordinator for hydrography and charting** should establish and chair a national hydrographic consultative committee or forum that coordinates national hydrographic requirements including input to a National Charting Plan, a National Hydrographic Survey Plan and a National

Maritime Safety Information Plan. This group should include representatives from all stakeholders, including but not limited to: maritime police, ship operators, port authorities, maritime education authorities, provincial representatives, tourism operators, fisheries, geology and coastal survey, and SPC-SOPAC and other potential assistance agencies;

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## Annex B – List of Contacts

<b>Ministry of Communications, Transport and Tourism Development (MCTTD)</b>	Deputy Secretary and acting OIC Marine Division	Ms Teboranga Tioti teboranga@gmail.com
<b>Marine Division</b>	Marine Officer	Captain Omirete Tabureka otabureka@mcttd.gov.ki otabureka@yahoo.com 25629 / 95859
<b>Kiribati Ports Authority</b>	Pilot Boat Master	Kirikori Baoro bwaoro.kirikori09@gmail.com 93181
<b>Kiribati Shipping Services Ltd</b>	Captain/Chief Officer	Bonnari Baikia buotanrouta@gmail.com 92434
<b>Office of the Te Beretitenti (Office of the President)</b>	Secretary	Tangitang Kaureata secretary@ob.gov.ki 21183
<b>Marine Training Centre</b>	Marine Officer	Riennang Ioane rienking@gmail.com 95162 / 26086
<b>Kiribati Meteorological Services</b>	Meteorological Officer	Teera Teatam misstetam.t@gmail.com 26511 / 25444
<b>Telecommunication Services of Kiribati Limited</b>	TSKL Officer	Teangina Binataake t2binataake@gmail.com 26005 / 25089 / 99488
<b>Department of Tourism Development</b>	OIC Kiribati Tourism Office	George Kum Kee gkumkee@kiribatitourism.gov.ki 25573 / 26003
<b>Police Maritime Unit</b>	Sergeant	Baibuke Mwemwe bmark179@gmail.com 26187 EXT 231 / 93571
<b>Survey &amp; Land Unit</b>	Senior Land Surveyor	Boata Iabeta iabetb@gmail.com 21283 / 99957
<b>Disaster Management Unit</b>	Communications Officer	Rooti Terubea rterubea@ob.gov.ki 21183 / 91409
<b>Ministry of Environment, Lands &amp; Agriculture Development</b>	Environment Inspector	Teema Biko info@environment.gov.ki 28211 / 28647
	Environment Inspector	Putu Tofinga info@environment.gov.ki 28211 / 28647

<b>DOJIN Ships Agent</b>	Agent Representative	Terakau Tii dojin.Tarawa@gmail.com 25598
<b>New Zealand High Commission</b>	High Commissioner	H.E. Michael Wehi Mailetonga Walsh mike.walsh@mfat.govt.nz 21402
	First Secretary	Mr Michael Upton michael.upton@mfat.govt.nz 21402
<b>Australian High Commission</b>	High Commissioner	H.E. Brett Aldam brett.aldam@dfat.gov.au
<b>Australian Department of Defence</b>	Maritime Surveillance Adviser - Kiribati	LCDR Chris Brough RAN msakiribati@gmail.com 26597 / 92287

## Annex C – Typical Costs of Portable Surveying Equipment

An estimated breakdown of costs for the purchase of a self-contained outfit of hydrographic survey and data processing equipment is shown in the table below. Costs are based on a presentation made at the SWPHC Capacity Building Seminar, Port Moresby in March 2009. Funding would also be required for regular maintenance of the equipment and for the training and requalification of operators.

EQUIPMENT AND SOFTWARE	Approximate Price USD
Single beam echo sounder - 200kHz	7,500
Single beam echo sounder - dual 200 khz+ 30kHz.	9,800
Combined echo sounder and logger - 200 kHz.	13,500
Combined echo sounder and logger – 200 kHz +30kHz.	optional (15800)
DGPS service, annually	1,700
Acoustic Tide Gauge	10,500
Post processing for DGPS, single frequency	12,000
Digital sidescan sonar	20,000
Hydrographic data processing software	6,500
Ruggedized laptop	5,000
Desktop PC for processing	2,250
Plotters	8,000
Accessories	5,000
<b>Approximate total for equipment (echo sounder, sonar, tide gauge, data logger, GPS, plotter, post-processor)</b>	<b>110K-140K</b>
Training in regional centre (inclusive of travel, etc)	50,000



# Annex D – Kiribati Dependency on Hydrography and Charting

## Introduction

A remote country of 33 scattered coral atolls, Kiribati has few natural resources and is one of the least developed Pacific Island states. Commercially viable phosphate deposits were exhausted at the time of independence from the UK in 1979. It has few natural resources, no manufacturing industry or commercial agriculture. Copra and fish now represent the bulk of production and exports. The economy has fluctuated widely in recent years. Economic development is constrained by a shortage of skilled workers, weak infrastructure, and remoteness from international markets. Tourism provides more than one-fifth of GDP. Private sector initiatives and a financial sector are in the early stages of development. Foreign financial aid from the EU, UK, US, Japan, Australia, New Zealand, Canada, UN agencies, and Taiwan accounts for 20-25% of GDP. Remittances from seamen working on merchant ships abroad account for more than \$5M each year.

The major source of revenue to progress development in Kiribati is through various aid agencies - primarily from Australia, Asian Development Bank (ADB), European Union, New Zealand, Taiwan, UN Development Program, the World Bank and the World Health Organization. Kiribati receives around \$15M annually for the government budget from an Australian trust fund.<sup>1</sup>

The main dependence on hydrography and charts is in support of the import of products to sustain the islands, export of copra, fish and other marine products, tourism and inter-island services.

## Kiribati's Island Groups

The geographical composition of the Republic of Kiribati with a mix of small inhabited and uninhabited coral atolls and islands scattered over a vast ocean area (approximately 3.5 million square kilometres) requires that the dependence on hydrography and charting of each group be identified separately as well as part of the Republic as a whole.

The Republic of Kiribati, formerly part of Gilbert and Ellice colony consists of three island groups and the isolated island of Banaba summarized below. The administrative centre of Kiribati is at Bairiki on Tarawa Atoll (1°25'N 173°00'E) in the Northern Gilbert Group.<sup>2</sup>

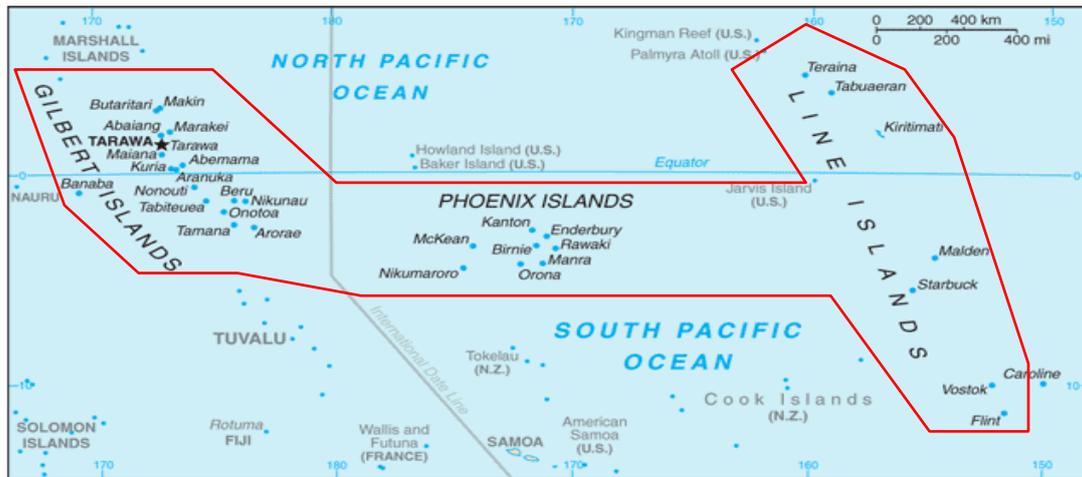
- Gilbert Group, lying between 2°40'S and 3°20'N and 172°40'E and 177°00'E. Those islands lying S of the equator are known as South Gilbert Group, and those N of the equator as North Gilbert Group. This group is the most compact and most densely populated of the Kiribati republic and the seat of government. South Tarawa, where the country's administrative centre is located, is reported to be the most densely populated place on earth. The Gilbert Group, the most populous atolls of the Republic of Kiribati, has no commercial assets other than copra which is sent to Tarawa for export.
- Banaba, formerly known as Ocean Island, lies 300 miles west of the South Gilbert Group and is the most westerly island of the Republic of Kiribati. Once the centre of phosphate mining, in 1979 the phosphate deposit had been worked out and the industry closed down. Although still inhabited the island has little economic significance and other than a small boat harbour, it has no marine facilities.
- Phoenix Group, lying between 5°00'S and 2°30'S and 174°30'W and 170°30'W. With the exception of Abu-Riringa (Kanton) Island, the eight islands and atolls that comprise the group are uninhabited other than by wildlife. This provides the primary importance of the group and is the world's largest marine conservation area. Aba-Riringa, with a population of less than 100, is a planned destination for cruise vessels.
- Line Island Group, lying across the equator between 161°W and 151°W. The three islands of the Northern Line Group have a commercial significance with established coconut plantations and visits from

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<sup>1</sup> CIA Fact Book <https://www.cia.gov/library/publications/the-world-factbook/geos/kr.html> [accessed 22 October 2011]

<sup>2</sup> NP61 p.17

cruise ships. The islands forming the Central and Southern Groups are now uninhabited and are designated as wildlife sanctuaries.



Islands forming the Republic of Kiribati

The atolls of the Republic of Kiribati rely for their existence solely on the import of goods by sea to sustain life. The islanders have throughout their history relied on the sea for sustenance; life in the modern world has made this reliance even more essential.

A short summary of each island and atoll forming the Republic of Kiribati, taken primarily from Admiralty Sailing Directions (NP 61 and NP62), is at Appendix 1 - Analysis of Hydrographic Requirements - Island by Island.

## Ports and Harbours

Of the 33 islands in the republic 13 are inhabited. Ships of any significant size can only be received at Tarawa (Port Betio) and Kiritimati (Port Kiritimati). These ports are operated by the Kiribati Port Authority. Kiribati has three ports of entry, Tarawa, Kiritimati and Tabuaeran (Fanning) islands, all of which are International Ship and Port Facility Security (ISPS) compliant ports. All imports and exports for Kiribati pass through Tarawa which is the hub port for the entire republic.

- Port Betio** (1°21'N 172°56'E). Tarawa is the administrative centre for the Republic of Kiribati with its port, Port Betio, the main port of entry for Kiribati. The harbour is equipped to handle general cargo vessels and small tankers. Containers are also handled. Cargo, including containers, is worked by lighters between the anchorage and Betio Harbour. The maximum size of vessel handled alongside is 1000 gt (for example, *NEI Matangare*) whilst at the anchorage vessels of up to LOA 195m, draught 9.4m can be received.<sup>3</sup> In the year up to October 2011 Port Betio was visited by 199 foreign flag vessels with a total tonnage of 536,272 gt.<sup>4</sup>

<sup>3</sup> NP61 pp.450-52

<sup>4</sup> Kiribati Marine Department Records



Port Betio<sup>5</sup>

- **Port Kirimati (Port London)** (1°59'N 157°28'W). On Kiritimati, Port London is the main port and a port of entry for Kiribati. The port's wharf is 94 m (308 ft) in length with depths alongside reported (1983) to be from 1.0m at its S end to 2.5m at its N end, although the wharf was no longer in use. The main berth is a T-shaped jetty is situated on the W coast of Kiritimati Atoll, about 1¼ miles NNW of Bridges Point. The jetty is 220m in length terminating in a fendered berthing face, 80m in length, with a dolphin at each end. Operations on this jetty are susceptible to interruption by swell. General cargo and containers are handled on this berth.<sup>6</sup> Port London is a destination for cruise ships; there are plans for an upgrade of facilities at Port London to accommodate tender traffic from ships anchored offshore to Kiritimati Island at Port London.



T-Jetty on W Coast of Kirimati Island<sup>7</sup>

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<sup>5</sup> Google Earth

<sup>6</sup> NP62 pp.241-42

<sup>7</sup> Google Earth

- **Banaba** (0°51'S 169°32'E). The only harbour on Banaba is a Boat harbour in Home Bay, on the S side of the island; it is protected only from NE winds. There is no anchorage for large vessels in Home Bay. Anchorage might be obtained, in NW winds and little swell, on the sandy spit extending from Sydney Point in depths of not less than 18m, but it is not recommended. Two concrete wharves, each with a depth of 1.5m alongside, lie within the Boat Harbour.



Banaba Boat Harbour<sup>8</sup>

- **English Harbour, Tabuaeran Island** (3°51'N 159°22'W). English Harbour is the only port on Tabuaeran Island and is a port of entry for Kiribati. Ships visiting Tabuaeran Island either drift off the entrance to English Harbour or use Whaler Anchorage approximately 4 miles NW of English Harbour. The entrance channel and berths are only suitable for the 20m catamarans used to ferry passengers and cargo to and from ships waiting or anchored offshore.



English Harbour, Tabuaeran Island<sup>9</sup>

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<sup>8</sup> Google Earth

<sup>9</sup> Google Earth

## Planned Maritime Developments in Kiribati

There are a number of planned developments in the Kiribati maritime sector, these are summarized below.

- **Port Betio.** Under a Japanese aid programme the current wharf at Port Betio will be extended 262m northwards by an arm to a new alongside berth allowing for the direct loading and unloading of cargoes. The new berth will be 200m long and have an alongside depth of 9m at chart datum, see illustration below. A dredged channel to the new berth will also be created. This work is programmed to commence in 2012.



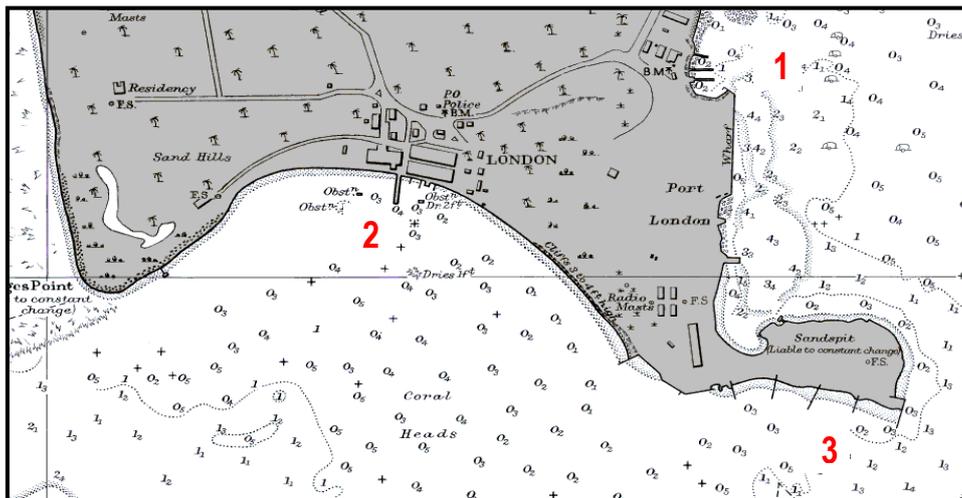
Port Betio Wharf Extension<sup>10</sup>

- **Tarawa – Population Growth.** Population growth in Kiribati is a serious long-term concern. On South Tarawa the population is projected to double by 2030. Water resources, already a scarce commodity, will be in ever increasing demand and there are plans to construct a desalination plant. In the short-term construction materials will come in by sea whilst in the long-term fuel to drive the plant will also be brought by sea. Commodities consumption will rise in proportion to the increase in population. These factors will drive a steep rise in imports by sea into Port Betio over the next two decades at least.<sup>11</sup>
- **Cruise Terminals at Kiritimati and Tabuaeran (Fanning) Island.** Under New Zealand Agency for International Development (NZAID) programmes the cruise ship tender jetties and tourist facilities at Kiritimati Island and Tabuaeran (Fanning) Island are to be upgraded. The options for new tender jetties at Port London, Kiritimati, are shown below. The option sites are shown on the diagram in order of preference; Option One is the current site for the embarkation and disembarkation of passengers.

<sup>10</sup> illustration from Marine Department

<sup>11</sup> Asian Development Bank projections

The cruise ship anchorage and facilities at Fanning Island are illustrated below:



Options for Port London Cruise Terminal<sup>12</sup>

*MV Norwegian Star* (91,740gt) has visited Fanning Island. The ship carries a total complement of 3,340 and has a draft of 8.53m.



*MV Norwegian Star* at Fanning Island in 2010

- **Butaritari.** Butaritari will be used as a transshipment port for fish caught in Kiribati waters following the upgrade of Port Betio.
- **Tabiteuea.** Tabiteuea now has a medical centre and secondary school increasing marine traffic to and from the island. It is a domestic aircraft refuelling stop and takes substantial fuel supplies by sea.

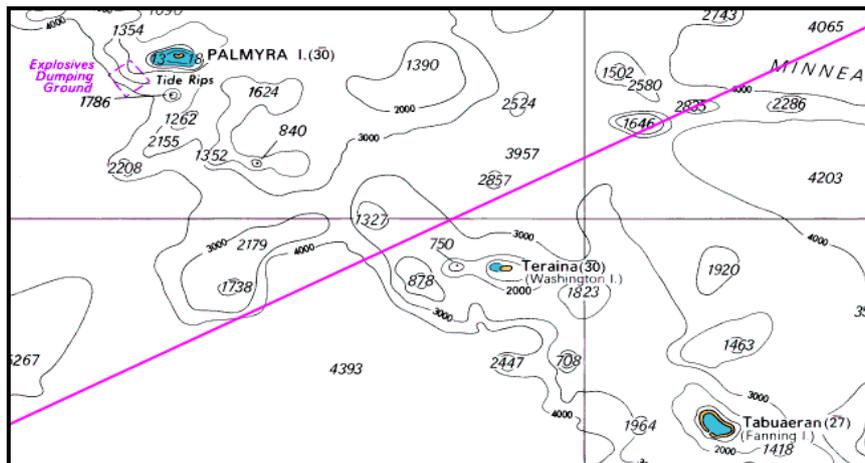
## Inter-Island Communication Routes

Inter-island communication for both passengers and freight is primarily by sea using local cargo and ferry vessels. This service is supplemented by light aircraft services using an extensive network of island runways. All freight for Kiribati enters the country through Port Betio as a shipment hub point and is then transhipped to other atolls in the three groups. Cargoes outward from Tarawa include all items to maintain life on the remote atolls with return cargoes of copra for export through Port Betio.

<sup>12</sup> Taylor and Tonkin Activity Concept Note 2634259v2

## Shipping Routes including Vigias

In addition to Carondelet Reef and Winslow Reef there are a number of vigias (oceanic shoal depths) within Kiribati's EEZ. These are listed at Appendix 2 – Analysis of Isolated Reefs and Vigias within Kiribati EEZ.



Ocean Shipping Route - Panama to Torres Strait<sup>13</sup>

## Tourism

Cruise ship operations at Tabuaeran (Fanning) Island and Kiritimati Island are considered a vital part of Kiribati's limited employment opportunities and a source of foreign revenue. A study by the New Zealand engineering company Tonkin and Taylor as part of a New Zealand Aid Programme at Kiritimati states:

*In terms of visitor arrivals, Kiribati has always maintained a healthy stream of cruise ship tourism visitation to the nation. After peaking in 2003 at 123,000 cruise ship visitors, generating nearly AU\$5.5M into the Kiribati GDP, cruise shipping fell to zero in 2008 and 2009 as a direct result of infrastructure issues on Fanning and Kiritimati Island.<sup>14</sup>*

## Fishing

Fishing licences are granted by the Kiribati government Ministry of Fisheries to vessels from States in East Asia including Japan, Taiwan, Korea, and China. Fishing vessels operate seasonally with reefer ships collecting catches for outward shipment to the East Asia region. This represents a major source of income for Kiribati, currently assessed as AUD25 million per annum.<sup>15</sup>

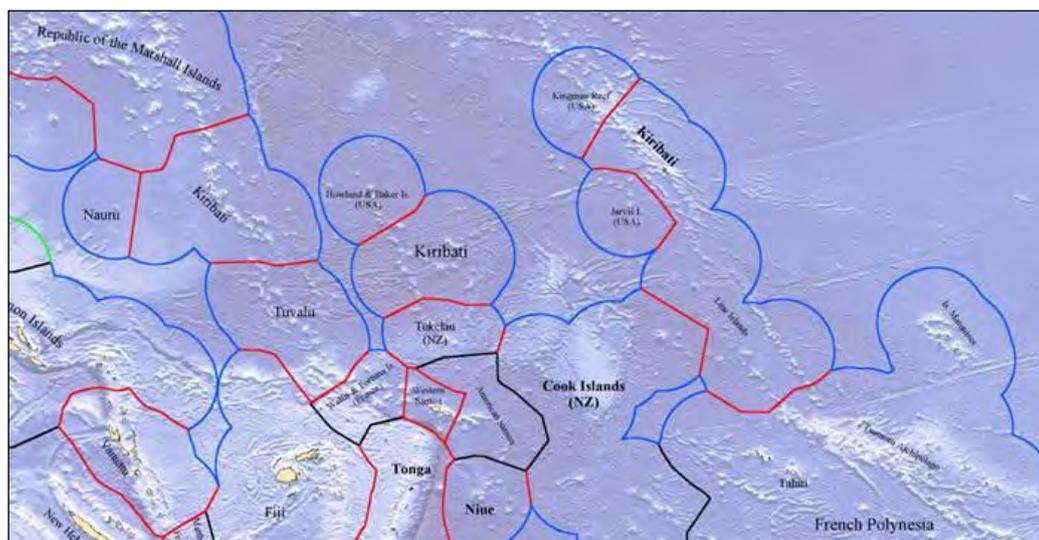
<sup>13</sup> BA4617 Tuvalu to Palmyra Island

<sup>14</sup> Taylor and Tonkin Activity Concept Note 2634259v2

<sup>15</sup> Asian Development Bank data

## Maritime Boundaries

Kiribati claims a 12 mile territorial sea, a contiguous zone of 24 miles and an EEZ of 200 miles.<sup>16</sup> Kiribati's EEZ covers approximately 1.37 million square miles of ocean and is almost 5,000 times as big as its land area. As can be seen in the following diagram 'SW Pacific Maritime Boundaries', none of Kiribati's maritime boundaries have as yet been agreed with its neighbours and presently there are no active discussions on boundary delimitation between Kiribati and neighbouring states. To do so from a position of strength, Kiribati will require medium to large scale official charts based on modern data referenced to WGS84.



SW Pacific Maritime Boundaries

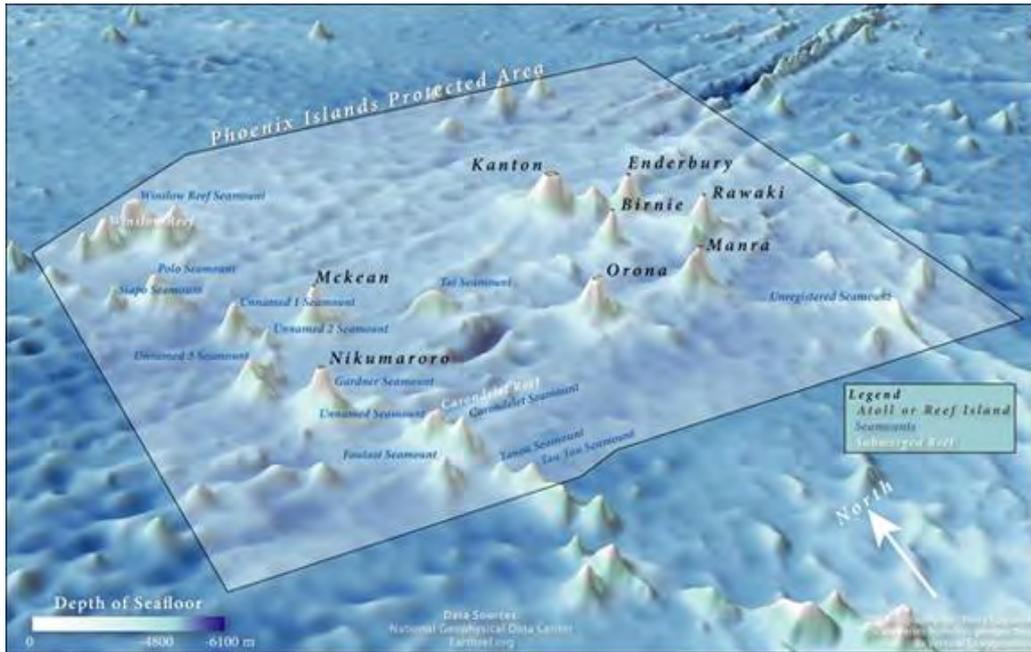
## Environment <sup>17</sup>

Environmental studies for Kiribati are undertaken through aid programmes such as the EU Project - Reducing Vulnerability of Pacific States that funded a 2005 survey programme in the North Gilbert Group conducted by SOPAC.

The Phoenix Islands Protected Area (PIPA), covering an area of 408,250 km<sup>2</sup> (157,626 sq. miles) is the largest marine protected area in the Pacific Ocean and the largest marine conservation effort of its kind by a Least Developed Country (LDC). Kiribati first declared the creation of PIPA at the 2006 Conference of the Parties to the Convention on Biological Diversity in Brazil. On January 30, 2008, Kiribati adopted formal regulations for PIPA that more than doubled the original size to make it at that time the largest marine protected area on Earth. In 2010 PIPA was added to the list of UNESCO World Heritage sites. It is the largest and deepest World Heritage site on Earth. PIPA includes all eight atoll and low reef islands of the Kiribati section of the Phoenix Island group, Rawaki, Enderbury, Nikumaroro, McKean, Manra, Birnie, Aba-Riringa and Orona. PIPA also includes two submerged reefs, Carondelet Reef and Winslow Reef, with Carondelet Reef being as little as 3 to 4 metres underwater at low tide. It is estimated that there may be more than 30 seamounts within PIPA, though only nine have been named so far.

<sup>16</sup> NP61 p.17

<sup>17</sup> <http://phoenixislands.org/index.php> [Accessed 25 Oct 2011]



Phoenix Islands Protected Area<sup>18</sup>

## Defence including Coastguard

Kiribati operates a maritime surveillance vessel. It is based at Port Betio. The limitations of existing charts impact on the ability to conduct effective coastal patrols in many areas.

<sup>18</sup> [http://phoenixislands.org/3d\\_map.html](http://phoenixislands.org/3d_map.html) [Accessed 23 Oct 2011]



## Annex E – Existing Hydrographic Data for Kiribati

### General

Whilst there are no national holdings of hydrographic data, modern data holdings for the Republic of Kiribati are greater than might at first appear to be the case. Some modern data has been acquired by the governments of Australia and the United States along with the regional organization SPC-SOPAC. The government of Kiribati has agreed to the release to the UKHO, as Primary Charting Authority, of all the hydrographic data collected in its waters

### National Data

The government of Kiribati has no bathymetric data holdings.

### Australia

The Royal Australian Navy Deployable Geospatial Support Team (DGST) has undertaken a modern survey of Port Betio; this survey has not as yet been forwarded to the Primary Charting Authority (UKHO) for charting action. The Kiribati government should instruct Australia to forward the bathymetric information to the UKHO.

### SPC SOPAC

SOPAC has obtained modern bathymetric data covering Kiribati waters in the North Gilbert Group. This data was gathered in 2005 by SOPAC under an EU sponsored project.

<b>Location</b>	<b>MBES Coverage</b>
Abaiang	2km offshore on all sides
Abemama	Up to 500m offshore on all sides
Banaba	2km offshore on all sides
Onotoa	1km off the western barrier reef
Tarawa	Up to 1.5km offshore on all sides

In addition, SOPAC has conducted a survey of the approach to Port Betio and the channel to the anchorage off the port.

### United Kingdom Hydrographic Office

UKHO has bathymetric data covering Kiribati waters up to the late 1960s. UKHO does not hold any modern hydrographic data.

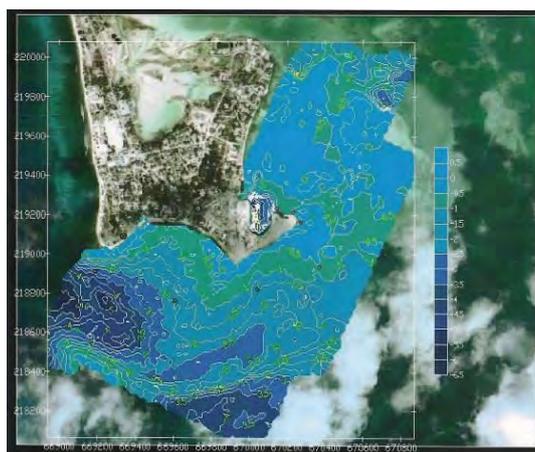
### United States of America

Hydrographic survey operations by US government agencies have taken place in Kiribati during World War II and again in very recent times. The wartime data has been included on current British Admiralty charts; however, the modern data acquired in the past decade or so has not been provided to Kiribati. MBES data in the oceanic depths of Kiribati waters was obtained in 1999 by RV Melville. Inshore MBES surveys have been conducted by United States military survey teams in various locations including Port London.

It is understood that the Naval Mobile Construction Battalion (NMCB) organisation and the US Navy Oceanographic Office (NAVO) have undertaken surveys in Port Betio, at Kiritimati and Fanning Islands; this data has not yet been passed to Kiribati, and on to the Primary Charting Authority.

The Kiribati government should instruct the US to forward the bathymetric information to the UKHO.

An image showing data from the survey at Port London, Kiritimati is shown below.



US Survey of Port London, Kiritimati Island

## IHO C55 - Status of Hydrographic Surveys

The current state of surveys in Kiribati as summarized in IHO Publication C55 'Status of Hydrographic Surveying and Nautical Charting Worldwide' Third Edition (2004) updated 27 September 2011 is shown in the table below. The Kiribati EEZ is approximately 1.37 million square miles of which the area with depths more than 200m is approximately 4,500 times that of the area where depths are less than 200m, including approximately 220 square miles of land area. Of that with depths less than 200m approximately 80% lies within atoll locked lagoons with access by shallow boat channel only. Given the imprecise delineation of the 200m contour and the incomplete knowledge of surveys undertaken in Kiribati waters outside the 200m contour the figures included in C55 are at best approximate. Based on the research conducted by the IHO Team during its technical visit in November 2011 the figures have been revised and are shown in the right-hand column of the following table.

Area Code	Definition	C-55 (%)	Revised value (%)
A1	Area adequately surveyed (<200m)	0	3
A2	Area adequately surveyed (>200m)	0	5
B1	Area requiring resurvey at larger scale or to modern standards (<200m)	20	8
B2	Area requiring resurvey at larger scale or to modern standards(>200m)	0	5
C1	Area which has never been systematically surveyed (<200m)	80	80
C2	Area which has never been systematically surveyed (>200m)	100	95

Extract from IHO C-55 - Status of Hydrographic Surveys - Kiribati [Updated 16 May 2007]<sup>19</sup>

<sup>19</sup> IHO C55 Region L p.11 [Accessed 23 Oct 2011]

## Annex F – Charting Analysis of Kiribati Waters

### Kiribati National Charts

The Republic of Kiribati does not have a chart producing capability and relies historically on the United Kingdom to fulfil this function.

### British Admiralty Charts

For historical reasons the United Kingdom, through the UKHO remains the Primary Charting Authority for Kiribati. Not all charts are referred to WGS 84. Most of the charts are on various other reference systems resulting in difficulty and inaccuracy when mariners attempt to transfer positions from chart to chart. Data is noted as being old, imperfect and on undefined reference systems in many cases. A summary of current UKHO charting is shown below.

BA Chart	Title	Scale	Published (Last NM/Year)	Annual Sales 2010(2011)
102	Plans in the Central Pacific, Malden Island and Malden Island Anchorage Malden Island Malden Island Anchorage	1:50,000 1:12,000	21 Feb 1964 4445/06	17 (23)
184	Pacific Ocean, Plans of the Phoenix Islands McKean Island Birnie Island Phoenix Island Hull (Orona) Island Sydney (Manra) Island Enderbury Island Gardner Island (Nikumaroro) Island Canton (Aba-Riringa) Island	1:25,000 1:25,000 1:25,000 1:40,000 1:25,000 1:50,000 1:45,000 1:80,000	19 May 1950 2382/80	69 (49)
700	Pacific Ocean, Gilbert Islands, Maiana to Marakei	1:175,000	17 Jul 1964 4445/06	100 (93)
731	Gilbert Group	1:800,000	22 Apr 1994 Nil	318 (218)
743	Pacific Ocean, Gilbert Islands, Abemama South Passage	1:50,000 1:25,000	12 Apr 1963 1153/85	28 (29)
755	Pacific Ocean, Gilbert Islands, Abaiang Bingham Channel	1:50,000 1:25,000	17 Jul 1964 1153/85	36 (46)
767	Pacific Ocean, Gilbert Islands, Tabiteuea South Lagoon.	1:50,000	6 Jan 1966 4445/06	35 (33)
768	Pacific Ocean, Plans in the Gilbert Islands Arorae Nonouti Peacock Anchorage	1:100,000 1:50,000 1:75,000	27 Oct 1967 4445/06	30 (34)
1451	South Pacific Ocean, Phoenix Islands, Canton Island Lagoon Entrance	1:12,000	2 Apr 1954 4445/06	19 (24)

BA Chart	Title	Scale	Published (Last NM/Year)	Annual Sales 2010(2011)
2867	Plans in the North Pacific Ocean Christmas Island Palmyra Island Entrance Washington Island Palmyra Island	1:150,000 1:15,000 1:45,000 1:50,000	28 Mar 1959 5694/07	122 (85)
2971	North Pacific Ocean, Fanning Island Fanning Island Whaler Anchorage English Harbour	1:48,690 1:9,070 1:6,050	23 Apr 1898 4445/06	37 (41)
2993	Central Pacific Ocean, Plans in Christmas Island Cook Island Passage Port London	1:6,000 1:2,500	20 Sep 1963 4445/06	56 (47)
2995	Pacific Ocean, Christmas Island, Approaches to Port London	1:15,000	31 Jan 1964 4445/06	47 (52)
3269	Pacific Ocean, Plans in the Gilbert Islands Onotoa Butaritari Betio Anchorage Kuria Butaritari Anchorage Nikunau Beru Tamana	1:150,000 1:151,200 1:30,070 1:150,000 1:35,000 1:49,910 1:75,000 1:150,000	13 Nov 1964 5249/09	77 (62)

## Proposed Chart Modernization Programme

During the technical visit a careful review of the existing charting was undertaken with stakeholder representatives from the government of Kiribati and marine operators. From the in-country discussions and from an analysis of the surveys and charting conducted prior to the technical visit it is apparent that many of the charts and plans continue to be published for historical reasons only and are not covering areas used by shipping today, indeed they may even tempt ships to enter areas that it would be wiser to avoid. As a result of these observations and discussions with the stakeholders, it is obvious that a revised charting scheme is required.

Modernization of some of the existing charts and plans that are being proposed to remain in the revised coverage will require re-scheming to cover modern requirements and to incorporate modern data.

For those areas covered by existing charts that are likely to be withdrawn, it is proposed to follow the example of BA731 - Gilbert Group and produce similar charts covering the Phoenix Group and the Line Islands. These charts would then allow:

- the safe conduct of inter-island traffic;
- the safe passage of cruise ships in and around the atolls, particularly in areas such as Carondelet Reef;
- provide charting for the Phoenix Islands Protection Area;
- maintain charting at an adequate scale on the WGS84 (satellite) datum following the demise of the eclectic collection of plans currently published.

The following table outlines the key aspects of a chart modernization plan.

Title	Coverage
Gilbert Islands	BA 731 as published but revised with islands related to WGS84 if not already so charted and incorporating new bathymetric data provided by SPC-SOPAC.
Phoenix Islands	New chart covering the atolls of Nikumaroro, Orona, Manra, Rawaki, Birnie Island, McKean Island, Enderbury Island and Kanton Island (Aba-Riringa)
Line Islands	New chart covering the atolls of Kiritimati, Tabuaeran, Teraina, Malden Island, Starbuck island, Vostok Island, Millennium Island and Flint island.
Tawara and Port Betio	New chart Tarawa Atoll and Approaches with a plan of Port Betio incorporating new data supplied by Australia, SPC-SOPAC and the USA.
Plans in Kiribati	New chart(s) containing coverage of Fanning Island including English Harbour, Kanton Island, and Kiritimati Island including Cook island Passage and Port London. Butaritari and anchorage.
Miscellaneous Chart and Plans	Following chart revision programme above and delete those recommended in this Annex.

## Review of Current Charting and Modernization

The table below provides justifying statements for the modernization, retention or deletion of certain British Admiralty charts.

	Retain current chart or plan with or without additional data.
	Delete current chart or plan and replace with a new chart or plan with or without additional data.
	Delete current chart or plan.

BA Chart	Code	Title	Remarks
102		Plans in the Central Pacific, Malden Island and Malden Island Anchorage	
		Malden Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include Malden Island on New Chart (NC) of Line Islands.
		Malden Island Anchorage	Not required.
184		Pacific Ocean, Plans of the Phoenix Islands	
		McKean Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include on NC of Phoenix Islands.
		Birnie Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include NC of Phoenix Islands.
		Phoenix Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include on NC of Phoenix Islands.
		Hull (Orona) Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include on NC of Phoenix Islands.
		Sydney (Manra) Island	Uninhabited island with no requirement for charting at the current scale. Propose include on NC of Phoenix Islands.
		Enderbury Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include on NC of Phoenix Islands.
		Gardner (Nikumaroro) Island	Uninhabited island with no requirement for charting at the current scale in support of vessels subject to SOLAS regulations. Propose include on NC of Phoenix Islands.
		Canton (Aba-Riringa) Island	Cruise ship traffic supports this plan being merged with BA1451 as part of a NC. Additional data required - which may be held by US authorities. In addition propose include on NC of Phoenix Islands.
700		Pacific Ocean, Gilbert Islands, Maiana to Marakei	NC to supersede this one to provide the approach chart of Tarawa and incorporate the plan of Port Betio in lieu of that on BA3269.
731		Gilbert Group	Retain but incorporate new SPC-SOPAC and US data and ensure that islands are positioned with reference to WGS84.

BA Chart	Code	Title	Remarks
743		Pacific Ocean, Gilbert Islands,	Not required to be charted at this scale; delete. Incorporate new

		Abemama South Passage	SPC-SOPAC and USA data on BA731 and ensure that islands are positioned with reference to WGS84.
755		Pacific Ocean, Gilbert Islands, Abaiang	Not required to be charted at this scale; delete. Incorporate new SPC-SOPAC and USA data on BA731 and ensure that islands are positioned with reference to WGS84.
		Bingham Channel	Not required to be charted at this scale; delete.
767		Pacific Ocean, Gilbert Islands, Tabiteuea South Lagoon.	Not required to be charted at this scale; delete.
768		Pacific Ocean, Plans in the Gilbert Islands	
		Arorae	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.
		Nonouti	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.
		Peacock Anchorage	Not required to be charted at this scale; delete.
1451		South Pacific Ocean, Phoenix Islands, Canton Island Lagoon Entrance	Cruise ship traffic supports this plan being merged with BA184 Plan of Canton (Aba-Riringa) as part of a NC. Additional data required which may be held by US authorities.
2867		Plans in the North Pacific Ocean	
		Christmas Island	Cruise ship traffic supports this plan being merged with BA2995 Approaches to Port London as part of a NC. Additional data required which may be held by US authorities. Intentions are for a resurvey of the area under a New Zealand aid programme.
		Palmyra Island Entrance	Not required to be charted at this scale; delete.
		Washington Island	Not required to be charted at this scale; delete.
		Palmyra Island	Not required to be charted at this scale; delete.
2971		North Pacific Ocean, Fanning Island	
		Fanning Island	Cruise ship traffic supports the revision of this plan and that of English Harbour. Additional data required which may be held by US authorities.
		Whaler Anchorage	Not required to be charted at this scale; delete.
		English Harbour	See comments above regarding BA2971 Fanning Island
2993		Central Pacific Ocean, Plans in Christmas Island	
		Cook Island Passage	NC using US data and merging the plans of Cook Island Passage and Port London to be merged and incorporated with BA 2995 Approaches to Port London. Chart required in support of cruise ship traffic. See also BA2867.
		Port London	See comments for Cook Island Passage above.
2995		Pacific Ocean, Christmas Island, Approaches to Port London	See comments for BA2867 and BA2993.

BA Chart	Code	Title	Remarks
3269		Pacific Ocean, Plans in the Gilbert Islands	
		Onotoa	Not required to be charted at this scale; delete. Incorporate new SPC-SOPAC and USA data on BA731 and ensure that islands are positioned with reference to WGS84.

		Butaritari	This plan and that for Butaritari Anchorage required to support the export of fish. Butaritari will be used in lieu of Port Betio for this activity in late 2012.
		Betio Anchorage	New plan to supersede this one using SPC-SOPAC, Australian and US data to complement the approach chart of Tarawa, see comments for BA700.
		Kuria	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.
		Butaritari Anchorage	See notes for Butaritari above.
		Nikunau	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.
		Beru	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.
		Tamana	Not required to be charted at this scale; delete. Chart using BA731 Gilbert islands and ensure that the island is positioned with reference to WGS84.

# Annex G - Proposals for Hydrographic Surveys in Kiribati

## General Assessment

### Introduction

Following the discussion in the report and its supporting Annexes and Appendices, this Annex outlines proposed programmes for the modernization of hydrographic surveys in Kiribati.

### Ports and Harbours

The ports, harbours and approaches requiring modern hydrographic data are:

- Port Betio, Tarawa - Sole port of entry and transhipment port for Kiribati atolls
- Butaritari - Fish transhipment and export location
- English Harbour, Tabuaeran (Fanning) Island - Cruise ship destination
- Port London, Kiritimati Island - Cruise ship destination
- Kanton Island - Cruise ship destination

Some of the locations above are covered by modern hydrographic data that is not yet published on charts whilst others require new surveys to be conducted.

### Island Assessment

A summary of the key elements of the analysis are set below whilst the full analysis is in Appendix 1 – Analysis of Hydrographic Requirements – Island by Island.

The use of the emerging technology of satellite derived bathymetry is recommended as a cost effective way of obtaining data for the general assessment of hydrography at and around the atolls comprising the Republic of Kiribati. Any survey programme should be closely linked to environmental studies to gain the maximum value from the imagery purchased for this work.

- **Gilbert Group.** With the exception of Tarawa and Butaritari it is recommended that initial surveys of these atolls be obtained from satellite derived bathymetry techniques. This data gathering operation will supplement the work already conducted by SOPAC at Abemama, Onotoa and Abiang. Further work should only be undertaken after careful inspection of the satellite-derived data.
- **Phoenix Group.** Of the eight atolls that comprise the group only one, Aba-Riringa, is inhabited and then only by a very small community. The other atolls, although in the PIPA, have no commercial or administrative significance. With the exception of Aba-Riringa it is recommended that initial surveys of these atolls be conducted using satellite derived bathymetry techniques.
- **Line Island Group.** With the exception of the detailed work required at Fanning Island and Kiritimati Island it is recommended that initial surveys of these atolls be conducted using satellite derived bathymetry techniques.
- **Banaba.** The 2005 SOPAC survey should provide most of the required bathymetric data for Banaba. The difficult area close inshore inside the 20m contour remains to be surveyed and here the only area of interest is the small anchorage area off Sydney Point. This is considered to be a very low priority.

### Shipping Routes (including vigias)

Defined shipping routes through the atolls making up the Republic of Kiribati are difficult to determine with any precision. However, dangers lurk in the oceanic waters of Kiribati's EEZ and require to be accurately surveyed; the known and potential shoal areas are listed at Appendix 2 – Analysis of Isolated Reefs and Vigias within Kiribati

EEZ. Given the high cost of deploying ships to investigate and survey these regions it is recommended that an initial assessment of these areas be conducted using satellite remote sensing technology.

## Tourism

There are no specific tourist areas requiring surveying other than those discussed above under Ports and Harbours.

## Maritime Boundaries

The government of Kiribati has yet to negotiate its maritime boundaries with its neighbours. To do so from a position of strength Kiribati will require medium to large scale official charts based on modern data referenced to the WGS84 datum. SOPAC has already conducted mapping work to delineate the atolls in the Republic of Kiribati, therefore, further survey effort is unlikely.

## Environment

There are at present no specific environmental needs for hydrographic surveys; however, there is a need to chart the Phoenix Group at medium scale to support the Phoenix Islands Protection Area (PIPA). Seamounts require accurate delineation to identify areas of potential fish stocks, breeding and migration and are included in the section above titled 'Shipping Routes'. Bathymetry is only one of many sets of data that can be derived from satellite data and as noted in the 'Island Assessment' below the maximum amount of data should be extracted from any satellite data gathering programme.

## Coastal Zone Development

There are at present no specific coastal zone development needs for hydrographic surveys, however, the planning and eventual construction of the desalination plant at Tarawa will require this data. It is suggested that hydrographic surveys are included as part of the desalination plant project with subsequent data, including design and 'as-built' engineering drawings, being passed to UKHO to update charts in due course.

## Appendix 1 - Analysis of Hydrographic Requirements – Island by Island

Notes regarding individual atolls are taken primarily from Admiralty Sailing Directions (NP61 and NP62).

	Island	Survey Priority	Remarks
<b>North Gilbert Group</b>	Aranuka (0°10'N 173°35'E)  BA 731	<b>H</b>	<p>This inhabited atoll (population 852 in 2004), the southernmost atoll in the Group, consists of two islands, one forming the base and the other the apex of the triangular atoll and separated by a lagoon approximately 2.5 miles across. Anchorage may be obtained close offshore in a depth of 14-18m. The waters surrounding Aranuka and between it and the neighbouring atoll of Kuria are poorly or completely unsurveyed. The Admiralty Sailing Directions state that 'Most of Aranuka may be passed safely at a distance of not less than 3 miles'.</p> <p>BA 731 Gilbert Group. Only charted at small scale (1:800,000) from sketch survey data.</p> <p><i>The waters around Aranuka require surveying to modern standards. Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Kuria (0°14'N 173°25'E)  BA 3269	<b>H</b>	<p>This inhabited atoll (population 862 in 2004) consists of two islands separated by a narrow channel spanned by a bridge. There is no central lagoon but a broad fringing reef encloses the islands. Anchorage may be obtained off Buariki in a depth of 24m. The waters surrounding Kuria and between it and the neighbouring atoll of Aranuka are poorly or completely unsurveyed. The Admiralty Sailing Directions state that 'Kurua may be circumnavigated, at a distance of 2 miles from the reef, except off the NW side where it should be increased to not less than 5 miles.'</p> <p>BA 3269 Plans in the Gilbert islands. Based on a sketch survey in 1962; large unsurveyed area of shoal water extending NW from Oneaka. No modern data included.</p> <p><i>The waters around Kuria require surveying to modern standards. Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Abemama (0°24'N 173°51'E)  BA 743	<b>M</b>	<p>This inhabited atoll (population 3608 in 2004), upon which are three islands, lies close NE of Aranuka. The central lagoon appears deep and clear of dangers and was fully surveyed in 1959; the area E of Abatiku Island is studded with numerous coral heads and has not been closely examined. Entrance to the lagoon is through Western Passage, 2 miles NNE of Abatiku Island (0°23'N 173°47'E), or through South Passage. The waters surrounding Kuria and between it and the neighbouring atoll of Aranuka are poorly or completely unsurveyed. The Admiralty Sailing Directions state that 'Abemama may be circumnavigated, at a distance of 2 miles from the reef'.</p> <p>BA 743 Abemama. Based on a survey by the British navy in 1959. No modern data included.</p> <p>Uncharted survey data: SOPAC MBES survey in 2005 on the outer edge of the reef from close inshore delineating the 50m and 100m contours.</p> <p><i>Remote sensing should be considered as reconnaissance data to confirm the 1959 survey and also identify any need for further survey programmes.</i></p>

	Island	Survey Priority	Remarks
<b>North Gilbert Group</b>	Maiana (0°56'N 173°00'E)  BA 700	<b>H</b>	<p>This inhabited atoll (population 1685 in 2004) consists of one continuous island forming the NE and SE sides, and a reef, awash, on its NW and SW sides; the position and extent of this reef had not been accurately determined. The lagoon, although routinely accessed by small local vessels, is shallow and obstructed with many dangers. The W side of Maiana is dangerous and should be approached with caution. The sea seldom breaks and discoloration of the shoal water is often not discernible; numerous scattered shoal patches exist within the charted 183 m (100 fm) depth contour. Maiana may be circumnavigated, in deep water at a distance of not less than 4 miles from the reef.</p> <p>BA 700 Maiana to Marakei. Based on British navy surveys between 1959 and 1963 or US or Japanese data but virtually unsurveyed. No modern data included.</p> <p><i>Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Tarawa (1°25'N 173°00'E)  BA 700 BA 3269	<b>L</b>	<p>This is the main and largest centre of population in Kiribati (population 41,400 in 2004) and has the only commercial port of any consequence; vessels up to 195m LOA and 9.4m draught can use the anchorage off Betio.</p> <p>BA 3269 Plans in the Gilbert islands. Betio Anchorage, based on British navy survey dated 1959 with additions from United States charts of 1944 and Japanese charts of 1943. No modern data included.</p> <p>BA 700 Maiana to Marakei. Based on British navy surveys between 1959 and 1963. No modern data included.</p> <p>Uncharted survey data: a. SOPAC MBES survey 2005 on the outer edge of the reef from close inshore to between 500m and 100m offshore. b. SOPAC MBES survey 2005 in the approaches to Betio anchorage. c. USA MBES survey 1999 offshore of the SOPAC survey on the S and W sides of Tarawa.</p> <p><i>It is recommended that with the pending port improvements the survey of the approach channel and anchorage at Port Betio be completed to modern standard. As a lower priority satellite remote sensing should be considered as reconnaissance data for the remainder of the lagoon and to complete the shallow water around the edge of the seaward edge of the reef.</i></p>
	Abaiang (1°51'N 172°55'E)  BA 755	<b>L</b>	<p>Abaiang is an inhabited atoll (population 3628 in 1998) lying close N of Tarawa. There are no safe anchorages for large vessels off Abaiang. Bingham Channel with a least depth of 2.7m is the main entrance into the lagoon. The lagoon is obstructed with numerous shoals and reefs. The area W and N of a line joining Bingham Channel and Tebunginako village is unsurveyed.</p> <p>Uncharted survey data: a. SOPAC MBES survey 2005 on the outer edge of the reef from close inshore up to 1000m offshore. b. SOPAC SBES survey 1999 of the waters of the lagoon. c. USA MBES survey 1999 offshore of the SOPAC survey on the W side of Abaiang.</p> <p>BA 755 Abiang. Based on a survey by the British navy in 1961-62. No modern data included.</p> <p><i>Such surveying as is required can be achieved using satellite remote sensing.</i></p>

	Island	Survey Priority	Remarks
<b>North Gilbert Group</b>	Marakei (2°00'N 173°17'E)  BA 700	L	<p>Marakei is an inhabited atoll (population 2312 in 2004) lying close NE of Tarawa. Anchorage can be obtained off Rawannawi (18m) and Baretoa passage (27m) although both are untenable in northerly swells between November and March. The enclosed lagoon can only be accessed by boats.</p> <p>BA 700 Maiana to Marakei. Based on British navy surveys between 1959 and 1963. No modern data included</p> <p><i>Such surveying as is required can be achieved using satellite remote sensing.</i></p>
	Butaritari (Makin) (3°10'N 172°50'E)  Little Makin (3°20'N 172°58'E)  BA3269	M	<p>Butaritari (Makin) and Little Makin (total population 4585 in 2004) are the northern most islands in the group. The atoll consists of an almost continuous and narrow strip of land that occupies the south eastern side of the formation, a broken series of smaller islets on the W side and a few small islets on the E side. Its N side comprises mainly submerged reef and broad reef flats that are broken by a number of channels. Little Makin extends NE from Butaritari on a continuation of the ridge on which the atoll stands. The main entrance to the Butaritari lagoon is via the South Channel (12m) leading to Butaritari anchorage (12-16m); other anchorages exist for small vessels.</p> <p>BA 3269 Plans in the Gilbert islands. Based on United States charts of 1944 and Japanese charts of 1943. No modern data included.</p> <p><i>The approaches to and anchorage at Butaritari were last surveyed in 1940s, it is recommended that the survey is updated. Satellite remote sensing should be considered as reconnaissance data for the remainder of the lagoon and reef areas to assess the requirement for further survey programmes.</i></p>

	Island	Survey Priority	Remarks
South Gilbert Group	Arorae (2°38'S 176°49'E)  BA 768	L	<p>Arorae (population 1527 in 2004) is a long narrow island with a fringing reef. Tebike Reef (3.7m to 7.3m) extends 1¼ miles NW from the N tip of the island. Anchorage may be obtained off the W coast of the island in 25m. Landing is by canoe over the fringing reef.</p> <p>BA 768 Plans in the Gilbert Islands. Based on British navy sketch survey dated 1959. No modern data included</p> <p><i>Satellite remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Tamana (2°30'S 175°59'E)  BA 3269	L	<p>Tamana (population 1351 in 2004) is a small oval island with a fringing reef. There are no anchorages off the island, except for small vessels for which local knowledge is required, as there are depths of over 200m about 1 cable from the breakers on the edge of the fringing reef. A boat passage about 5 m wide and suitable only for canoes and surfboats has been blasted through the reef adjacent to the Government Station.</p> <p>BA3269 Plans in the Gilbert islands. Based on British navy sketch survey dated 1959. No modern data included.</p> <p><i>Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Onotoa (1°51'S 175°33'E)  BA 3269	L	<p>Onotoa (population 2043 in 2004) is an atoll enclosing a shallow lagoon. Anchorage may be obtained offshore.</p> <p>BA3269 Plans in the Gilbert islands. From a sketch survey in 1910 with additions in 1961. No modern data included.</p> <p>Uncharted survey data: SOPAC MBES survey 2005 on the outer edge of the reef from close inshore up to 500m.</p> <p><i>Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Nikunau (1°21'S 176°27'E)  BA 3269	L	<p>Nikunau (population 1741 in 2004) is a small elongated island with a fringing reef. Anchorages are available but only suitable for small local vessels.</p> <p>BA3269 Plans in the Gilbert islands. Based on an incomplete British navy hydrographic survey dated 1959. No modern data included.</p> <p><i>Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>

	Island	Survey Priority	Remarks
<b>South Gilbert Group</b>	Beru (1°20'S 176°00'E)  BA 3269	L	<p>Beru (population 2732 in 2000) is fringed by a reef on its E side; on its W side the barrier reef extends up to 2 miles offshore and encloses a shallow lagoon through which there are boat passages at HW. Foul ground extends 3 cables SSE from the SE end of the fringing reef, and 1 mile NW from the NW end. Anchorages are only suitable for local vessels.</p> <p>BA3269 Plans in the Gilbert islands. Based on Japanese charts of 1943 with some corrections to 1960. No modern data included.</p> <p><i>Satellite remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Tabiteuea (1°20'S 174°52'E)  BA 767 BA 768	L	<p>Tabiteuea (population 4283 in 2001) the largest atoll of Gilbert Group, is about 37 miles long and consists of a chain of islets lying in a NW/SE direction. A lagoon lies at the S end of the atoll, and Peacock Anchorage at the N end. The principal Government station is at Utiroa (1°13'S 174°45'E) on the S end of Anikai (Eanikai), the northern most island; a second Government station is at Teobokia (1°28'S 175°03'E) on Buariki in the S.</p> <p>BA 767 Tabiteuea South Lagoon. Based on British navy surveys dated 1963. No modern data included</p> <p>BA 768 Plans in the Gilbert Islands. Peacock anchorage based on British navy sketch survey dated 1959 with aerial photography from 1963. No modern data included</p> <p><i>Satellite remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>
	Nonouti (0°40'S 174°20'E)  BA 768	L	<p>Nonouti (inhabited) an atoll 22 miles long in a NW/SE direction, consists of a main island on its E side, and a chain of islets continuing W and S, ending with Numatong. A lagoon enclosed by a broken reef lies on the W side of the atoll. Anchorage for small vessels only. The Government station is at Kairaoa (0°40'S 174°27'E) in the Matang district. In the 2002 census, the population of the atoll was 2303.</p> <p>BA 768 Plans in the Gilbert Islands. Based on British navy surveys dated 1963. No modern data included</p> <p><i>Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes.</i></p>

	Island	Survey Priority	Remarks
<b>Phoenix Group</b>	Nikumaroro (4°40'S 174°31'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. Anchorage may be obtained only by small vessels. Landing is by boat channel cut through the fringing reef to the beach.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Orona (4°30'S 172°11'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. Anchorage may be obtained offshore by vessels of moderate draught.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Manra (4°27'S 171°15'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. Anchorage may be obtained close inshore in a depth of 16m.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Rawaki (3°43'S 170°43'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. Anchorage (20m) may be obtained close offshore.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>

	Island	Survey Priority	Remarks
Phoenix Group	Birnie Island (3°35'S 171°31'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. Anchorage (16m) may be obtained inshore. Landing can be made over the fringing reef.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	McKean Island (3°36'S 174°08'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. There is no suitable anchorage. Landing can be made over the fringing reef.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Enderbury Island (3°08'S 171°05'W)  BA 184	L	<p>This uninhabited atoll is of no commercial or administrative significance. There is no suitable anchorage. Landing is by boat over the fringing reef.</p> <p>BA 184 Plans in the Phoenix Islands. Based on United States' charts of 1943. No modern data included</p> <p><i>The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Aba-Riringa Island (2°49'S 171°40'W)  BA1451	H	<p>Formerly Kanton Island, this is the only inhabited atoll in the Phoenix Group; population of 61 in 2000. The offshore anchorage is only suitable for vessels drawing less than 7m. Access to the berth at Aba-Riringa is gained through the man-made north channel which, like the shallower south channel on the other side of Spam Island, can only be accessed for very limited periods at slack water.</p> <p>BA 1451 Canton Island and Lagoon Entrance. Based on US Government charts published in 1941.</p> <p><i>There are two surveying requirements: the western entrance channels, lagoon and outer anchorage and the waters surrounding the atoll. The former has been discussed under Ports and Harbours in this Appendix. Survey of the surrounding waters and the remainder of the lagoon may be achieved using satellite remote sensing techniques. Given the strong tidal flow, surveying the two access channels is likely to be extremely challenging.</i></p>

	Island	Survey Priority	Remarks
Line Island Group	Kiritimati Atoll (1°55'N 157°25'W)  BA 2867 BA 2995	H	<p>Formerly known as Christmas Island, is the principal island of the Line Group. During World War II the island was used as a US staging post and between 1956 and 1964 as a base for nuclear tests by the United Kingdom and the United States. It is now a coconut plantation and has been declared a Government Wildlife Sanctuary. This is one of the few inhabited islands in the group; population 1400 in 2007. Anchorages off the island may be obtained in good conditions. Port London is the main centre; it is accessible by shallow draft craft only.</p> <p>BA 2867 Plans in the North Pacific Ocean. Based on New Zealand Government surveys between 1939 and 1941.</p> <p>BA 2995 Approaches to Port London. Based on New Zealand Government survey dated 1956 with additions in 1963.</p> <p>Uncharted surveys: A recent US military MBES survey of Cook Island Passage and Port London</p> <p><i>US survey data should be consulted before survey plans for Cook Island Passage and Port London are made; surveys may be conducted under the NZ Aid programme work for cruise ship operation at Port London. The Bay of Wrecks on the island's east coast is noted as 'Very Dangerous' on BA2867 and should be surveyed to IHO Order 1a.</i></p>
	Tabuaeran (3°51'N 159°22'W)  BA 2971	M	<p>This is one of the few inhabited islands in the group. Once an important link in the Pacific Ocean cable system it is now a commercial coconut plantation. Cruise ships make occasional visits. In 2006 the population was about 1980. English Harbour is the main centre off which is an anchorage. The approach channel to the settlement on Weston Point is said to be only 18 feet deep and thus entry is only suitable for shallow draft vessels.</p> <p>BA 2971 Fanning Island including a plan of English harbour and Whaler Anchorage. Chart based mainly on data from 1897 with minor additions during the last century.</p> <p><i>Such surveying as is required can be achieved using satellite remote sensing techniques supplemented by IHO Order 1a or 1b surveys at and in the approaches to English Harbour.</i></p>
	Teraina (4°43'N 160°23'W)  BA 2867	L	<p>This is one of the few inhabited islands in the group; population 1155 in 2005. Anchorage off the island may be obtained in good conditions; landing is considered always to be difficult and dangerous.</p> <p>BA 2867 Plans in the North Pacific Ocean (Washington Island). Based on a US Government chart dated 1947, virtually unsurveyed.</p> <p><i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>
	Starbuck Island (5°38'S 155°53'W)  Uncharted	L	<p>This uninhabited coral island is of no commercial or administrative significance. Landing is generally dangerous and difficult. Anchoring, although possible in favourable conditions and for short periods, is not recommended.</p> <p><i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i></p>

	Island	Survey Priority	Remarks
Line Island Group	Malden Island (4°00'S 155°00'W)	L	This uninhabited coral island is of no commercial or administrative significance. Landing is generally dangerous and difficult. Anchorage may be obtained off this island.
	BA102		BA102 Malden Island. Anchorage based on a survey by the New Zealand navy in 1956, topography from uncontrolled photographic mosaic. No modern data included. <i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i>
	Flint Island (11°26'S 151°48'W)	L	This uninhabited coral island is of no commercial or administrative significance. Landing can be made through a channel cut into the reef on the NW side of the island. Anchoring, although possible in favourable conditions is not recommended. <i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i>
	Vostok Island (10°06'S 152°23'W)	L	This uninhabited coral island is of no commercial or administrative significance. Landing can be made through a channel cut into the reef on the S side of the island. Anchoring is not practicable off this island. <i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i>
	Millennium Island (9°57'S 150°13'W)	L	This uninhabited coral island is of no commercial or administrative significance. When there is no surf, landing can be made anywhere on the island. Anchoring is not practicable off this island. <i>Such surveying as is required can be achieved using satellite remote sensing techniques.</i>

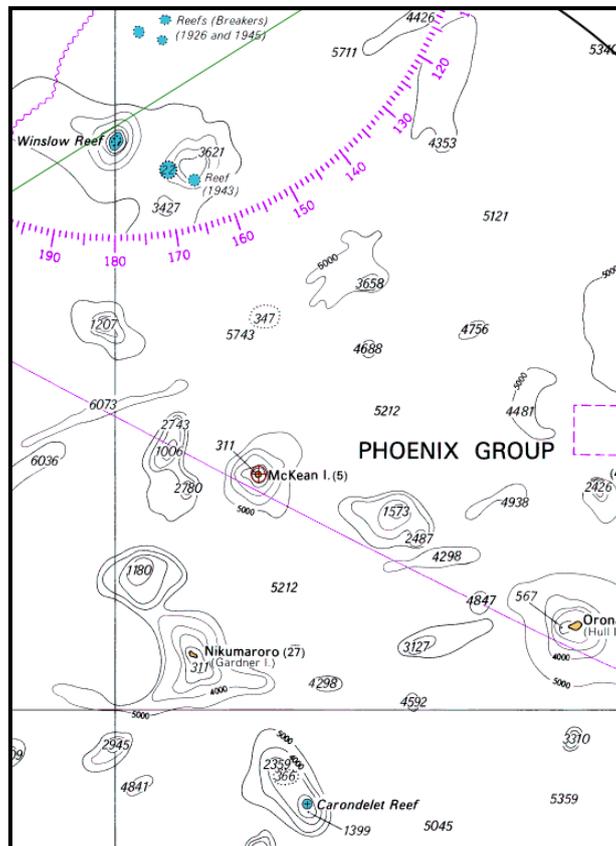
Banaba Island	Survey Priority	Remarks
Banaba (0°51'S 169°32'E)  No large scale chart	L	Until 1978 known as Ocean Island, it is about 81m high with a flat summit sloping regularly to the coast; it is bordered by cliffs from 4 to 9 m high, except in a part of Home Bay on the S side, and is fringed by a narrow reef. Banaba's population in 2001 was 200. Formerly, phosphate was mined in large quantities and exported, but in 1979, the phosphate deposit had been worked out and the industry closed down. Although home to a significant population the island possesses only a shallow boat harbour, whilst the only anchorage (off Sydney Point) can only be used in limited conditions and with little swell running. <i>The 2005 SOPAC survey can provide most of the survey requirement for Banaba. The difficult area close inshore inside the 20m contour remains to be surveyed. The only area of interest inside the 20m contour is the small anchorage area off Sydney Point.</i>



## Appendix 2 - Analysis of Isolated Reefs and Vigias within Kiribati EEZ

### Phoenix Group Reefs and Vigias

Reef	Lat	Long	Depth	Remarks
Winslow	1° 35'S	175° 00' W	Unknown	
Unnamed	1° 47'S	174° 40' W	22m	
Unnamed	1° 50'S	174° 30' W	Unknown	Reported 1943
Carondelet	5° 34'S	173° 50'W	Awash	

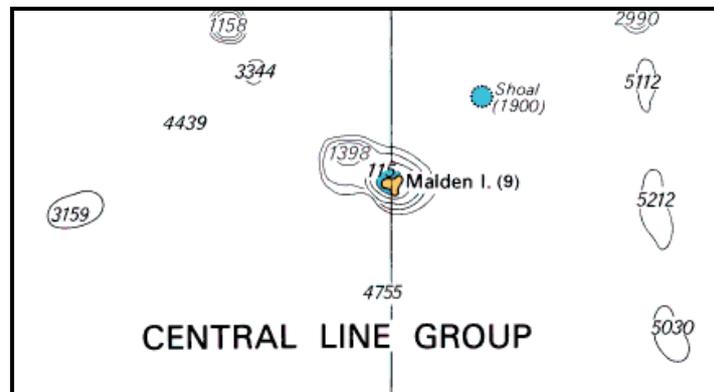


Phoenix Group Reefs and Vigias <sup>20</sup>

<sup>20</sup> BA4617 Tuvalu to Palmyra Island

## Central Line Group Vigia

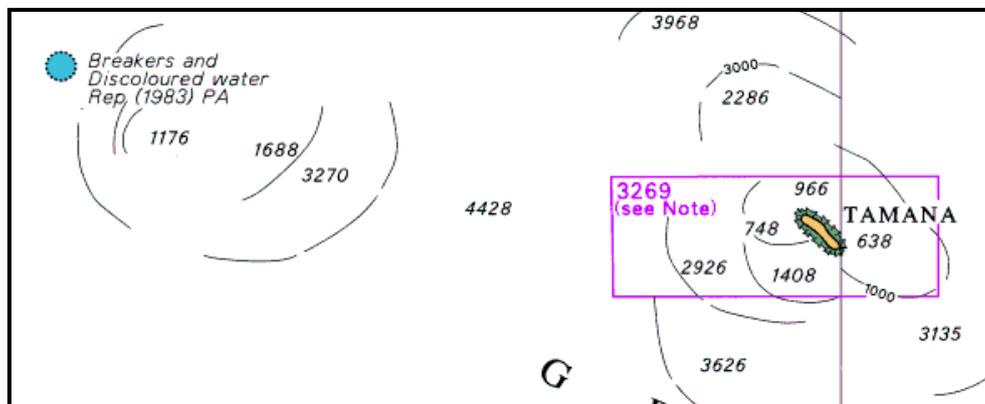
Reef	Lat	Long	Depth	Remarks
Unnamed	3° 40'N	154° 38' W	Unknown	Reported 1900 32NM ME of Malden Island



Phoenix Group Reefs and Vigias <sup>21</sup>

## Gilbert Island Group

Reef	Lat	Long	Depth	Remarks
Unnamed	2° 21'S	175° 20' E	Unknown	Reported 1983 (PA) 40NM NW of Tamana

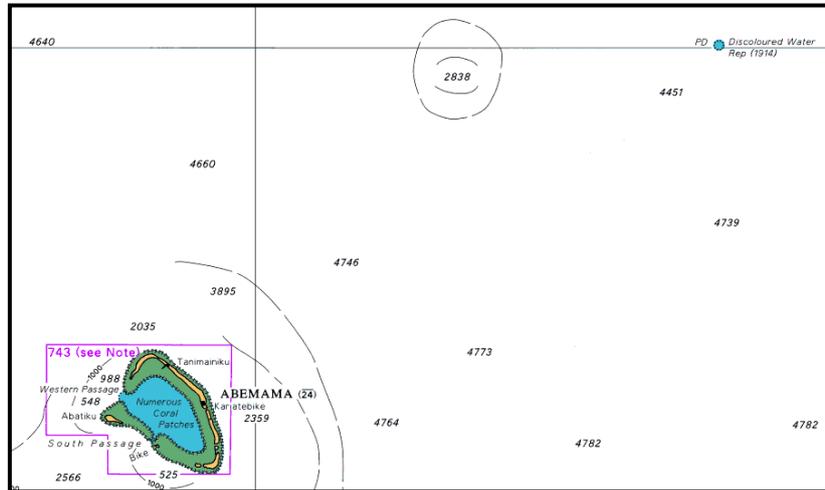


Vigia NW of Tamana <sup>22</sup>

<sup>21</sup> BA4617 Tuvalu to Palmyra Island

<sup>22</sup> BA 731 Gilbert Group

Reef	Lat	Long	Depth	Remarks
Unnamed	1° 00'N	174° 44'E	Unknown	Reported 1914 (PD) 65NM NE of Abemama



Vigia NE of Abemama<sup>23</sup>

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<sup>23</sup> BA 731 Gilbert Group



## Appendix 3 - Proposed National Hydrographic Survey Programme

### National Hydrographic Survey Plan

The chart modernisation plan proposed in this paper will require new data - both bathymetric and topographic. Topographic data can be obtained by the PCA (UKHO) using satellite imagery as used routinely in the compilation of other charts. Some bathymetric data is either already available but not yet published or should be acquired under a hydrographic data gathering programme.

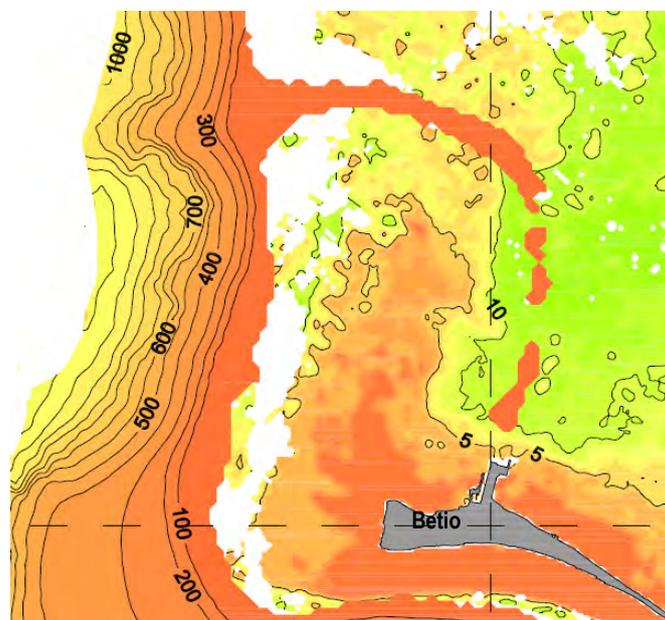
The cost of completely surveying all the atolls in the Republic of Kiribati using satellite remote sensing technology would be in the order of £1.07M. However, balanced against this should be the prospect of using the same derived base data for other purposes including environmental monitoring and mapping and providing the necessary data set for the effective negotiation of Kiribati's EEZ. Approximately a further £0.75M would be required to survey targeted areas to a higher order of accuracy and thoroughness than could be obtained by satellite remote sensing or informal survey methods.

A summary of survey requirements is given below.

### Ports and Harbours

- **Port Betio, Tarawa**

Parts of Port Betio have been surveyed in recent years by the Royal Australian Navy, the United States' Naval Mobile Construction Battalion (NMCB) and SPC-SOPAC. The limits of the former two surveys are not known, the limits of the SOPAC survey as shown below cover the deep water off the coast of Tarawa and the approach channel to the berth at Port Betio. It is considered likely that no further hydrographic surveys will be required other than those undertaken after the port upgrade programme. Normally, this would be part of the upgrade project. The area of the reef edge and to seaward, shown in white in the diagram below, can be obtained from satellite imagery and existing published survey data.



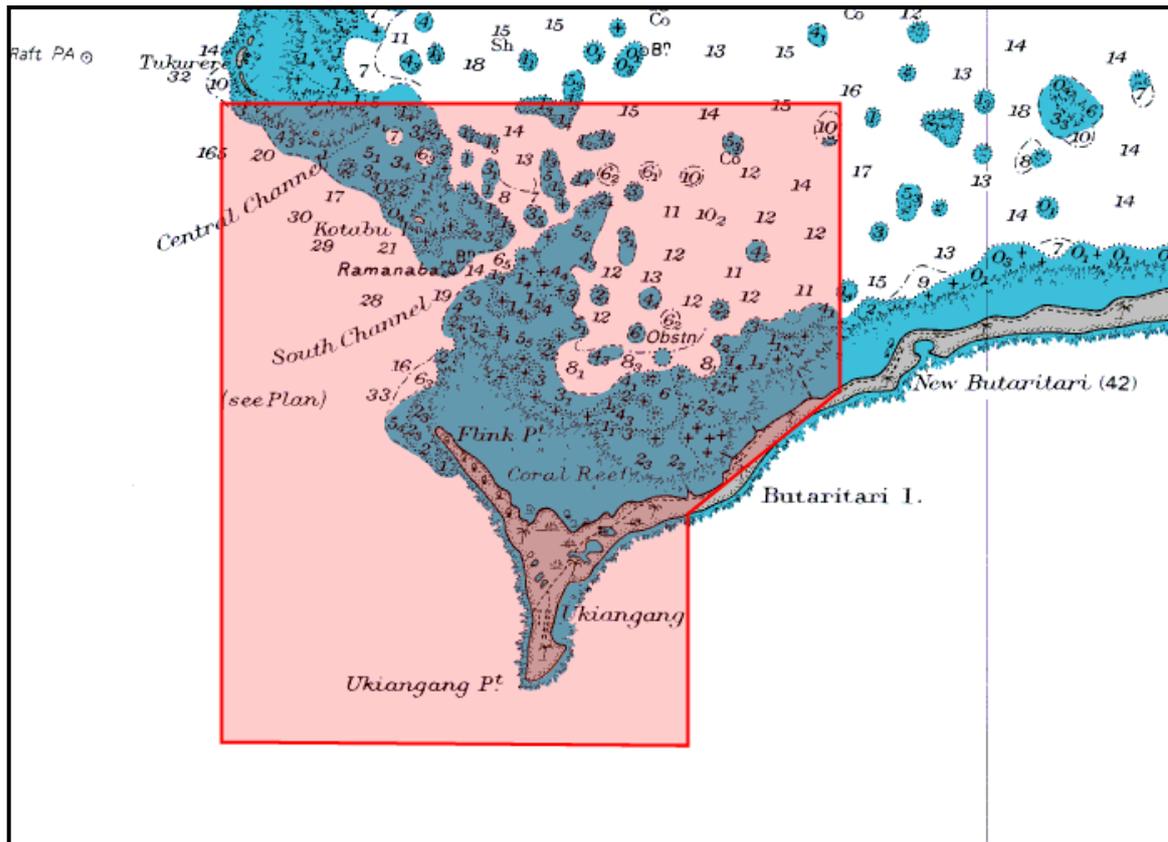
SOPAC survey at Tarawa and Port Betio

- **Butaritari**

*Survey Requirement.* Given the complexity of this area it is suitable for either lidar or satellite derived bathymetry techniques. As a first priority it is suggested that the 30m contour be delineated and the waters inshore of this contour surveyed (approximately 65 km<sup>2</sup>). Should resources be available (e.g. SPC-SOPAC) then the deep water outside the contour but inside the plan area shown below should be surveyed to IHO Order 2.

*Survey Costs.* The following estimates of survey costs are provided.

- <30m using lidar - £200,000
- <30m using satellite derived bathymetry - £13,000
- >30m using MBES - uncoded as part of SOPAC or similar programme

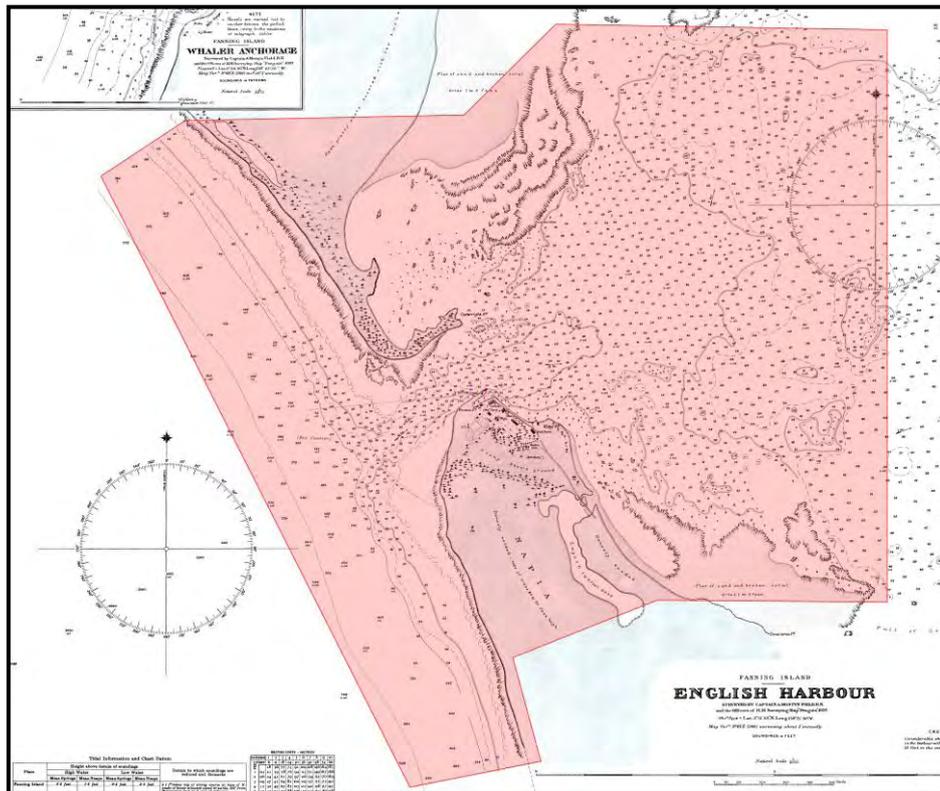


- **English Harbour, Tabuaeran (Fanning) Island**

*Survey Requirement.* Given the complexity of this area it is suitable for either lidar or satellite derived bathymetry techniques. As a first priority it is proposed that the 30m contour be delineated and the waters inshore of this contour surveyed (approximately 6 km<sup>2</sup>). Should resources be available (e.g. SPC-SOPAC) then the deep water outside the contour but inside the plan area shown below should be surveyed to IHO Order 2. The use of SPC-SOPAC assets may well cover the shallower waters inside the 30m contour in particular the channels into the lagoon.

*Survey Costs.* The following estimates of survey costs are provided.

- <30m using lidar - £80,000
- <30m using satellite derived bathymetry - £2,500
- >30m using MBES - uncosted as part of SPC-SOPAC or similar programme

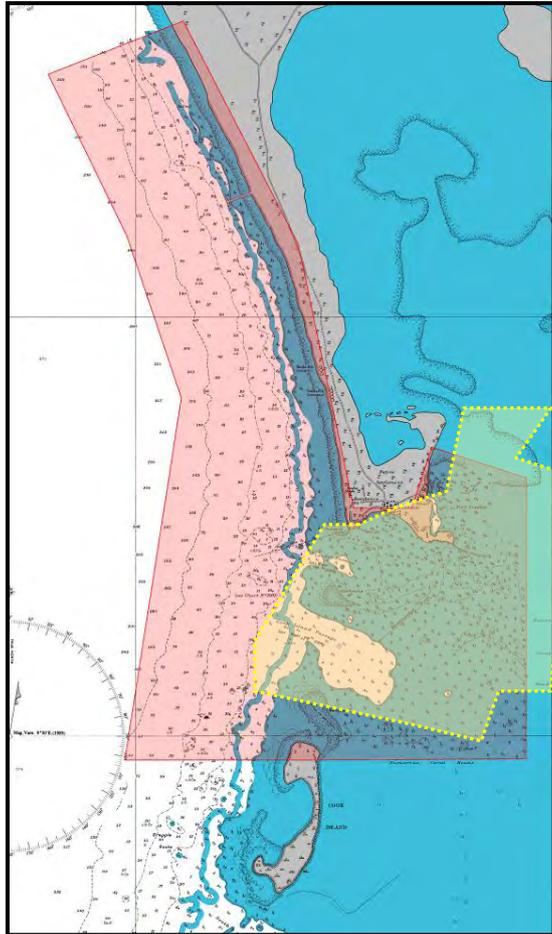


### Port London, Kiritimati Island

*Survey Requirement.* The inshore area shown in yellow on the diagram below has recently been surveyed by the United States Naval Mobile Construction Battalion (NMCB) organisation. It is proposed that to augment this data northwards along the coast and to the south of Cook island Passage satellite derived bathymetry should be obtained. Should resources be available (e.g. SPC-SOPAC) then the deep water outside the contour but inside the plan area shown below should be surveyed to IHO Order 2. The use of SPC-SOPAC assets may well cover the shallower waters not covered by the NMCB survey. A further alternative is to use assets under the NZ MFAT project for the rehabilitation of Port London or Port Ronton as defined in this project.

*Survey Costs.* The following estimates of survey costs are provided.

- <30m using lidar - £80,000
- <30m using satellite derived bathymetry - £4,000
- >30m using MBES - uncosted as part of SPC-SOPAC or similar programme

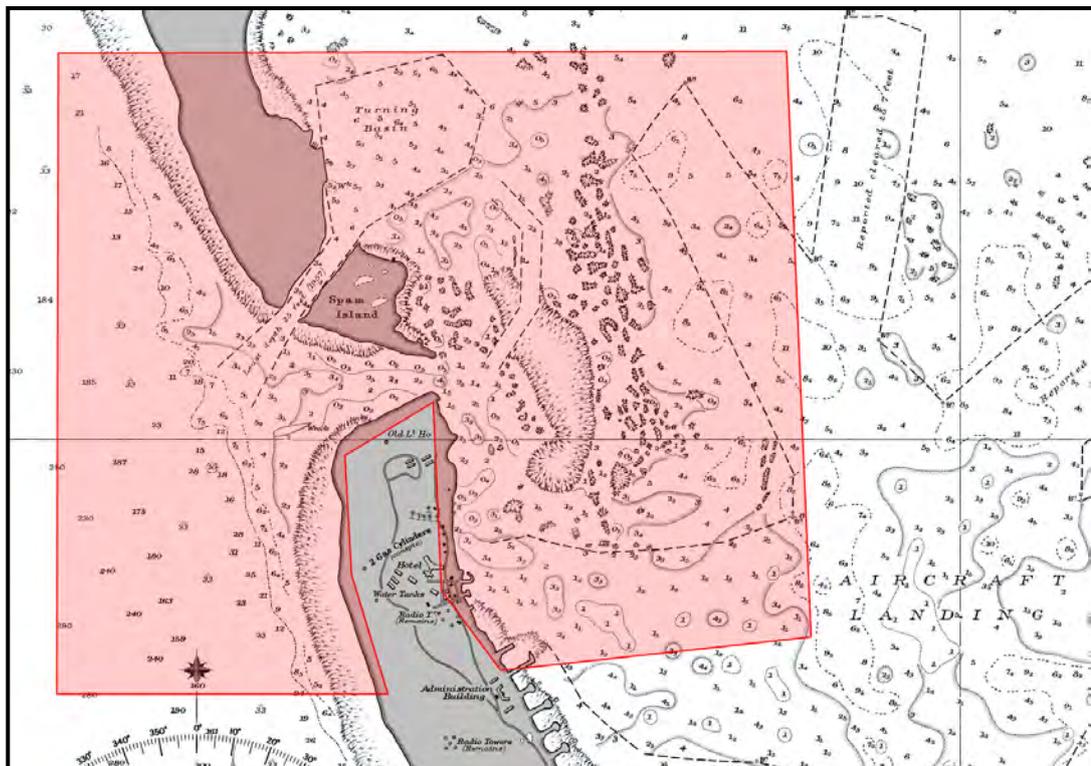


## Kanton Island

*Survey Requirement.* Given the complexity of this area it is suitable for either lidar or satellite derived bathymetry techniques. As a first priority it is suggested that the 30m contour be delineated and the waters inshore of this contour surveyed (approximately 5 km<sup>2</sup>). Should resources be available (e.g. SPC-SOPAC) then the deep water outside the contour but inside the plan area shown below should be surveyed to IHO Order 2. The use of SPC-SOPAC assets may well cover the shallower waters inside the 30m contour in particular the channels into the lagoon. Surveying the two access channels is, given the strong tidal flow, likely to be extremely challenging.

*Survey Costs.* The following estimates of survey costs noting that the small survey area will make the costs of lidar extremely expensive.

- <30m using lidar - £70,000
- <30m using satellite derived bathymetry - £2,000
- >30m and approach channels using MBES - uncoded as part of SPC-SOPAC programme



## Atolls and Islands

	Island	Survey Priority	Remarks and Cost Estimate
North Gilbert Group	Kuria (0°14'N 173°25'E) Aranuka (0°10'N 173°35'E)	H	The waters around Kuria and Aranuka require surveying to modern standards. Satellite remote sensing should be considered as reconnaissance data for further survey programmes if necessary. Both islands should be surveyed at the same time to save data capture costs. <i>Approximate area - 300 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £60,000</i>
	Abemama (0°24'N 173°51'E)	M	Uncharted survey data: SOPAC MBES survey 2005 on the outer edge of the reef from close inshore delineating the 50m and 100m contours. Remote sensing should be considered as reconnaissance data to confirm the 1959 survey and for further survey programmes if necessary. <i>Approximate area - 275 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £55,000</i>
	Maiana (0°56'N 173°00'E)	H	Remote sensing should be considered as reconnaissance data for further survey programmes if necessary. <i>Approximate area - 250 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £50,000</i>
	Tarawa (1°25'N 173°00'E)	L	Uncharted survey data: a. SOPAC MBES survey 2005 on the outer edge of the reef from close inshore to between 500m and 100m offshore. b. SOPAC MBES survey 2005 in the approaches to Betio anchorage. c. NOAA MBES survey 1999 offshore of the SOPAC survey on the S and W sides of Tarawa. As a low priority remote sensing should be considered as reconnaissance data for the remainder of the lagoon and to complete the shallow water around the edge of the seaward edge of the reef. <i>Not costed.</i>
	Abaiang (1°51'N 172°55'E)	L	Uncharted survey data: a. SOPAC MBES survey 2005 on the outer edge of the reef from close inshore up to 1000m offshore. b. SOPAC SBES survey 1999 of the waters of the lagoon. c. NOAA MBES survey 1999 offshore of the SOPAC survey on the W side of Abaiang. It is unlikely that further surveying will be required. <i>Not costed.</i>
	Marakei (2°00'N 173°17'E)	L	Such surveying as is required can be achieved using remote sensing. <i>Approximate area - 55 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £11,000</i>
	Butaritari (Makin) (3°10'N 172°50'E)  Little Makin (3°20'N 172°58'E)	M	The approaches to and anchorage at Butaritari were last surveyed in 1940s, it is recommended that the survey is updated. Remote sensing should be considered as reconnaissance data for the remainder of the lagoon and reef areas to assess further survey programmes. <i>Approximate area including Makin Island - 625 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £125,000</i>

	Island	Survey Priority	Remarks
<b>South Gilbert Group</b>	Arorae (2°38'S 176°49'E)	L	Remote sensing should be considered as reconnaissance data <i>that will also identify any need</i> for further survey programmes. <i>Approximate area - 20 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £4,000</i>
	Tamana (2°30'S 175°59'E)	L	Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 10 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £2,000</i>
	Onotoa (1°51'S 175°33'E)	L	Uncharted survey data: SOPAC MBES survey 2005 on the outer edge of the reef from close inshore up to 500m. Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 150 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £30,000</i>
	Nikunau (1°21'S 176°27'E)	L	Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 40 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £80,000</i>
	Beru (1°20'S 176°00'E)	L	Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 65 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £13,000</i>
	Tabiteuea (1°20'S 174°52'E)	L	Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 810 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £162,000</i>
	Nonouti (0°40'S 174°20'E)	L	Remote sensing should be considered as reconnaissance data that will also identify any need for further survey programmes. <i>Approximate area - 830 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £166,000</i>

	Island	Survey Priority	Remarks
Phoenix Group	Nikumaroro (4°40'S 174°31'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 15 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £3,000</i>
	Orona (4°30'S 172°11'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 50 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £10,000</i>
	Manra (4°27'S 171°15'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 15 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £3,000</i>
	Rawaki (3°43'S 170°43'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 3 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £600</i>
	Birnie Island (3°35'S 171°31'W)	L	The survey requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard with the shoal waters surrounding it accurately delineated. Such surveying as is required can be achieved using remote sensing techniques. <i>Approximate area - 4 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £800</i>
	McKean Island (3°36'S 174°08'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 2 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £400</i>
	Enderbury Island (3°08'S 171°05'W)	L	The only requirement is for the atoll to be correctly positioned on modern small scale charts as a navigational hazard. Such surveying as is required can be achieved using satellite remote sensing techniques. <i>Approximate area - 12 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £2,400</i>
	Aba-Riringa Island (2°49'S 171°40'W)  BA1451	H	There are two surveying requirements: the western entrance channels, lagoon and outer anchorage and the waters surrounding the atoll. The former has been discussed under Ports and Harbours in this Appendix. The surrounding waters and the remainder of the lagoon may be surveyed using satellite remote sensing techniques. <i>Approximate area - 85 km<sup>2</sup></i> <i>Approximate cost by satellite survey methods - £17,000</i>

	Island	Survey Priority	Remarks
Line Island Group	Kiritimati Atoll (1°55'N 157°25'W)	H	<p>Uncharted surveys: A recent US military MBES survey of Cook Island Passage and Port London. US survey data should be consulted before survey plans for Cook Island Passage and Port London are made; surveys may be conducted under the NZ Aid programme work for cruise ship operation at Port London. The Bay of Wrecks on the island's east coast is noted as 'Very Dangerous' on BA2867 and should be surveyed to IHO Order 1a.</p> <p><i>Area at Order 1a - 120km<sup>2</sup></i>  <i>Estimated cost of Order 1a survey - £310,000</i>  <i>Area to be surveyed by satellite - 760 km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £152,000</i></p>
	Tabuaeran (3°51'N 159°22'W)	M	<p>The survey requirement can be achieved using satellite remote sensing techniques supplemented by IHO Order 1a or 1b surveys at and in the approaches to English Harbour which are described at 'Ports and Harbours' in this Appendix.</p> <p><i>Area to be surveyed by satellite - 165 km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £33,000</i></p>
	Teraina (Washington) (4°43'N 160°23'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 35 km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £7,000</i></p>
	Starbuck Island (5°38'S 155°53'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 50km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £10,000</i></p>
	Malden Island (4°00'S 155°00'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 80km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £16,000</i></p>
	Flint Island (11°26'S 151°48'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 50km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £10,000</i></p>
	Vostok Island (10°06'S 152°23'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 30km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £6,000</i></p>
	Millennium Island (9°57'S 150°13'W)	L	<p>The survey requirement can be achieved using satellite remote sensing techniques.</p> <p><i>Area to be surveyed by satellite - 30km<sup>2</sup></i>  <i>Approximate cost by satellite survey methods - £6,000</i></p>

Banaba Island	Survey Priority	Remarks
Banaba (0°51'S 169°32'E)	L	<p>The 2005 SOPAC survey can provide most of the survey requirement for Banaba. The difficult area close inshore inside the 20m contour remains to be surveyed. The only area of interest inside the 20m contour is the small anchorage area off Sydney Point.</p> <p><i>Not costed.</i></p>