ECONOMIC AND FINANCIAL ANALYSIS

A. General

1. The proposed project will finance several activities to improve the safety of interisland navigation and provide resilient outer island access infrastructure for four outer islands in Kiribati. The project scope includes a hydrographic survey to establish digital chart coverage of the outer islands to make navigation safer in the country's waters in accordance with international conventions and small-scale maritime interventions, which are needed to improve the delivery of basic goods and services to the outer islands. The project will finance rehabilitation of causeways in these islands to reduce transport costs within the islands and improve resilience to climate change and disaster risks.

2. The four islands considered for the project investment are Abaiang, Nonouti, Beru, and Tabiteuea South. Kiribati's 33 islands are scattered over a large area of central and western Pacific Ocean and constrained by geographic isolation, a small population, and high transport and shipping costs. The nation depends on maritime transport to import essential manufactured goods, export agriculture and fishery products, and connect and resupply outer island communities. Only two ports are capable of handling international shipping—one in Betio and the other in Kiritimati and the outer islands, which are served by domestic (interisland) shipping. Safe navigation aids are limited and defined island access infrastructure nonexistent. The proposed project will tackle these constraints and ease safer access to the outer islands.

3. Standard demand analysis to calculate the project benefits is not applicable for some project components. Therefore, cost-effectiveness analysis or cost–benefit analysis was used for individual subprojects, depending on whether the benefits of the subproject were quantifiable or not.[1] For example, the installation of aid to navigation (ATON) is essential but does not lead to direct economic benefit or reduced operating costs. In these cases, the cost-effectiveness analysis defines the needs that must be met by each subproject, develops alternative options that can satisfy these needs, and ensures that the chosen option is the most cost-effective among the mutually exclusive and technically feasible alternative interventions. Where options have different cash flows over time, discounted cash flow techniques were used to compare them on a net present cost (NPC) basis. In some cases, alternatives will have similar NPCs, in which case other, nonquantifiable criteria must be used to make the final selection. In cases where benefits of the subproject are quantifiable, a cost–benefit analysis was used. In the project economic analysis, cost-effectiveness analysis was used for hydrographic surveying, maritime ATONs, and island access infrastructure, and cost–benefit analysis was used for rehabilitation of island-crossing causeways.

B. Assumptions and Parameters

4. All costs and benefits were valued in 2019 constant prices, and all analyses used world price numeraire expressed in United States dollars, adjusted in accordance with standard cost–benefit procedures, a review of previous Asian Development Bank (ADB)– and World Bank–funded Kiribati project analyses, and ADB guidelines. Financial prices were converted into economic prices by removing all taxes. The currency is pegged 1:1 to the Australian dollar. There are no taxes on imports and exports so a standard conversion factor of 1.0 was applied. A shadow wage rate factor of 0.6 was applied to the unskilled component of labor-based wage rates.

[1] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

5. For the cost-effectiveness analysis, the alternatives were compared using NPCs with the ADB-recommended discount rate of 9% in real terms over 20 years of project appraisal. For the cost–benefit analysis, cost and benefit streams in the with- and without-project scenarios were compared and the economic internal rate of return estimated from the net benefit stream over the analysis period, following ADB guidelines.

C. Economic Assessment of Project Components

6. **Project component 1: Hydrographic surveying.** Most of the waters surrounding Kiribati are not surveyed to a standard needed for safe navigation. This represents a significant safety issue and a constraint on development and maintenance of infrastructure in all islands. Hydrographic survey work will entail establishing accurate tidal predications in the outer islands and will be used to design infrastructure and plan and schedule shipping operations. The Kiribati 20-year Vision 2016–2036 prioritizes hydrographic surveys to enable connectivity and accessibility between islands and deliver social and economic benefits.[2]

7. The United Kingdom Hydrographic Office (UKHO) is the primary charting authority for Kiribati, producing the official navigational charts on behalf of the Government of Kiribati. The UKHO has prepared a scoping study to assess options for conducting the hydrographic survey in the project islands. Three alternative survey methods were considered: (i) vessel-based, (ii) airborne, and (iii) combined (airborne and vessel). The airborne laser bathymetry would provide the highest standard of accuracy. Vessel-based surveys are not useful without airborne surveys and are dangerous. Vessel-based surveys alone have not been considered as an option but only to supplement airborne surveys as needed. Tidal observations and chart compilation are needed. Table 1 shows the one-time cost to establish the charts. The airborne surveys would deliver charts of sufficient quality to enable much improved safety of navigation and are recommended for the project at a cost of about $5 million.

Table 1: Summary of Cost-Effectiveness Comparison for Hydrographic Surveying Options

Task	Airborne Surveys ($ million)	Combined Airborne and Vessel-Based Surveys ($ million)
Nonouti	0.917	1.334
Beru	0.767	1.354
Abaiang	0.747	1.594
Tabiteuea South	1.364	2.129
Tidal observations	0.196	0.196
Chart compilation	0.248–0.372	0.248–0.372
Project management	0.216–0.552	0.216–0.552
Total	**4.455–4.915**	**7.071–7.621**

Source: United Kingdom Hydrographic Office.

8. **Project component 2: Resilient outer island access infrastructure.** This component will have three subcomponents: (i) maritime ATONs, (ii) island access infrastructure improvement, and (iii) rehabilitation of island-crossing causeways.

9. **Project component 2.1: Maritime ATONs.** For safe shipping to the outer islands, mariners require visual references or ATONs such as beacons, buoys, and lighthouses. Many ATONs in the outer islands of Kiribati are missing, meaning that dangers are unmarked. The technical needs assessment carried out by the International Association of Lighthouse Authorities in 2016 recommended several ways to improve capacity and identified the greatest needs, which

[2] Government of Kiribati. 2016. *Kiribati 20-Year Vision, 2016–2036.*

are in designing a more enduring lagoon ATON structure, resourcing the materials to fabricate them, accessing a reliable workboat for installation and monitoring, and establishing a proper system of ongoing asset management and maintenance. The proposed project will establish 45 ATONs and provide training for design, installation, and maintenance at an estimated cost of $2 million. The ongoing maintenance will be undertaken by the Marine Division of the Ministry of Information, Communication, Transport and Tourism Development (MICTTD). The incremental cost of maintenance is considered negligible with training provided under the project. The ATONs are essential for shipping safety. No technical alternatives can be considered and, therefore, no cost-effectiveness analysis was undertaken.

10. **Project component 2.2: Island access infrastructure improvement.** No maritime infrastructure for ship-to-shore transfer, such as jetties or ramps, is available in any of the outer islands. The ocean sides of the islands oriented to the east are exposed to large waves coming from the prevailing wind direction, making vessel berthing and navigation unsafe. The lagoon sides of the islands are oriented to the west but have extensive and extremely shallow sandbanks or rock outcrops, making ship access possible only during high tide. In general, the topography and bathymetry of the islands are unfavorable to shipping and present challenges to safe and efficient ship-to-shore transfer. Several options were explored in each island:

(i) In Abaiang, two sites were considered: Tabontebike and Taburao. Tabontebike (South West Abaiang) is a favored vehicle reception point as the lagoon does not have to be navigated to access the shore, However, Tabontebike is an hour away from the population center of Taburao and it is unlikely that a purpose-built jetty will be regularly used. Taburao is a population center, to which general goods are regularly delivered and where passengers regularly board and disembark. The jetty and ramp in Tabontebike would be less beneficial because of its long distance from the main population center. The most cost-effective site is Taburao (Table 3).

(ii) In Beru, Tebikeriki (north), Taboiaki (south), and Weneete beach (northwest end) sites were studied. Tebikeriki is the primary shipping point on Beru. Tebikeriki is the only location among all project islands where dredging is feasible, considering the significant improvement of current operations. Dredging of Taboiaki channel in Beru could worsen erosion, diminishing the benefits. In Weneete beach, there is a high risk that sand would move into the dredged channel, reducing the benefits. Weneete is also far from deep water, making it a less safe option to navigate than Tebikeriki. The cost-effectiveness analysis recommends Tebikeriki as the preferred site.

(iii) In Nonouti, Matang and Tamanuku were considered. Matang is a town center and primary location for delivery of general goods and refined oil products. A new jetty or dredged channel are infeasible because of the terrain and conditions, but construction of a multipurpose facility was considered.[3] Tamanuku is the favored vehicle reception point and options to construct a boat ramp roll-on/roll-off (RORO) facility were examined. The Matang option would clearly benefit the main population of the island near the site, considering that existing facilities (goods store and ice works) are there. The Tamanuku option would be effective for shallow draft landing craft or landing barges at high tides. There are no plans for such vessel to be used in Nonouti so there

[3] The facility would consist of a concrete base slab, steel or timber framing, and corrugated iron roof sheeting. The structure would be generally open or not cladded, and an enclosed area would be built in the rear of the building. This is a suitable area for ATON fabrication and storage of valuables (tools, fuel, cement, among others). It is anticipated that this new facility will be used as a workshop for the ATON project components. A cradle with a concrete apron will be installed on the seafront near the shed and used to retrieve small boats such as 2.4-ton landing craft.

is a risk that the RORO ramp would not be used. The most cost-effective site is Matang for a multipurpose maritime facility.

(iv) Tabiteuea South has three potential sites (Buariki, Takuu, and Rawa Ni Kabako) that could be developed to improve access and safety. Considering the high cost of dredging and the small population, construction of a multipurpose facility at a low cost was also considered at Buariki. Takuu (southwest end) was examined to provide secondary alternate for landing site. Options to dredge a channel and construct a jetty were examined. Rawa Ni Kabako was considered for a small jetty to be used by tender boats approaching from the east during westerly winds. Dredging options in Buairiki or Takuu in Tabiteuea South would provide fewer benefits because of the risk of siltation and low cargo volumes. A jetty at Rawa Ni Kabako in Tabiteuea South would be infrequently used since interisland ships generally approach from the west (lagoon side of the island). The most cost-effective site is Buariki for a multipurpose maritime facility.

11. Table 2 summarizes the analysis conducted for each island. In conclusion, the cost-effectiveness analysis suggests that a new ramp, shelter, and on-ramp pontoon should be constructed in Taburao for better passenger access to Abaiang. In Beru, dredging an approach channel and turning basin in Tebikeriki to allow interisland vessels to access the shore is considered the preferred economic option. A new shelter, ATON workshop, and winch with cradle to allow better fabrication and maintenance of ATONs and maintenance and storage of small boats is proposed for Nonouti and Tabiteuea South. The present value of operation and maintenance cost over the analysis period of 15 years is included in the comparison.

Table 2: Summary of Cost-Effectiveness Comparison of Infrastructure Options
($ million)

Island	Infrastructure Options	Construction	Operation and Maintenance	Total Cost
Abaiang (population: 5,568)	Tabontebike—Jetty and ramp	8.2	0.34	8.54
	Taburao—Jetty and ramp	**4.8**	**0.34**	**5.14**
Beru (population: 2051)	**Tebikeriki—Channel dredging and shoreside improvements**	**4.9**	**0.17**	**5.07**
	Taboiaki—Channel dredging	3.4	6.2	9.6
	Weneete—Cutting back reef	10.4	0.34	10.74
Nonouti (population: 2,743)	**Matang—Multipurpose maritime facility**	**1.4**	**0.09**	**1.49**
	Tamanuku—Jetty and ramp	6.5	0.34	6.84
Tabiteuea South (population: 1,306)	**Buariki—Multipurpose maritime facility**	**1.4**	**0.09**	**1.49**
	Buariki—Channel dredging	5.8	9.2	15.0
	Takuu—Channel dredging	3.0	9.2	12.2
	Rawa Ni Kabako—Jetty (ocean side)	5.0	0.34	5.34

Source: Asian Development Bank estimates.

12. **Project component 2.3: Rehabilitation of island-crossing causeways.** The causeways to be rehabilitated are in three outer islands: Tabiteuea South, Beru, and Nonouti. They are in poor to very poor condition, requiring repair or replacement of wearing courses, including installation of countermeasures to erosion and of culverts, or reconstruction of sections of failed causeways.[4] Without the project, the causeways will not be rehabilitated and thus be in

[4] There are significant failures to some causeway walls in some places and evidence of ongoing subsidence of the core of the causeways. This is severe and may lead to collapse of the causeways in the near-term.

very poor condition or fail during the evaluation period. A cost–benefit analysis of the causeway rehabilitation component was conducted using the roads economic decision model (RED), which computes annual road agency's and users' costs over the evaluation period.[5] The unit vehicle operating costs and vehicle speeds are calculated for the without- and with-project case first, then annually for forecast traffic, total vehicle operating costs, travel time costs, and carbon dioxide (CO_2) emissions to derive the annual net benefits with the project. Generated traffic benefits are calculated using the rule of half as is standard practice.

13. The quantified economic benefits comprise savings in vehicle operating costs and travel time of traffic using the causeways. The improved facilities will significantly improve the travel speed to normal level at these locations and reduce fuel consumption, thereby reducing CO_2 emissions.[6] The evaluation includes valuation of CO_2 emissions in monetary terms.[7] The analysis considered an evaluation period of 23 years, including 3 years for construction from 2020 to 2042. The total financial capital cost for the causeways works is estimated at $8.0 million. The costs include pavement rehabilitation and associated costs, such as erosion countermeasures, structural repairs to causeway walls, and design and supervision. Economic costs were derived from financial costs and exclude price contingencies, taxes, duties, subsidies, and royalties. The economic costs are estimated to be 80% of the financial costs and apply a shadow wage rate factor to the labor component, which is considered at 5%. The causeways are expected to receive routine and periodic maintenance. The residual value of the project works is 40%.

14. The average daily traffic growth is 2.0% per year for all vehicles based on estimated gross domestic product (GDP) growth projections and an assumed elasticity of 1.2, halved considering that the outer islands could have lower economic growth than the overall economy.[8] The traffic growth rate is conservative considering population and economic growth and is kept at 2% over the analysis period. The economic value of passenger time is valued at $2.80 per hour per passenger, corresponding to two times the minimum wage for work trips.[9] The amount of time saved is marginal in case of rehabilitation (up to a minute) but will be significant (20–30 minutes) in case of causeway failure. Generated traffic is computed assuming a price elasticity of demand equal to –1.5.[10] The estimated generated traffic range is 25%–55% of normal traffic, depending on the estimated travel cost savings at each causeway. For failed causeways requiring reconstruction of walls and structures, the economic benefits are calculated assuming that the causeways will fail in 10 years, forcing users to take other modes of transport.

15. Eleven causeways will be rehabilitated under the project (Table 3). The economic evaluation was done for all the causeways, totaling 2,965 meters. The causeways are unsealed

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[5] The economic analysis of component 2.3 was prepared by the World Bank team and adopted for this report. RED is a software tool for the analysis and appraisal of road investment decisions on low-volume roads.

[6] The total gross CO_2 emissions in the initial years of operation under the without-project scenario are estimated at 74.6 tons and under the with-project scenario at 84 tons, resulting in a net increase of CO_2 emissions of about 9.3 tons per year. However, considering the failure of several causeways, CO_2 emissions will see a net reduction of 76 tons per year with the project.

[7] Intergovernmental Panel on Climate Change. Fifth Assessment Report (AR5). https://www.ipcc.ch/report/ar5/syr/; and High-Level Commission on Carbon Prices. 2017. *Report of the High-Level Commission on Carbon Prices*. World Bank.

[8] GDP has grown on average at 3.4% per year from 2011 to 2019 in constant prices.

[9] The minimum wage for local businesses and companies is A$1.30 an hour while the minimum wage for overseas-funded projects is A$3.00 an hour.

[10] The price elasticity of demand for transport measures the responsiveness of traffic to a change in transport costs following a road investment, and international experience indicates a range of –0.6 to 2.0. A value of –1.5 at the higher end of this range was adopted considering the induced traffic from island access infrastructure investment also. A price elasticity of –1.5 means that a 10% decrease in vehicle operating costs will result in 15% more generated traffic.

and carry about 445 vehicles per day on average.[11] Traffic is composed mostly of motorbikes (94%) and small trucks and a few cars (6%). Table 4 provides the estimated average unit vehicle operating costs over the analysis period without and with the project.[12]

Table 3: Causeways Basic Characteristics

No.	**Island**	**Causeway**	**Length** (m)	**Width** (m)	**Traffic** (vpd)
C01	Tabiteuea South	Northern Causeway	150	3.6	342
C02	Tabiteuea South	2nd Causeway from the North	102	6.7	504
C03	Tabiteuea South	3nd Causeway from the North	530	5.5	594
C04	Tabiteuea South	Southern Causeway	420	2.7	594
C05	Beru	Northern Causeway	420	4.9	414
C06	Beru	Southern Causeway	274	3.4	756
C07	Nonouti	Northern Causeway	275	2.6	252
C08	Nonouti	2nd Causeway from the North	330	2.7	252
C09	Nonouti	3rd Causeway from the North	144	5.6	162
C10	Nonouti	4th Causeway from the North	144	3.0	252
C11	Nonouti	Southern Causeway	167	4.3	162
Total or Average			2,956	4.0	445

m = meter, vpd = vehicle per day.
Source: World Bank estimates.

Table 4: Unit Vehicle Operating Costs
(US$/vehicle-kilometer)

Scenario	**Motorbikes**	**Small Trucks and Cars**
Without project	0.19	1.32
With project	0.17	1.19

Source: World Bank estimates.

16. **Causeway economic evaluation results.** The overall economic internal rate of return (EIRR) of this component is 10.9% (Table 5), indicating a rate of return above the opportunity cost of 9%. Sensitivity tests determined the effect of variations in key input parameters and with overall capacity development component costs added. Sensitivity analysis shows that the component is economically justified even if construction costs are 15% higher or if the estimated traffic growth rate is 15% lower or both. If construction costs are 15% higher and the estimated traffic growth rate 15% lower, the overall EIRR will drop to 9.1%. The cost–benefit streams for the overall project are in Table 6.

Table 5: Economic Evaluation Summary

Island	**NPV at 9% ($ million)**	**Base EIRR (%)**	**EIRR Sensitivity (%)**		
			A: Cost +15%	**B: Traffic growth rate –15%**	**C: A and B**
Tabiteuea South	0.7	12.0	10.7	11.5	10.1
Beru	-0.1	8.6	7.4	8.2	7.0
Nonouti	0.6	13.7	12.4	13.2	11.8
Total	**1.2**	**10.9**	**9.6 (+22%)**	**10.4 (-56%)**	**9.1(+/–16%)**

Note: Switching values given in parentheses.
EIRR = economic internal rate of return, NPV = net present value.
Source: World Bank estimates.

[11] Condition and traffic were estimated by visual observation and traffic counts conducted in 2019.
[12] Over the evaluation period, without the project, the causeways are estimated to have a roughness of 18 meters/kilometer, while with the project, roughness will decrease to 9 meters/kilometer, expressed in international roughness index.

Table 6: Cost–Benefit Streams for the Causeways
($ million)

Net Economic Benefits								
Agency Benefits		User Benefits						
Investment Costs	Maintenance Costs	Normal Traffic VOC	Normal Traffic Time	Generated Traffic VOC	Generated Traffic Time	Road Safety	CO_2 Benefits	Total
–1.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–1.183
–2.957	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–2.957
–1.774	0.000	0.000	0.000	0.000	0.000	0.000	0.000	–1.774
0.000	–0.004	0.056	0.097	0.015	0.026	0.000	–0.001	0.189
0.000	–0.004	0.058	0.099	0.015	0.026	0.000	–0.001	0.193
0.000	–0.004	0.059	0.101	0.016	0.027	0.000	–0.001	0.197
0.000	–0.004	0.060	0.103	0.016	0.027	0.000	–0.001	0.201
0.000	–0.004	0.061	0.105	0.016	0.028	0.000	–0.001	0.205
0.000	–0.004	0.062	0.107	0.016	0.028	0.000	–0.001	0.209
0.000	0.003	0.356	0.525	0.222	0.325	0.000	0.010	1.442
0.000	0.003	0.363	0.536	0.227	0.332	0.000	0.010	1.471
0.000	0.003	0.371	0.547	0.231	0.338	0.000	0.010	1.501
0.000	0.003	0.378	0.557	0.236	0.345	0.000	0.011	1.531
0.000	0.003	0.386	0.569	0.241	0.352	0.000	0.011	1.562
0.000	0.003	0.393	0.580	0.246	0.359	0.000	0.012	1.593
0.000	0.003	0.401	0.592	0.251	0.366	0.000	0.012	1.625
0.000	0.003	0.409	0.603	0.256	0.374	0.000	0.013	1.658
0.000	0.003	0.417	0.616	0.261	0.381	0.000	0.013	1.691
0.000	0.003	0.426	0.628	0.266	0.389	0.000	0.014	1.725
2.366	0.003	0.434	0.640	0.271	0.396	0.000	0.014	4.126
							Net present value at 9%	**1.2**
							Economic internal rate of return	**10.9%**

VOC = vehicle operating cost.
Source: World Bank estimates.

D. Financial Sustainability Analysis

17. The objective of the analysis was to ensure that the project is financially sustainable. The project components are nonrevenue-generating infrastructure, and the financial analysis focused on assessing the capacity of the implementing agency to absorb the incremental operation and maintenance (O&M) cost associated with project. The analysis involved identifying the budget allocation for O&M in various entities, estimating the incremental O&M cost associated with the proposed project, approximating the impact on overall O&M requirements, and assessing the likelihood of adequate budget allocation to cover the required maintenance and the responsible entities' execution capacity.

18. The MICTTD is responsible for O&M of shipping-related infrastructure and the Ministry of Infrastructure and Sustainable Energy (MISE) for maintenance of causeways. The requirement for maintenance of infrastructure created under the project is about $0.2 million annually for the MICTTD and $0.03 million annually for the MISE.

19. The maintenance allocation in the MICTTD budget has been negligible for shipping infrastructure as the port authority has operated minimal infrastructure in addition to existing major ports. The annual recurrent expenditure budget for the MICTTD is about $3.0 million and expected O&M expenditure will be about 7% of recurrent expenditure. If the recurrent and developmental budgets allocated for the MICTTD are considered, additional maintenance expenditure will be close to 1% of total allocation. The project includes a capacity-building component and will support the MICTTD in establishing maintenance capacity in the outer islands. The grant agreement may seek additional assurances from the government that adequate funds for maintenance will be allocated in the budget of the MICTTD for outer island maritime infrastructure maintenance.

20. The MISE has a budget allocation of about $3.5 million annually for recurrent expenditure, including $0.82 million annually for infrastructure maintenance. The additional maintenance cost of the causeway section is less than 4% of the annual infrastructure maintenance budget of the MISE, less than 1% of the recurrent expenditure, and insignificant if we consider the total recurrent and developmental budget allocated for the MISE. The poor condition of the causeways indicates limited attention given to maintaining them. Adequate capacity and commitment to ensure sustainable maintenance will be developed under the capacity development component.