CCOP/SOPAC Technical Report 82

4 May 1988

INITIAL SURVEY OF THE BETIO/BAIRIKI CAUSEWAY, TARAWA, REPUBLIC OF KIRIBATI

September 1987

by

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Prepared for: Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) Kiribati Project: CCSP/KI.4

Contributed by: Canada, International Centre for Ocean Development

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SUMMARY

A ten-day field programme was conducted in South Tarawa in September 1987 to establish a monitoring programme on the recently completed Betio/Bairiki Causeway. The monitoring programme addressed the concern that causeway construction could sufficiently alter sediment dispersal in the area to cause accelerated coastal erosion on either Betio or Bairiki. Four activities were undertaken during the survey:

1. construction drawings were acquired;

2. an aerial reconnaissance overflight was undertaken;

3. beach profiles were established and surveyed;

4. reconnaissance ground observations were made.

By comparison of pre- and post-construction sediment dispersal patterns in the causeway area, an assessment of impact is possible.

A review of previously published reports and observations indicate (a) that approximately 1,200 to 2,500 m^3/yr of carbonate sediment is produced on the reef flat in the causeway vicinity and (b) that some of this material accumulated in the bars on the reef flat and some was transported to the west. The contribution of other sources in the area, such as from the lagoon or from the east, is unknown. In excess of 8,500 m^3/yr has accumulated on Betio over the last 40 years, indicating that

other sources, such as material from the lagoon, contribute sediment to Betio.

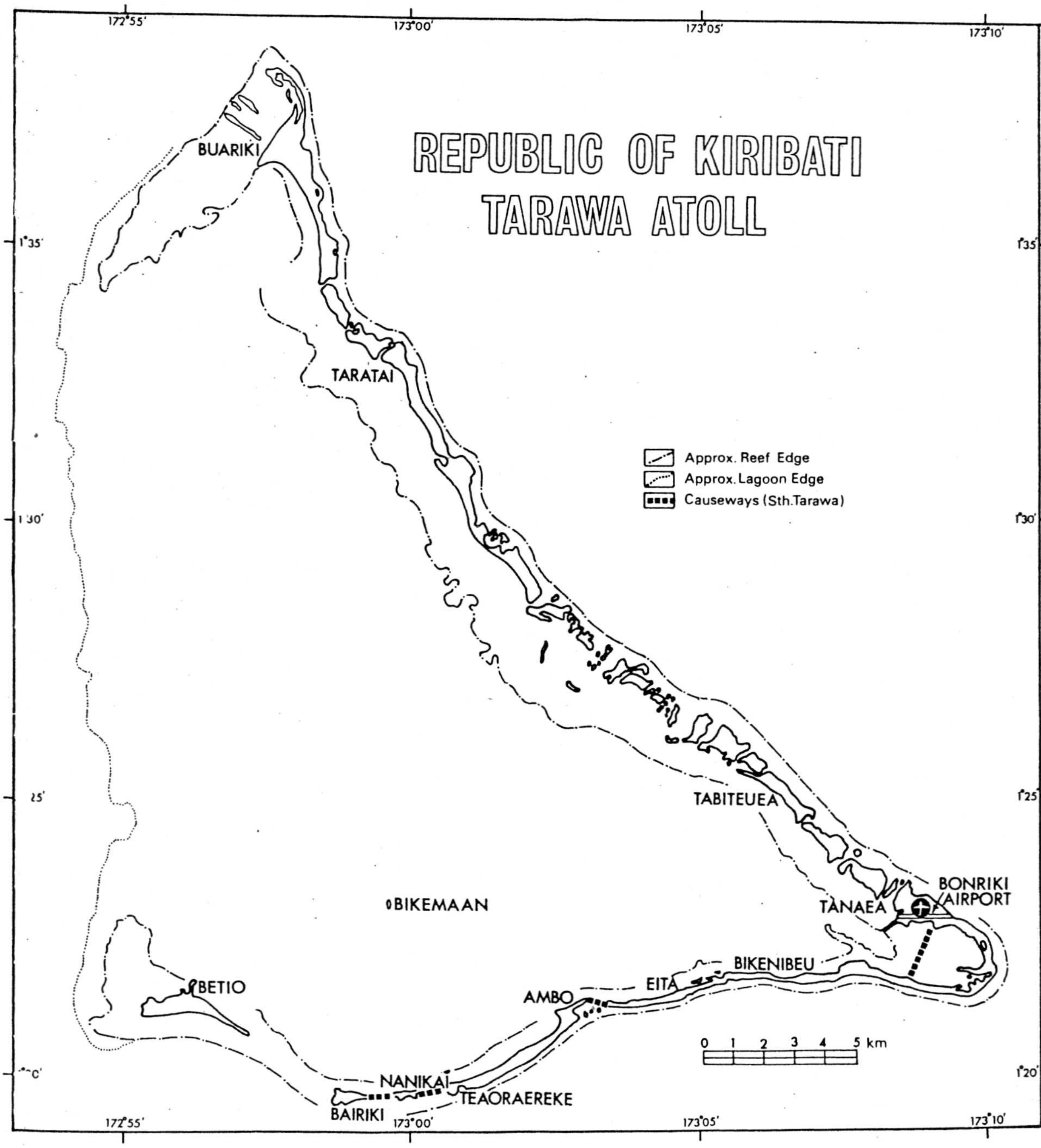

FIGURE 1 Location map of the Tarawa atoll area.

In excess of 90,000 m^3 of sand material has accumulated adjacent to the causeway since construction. Much of this material probably came from the bars that were previously present in the area. The causeway, fisheries channel and borrow pits, from which construction material for the causeway was taken, may be removing a significant proportion of the annual sediment production and there is the potential to remove all of the 1,200 to 2,500 m^3 produced in the area from the sediment dispersal system. While this is of concern, the quantitative effect on the Betio shoreline cannot be predicted at the present time.

It is recommended that the beach and causeway profiles be surveyed at four-month intervals so as to closely monitor changes along the causeway and along the Betio shoreline. Annual monitoring of the borrow pits and fisheries channel should be initiated during the next survey. Following a proposed resurvey in January, 1988, the impact of the causeway will be reassessed.

INTRODUCTION

This report describes the results of a 10-day survey of the Betio/Bairiki Causeway on Tarawa Atoll (Fig. 1), Republic of Kiribati. The survey was made in September 1987, two months after causeway completion and was intended to serve as a baseline for monitoring the effects of the causeway on coastal processes in the area.

This work was undertaken as part of the CCOP/SOPAC Work Programme element CCSP/KI.4 (Baseline studies of inshore areas in Kiribati for coastal development and protection).

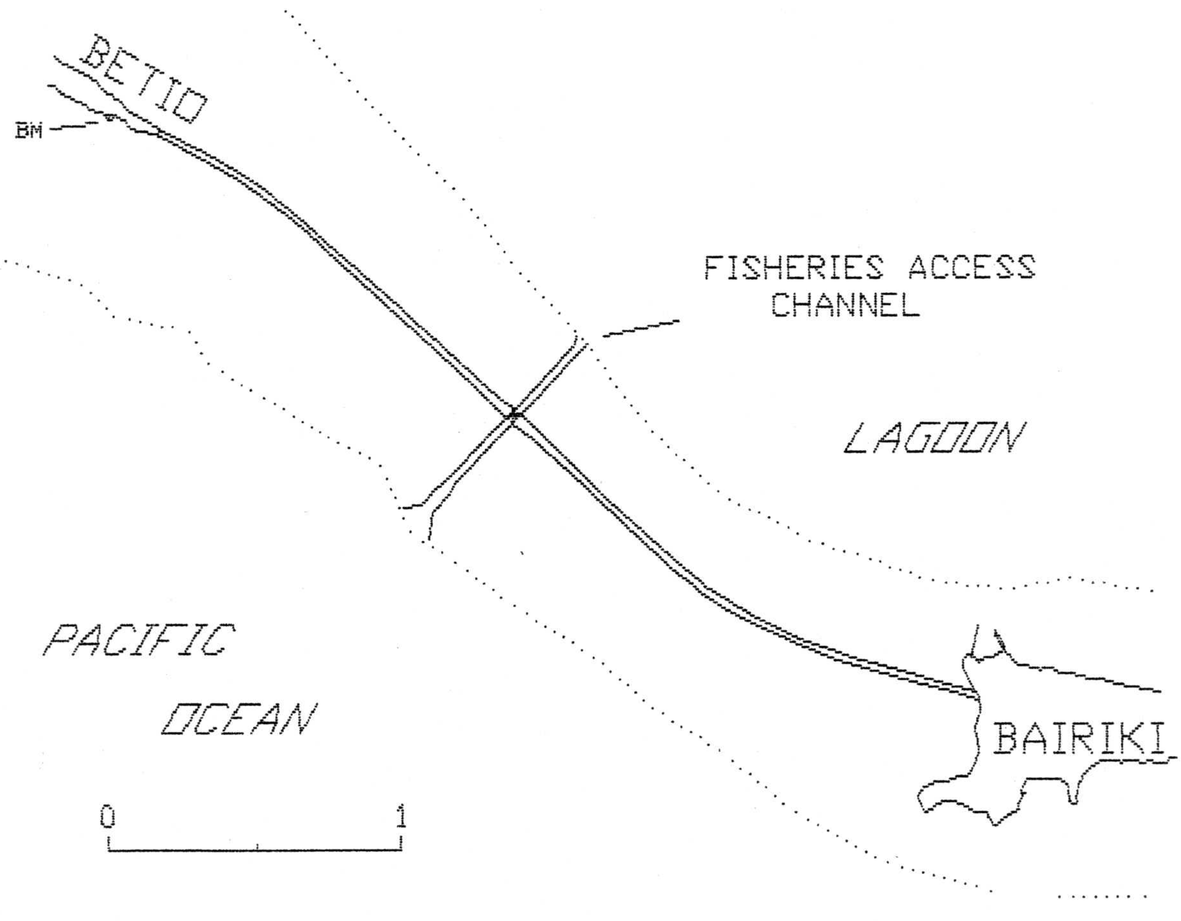

FIGURE 2 Location of the Betio/Bairiki causeway and fisheries access channel.

FIGURE 3 (a) Aerial photograph of the Betio end of the causeway looking eastward (September, 1987).

(b) Aerial photograph of the Bairiki end of the causeway looking westward (September, 1987).

BACKGROUND

The Betio/Bairiki Causeway was initially considered as early as 1966 and initial construction tenders were let in 1977. Construction began in 1978 but ceased 4 months later as a result of a shortage of dredgeable material.

Final construction began in August, 1987 and was completed in July 1987 under the sponsorship of the Japan International Co-operation Agency (JICA, 1985).

The causeway is of solid fill construction, 3.4 km long and contains a single breach as access for small fishing boats, known as the "fisheries access channel" (Figs 2, 3). Although no "as built" drawings have been produced, construction followed design very closely, and design drawings adequately depict construction detail (Bill Young, pers. comm., 1987). Design sections are shown in Figure 4 and design specifications provided in Table 1. The concrete slope protection consisted of "grout-filled fabric" which took on the appearance of concrete pillows.

The main concerns in the design development were:

(1) a causeway height sufficient to prevent overtopping; and

(2) an alignment that would minimize transport of fill material from borrow areas to the causeway (JICA, 1985).

Wave hindcasting indicated that the maximum offshore waves are from the southeast with a significant height (H_s) of 6.1m (50 year return period). Refraction and shoaling analysis indicated that this wave would have approximately H_s of 0.7m at the causeway at high tide and may be associated with a set-up of 0.7m.

MHWS	1.8m
Set-up/run-up	0.7m
Wave height	+0.7m
	+3.2m above datum (MSL is 0.94m above datum)

A design formation height of +3.3m was chosen to allow for some camber of the causeway road surface. In addition, concrete dividers or parapets extend up to +3.8m to provide additional protection against wave run up (Fig. 4).

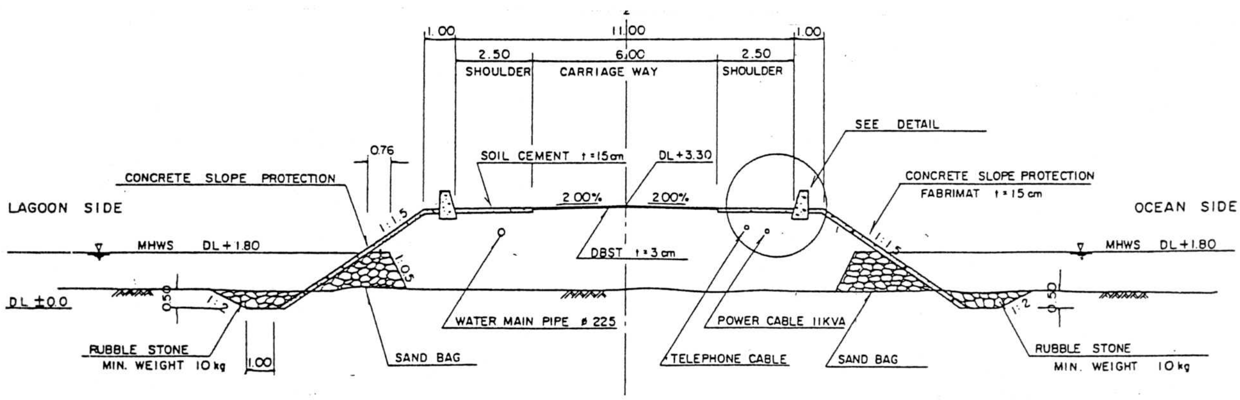

FIGURE 4 Typical design cross-section of the causeway (from JICA, 1985)

Table 1 Causeway Design Specifications[1]

Causeway

Length:	3.4km
Width:	13.0m (surface)
	25.0m (base)
Height:	+3.3m (roadway)
	+5.3m (bridge roadway)
Embankment Volume:	144,400m^3
Side Slope:	1:1.5 (concrete covering)

Fisheries Access Channel

Length:	800m
Width:	10m
Base Elevation:	-1.7m

[1] Chart datum used for all vertical references; MSL is 0.94m above datum, MHWS is +1.8m and MLWS is +0.4

Fill requirements for the causeway were as follows :

Embankment Fill	144,400m^3
Sand for Bags	14,700m^3
Rubble Toe protection	5,900m^3
	159,100m^3

Aggregate for concrete used in fill for the mats, the bridge and the parapets was taken from the Bonriki borrow pits near the airport and is not included in the above estimates.

Fill was taken from 3 areas near the causeway (Fig. 5) in addition to the aggregate from Bonriki. No precise estimates on the amount of fill taken from each area are known, however, previous estimates of fill in the bars along the causeway alignment, referred to as Borrow Area "B", were in the order of 90,000m^3. Amounts taken from borrow Areas "C" and "D" could have been as much as 75,000m^3 each (JICA, 1985). In addition, as much as 22,000m^3 was excavated from the fisheries channel, an unknown amount of which was used for toe-protection and fill.

SURVEY OBJECTIVES

The purpose of this survey was to document immediate post-construction conditions of the sediment dispersal system in the vicinity of the causeway. Of particular concern was that disruption of the sediment dispersal system could cause coastal erosion or accretion in areas adjacent to the causeway. Specific objectives of the field survey were to:

(1) document the accumulation of sand adjacent to both sides of the causeway;

(2) document sediment transport directions along the causeway and adjacent coastal areas;

(3) document location and infilling of reef-flat borrow pits;

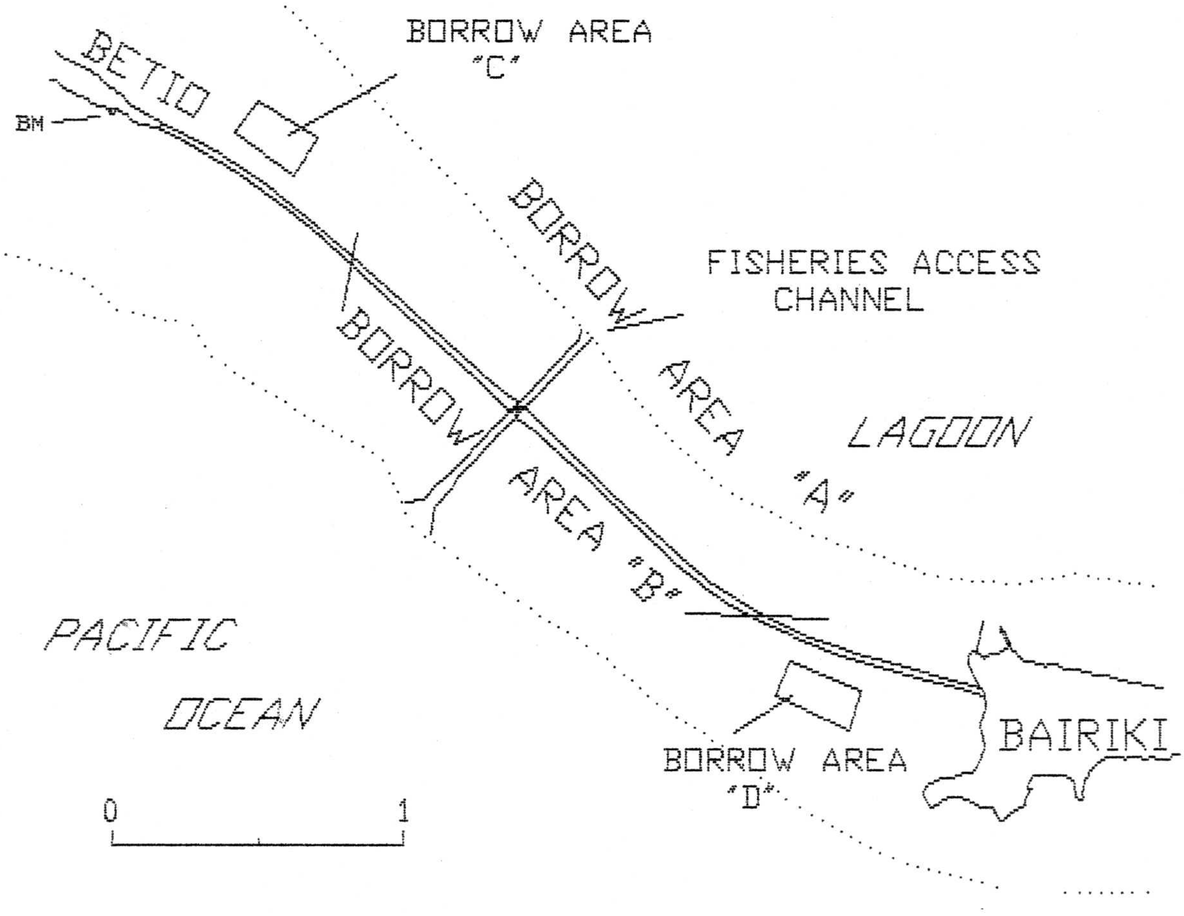

FIGURE 5 Location of borrow areas from which fill material was taken for the causeway. Area "A" was not used during the latest construction phase but was used during a previous construction attempt.

(4) make observations of coastal erosion or accretion (a) along the causeway and (b) adjacent coastal areas.

PERSONNEL PARTICIPATING

The support of the Republic of Kiribati is appreciated during this survey. In particular the following individuals provided valuable assistance:

Marae Irata, Assistant Secretary of Natural Resource Development

Abureti Takaio, Assistant Secretary of Natural Resource Development

Being Yeeting, Fisheries Officer, Fisheries Division

Bill Young, Chief Engineer, Public Works

Kaareti Teuataake, Surveyor, Lands & Surveys

Tim Orsborn, Chief Pilot, Air Tungaru

PRE-CAUSEWAY SEDIMENT DISPERSAL

Previous Studies

Howorth (1982a) used sequential vertical aerial photos to evaluate coastal stability on Betio and conducted a field reconnaissance of coastal structures. The airphoto analysis indicated that between 1945 and 1969 major coastal accretion had occurred along northwest Betio, to the east of Betio harbour, and locally along the western end of Betio. Some areas of coastal erosion had occurred but the net areal change was in the order of +117,000m^2. Assuming the normal thickness of beach face accretion zone is 2.5m, then an estimated 8,500m^3/yr was added to Betio. Howorth (1982b) also established beach profiles which have been useful in evaluating (a) natural fluctuations in shoreline position due to changes in wind intensity and (b) longterm changes that have resulted from construction projects in the coastal zone.

Carter (1983) conducted beach profile surveys, current measurements and wave hindcasting to evaluate potential effects of the proposed causeway. He concluded that the causeway would probably have minimal effect on sediment transport and circulation, although he estimated between 2,800 to 4,200m^3/yr might have transferred from the north to south side of the causeway to replenish southern Betio beaches. He also recommended that no borrow material be removed from the southern reef flat because removal could affect local wave refraction patterns.

Of special interest to the study were the observations of Zann (1981) that "sediment-laden lagoon waters flowing into oceanic waters deposit fine silt over the reef slope, smothering corals and reefs of the terrace .... there appears to be a considerable movement of lagoon water by east to southeast trades through the causeway area into the open sea, where lagoonal sediments are deposited as scree on the reef slope .... thus lagoonal sediments are continuously being lost to the seaward slopes via the Bairiki/Betio platform."

Burne (1984) reviewed previous studies from the Tarawa area (e.g. Zann, 1981; Weber and Woodhead, 1972) as part of a field survey on the sediment dispersal of South Tarawa. Some of the significant points made by Burne (1984) were:

1. there was no strong evidence to support the concept of extensive longshore drift in the area and most coastal sediment accumulations could be explained as onshore transport.

2. the extensive sand accumulation in the northwestern corner of Betio probably occurred as west-to-east movement of sands from the sand bodies west of Betio.

3. the sand accumulating off the western end of Betio is "*Halimeda*-rich", suggesting a lagoonal origin.

4. provenance work done by Zann (1981) indicates a reef front/reef flat origin for most sands on South Tarawa.

Byrne (1987) reviewed aerial photographs to evaluate potential effects of the causeway. He speculates that the reef flat between Betio and Bairiki is a major sediment source for the material accumulating on the northwest portion of Betio, sand forms on the reef, accumulates in the bars, and then moves westward along the bars and the south coast of Betio. Byrne (1987) suggests that the causeway has now removed this sediment source and only sand formed on the south reef will now be supplied to Betio. Carter (1983) reached a similar conclusion, indicating that artificial beach nourishment may be required.

Maps of Reef Flat Bars

Aerial photographs from July 1968 were reviewed to determine sediment dispersal patterns under pre-causeway conditions. The reef flat is characterized by a series of sand and gravel bars, cut by semi-permanent tidal channels and washover channels (Fig. 6a).

The position of the bars on the flat suggests that some type of dynamic equilibrium exists in terms of ocean- and lagoon-directed sediment transport. Slipfaces on the bars and tidal channel morphology suggests a lagoon-directed transport. There is a slight suggestion of dominant longshore transport to the west, as indicated by deflection of sand sheets seaward of the passes.

The 1969 aerial photographs show the same general features of the bars and passes, but washover channels are more common (Figure 6b). Also morphology of the tidal channels suggests a lagoon-directed sediment transport whereas slip-faces on the bars suggest an ocean-directed transport. A veneer of sheet-sands on the south side indicates a recent overwash event from the lagoon to the ocean. The bar morphology provides no indication of longshore transport in terms of bar or tidal pass morphology.

Pre-Causeway Sediment Dispersal

Previous reports have indicated that the area of the Betio-Bairiki Causeway is an important source of sediment to the surrounding islands, particularly to Betio, although Burne (1984) suggests sources to the west may be important. In that the area of this reef is in the order of 3.3×10^6 m^2, then approximately 1.6 to 3.3 million kg/yr or 1,200 to 2,500m^3/yr (assumes bulk density of 1,270 kg/m^3; Carter, 1983) of carbonate sand will be produced on the reef around the causeway (see section, "Sediment Budget" for details of the calculation).

A balance of wave energy between the lagoon and ocean had resulted in a quasi continuous reef-flat bar between Betio and Bairiki. The bar position moved in response to episodic storm events from either the lagoon or ocean side.

Although there is no strong indication of longshore sediment transport along the bars, transport along the southern coast of Betio is to the west, as indicated by (a) the groin-effect of gun emplacements on the southeastern shore and (b) the accumulation of material on the east side of Betio Harbour.

POST-CONSTRUCTION SURVEYS

Reconnaissance Observations

Causeway The causeway is performing generally as per design (e.g. there has not been any overtopping of the causeway, and there are no serious erosion or structural problems) with significant beach development along much of its length. In only a few locations is the toe protection exposed, and as sediment continues to build up against the causeway, these areas may eventually be covered.

A significant portion of the causeway was damaged during a December 1986 storm. The broken slope protection, an estimated

1,000m or (15% of the total), was pushed away from the causeway and new slope protection installed.

Borrow pits were made in two areas, one to the southeast and one to the northeast of the causeway (Borrow Areas "C" and "D" of Figure 5). There is no documentation on the amount of material removed and pits did not follow the original design. They are smaller in area and considerably deeper (Fig. 7). As such, they are likely to act as significant sediment sinks until such time as they are

FIGURE 7 Aerial photograph of Borrow Pit "D" near Bairiki (September, 1987).

filled. This may involve up to 150,000m^3 (design estimates of fill required for causeway; JICA, 1985).

Channel In general, the fisheries access channel appears to be performing as per design (e.g. providing all-tide access across the reef) with one exception. At a location approximately 100m south of the bridge, the channel is infilled with sediment to a depth of -0.2m relative to datum (Fig. 8). With this exception, the channel appears to be near design depth at most locations. Also, observations of breaking waves at the reef edge at high tide indicate that wave breaking does not occur at the channel mouth.

The reason for the channel infilling is of potential significance to the sediment budget of the area. There is ponding of water between the outer reef and the causeway. The base of the reef flat appears to be about 0.5 to 1.0m above datum and as the tide level falls below this level, water and sand drain off longitudinally into the channel. The sand apparently accumulates where the longitudinal flow intersects the channel, although this is surprising given the strong currents that occur in the channel (design estimates were up to 3 m/s or 6 knots; JICA, 1985). Up to 500m^3 has accumulated there since the channel opening.

Sand accumulation is of concern because it affects the navigability of the channel (water depth of about 0.3m at MLWS) and because it indicates that the channel is a significant sediment sink for sand production on the south reef flat. The 500m^3 of sand accumulation is equivalent to the annual sand production for the south reef flat adjacent to the causeway (refer to section "Sediment Budget" for details).

FIGURE 8 (a) Fisheries access channel looking toward the lagoon. Note the shoal area in the channel due to draining of the reef flat. Note also the greater beach width to the right of the bridge, indicating a right-to-left longshore transport (westward) on the ocean side.

(b) Fisheries access channel looking toward the ocean. The greater beach width to the right of the bridge indicates a right-to-left longshore transport (eastward) on the lagoon side.

Cross-Causeway Profiles and Sediment Accumulation

In September 1987, cross-causeway profiles were surveyed at 100 m intervals along the causeway (Fig. 9) to estimate sediment accumulation adjacent to the causeway. Beach profiles and survey data are included in Appendices A and B. An example of a post-construction beach profile is included in Figure 10.

Sediment accumulation volumes were estimated by (a) measuring the cross-sectional area between the causeway design profile and the beach surface, and (b) extrapolating this area to the 50 m sections on each side of the profile. The volume of sediment associated with each profile is indicated in Table 2. The data are useful for assessing the immediate post-construction performance of the causeway and the potential effects on the local sediment budget.

The measurements indicate that a significant volume of sediment (92,000m^3) has accumulated adjacent to the causeway since construction, although it is unknown how much of the previous bar sediment was used in causeway construction (Bill Young, pers. comm., 1987). Approximately 39,000m^3 have accumulated along the ocean side and 53,500m^3 along the lagoon side. The difference in accumulation does not necessarily reflect a lagoon to ocean transport but may simply represent a large amount of material initially present on the lagoon side of the causeway.

Alongshore variations in sediment accumulations are more significant on the ocean-side of the causeway (Table 2) and there are several locations, where virtually no sediment has accumulated. An overlay of the pre-causeway bar positions in

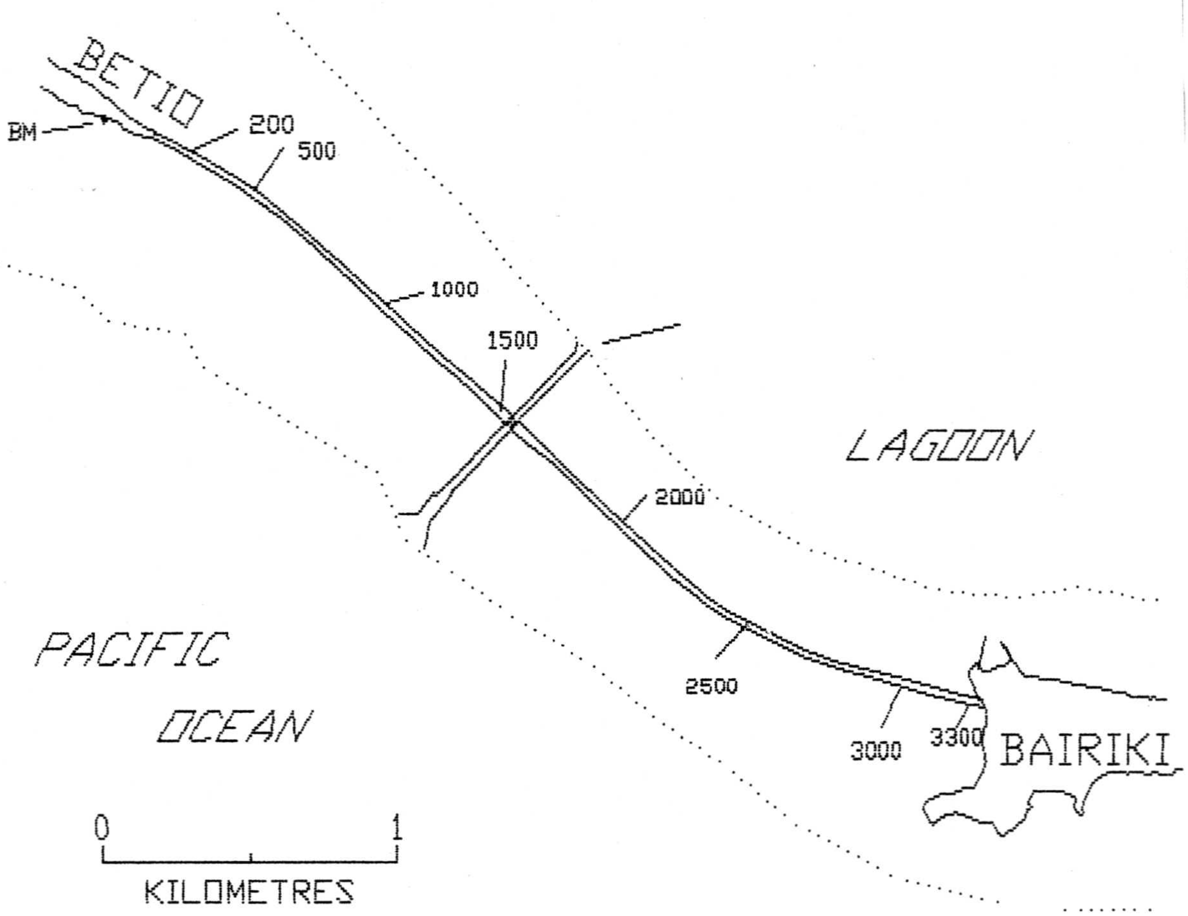

FIGURE 9 Location of causeway beach profiles. Profiles were surveyed every 100 m, beginning at location 200 (near the western end of the causeway) and extending to location 3300 (near the eastern end of the causeway).

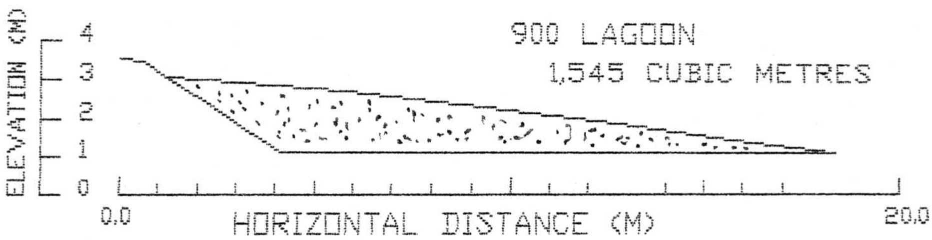

FIGURE 10 Example of a beach profile adjacent to the causeway. The shaded area indicates accumulated sand material.

1969 (Fig. 11) indicates that the areas of present sediment deficiency cannot be correlated with former tidal channel positions.

There is some indication of longshore transport directions apparent in the data, specifically measurements made on each

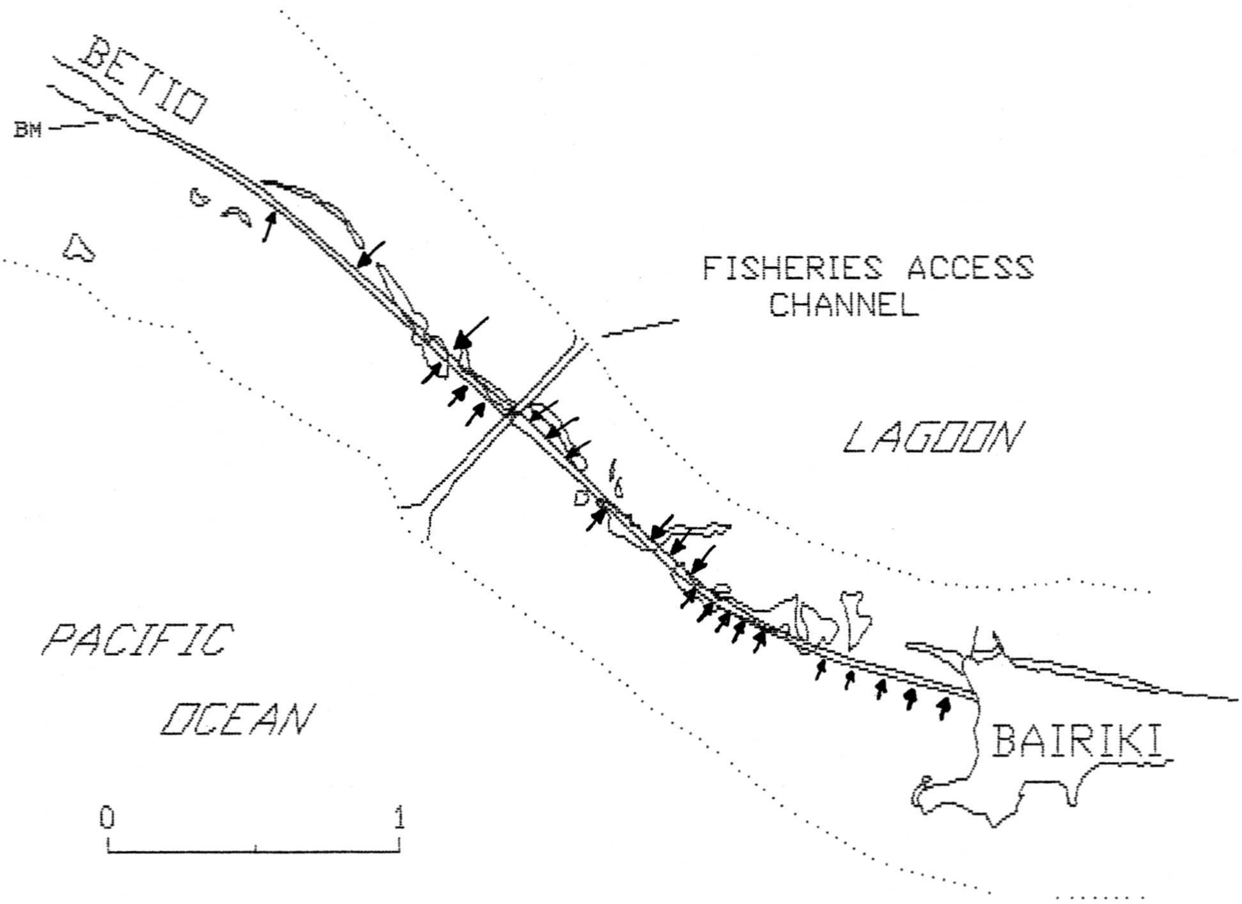

FIGURE 11 Relationship of bar positions (June, 1969) to present areas of sediment deficiency (indicated by arrows).

TABLE 2 Volume of Sediments along Causeway.

OCEAN VOLUME (M^3)	DISTANCE ALONG CAUSEWAY FROM BETIO (metres)	LAGOON VOLUME (M^3)
	100	
	200	1,260
2,671	300	1,030
2,746	400	1,376
2,254	500	1,522
719	600	1,546
1,026	700	2,736
2,651	800	838
1,946	900	1,545
1,930	1000	1,015
2,511	1100	1,224
1,970	1200	756
424	1300	1,268
602	1400	2,724
373	1500	1,150
FISHERIES ACCESS	BRIDGE	FISHERIES ACCESS
1,659	1600	320
1,587	1700	387
2,081	1800	914
861	1900	1,414
1,345	2000	1,569
1,568	2100	1,352
1,402	2200	863
692	2300	888
*495	2400	828
439	2500	1,528
770	2600	2,074
1,188	2700	2,697
486	2800	2,218
*760	2900	3,747
*623	3000	4,768
*230	3100	7,916
*396	3200	
*384	3300	
85	3400	
38,874	TOTALS	53,473
Total (both sides)	92,347	

* indicates mostly rubble

side of the fisheries channel (Table 2). The measurements suggest east-to-west transport on the ocean side and west-to-east transport on the lagoon side. The fisheries channel appears to be a sediment sink for material being transported in either direction along the causeway (Fig. 8).

Post-Causeway Sediment Dispersal

A considerable volume of sand is presently accumulating adjacent to the causeway and more than 90,000m^3 has accumulated to date. The accretion adjacent to the causeway is regarded as beneficial as it will serve as a natural buffer against ocean waves.

Major features of the observed sediment transport system are summarized in Figure 12. At the time of the survey, longshore transport appeared to be to the west on the ocean side and to the east on the lagoon side. It is anticipated that the net (long-term) drift along the ocean side will be to the west. However, the apparent eastward longshore drift along the lagoon side is probably due to the anomalous occurrence of westerly winds for 1987. Past accumulations of sand to the east of the Betio and Bairiki jetties indicate dominant east to west transport. However, these areas are currently being eroded, supporting the observation that the westerly winds may be temporarily causing eastward transport along the lagoon shore.

The fisheries access channel has completely silted in at one location (est. 500m^3) and appears to be interrupting longshore sediment transport. If the net transport in the channel is to the south, most of the sediment will be lost off the reef edge and lost from the system.

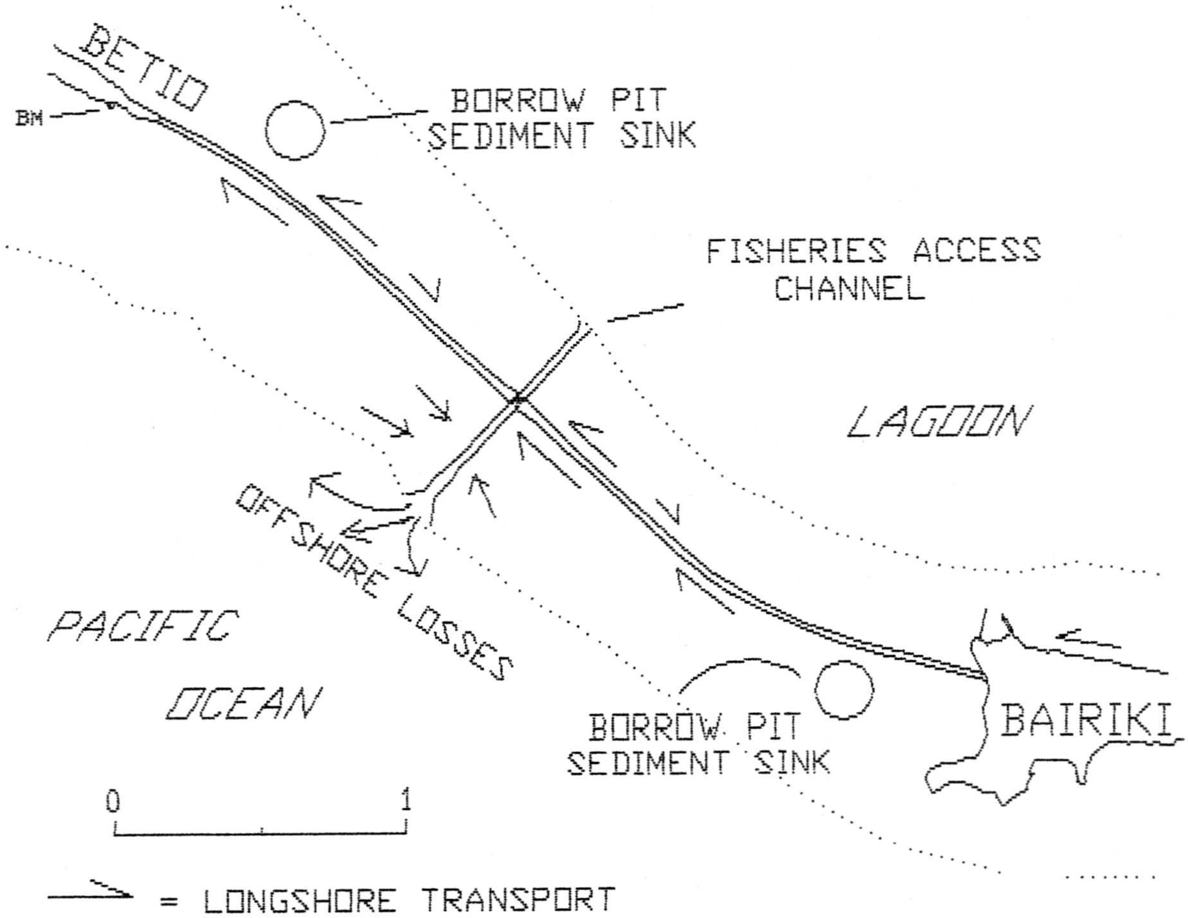

FIGURE 12 Summary of sediment transport paths around the causeway (larger arrows indicate present dominant transport directions).

Sediment Budget

A sediment budget was developed to assist with an assessment of potential impacts. This sediment budget is summarized in Table 3. For purposes of this discussion, the area of concern is the Betio to west Bairiki coastline and reef area (Fig. 13). Any increase of sediment losses to this system could result in accelerated coastal erosion on Betio.

Sources to the system include (a) carbonate material produced on the reef flat and reef front, (b) carbonate material produced in the lagoon and (c) material transported alongshore, principally from areas to the east. Given that the reef areas are in the range of 20×10^6 m^2, then an estimated 8,000 to 16,000 m^3/yr could be produced on or around the reef flat (based on a range of production rates of 0.5 to 1.0 kg/m^2/yr). There is no information on material contributed from the lagoon, although Burne (1984) notes that sand banks on western Betio are Halimeda-rich suggesting a lagoonal source. Marshall and Jacobsen (1985) suggest that most material is derived from the ocean reef flat and that the lagoon is a sediment sink. Although there is no hard evidence to support the assumption of a lagoonal sediment source, (a) extensive accumulations of material along the lagoon shore of other causeways, (b) the greater rate of accumulation of sand along the present causeway and (c) the presence of Halimeda-rich sands suggest lagoonal sources are possible. The lack of large sediment accumulations along the Bairiki shoreline suggest that only a small amount of sediment is contributed to the system from longshore transport. Therefore, the total sources are estimated to be at least 8,000 to 16,000 m^3/yr.

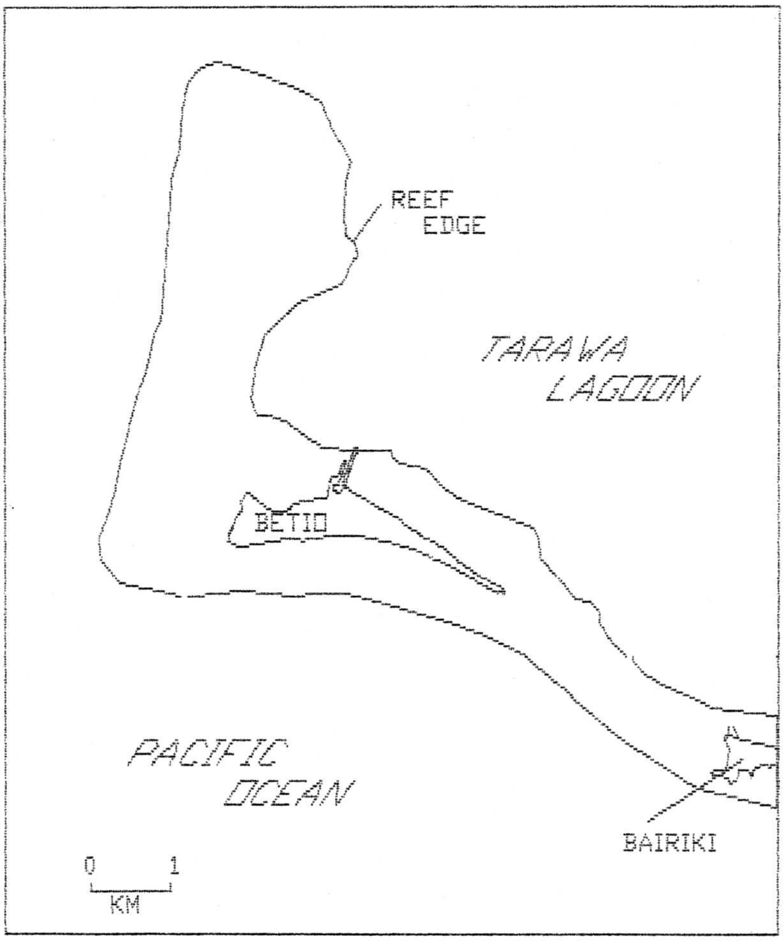

FIGURE 13 The area of the "coastal system" used in the sediment budget calculations.

TABLE 3 Sediment Budget for the Betio/west Bairiki "coastal system"

		Rate (m^3/yr)
I.	SOURCES:	
	Reef flat/reef front	8,000-16,000
	Lagoon	?
	Longshore transport	small
	Total Sources	>8,000-16,000
II.	SINKS:	
	Betio shoreline	8,500
	Offshore	?
	Lagoon	?
	Total Existing Sinks	>8,500
III.	NEW SINKS:	
	Causeway	2,000 (?)
	Borrow Pits	10,000
	Channel	2,000 (?)
	Total New Sinks	14,000
	Total Sinks at Present (I + II)	>22,500

Pre-existing sinks to the area include:

(a) accumulation of material along the Betio shoreline; and

(b) material lost offshore and to the lagoon.

The former, "a", is estimated at 8,500 m^3/yr (Howorth, 1982a), but the latter cannot be estimated, although it is likely that the estimate of material produced on the reef (8,000 to 16,000 m^3/yr) is actually the net balance between the amount produced and amount lost offshore. The estimates indicate that more than 8,500 m^3/yr were lost to the system through pre-existing sinks.

Of particular concern is that several new sinks have been added as a result of causeway construction, including:

(a) material accumulating along the causeway;

(b) material accumulating in the borrow pits;

(c) material lost offshore via the fisheries access channel.

No documented estimate is available yet for material accumulating adjacent to the causeway although an estimate of several thousand cubic metres per year is not unrealistic. Assuming the borrow pits are in the range of 150,000m^3 and will require 15 years to infill, about 10,000m^3/yr could be lost due to infilling. The fisheries access channel is intercepting both reef flat drainage and longshore transport. Although there is no way of estimating this loss accurately, the channel has infilled relatively rapidly (500m^3 in 3 months), suggesting several thousand cubic metres per year is not unrealistic. As such, potential sinks of up to 14,000m^3/yr have been added to the "coastal system".

There are many approximations in this budget estimate and the results must be interpreted cautiously. However, the analysis emphasizes:

(a) that several new sediment sinks have been added to the "system";

(b) that, as a first approximation, the sinks appear to be of the same order of magnitude as pre-existing sources and sinks. This result is reason for concern about the long-term impact of the causeway on the Betio coastal system.

CONCLUSIONS

1. Prior to causeway construction longshore drift was predominantly east to west, although reversals in drift direction have occurred during periods of anomalous westerly winds (i.e. during the Southern Oscillation or El Nino).

2. Historical records indicate net accumulation has been occurring around the island of Betio, in the order of 8,500m^3/yr.

3. Approximately 90,000m^3 of sediment has accumulated adjacent to the causeway as of September 1987.

4. Several new sediment sinks, including the beaches along the causeway, the borrow pits, and the fisheries access channel, have been added to the "coastal system". Preliminary estimates indicate these sinks are of comparable magnitude to pre-existing sources and sinks and are likely to reduce the rate of sediment accumulation on Betio.

RECOMMENDATIONS

1. In that the borrow pits and fisheries access channel appear to be acting as sediment sinks to the system, it is recommended that (a) the pits and (b) the channel and immediate approach areas be sounded to monitor changes in sand volumes. This will allow refinement of the sediment budget.

2. The surveys of sand accumulation adjacent to the causeway should be repeated at four-month intervals during the first year to ascertain sand accumulation rates.

3. Beach profiles on Betio and Bairiki should be resurveyed in early 1988 and subsequently at four-month intervals to monitor potential effects on beaches, particularly Betio.

4. Acquire a SPOT satellite image of South Tarawa to document areal extent and morphology of reef flat sand bodies (i.e., develop baseline data on immediate post-construction sand distributions).

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APPENDIX A

Cross-Causeway Profiles

10-11 September 1982

Beach profiles were surveyed at 100m intervals along the causeway to document the accumulation of material adjacent to the causeway.

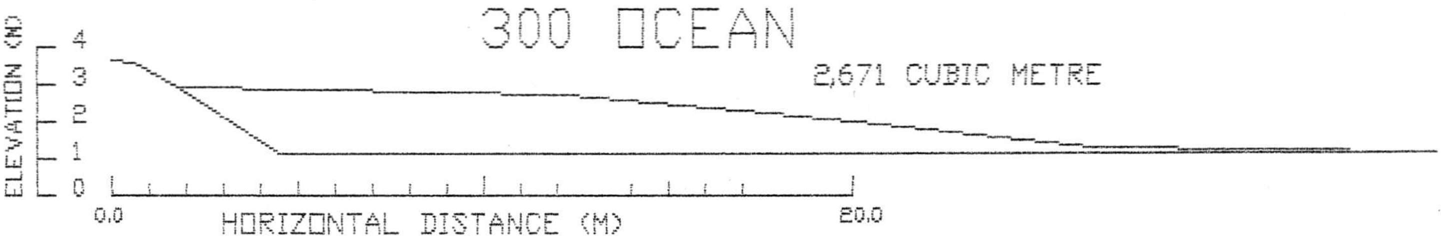
The profiles were located at previously marked 100 m intervals (e.g. 1000, 1100, 1200, etc. (see Fig.9).

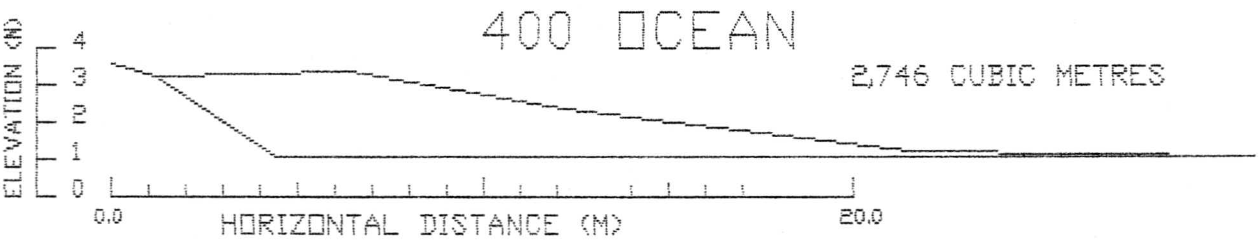
In all cases a datum to the outside of the concrete parapet was used as a starting point for all profiles.

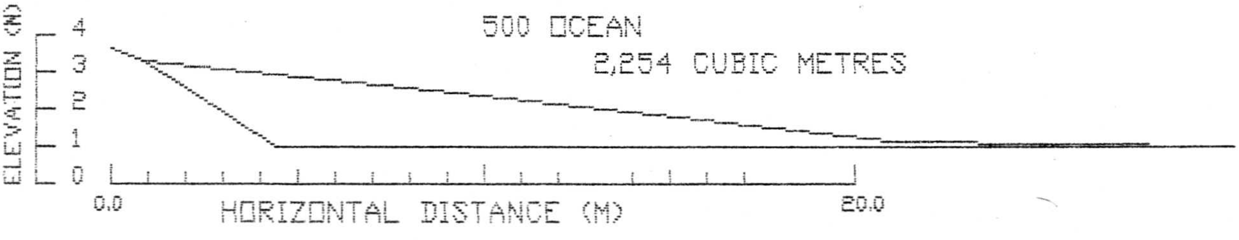
Design drawings were used to estimate horizontal position of datum points. Vertical elevation was established at each point by leveling from a known bench mark (BM2 at western end of the causeway).

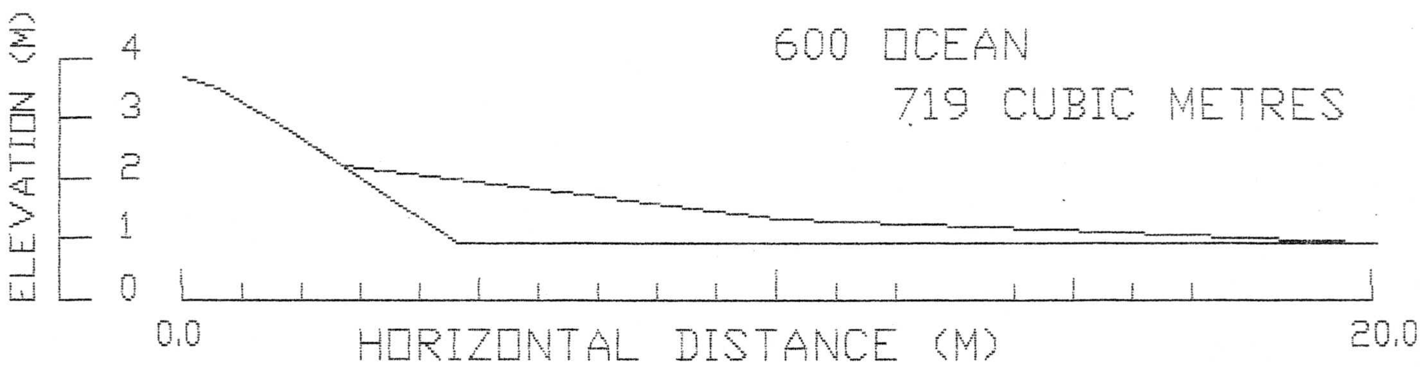
Profiles were surveyed using the Emery Beach Profile Survey Method, a fast reconnaissance survey method for determining large-scale (>10cm) beach changes.

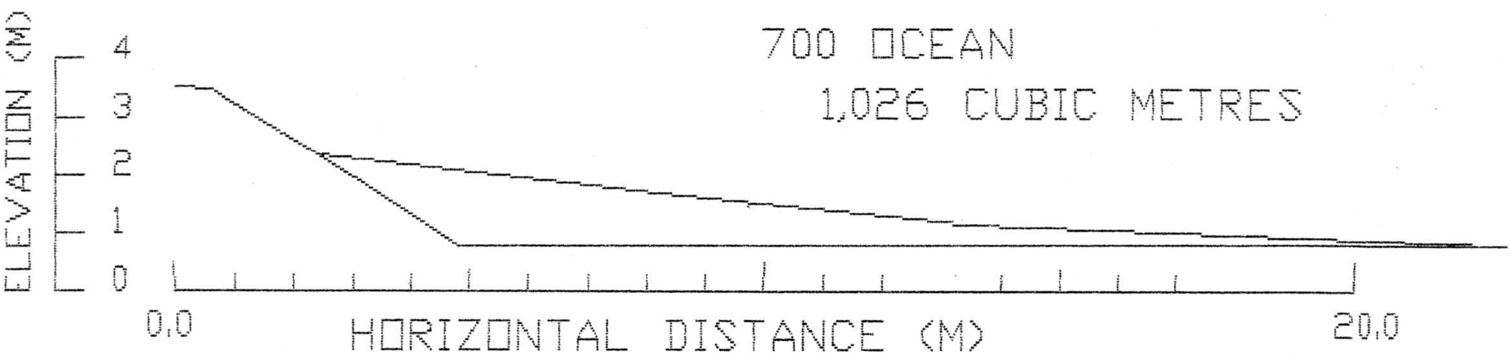
All profiles were recorded, planimetered and plotted using a computer assisted drafting program (AUTOCAD). All profiles are plotted with causeway bench marks to the left. Therefore, ocean-side profiles are plotted as if looking east and lagoon-side profiles are plotted as if looking to the west. NOTE THAT THE SCALE OF THE PLOTTED PROFILE VARIES DEPENDING ON THE PROFILE LENGTH.

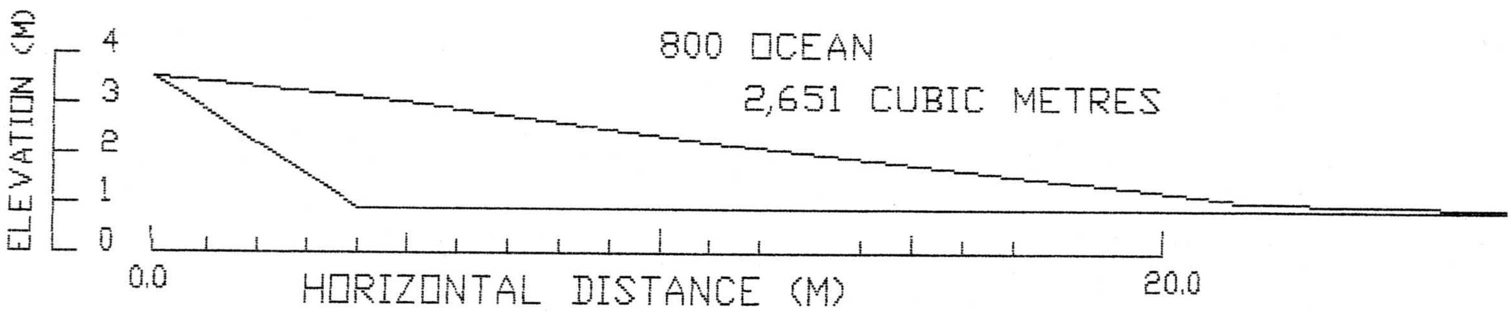

300 OCEAN
2,671 CUBIC METRE
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

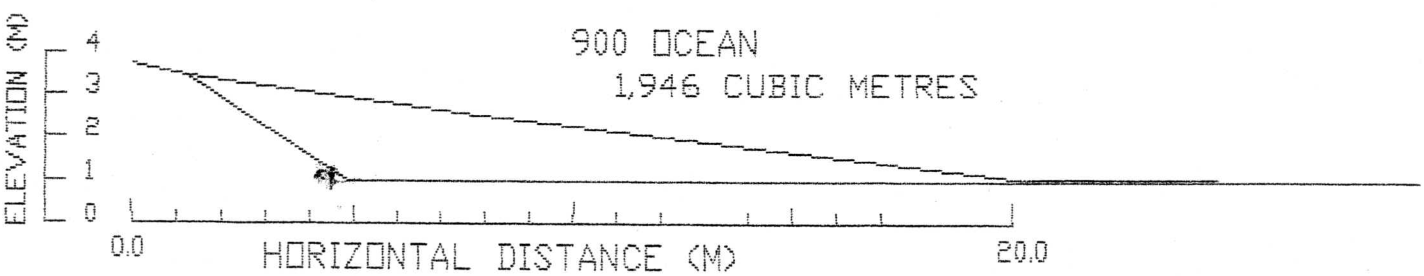

400 OCEAN
2,746 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

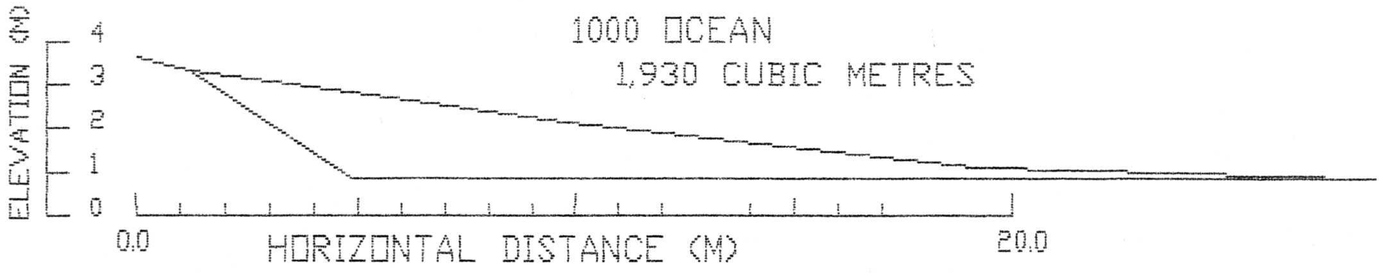

500 OCEAN
2,254 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

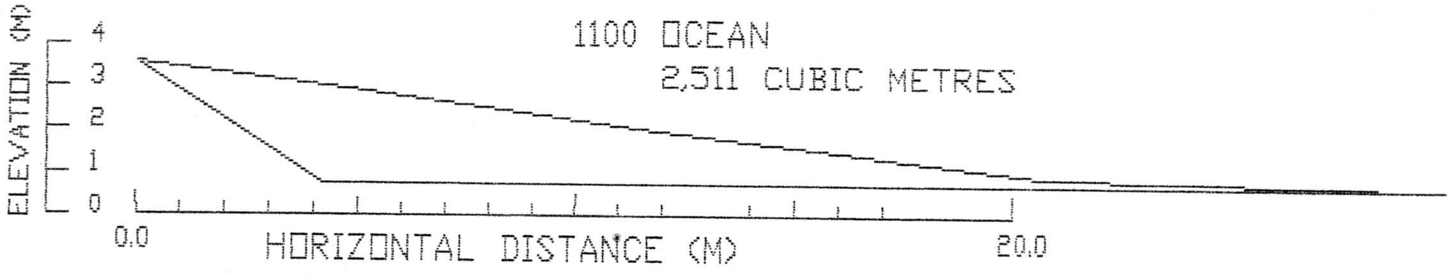

600 OCEAN
719 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

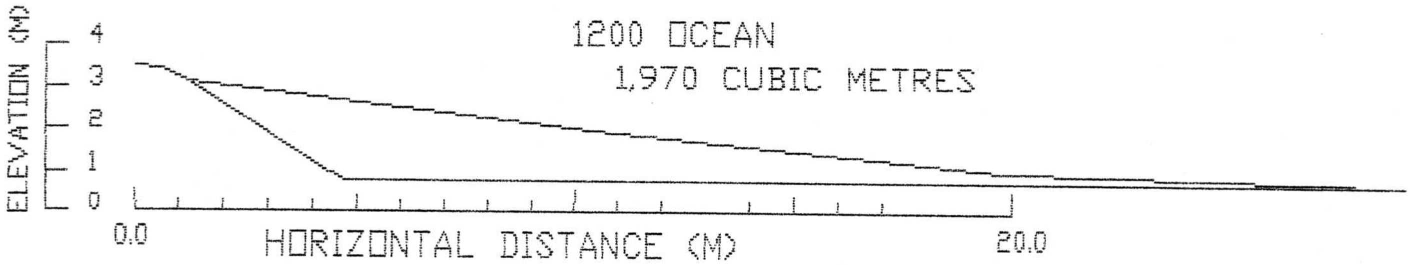

700 OCEAN
1,026 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

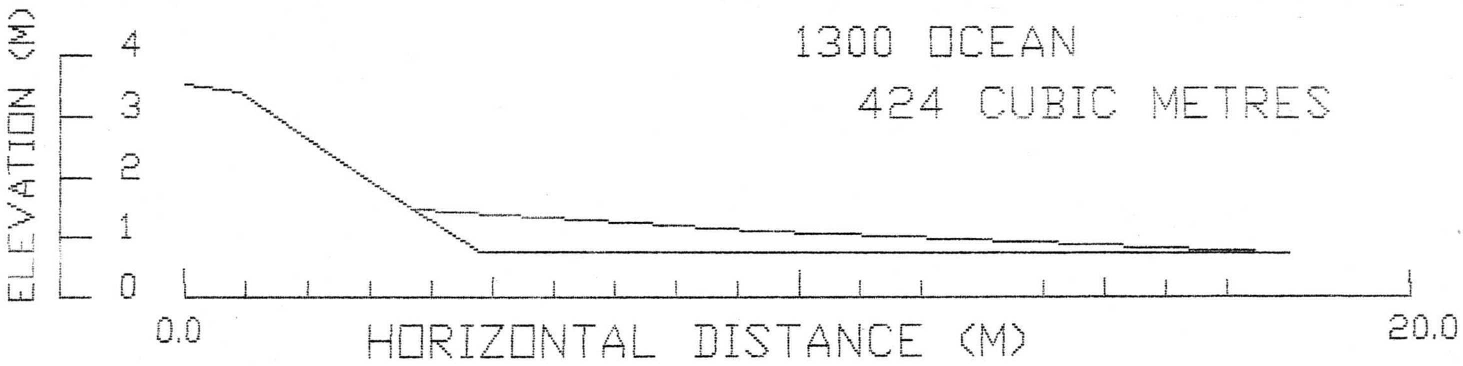

800 OCEAN
2,651 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

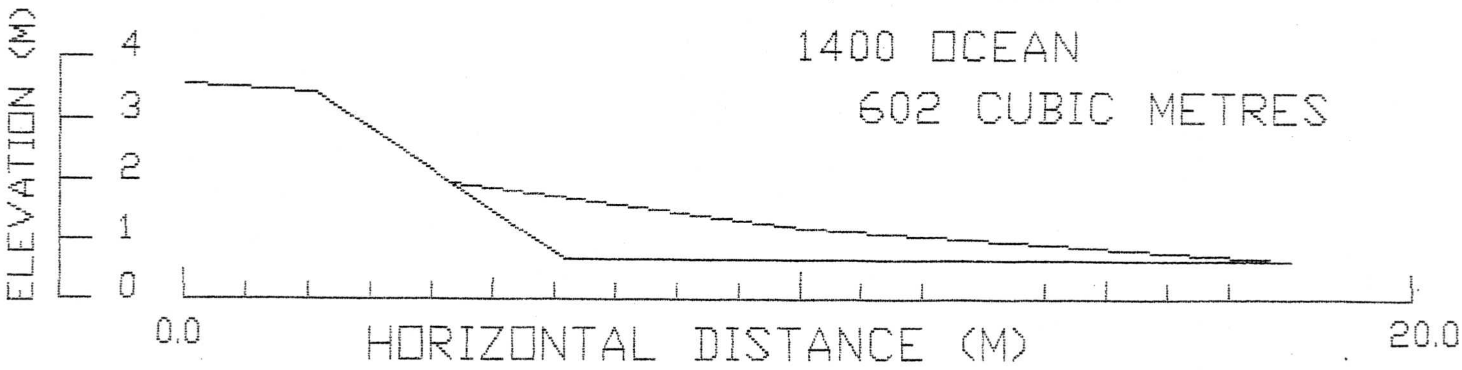

900 OCEAN
1,946 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

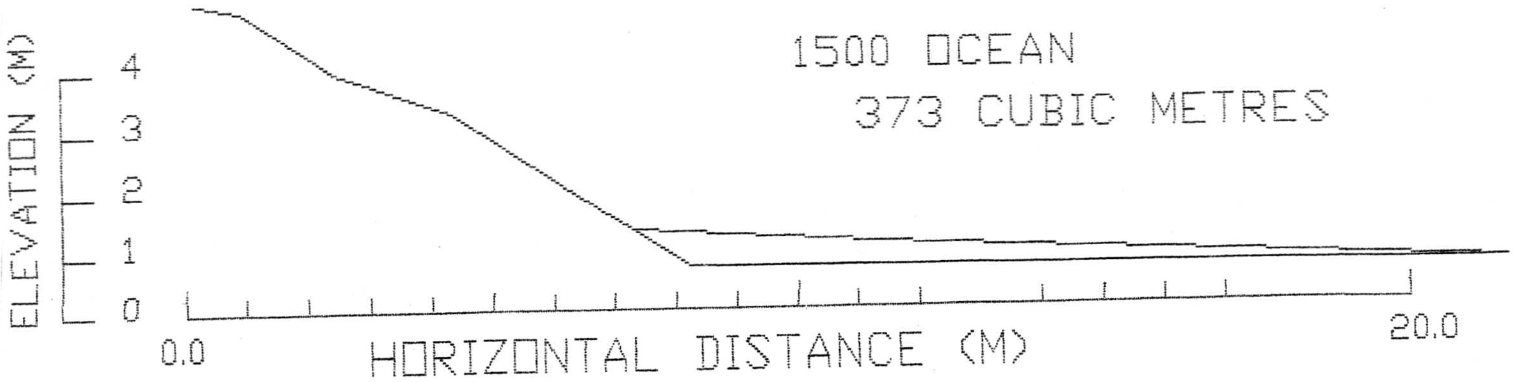

1000 OCEAN
1,930 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

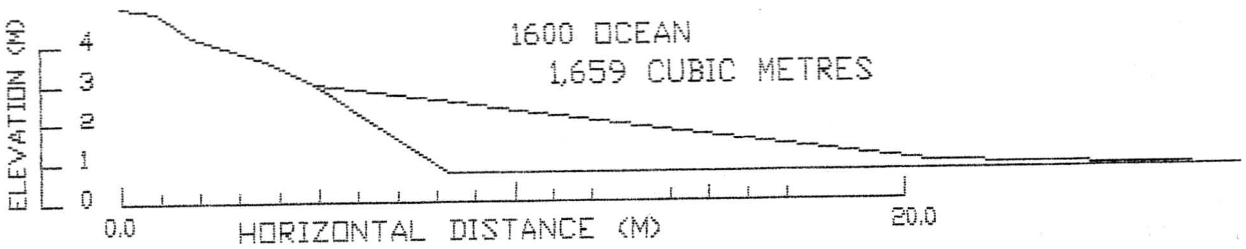

1100 OCEAN
2,511 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

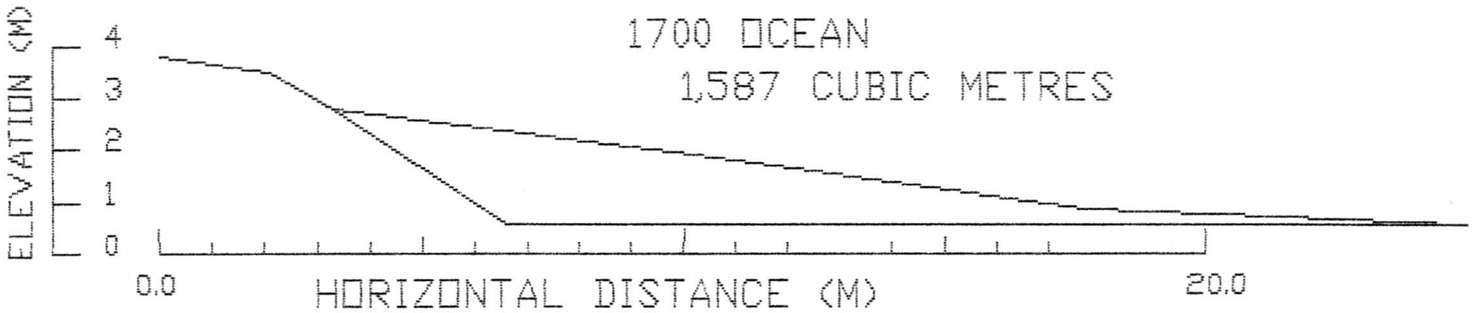

1200 OCEAN
1,970 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

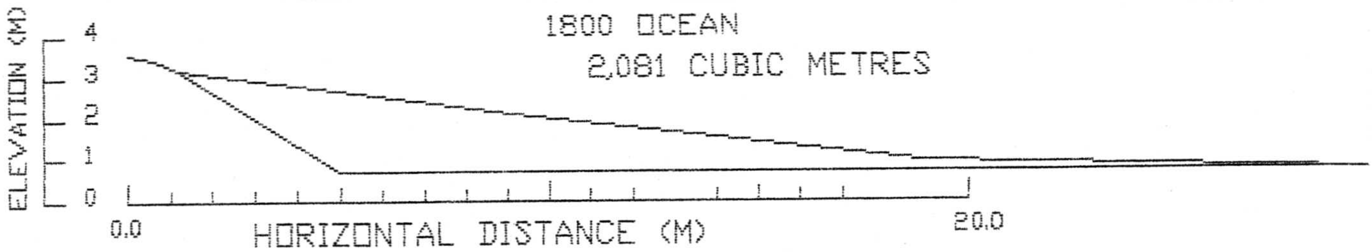

1300 OCEAN
424 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

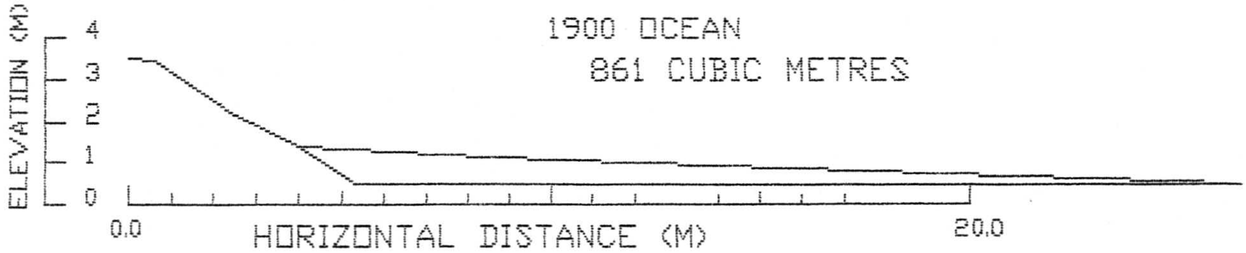

1400 OCEAN
602 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

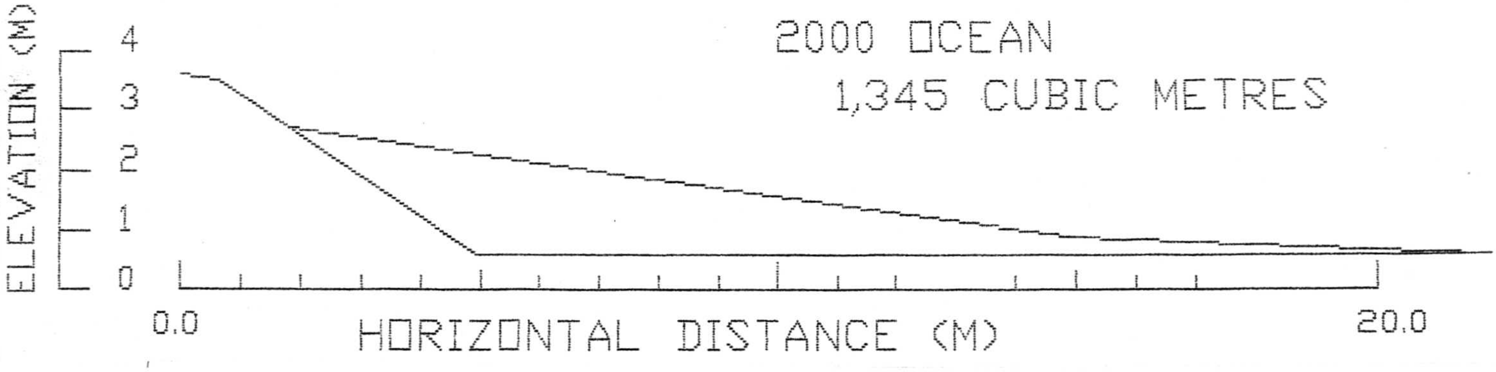

1500 OCEAN
373 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

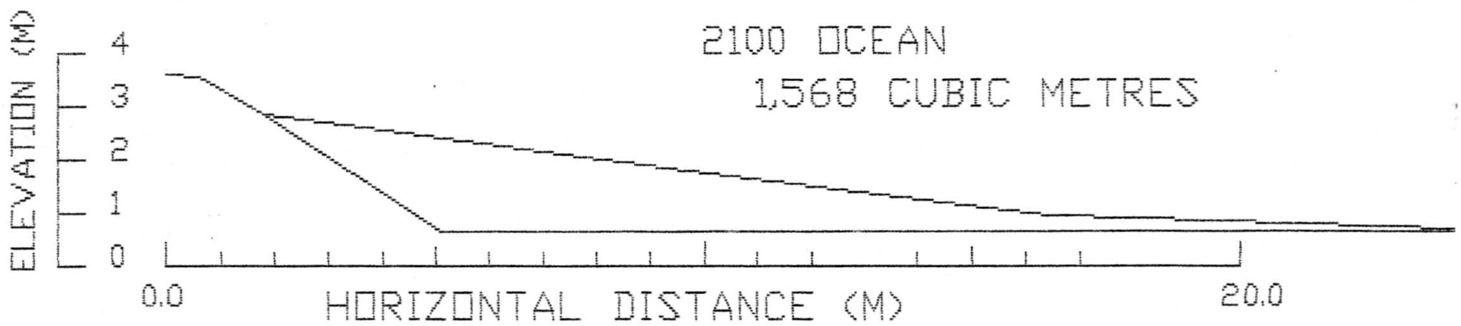

1600 OCEAN
1,659 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

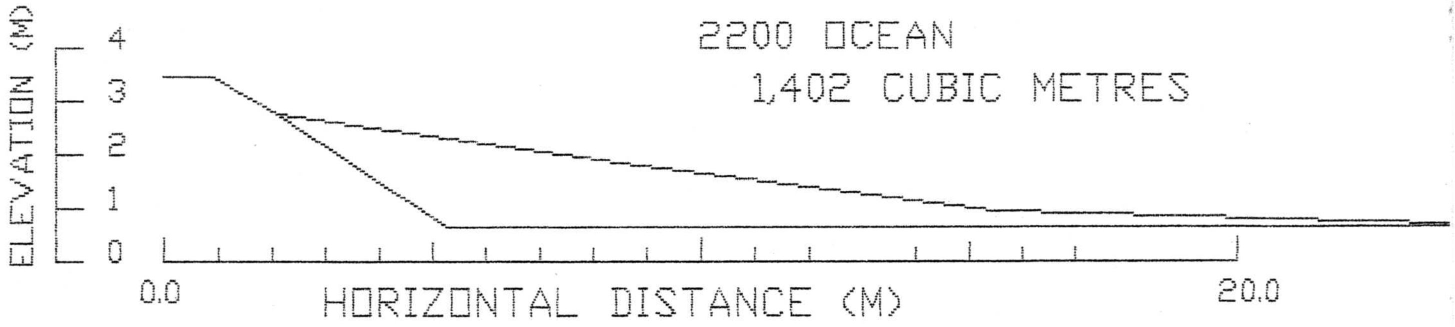

1700 OCEAN
1,587 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

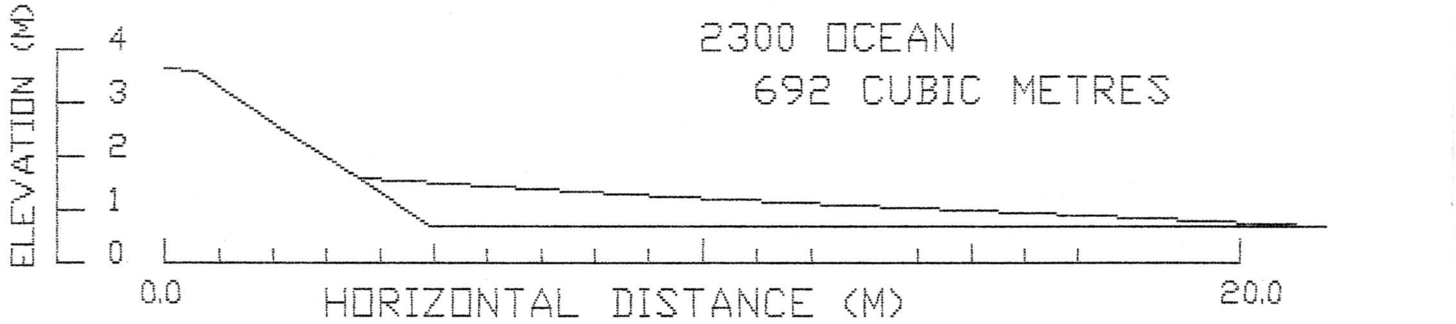

1800 OCEAN
2,081 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

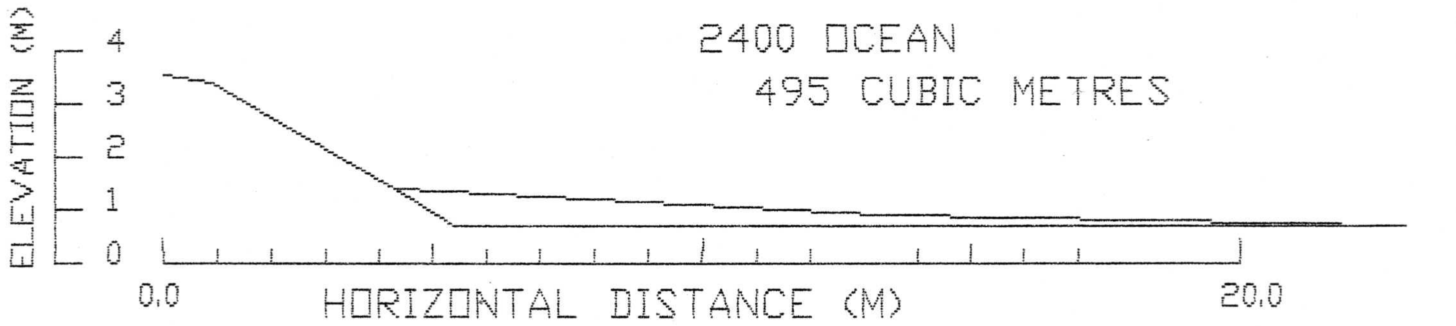

1900 OCEAN
861 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

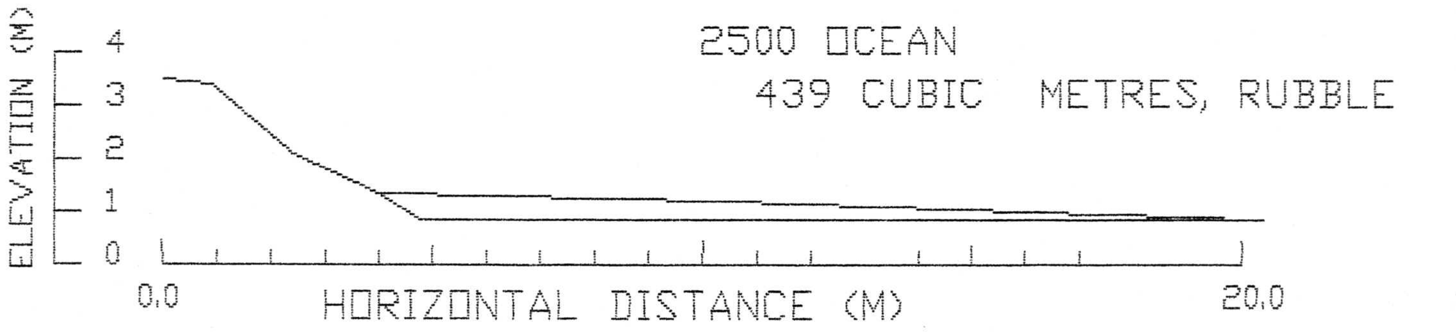

2000 OCEAN
1,345 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

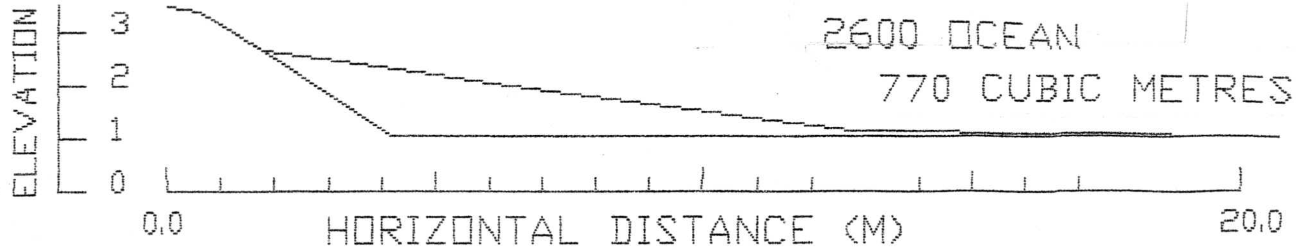

2100 OCEAN
1,568 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

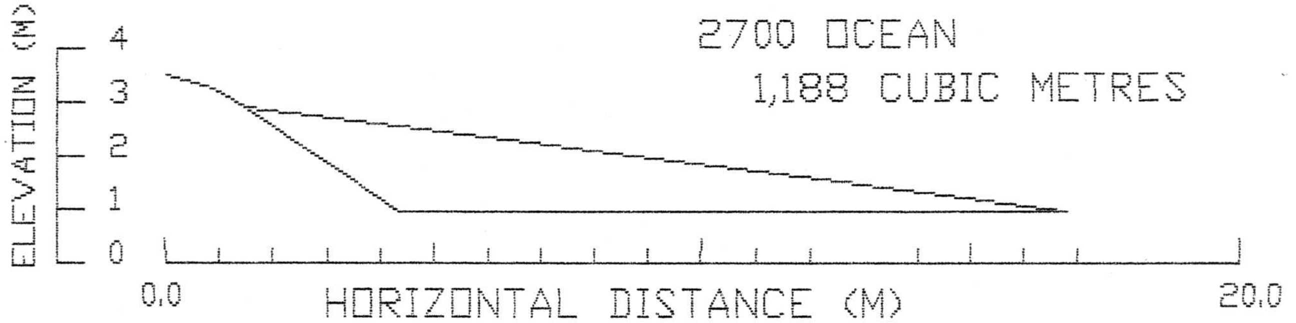

2200 OCEAN
1,402 CUBIC METRES
ELEVATION (M)
HORIZONTAL DISTANCE (M)
0.0
20.0

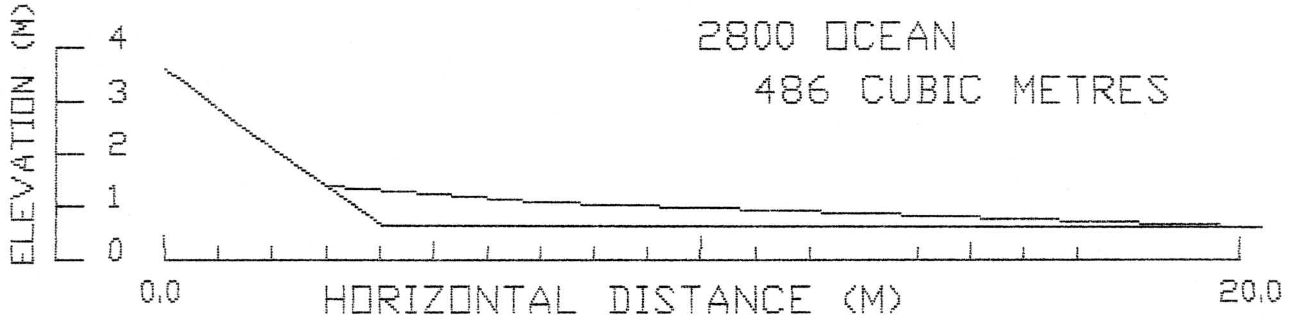

2300 OCEAN
692 CUBIC METRES
ELEVATION (M)
HORIZONTAL DISTANCE (M)
0.0
20.0

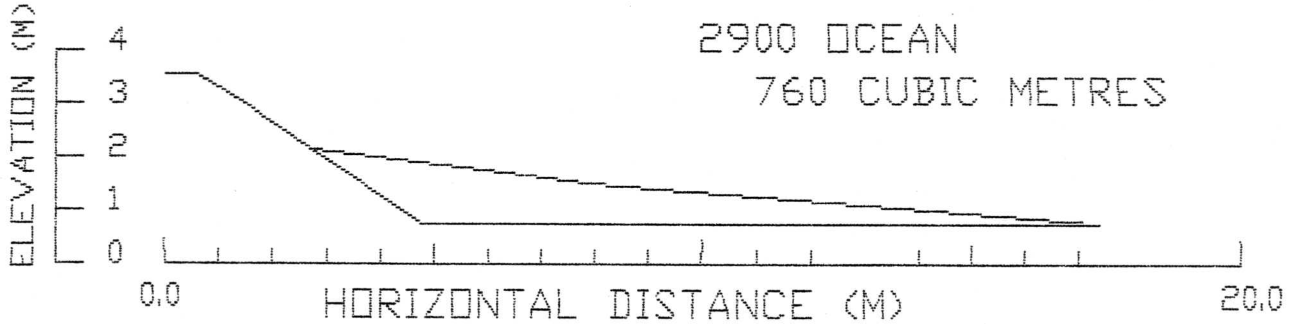

2400 OCEAN
495 CUBIC METRES
ELEVATION (M)
HORIZONTAL DISTANCE (M)
0.0
20.0

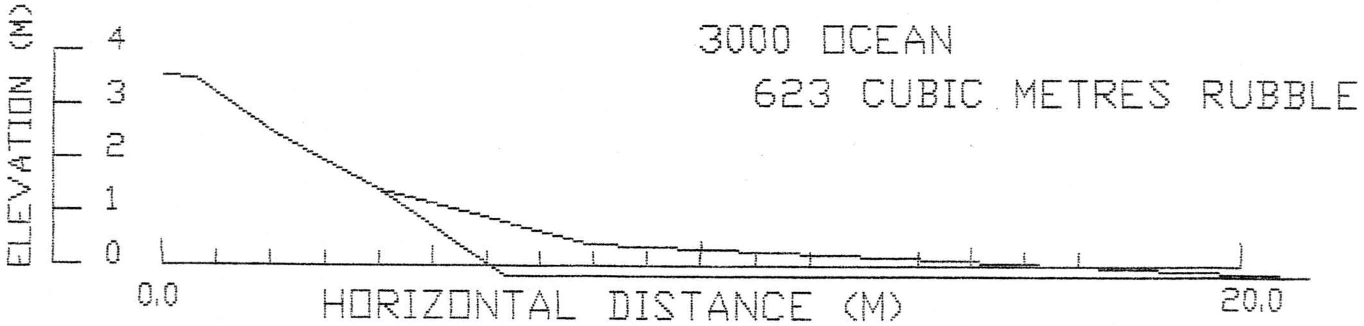

2500 OCEAN
439 CUBIC METRES, RUBBLE
ELEVATION (M)
HORIZONTAL DISTANCE (M)
0.0
20.0

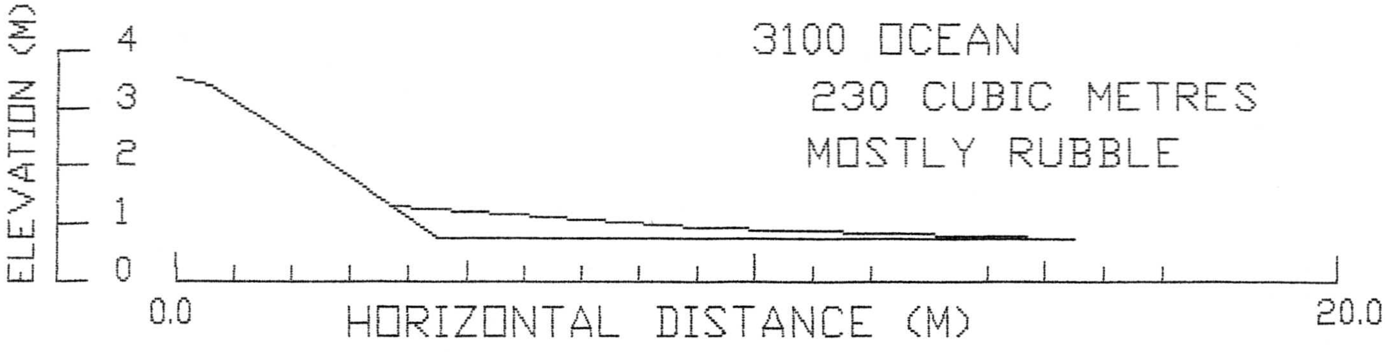

2600 OCEAN
770 CUBIC METRES
ELEVATION
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

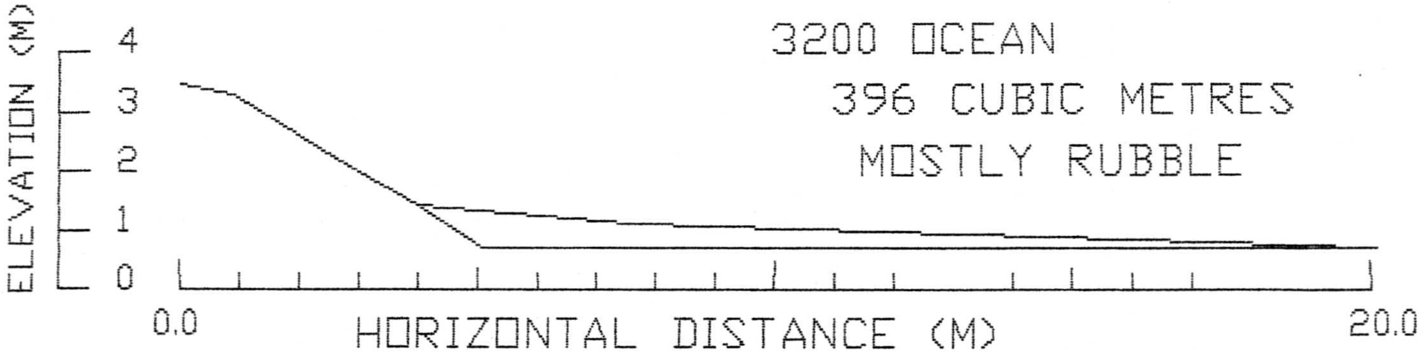

2700 OCEAN
1,188 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

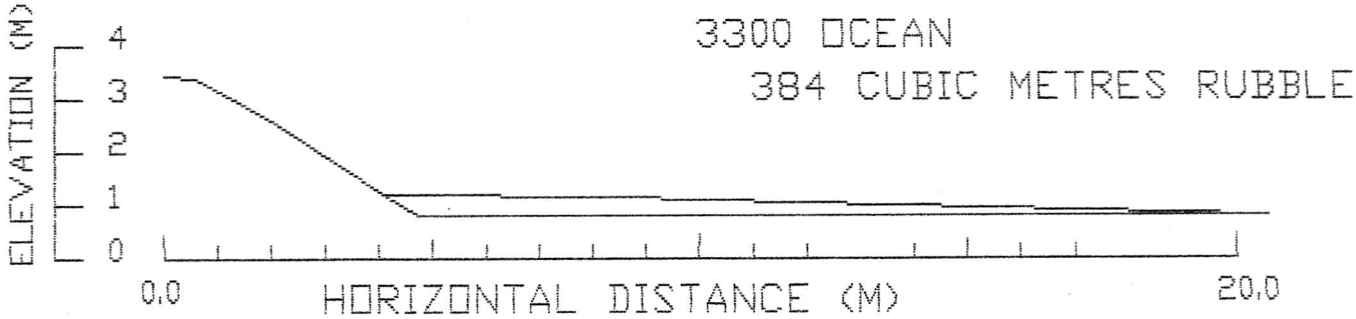

2800 OCEAN
486 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

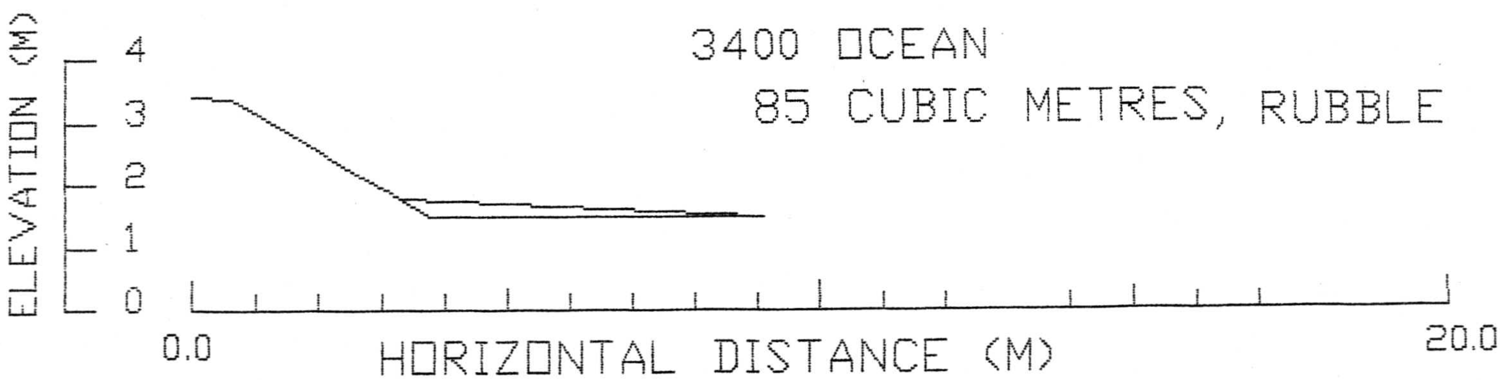

2900 OCEAN
760 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

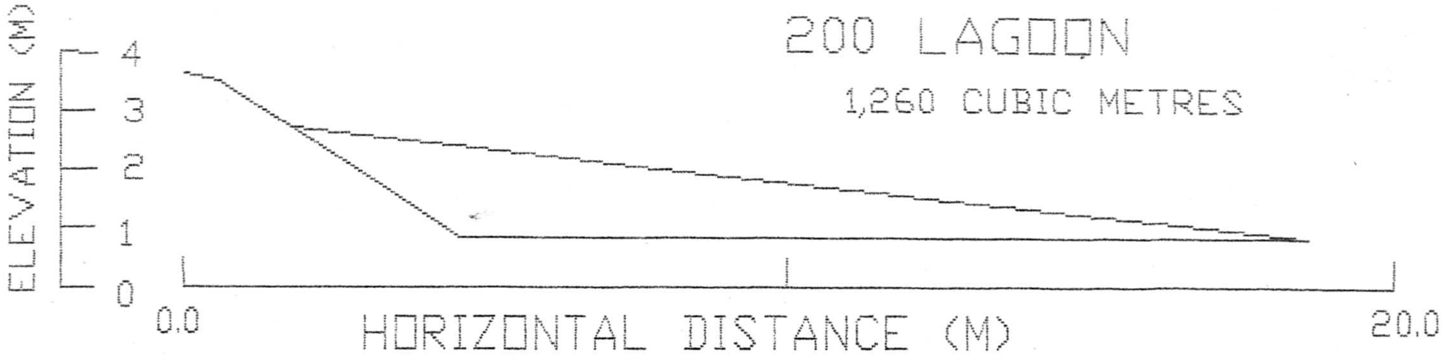

3000 OCEAN
623 CUBIC METRES RUBBLE
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

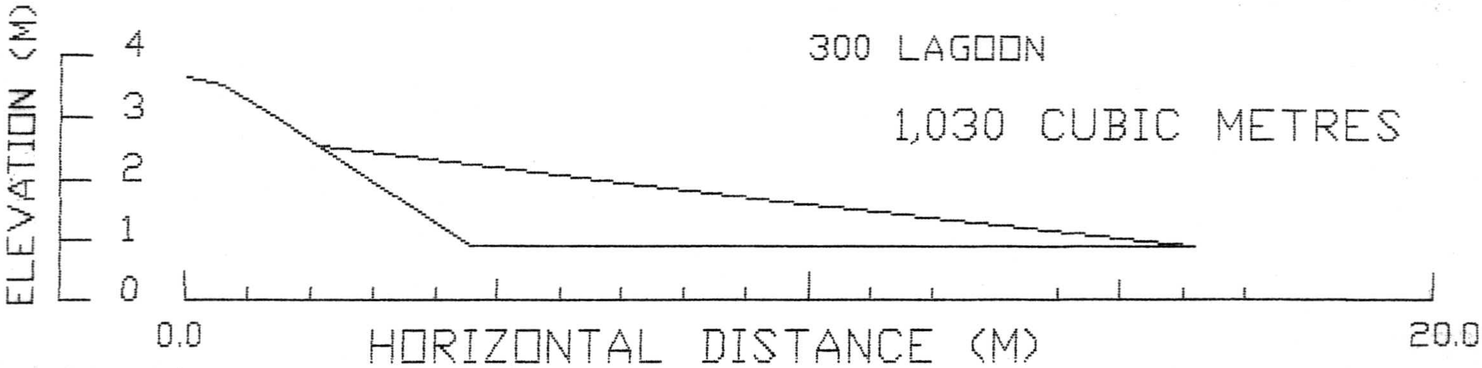

3100 OCEAN
230 CUBIC METRES
MOSTLY RUBBLE
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

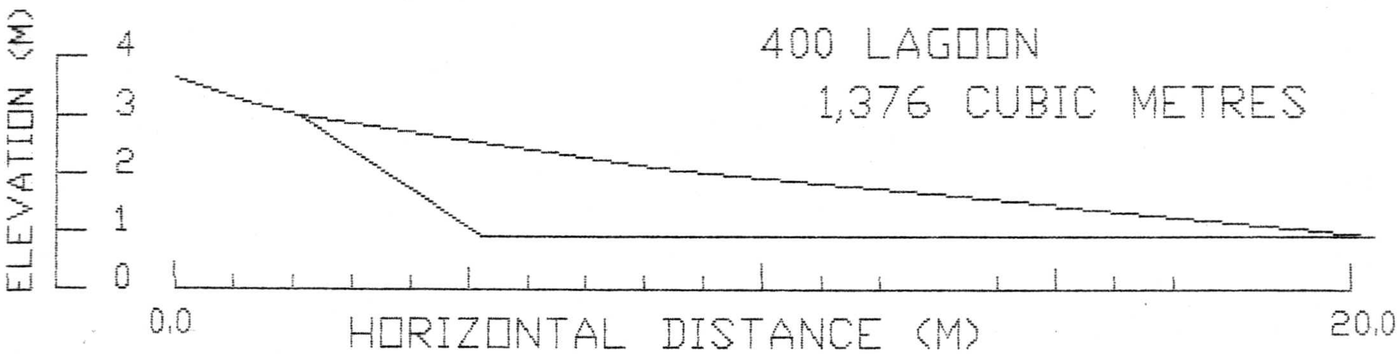

3200 OCEAN
396 CUBIC METRES
MOSTLY RUBBLE
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

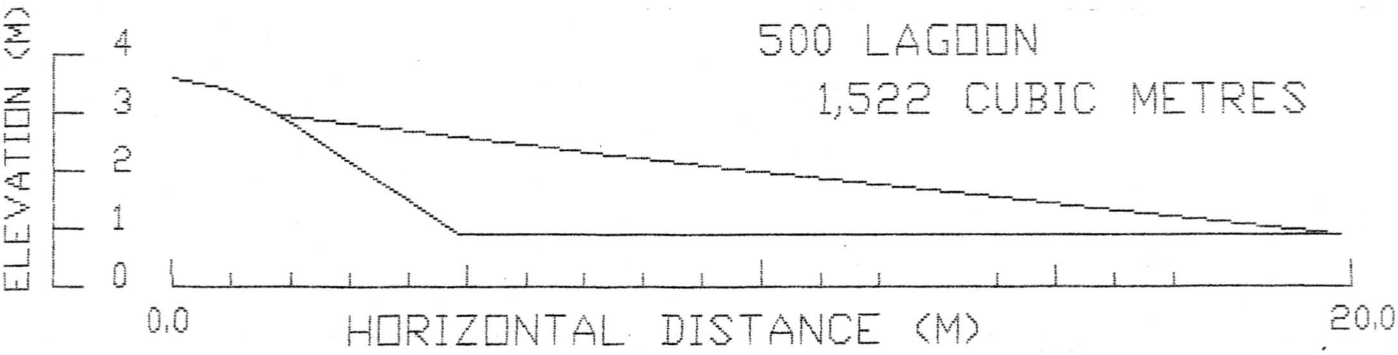

3300 OCEAN
384 CUBIC METRES RUBBLE
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

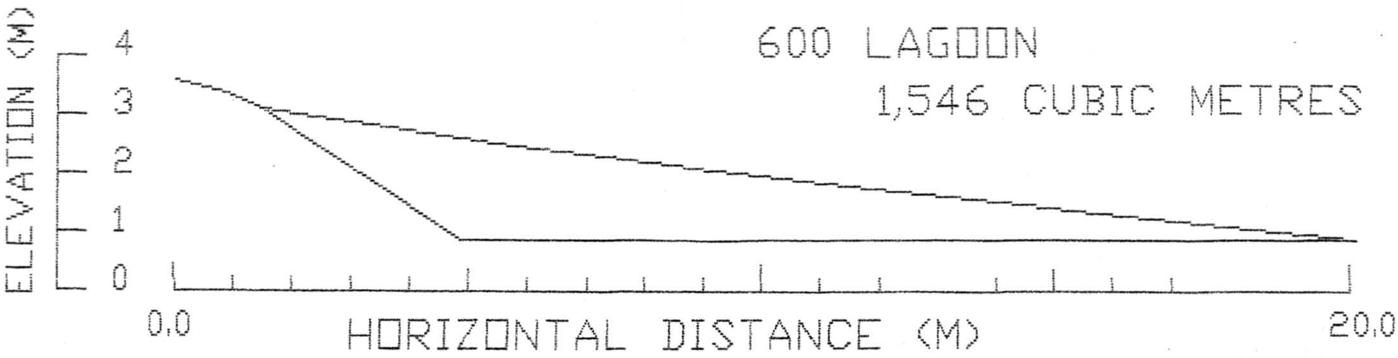

3400 OCEAN
85 CUBIC METRES, RUBBLE
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0


200 LAGOON
1,260 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

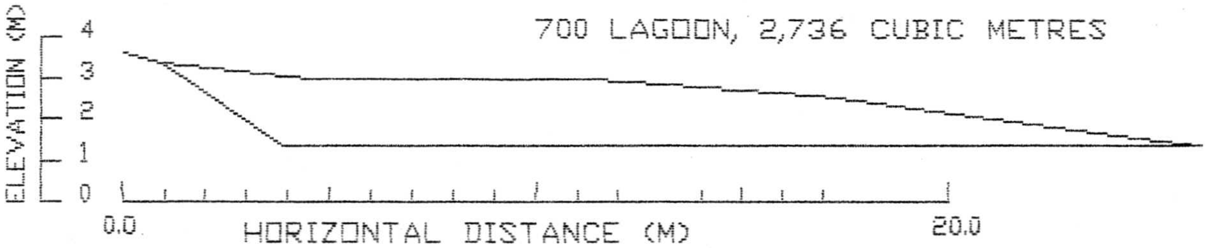

300 LAGOON
1,030 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)


400 LAGOON
1,376 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)

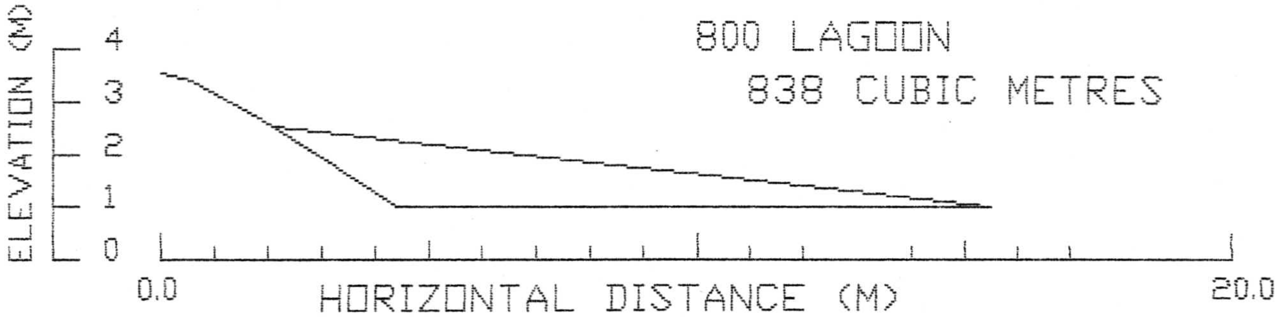

500 LAGOON
1,522 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)



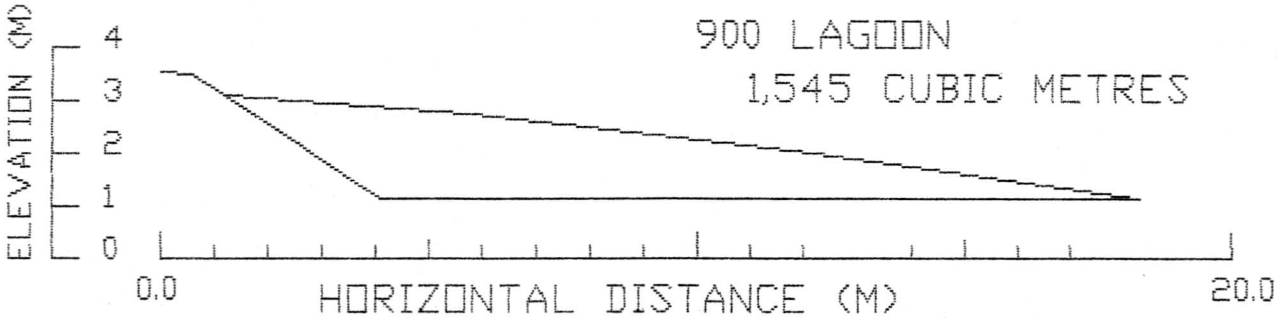
600 LAGOON
1,546 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0



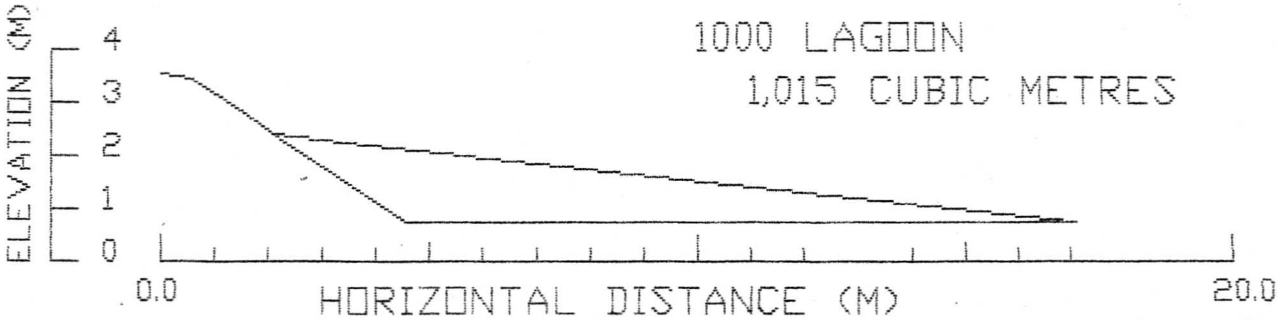
700 LAGOON, 2,736 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0



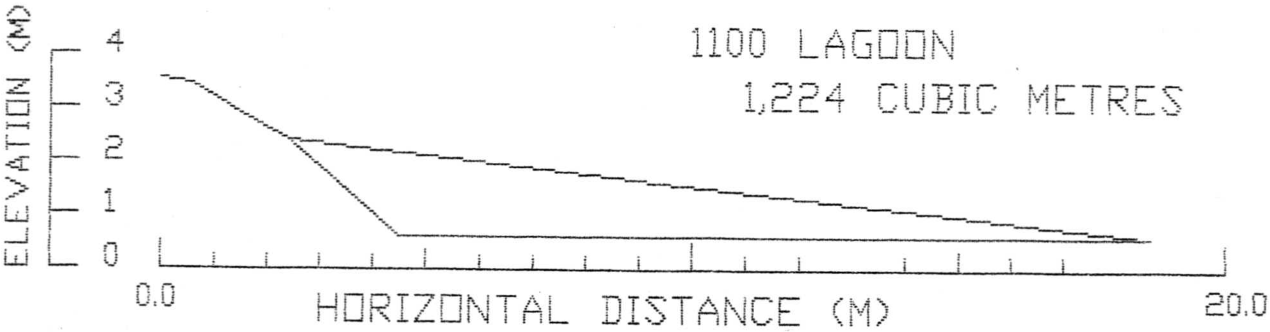
800 LAGOON
838 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

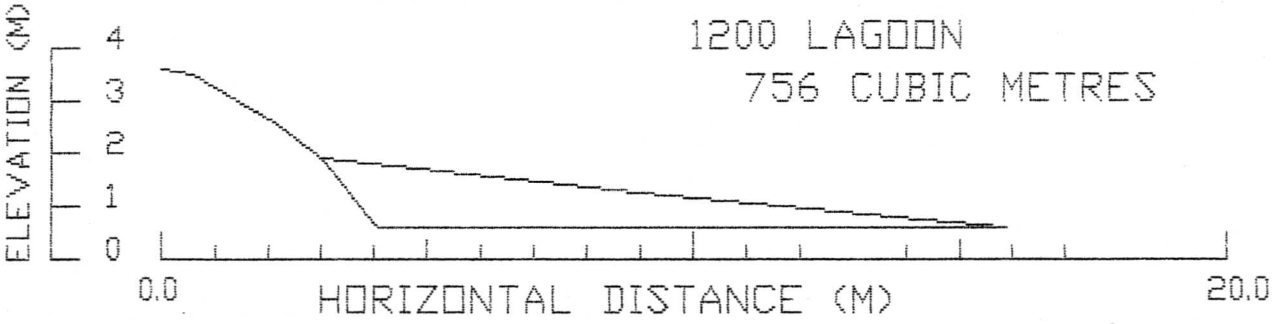


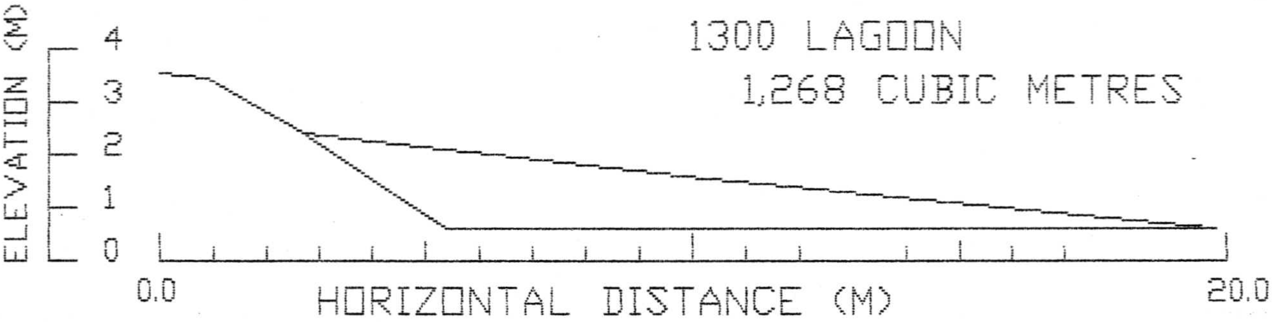
900 LAGOON
1,545 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

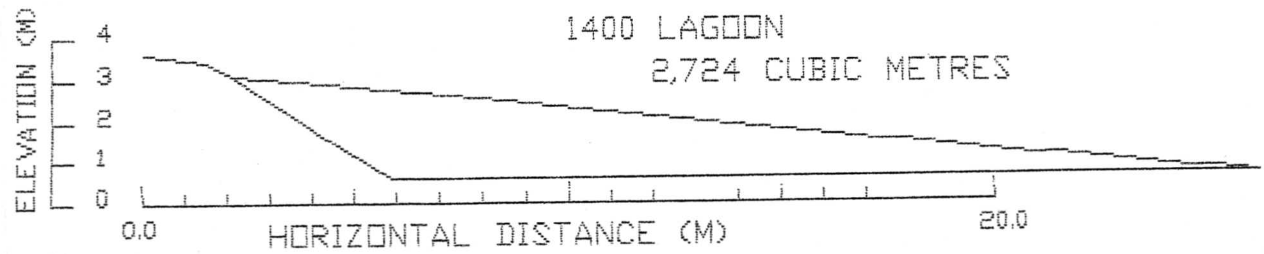


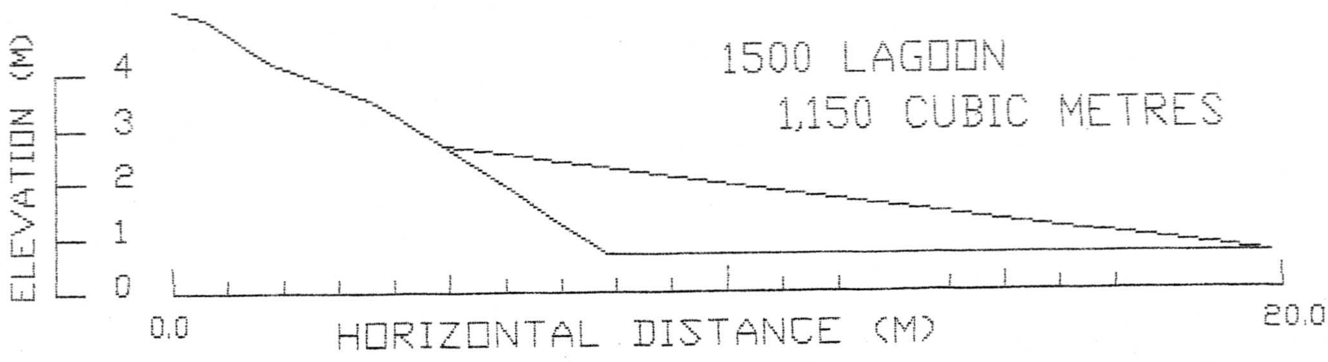
1000 LAGOON
1,015 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

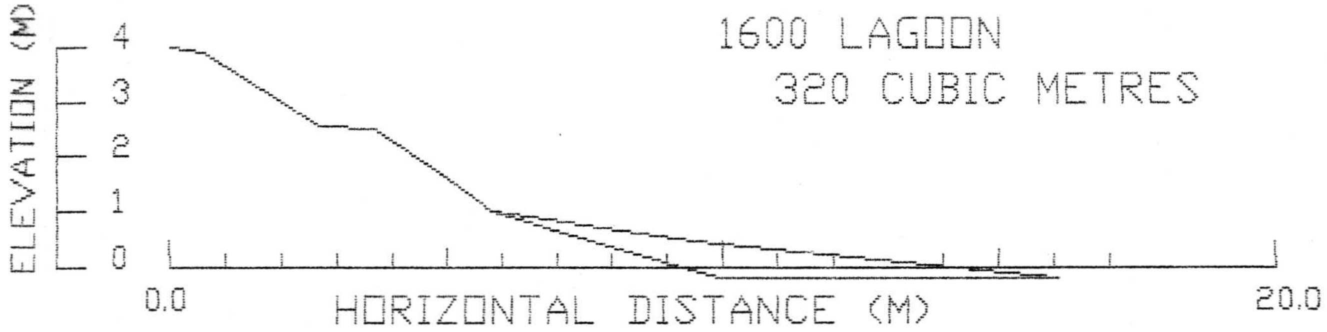

1100 LAGOON
1,224 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

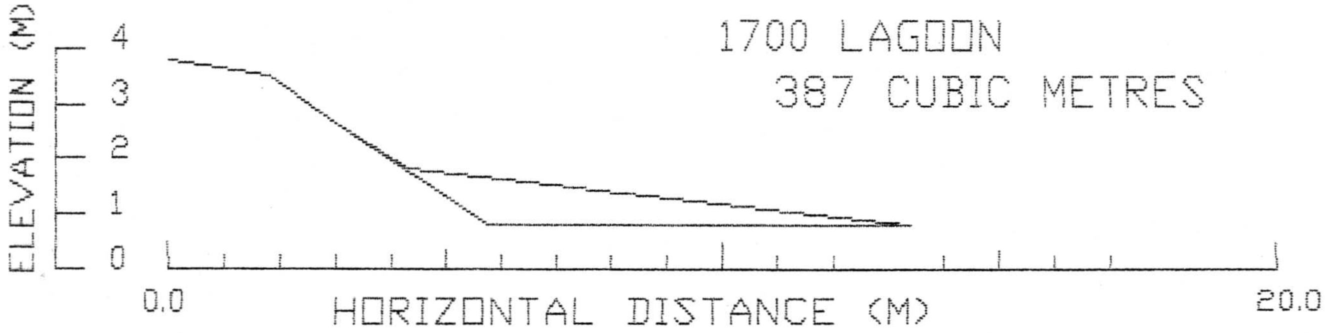

1200 LAGOON
756 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

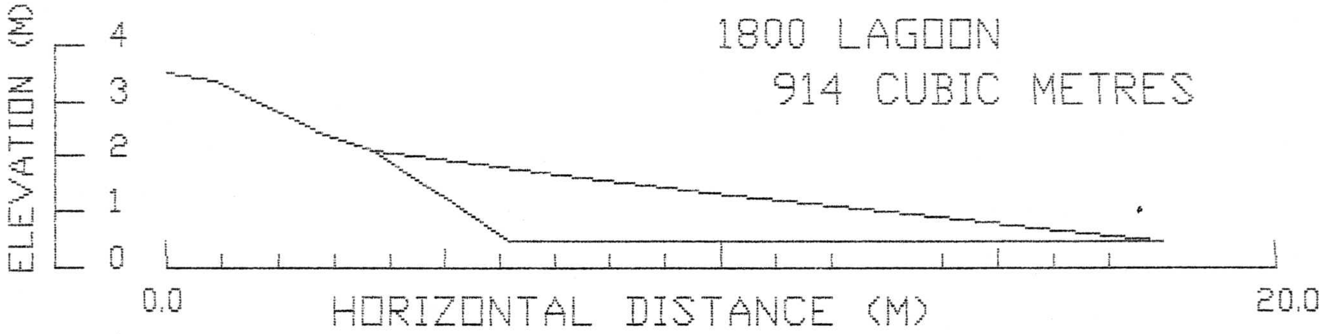

1300 LAGOON
1,268 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

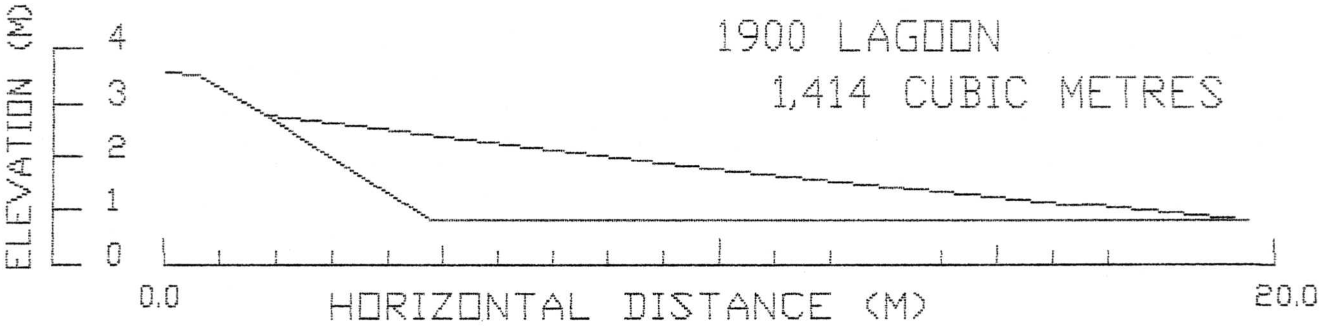

1400 LAGOON
2,724 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

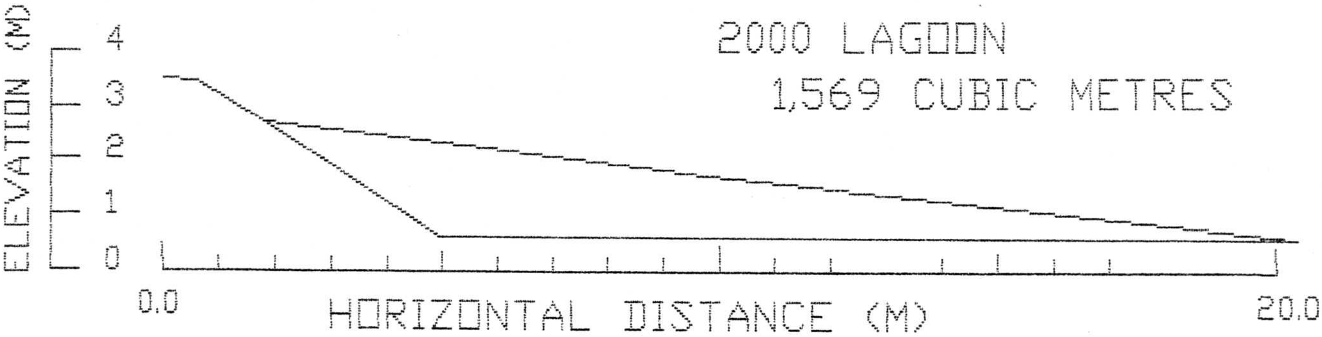

1500 LAGOON
1,150 CUBIC METRES
ELEVATION (M)
0
1
2
3
4
0.0
HORIZONTAL DISTANCE (M)
20.0

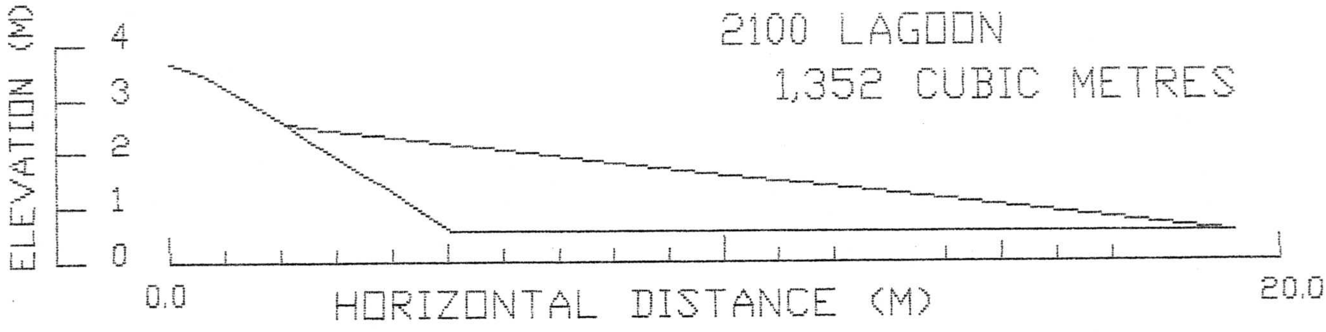

1600 LAGOON
320 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

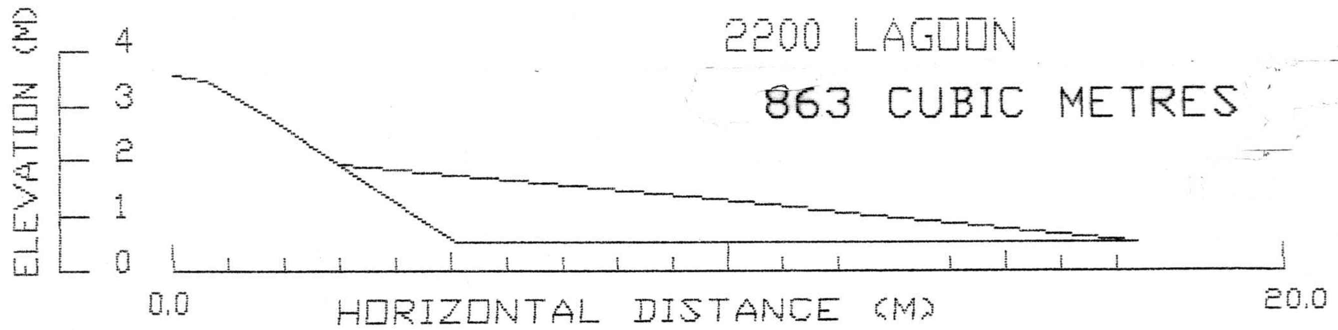

1700 LAGOON
387 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

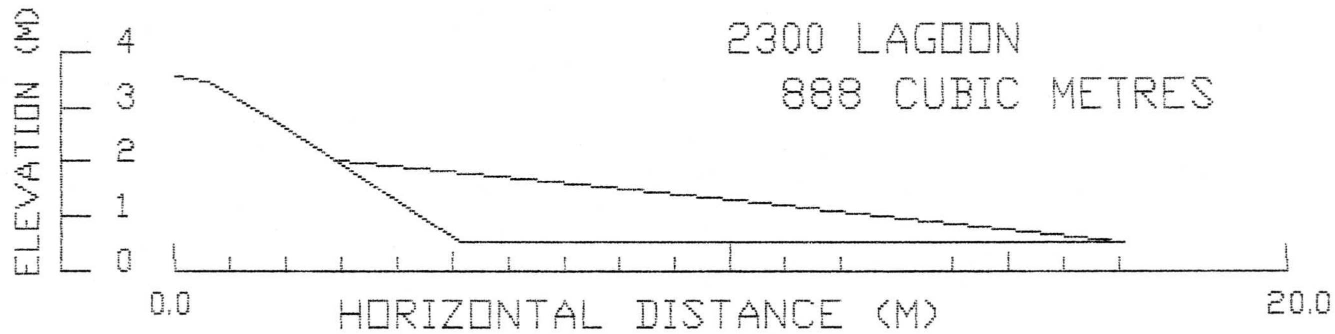

1800 LAGOON
914 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

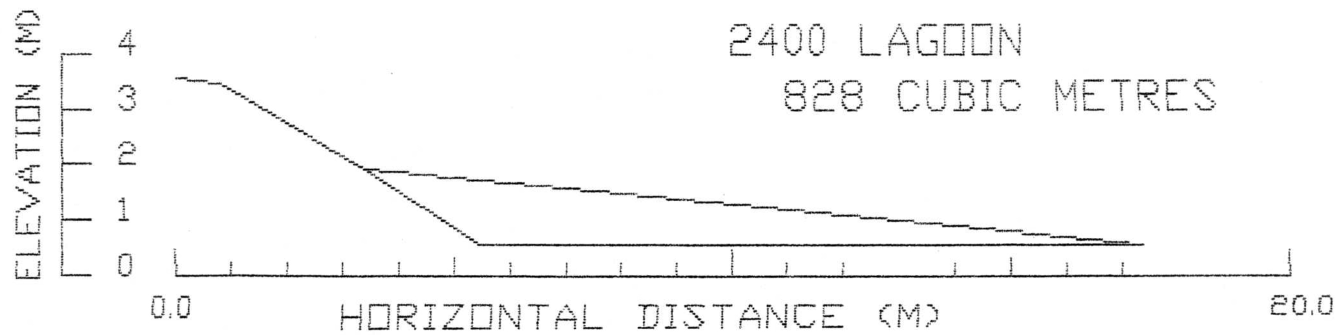

1900 LAGOON
1,414 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

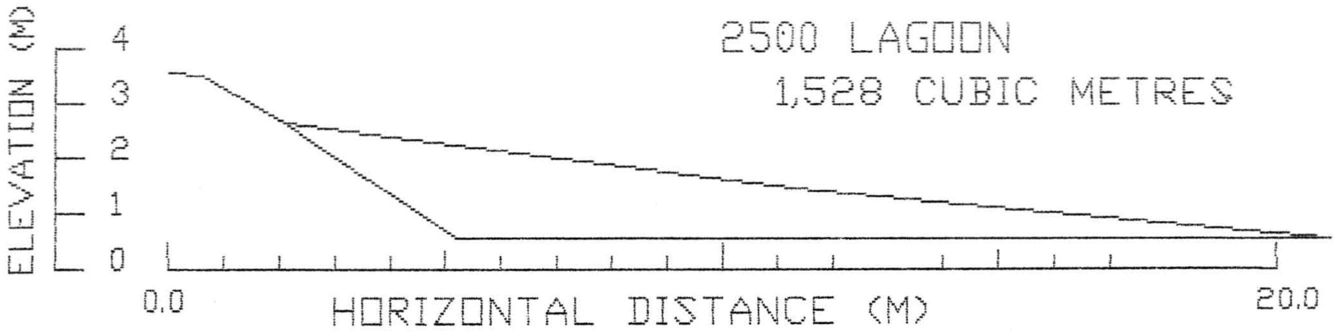

2000 LAGOON
1,569 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

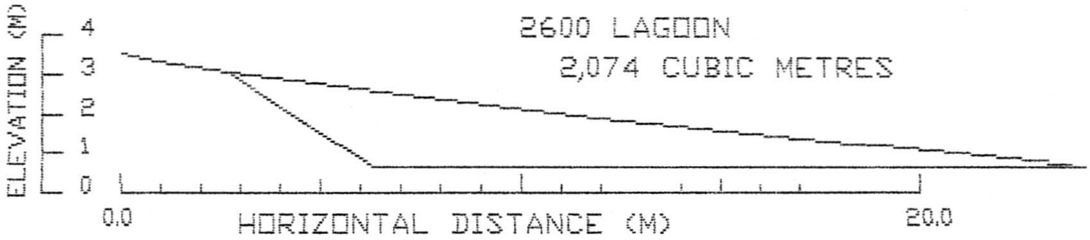

2100 LAGOON
1,352 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

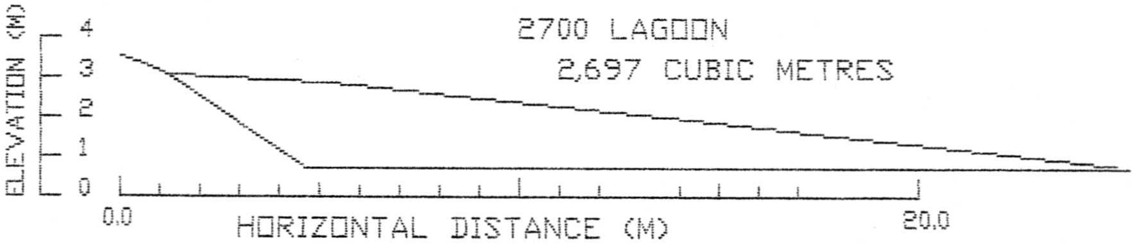

2200 LAGOON
863 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

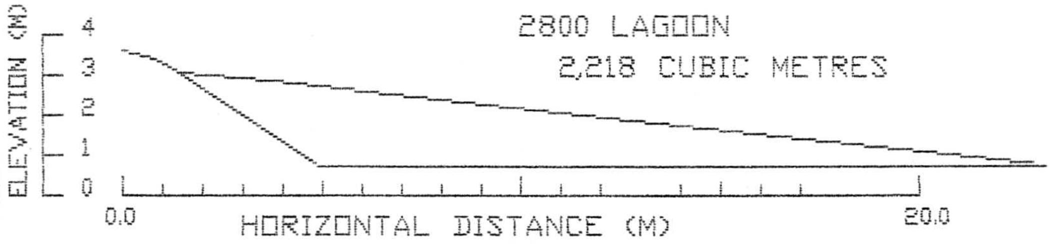

2300 LAGOON
888 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

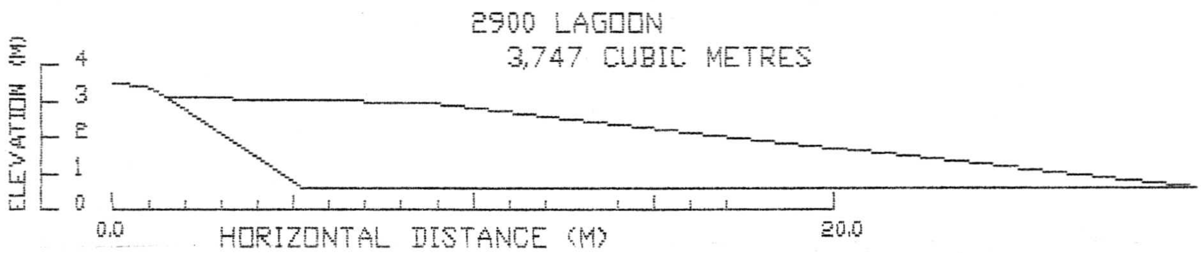

2400 LAGOON
828 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

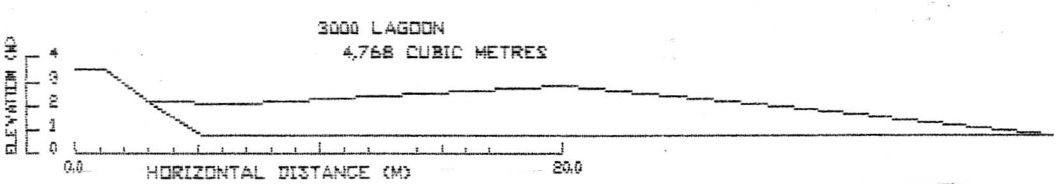

2500 LAGOON
1,528 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0

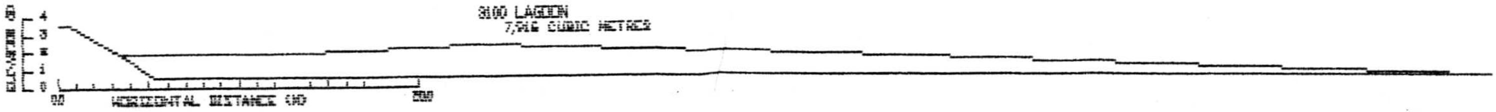

2600 LAGOON
2,074 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0


2700 LAGOON
2,697 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
HORIZONTAL DISTANCE (M)
20.0


2800 LAGOON
2,218 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)


2900 LAGOON
3,747 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)


3000 LAGOON
4,768 CUBIC METRES
ELEVATION (M)
4
3
2
1
0
0.0
20.0
HORIZONTAL DISTANCE (M)


3100 LAGOON
CUBIC METRES
4
3
1
0

APPENDIX B

Cross-Causeway Profile Survey Data

10-11 September 1987

Table B-1 Surveyed Datums of Cross-Causeway Profiles, September 1987

DATUM OCEAN-SIDE (M)	DISTANCE ALONG CAUSEWAY (M)	DATUM LAGOON-SIDE (M)
-	200	3.644
3.606	300	3.646
3.565	400	3.638
3.581	500	3.613
3.669	600	3.586
3.541	700	3.606
3.541	800	3.551
3.728	900	3.542
3.606	1000	3.545
3.550	1100	3.551
3.504	1200	3.591
3.542	1300	3.525
3.625	1400	3.600
5.183	1500	5.152
4.958	1600	5.014
3.798	1675[1]	3.862
3.551	1800	3.529
3.520	1900	3.559
3.581	2000	3.530
3.586	2100	3.668
3.438	2200	3.568
3.644	2300	3.564
3.564	2400	3.559
3.502	2500	3.560
3.506	2600	3.552
3.495	2700	3.522
3.593	2800	3.584
3.558	2900	3.514
3.540	3000	3.510
3.533	3100	3.565
3.479	3200	-
3.419	3300	-
3.428	3400	-

NOTES - General: Datum refers to height above chart datum
BM2 at Western end of Causeway provided reference

1 1700 Markers missing, used BLP 9 for 1700 Ocean and BLP 29 for 1700 Lagoon

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
200 Lagoon	0.0	3.64	datum
	0.6	3.51	to edge
	1.8	2.70	top beach, med. sand
	9.8	1.76	mid beach
	18.6	0.86	reef flat
300 Ocean	0.0	3.61	datum
	0.6	3.54	to edge
	1.8	2.90	top beach
	12.2	2.70	berm crest
	20.1	1.94	coarse sand
	26.5	1.24	top ripples, reef flat
	35.7	1.11	ripples, reef flat
300 Lagoon	0.0	3.65	datum
	0.6	3.51	to edge
	1.5	2.97	slope protection
	2.1	2.56	to top of beach
	8.8	1.74	mid beach
	16.2	0.92	reef flat, lag
400 Ocean	0.0	3.56	datum
	1.2	3.16	top sand, coarse sand
	6.4	3.32	coarse sand, shell
	12.2	2.34	coarse sand, shell
	21.6	1.18	reef flat, ripples
	30.8	1.02	reef flat, ripples
400 Lagoon	0.0	3.64	datum
	1.2	3.25	top rubble
	2.1	2.99	top sand
	8.2	2.11	mid beach, sand bags
	20.4	0.90	reef flat
500 Ocean	0.0	3.58	datum
	0.9	3.28	top of beach, med. sand
	7.9	2.52	beachface, med. sand
	14.6	1.80	beachface, coarse sand
	21.0	1.10	reef flat, ripples
	30.2	0.94	reef flat, ripples
500 Lagoon	0.0	3.61	datum
	0.9	3.44	to edge
	1.8	2.96	top sand, med. sand
	7.9	2.24	sand bag heap
	19.8	0.92	reef flat, some rubble

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
600 Ocean	0.0	3.67	datum
	0.6	3.51	slope protection
	1.8	2.80	top sand
	2.7	2.22	reef flat, ripples
	10.1	1.31	reef flat, ripples
	20.1	0.90	reef flat, ripples
600 Lagoon	0.0	3.59	datum
	0.9	3.35	to edge
	1.5	3.09	top sand/rubble, vegetation
	5.8	2.47	LHTS, med. sand
	11.9	1.75	beachface, med. sand
	20.1	0.85	reef flat, with ripples
700 Ocean	0.0	3.54	datum
	0.6	3.49	to edge
	1.5	2.91	slope protection
	2.4	2.36	top sand, coarse sand
	8.2	1.65	beachface, coarse sand
	13.4	1.11	reef flat, ripples
	22.6	0.75	reef flat, ripples
700 Lagoon	0.0	3.61	datum
	0.9	3.36	top rubble/sand
	4.6	2.96	berm runnel
	11.3	3.01	berm crest, LHTS
	16.8	2.57	beachface
	21.6	1.97	beachface
	26.2	1.37	reef flat
800 Ocean	0.0	3.54	top sand + 4cm over datum
	4.9	3.04	beachface, coarse sand
	11.0	2.28	beachface, coarse sand
	21.6	1.04	reef flat, coarse sand
	30.2	0.88	reef flat, ripples
800 Lagoon	0.0	3.55	datum
	0.6	3.39	to edge
	2.1	2.53	top of sand
	8.5	1.77	mid beach
	15.5	0.99	reef flat with cobble
900 Ocean	0.0	3.73	(datum at steps)
	1.2	3.43	top sand, coarse sand
	7.9	2.53	beachface, coarse sand
	15.2	1.67	beachface, coarse sand
	20.1	1.05	reef flat, ripples
	29.3	0.97	reef flat, ripples

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
900 Lagoon	0.0	3.54	datum, south of dredge pipe
	0.6	3.46	to edge
	1.2	3.08	top sand, vegetation
	5.8	2.72	LHTS
	12.2	1.96	mid beach
	18.3	1.14	reef flat
1000 Ocean	0.0	3.61	datum
	1.2	3.31	top sand, medium sand
	9.8	2.15	beachface, coarse sand
	19.2	1.08	reef flat, coarse sand
	28.3	0.88	reef flat, ripples
1000 Lagoon	0.0	3.54	datum
	0.6	3.44	to edge
	1.5	2.84	slope protection
	2.1	2.38	top beach, medium sand
	8.8	1.62	beachface
	17.1	0.73	reef flat, ripples
1100 Ocean	0.0	3.55	datum;sand+5cm above datum
	4.3	2.99	LHTS, medium sand
	11.9	1.95	beachface, coarse sand
	20.7	0.95	reef flat, ripples
	29.9	0.75	reef flat, ripples
1100 Lagoon	0.0	3.55	datum
	0.6	3.45	to edge
	1.5	2.90	slope protection
	2.4	2.40	top beach, medium sand
	9.8	1.51	beachface, medium sand
	18.6	0.59	reef flat
1200 Ocean	0.0	3.50	datum
	0.6	3.42	to edge
	1.2	3.12	top of beach, med. sand
	10.4	1.95	beachface, med. sand
	19.8	0.97	reef flat
	29.0	0.76	W.L. 1100
1200 Lagoon	0.0	3.59	datum
	0.6	3.49	to edge
	2.1	2.57	slope protection
	3.0	1.89	top of beach, med. sand
	8.5	1.29	beachface
	15.9	0.57	reef flat, coarse sand, ripples

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
1300 Ocean	0.0	3.54	datum
	0.9	3.41	to edge
	2.4	2.37	slope protection
	3.7	1.49	to beach, toe protection
	9.4	1.13	reef flat, ripples
	18.0	0.77	W.L. 1050
1300 Lagoon	0.0	3.52	datum pt.
	0.9	3.45	to edge
	2.7	2.36	top beach, med. sand
	9.8	1.58	beachface
	19.8	0.56	reef flat
1400 Ocean	0.0	3.60	datum
	2.1	3.45	to edge steps
	3.3	2.68	4th step
	4.3	1.95	top beach, coarse sand
	10.1	1.22	edge rubble
	18.0	0.70	reef flat, sand
1400 Lagoon	0.0	3.62	datum
	1.5	3.47	to edge
	2.1	3.15	top sand, vegetation
	7.9	2.61	LHTS, med. sand
	16.2	1.75	beachface, med. sand
	26.2	0.60	reef flat
1500 Ocean	0.0	5.18	datum
	0.9	5.01	to edge
	2.4	3.97	slope protection
	4.3	3.32	slope protection
	6.1	2.15	slope protection
	7.3	1.41	top sand
	11.3	1.17	beach with rubble
	21.9	0.79	reef flat
1500 Lagoon	0.0	5.15	datum
	0.6	5.00	to edge
	1.8	4.19	slope protection
	3.7	3.48	slope protection, ledge
	4.9	2.68	top sand, medium sand
	11.6	1.78	beachface, medium sand
	19.8	0.73	reef flat

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
1600 Ocean	0.0	4.96	datum
	0.9	4.83	to edge
	1.8	4.23	slope protection
	3.7	3.58	slope protection, edge ledge
	4.9	2.99	top sand
	12.2	2.04	beachface
	20.7	0.93	reef flat
	28.7	0.72	reef flat, some rubble
1600 Lagoon	0.0	4.01	datum
	0.6	3.90	to edge
	2.7	2.56	slope protection, inside of ledge
	3.7	2.50	slope protection, outside of ledge
	4.9	1.67	slope protection
	5.8	0.99	top rubble
	9.5	0.49	rubble with some sand
	16.1	-0.19	reef flat
1700 Ocean	0.0	3.80	datum (62cm below BLP 9 BM)
	2.1	3.50	to edge
	3.3	2.80	to beach, coarse sand
	11.0	1.81	beachface, evase sand
	17.7	0.91	to reef flat
	25.0	0.59	reef flat
1700 Lagoon	0.0	3.82	datum
	1.8	3.49	to edge
	3.0	2.67	to top sand
	4.3	1.82	beachface, coarse sand
	8.2	1.41	to reef flat
	13.4	0.83	reef flat
1800 Ocean	0.0	3.55	datum
	0.6	3.48	to edge
	1.2	3.21	top sand, coarse sand
	9.1	2.14	beachface
	18.9	0.94	reef flat
	31.4	0.69	reef flat
1800 Lagoon	0.0	3.53	datum
	0.9	3.36	to edge
	2.7	2.44	ledge in slope protection
	3.7	2.14	to top of sand
	9.8	1.36	beachface
	18.0	0.50	reef flat

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
1900 Ocean	0.0	3.52	datum
	0.6	3.43	to edge
	2.4	2.22	slope protection
	4.0	1.39	to top of sand, coarse sand
	8.5	1.14	edge ripples, rubble
	26.5	0.50	reef flat, ripples
1900 Lagoon	0.0	3.56	datum
	0.6	3.49	to edge
	1.8	2.78	to top of beach, fine sand
	9.4	1.88	beachface
	19.5	0.80	to reef flat
2000 Ocean	0.0	3.58	datum
	0.6	3.49	to edge
	1.8	2.71	to top of beach, med. sand
	7.6	1.89	beachface, med. sand
	14.9	0.93	to top reef flat
	21.9	0.61	reef flat, ripples v. coarse sand
2000 Lagoon	0.0	3.53	datum
	0.6	3.45	to edge
	1.8	2.71	to top sand, med. sand
	9.8	1.75	beachface, med. sand
	20.4	0.61	to reef flat
2100 Ocean	0.0	3.59	datum
	0.6	3.54	to edge
	1.8	2.85	to top sand
	8.5	1.96	beach face, coarse sand
	16.5	0.94	to reef flat, coarse sand
	25.6	0.66	reef flat
2100 Lagoon	0.0	3.67	datum
	0.6	3.47	to edge
	2.1	2.57	to beach, med. sand
	8.8	1.75	beachface, med. sand
	19.2	0.60	to reef flat
2200 Ocean	0.0	3.44	datum
	0.9	3.43	to edge
	2.1	2.76	top beach, med. sand
	8.5	1.84	beachface
	15.5	0.96	reef flat
	25.6	0.65	reef flat

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
2200 Lagoon	0.0	3.57	datum
	0.6	3.44	to edge
	1.8	2.76	slope protection
	3.0	1.94	to top of beach, med. sand
	9.8	1.28	beachface, med. sand
	17.4	0.54	reef flat, coarse sand w some rubble
2300 Ocean	0.0	3.64	datum
	0.6	3.56	to edge
	2.1	2.55	slope protection
	3.6	1.59	to top beach, rubble
	9.4	1.26	to outer edge rubble
	21.6	0.71	reef flat, ripples
2300 Lagoon	0.0	3.56	datum
	0.6	3.48	to edge
	1.8	2.74	slope protection
	2.9	2.04	to top of beach
	10.1	1.28	beachface
	17.1	0.55	reef flat, sand
2400 Ocean	0.0	3.56	datum
	0.9	3.39	to edge
	2.4	2.51	slope protection
	4.3	1.41	to top beach, sand bags
	13.4	0.91	rubble
	23.1	0.69	reef flat, ripples
2400 Lagoon	0.0	3.56	datum
	0.8	3.45	to edge
	2.0	2.76	slope protection
	3.4	1.93	top sand, med. sand
	10.1	1.30	beach face, med. sand
	17.4	0.57	reef flat
2500 Ocean	0.0	3.50	datum
	0.9	3.38	to edge
	2.4	2.41	slope protection
	4.0	1.36	rubble/sand bags
	10.4	1.21	to inner edge rubble
	20.4	0.85	to outer edge rubble, reef flat

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
2500 Lagoon	0.0	3.56	datum
	0.6	3.50	to edge
	1.5	2.99	slope protection
	2.1	2.63	to beach, med. sand
	11.3	1.51	beachface, med. sand
	21.0	0.56	reef flat
2600 Ocean	0.0	3.51	datum
	0.6	3.41	to edge
	1.8	2.65	to top beach, coarse sand
	6.4	2.01	beachface
	12.8	1.16	edge beach, rubble, reef flat
	20.7	1.06	reef flat, edge rubble
2600 Lagoon	0.0	3.55	datum
	0.9	3.36	to edge
	2.7	3.07	cement rubble, to top beach
	11.9	1.98	beach med. sand
	24.1	0.67	to reef flat, med. sand
2700 Ocean	0.0	3.50	datum
	0.9	3.23	to edge
	1.5	2.88	to top sand, med. sand
	7.6	2.13	beach
	16.8	0.98	to reef flat
2700 Lagoon	0.0	3.52	datum
	0.6	3.35	to edge
	1.2	3.05	to top of sand, med. sand
	5.2	2.89	LHTS, med. sand
	14.3	1.96	beachface
	25.3	0.74	reef flat
2800 Ocean	0.0	3.59	datum
	0.4	3.32	to edge
	1.4	2.53	slope protection
	3.0	1.38	to top sand
	7.0	1.12	edge rubble
	20.4	0.68	reef flat, ripples
2800 Lagoon	0.0	3.58	datum
	0.8	3.43	to edge
	1.4	3.05	to beach
	3.7	2.90	LHTS, med. sand
	12.8	1.85	beachface
	23.2	0.71	reef flat

PROFILE	HORIZONTAL (M)	VERTICAL(M)	NOTES
2900 Ocean	0.0	3.56	datum
	0.6	3.52	to edge
	1.5	2.98	slope protection
	2.7	2.16	to top sand
	7.9	1.52	edge of buried rubble
	17.4	0.78	reef flat, ripples
2900 Lagoon	0.0	3.51	datum
	0.9	3.43	to edge
	1.5	3.12	slope protection
	8.8	2.94	to top beach, coarse sand
	18.0	1.90	LHTS, coarse sand, pebbles
	30.2	0.61	reef flat
3000 Ocean	0.0	3.54	datum
	0.6	3.47	to edge
	2.1	2.46	slope protection
	4.0	1.38	toe, rubble
	7.9	0.39	seaward edge rubble
	21.3	-0.19	reef flat, ripples
3000 Lagoon	0.0	3.51	datum
	1.2	3.46	to edge
	2.1	2.84	slope protection
	3.0	2.23	
	6.7	2.10	edge slipface
	20.1	2.89	LHTS, berm
	29.0	1.98	beachface
	40.2	0.79	reef flat
3100 Ocean	0.0	3.53	datum
	0.6	3.42	to edge
	2.1	2.39	slope protection
	3.7	1.29	to toe
	9.1	0.93	edge rubble
	15.5	0.75	reef flat, W.L.
3100 Lagoon	0.0	3.56	datum
	0.6	3.53	to edge
	2.1	2.57	slope protection
	3.4	1.85	to top sand
	13.1	1.93	to base of berm
	23.5	2.31	berm crest actually 0.5m higher
	32.6	2.03	across channel
	47.9	1.54	across channel
	80.8	0.53	on small delta