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DEPARTMENT OF HEALTH, DIVISION OF ENVIRONMENTAL HEALTH

WATER POLLUTION REPORT NO. 2

Contracted By

CARIBBEAN RESEARCH INSTITUTE

COLLEGE OF THE VIRGIN ISLANDS

REPORT ON

EFFECTS OF DREDGING IN WATER BAY, ST. THOMAS

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TABLE OF CONTENTS

I. INTRODUCTION

This report presents the data and conclusions which result from preliminary investigations of the effects of dredging in Water Bay, St. Thomas. The observations and reportings were accomplished with the expenditure of six man-days of effort by members of the staff of the Caribbean Research Institute.

The data and recommendations in geology and sedimentology were contributed by Dr. David Raup and Dr. John Adams; and those in marine biology and ecology by Robert Brody. The report was prepared from their draft material by the author, who assisted each of the three in the field observations. Most of the material was derived from reconnaissance on 9 and 15 October, 1969; some from inspection trips 25 and 28 September, and on/ about 25 March, in the spring before dredging began. Aerial photographs were taken on 8 August, 1969.

II BACKGROUND INFORMATION

Water Bay is situated on the north shore of St. Thomas, about two miles from the eastern-most tip. It opens to the east to the Leeward Passage, an inter-island channel from the Atlantic Ocean to Pillsbury Sound; and it is bounded on the north by Coki peninsula, on the west by Pineapple Beach Club site, and on the south by the island land mass proper, ending at Footer Point which separates Water and Smith Bays. Part of the southern shore is the slope of Mt. Pleasant, which rises to 200 feet elevation. Between Footer Point and Mt. Pleasant is a lowland area which formerly was a salt pond, and which until recently had been used as a garbage dump. This area was overfilled with the dredging spoils. The sub-littoral area of the bay is about three million square feet, with a seaward opening on a north-south axis of about 1,500 feet and a westerly extension of about 2,000 feet.

Dredging last spring was allowed under Department of Interior Submerged Lands Permit No. 10 and U. S. Army Corps of Engineers Permit SASJ Permits (69-66). The Department of Interior Permit expires 31 December 1972. These permits allow the dredging and removal of 600,000 cubic yards of material; and Special Condition No. 5 of Department of Interior Permit No. 10 requires that the dredging be confined to water depths greater than 25 feet. This condition was "to insure preservation of the nearshore submarine resource." The permittee pays to the Office of Territories, U.S. Department of Interior, $0.10 for each cubic yard removed, subject to annual reconsideration of the fee.

The Water Bay bottom was subjected to spoiling on two prior occasions; first in 1961 for the original boat dockage and construction fills, and then again in 1965 for beach extensions and construction materials for the Pineapple Beach Club.

III. GENERAL OBSERVATIONS

Water Clarity

The site was visited in late September and early October. On the first visits, turbidity was not nearly as high as on the latter visits, with visibility initially along the northern shore up to about 20 feet. The weather had been exceptionally calm for several weeks, but between visits had returned to a near normal late summer/early fall condition; sea state of 2-3 and wind of 10-15 knots. At the last visit bottom could not be clearly seen anywhere in the bay in depths over 5 feet. Turbidity remained high off-shore east of Coki Point to depths of 30 feet, and gradually diminished along the north shore of the peninsula, over a 100 - 150 yard stretch westward in Leeward Passage, to normal clarity. Corals have been killed, as a result of deposition of sand particles, nearly to the eastern edge of Coki bathing beach. Large schools of baitfish were observed south of Coki Point, and are being preyed upon by birds; so apparently the vertebrate fauna is not being substantially affected. Water clarity is markedly improved along Pineapple Beach Club in water depths less than 10 feet -- the western 15% of the bay.

Causes of Sub-littoral Mortalities

Two primary modes are/were in operation:

1. Turbidity eliminates or reduces light penetration, and the coral algae symbionts are killed. These symbionts supply the proper metabolism of coral wastes and allow calcium carbonate fixation by the coral animals. When the symbiont algae die, the corals die.

2. Siltation causes clogging of the coral animal tissues and literally smothers the corals. There are apparently two mechanisms of siltation operative in the bay.

a) Initially, the dredge work disturbs the normal bottom cover of algae, grasses, and coral, killing some by actual physical disruption and suspending a large quantity of sediments of all sizes in the water mass. The large particles settle out within a few hours or days and fall upon the corals. If a sufficient amount of sediment falls upon a coral, the load will be too great to be removed by the coral's tentacular structure and death will ensue.

b) A second problem occurs as a result of the fine material put into suspension by the dredge activities. In Water Bay this is complicated by the apparent stratigraphy of the sediments on the small south shore beach. Dredge work removed a sufficient amount of sand to permit the sand on the beach area to "slump" back into the offshore waters. The terrestrial land under and behind the beach contains very fine clay particles and movement of this material accompanied (or followed) the change in beach topography. The extremely fine clay particles are held in suspension in the water, and those larger ones which settle kill by clogging or simply covering the low coral growth (e.g., Porites) with a slurry of clay-silt. The effects of this situation are obviously of much longer duration than those of the larger particles, and they are very much in evidence throughout Water Bay.

Inspection of Dredge Cuts

Figure I is a cross section sketch of a line from about the tip of Coki Point southward into the dredged area. The bottom areas from Coki Point south for about 100 yards are floored with corals to a depth of approximately 25 feet. Below this coral zone is a narrow strip of sand with the grass Cymodocea and non-calcareous algae (e.g., Caulerpa). This grass community is interrupted by a distinct trench, made by the dredge, which roughly follows the contour of the point. The trench profile at the section line cuts into the slope below the reef at 30 - 35 feet depth; it is about 15 feet wide. The bottom of the trench is 46 feet and the level rises on the offshore side to 40 feet. The dredge cut described above was followed for about 1/4 mile underwater. For almost all of the length, it follows exactly a 28 foot depth contour. Presumably the dredge operator had control of this as the line followed extended at the constant depth first west, then north, then west, then south.

IV. GEOLOGY AND SEDIMENTOLOGY

This section summarizes the effects of the dredging which caused the present high turbidity condition in the bay and the erosion of the small beach area on the south shore of the bay.

Erosion of the South Beach

The small beach on the south side of the bay shows evidence of rapid erosional retreat. The berm has been cut back to form a nearly vertical cliff several feet above sea level. Substantial portions of the root systems of several large trees have been exposed. The beach itself is coarse, gravelly, and contains little sand. It is steep and narrow. Some beachrock is exposed near water level. The beachrock shows no evidence of long exposure to the sea: it has not been attacked by marine borers nor does it support corals or other attached organisms; algae cover is extremely thin and spotty.

Offshore from the Beach

The following five zones are found:

1. Hard-packed, current-swept sand pavement.
2. Firm sand with small oscillation ripples.
3. Outcrops of a well-stratified, cohesive clay.
4. Remnants of a small reef or coral bank (mostly dead).
5. Loose, soupy bottom with a 2" - 12" layer of reworked clay overlying dead coral and clean sand.

The clay (3) outcrops at water depths of from 4 - 6 feet. The zone of reworked clay (5) extends out in the bay from a depth of about 8 feet. Its outer boundary was not found although it presumably occupies an area of several acres near the south beach.

Timing of the Beach Erosion

The present beach shows every evidence of having been eroded very recently (probably within the past few months). The cliff cut in the berm and the fresh beachrock are most eloquent in this regard, but all the observed

features support this conclusion. Furthermore, the beach is still actively eroding. The rock jetty constructed just east of the beach appears to have had little or no effect (it may even have increased the rate of beach erosion).

Clay Outcropping Offshore from the Beach

This could not have been deposited in the bay as we see it today. It is probably part of a larger clay deposit that underlies the present berm and beach. At some time in the past, the berm must have been farther out in the bay so that it formed a lagoon or salt pond, which served as a protected basin for clay deposition.

The present exposure of clay is a direct consequence of the erosion of the beach, which in turn was most probably touched off by dredging of sand close to shore.

Effects of Erosion of the Clay

Some of the clay that has been exposed to wave action in the shallow waters off the beach has moved downslope to form zone 5, referred to above. The rest of it has been (and continues to be) thrown into suspension and moved elsewhere in the bay. The latter has produced a level of turbidity which has reduced visibility to a few inches near the outcrops of clay and has had a noticeable effect on underwater visibility elsewhere, particularly along the southern margin of the bay. The reworked clay of zone 5 is also contributing to this turbidity and loss of visibility.

Contrast with Silting Caused by Dredging

Thin deposits of fine sand and silt stemming from the dredging operations are apparent in the northern half of the bay and have been responsible for partial killing of coral and other reef organisms along the north shore of the bay. Presumably, this silting took place during and shortly after the dredging and was geographically controlled by water current patterns at the time. This sand deposition also was found along the north shore of Coki peninsula, in varying magnitude.

The sequence of events leading to the exposure and erosion of the clay on the south side of the bay is entirely different and has quite different implications. The clay is now exposed in extremely shallow water and may be expected to provide a continuous supply of suspended material. Thus, elevated turbidity affecting the marine ecology and aesthetic value of the bay may be expected to continue until the clay supply is exhausted or until corrective measures are taken.

V. ECOLOGY AND BIOLOGY

General Survey

Acropora palmata along both south and north shores are nearly all necrotic; labyrintheform corals (Diplora, Montastrea) are somewhat less severely damaged, but obviously not well.

The margins of several patches of Thalassia along the western section of the south shore are abruptly curtailed and depth increases radically at these margins. These Thalassia patches are in water of 6 - 8 feet depth; the depth of the margins is 12 - 15 feet. The turbidity in these areas is high; calcareous fines are notable to depths of 8" - 12" before calcareous sands (Halimeda, etc.) are felt. Dredging was done in this area prior to the work done this year, and it appears the fines from the new dredging have settled into the old cut.

The corals in water 10 - 25 feet deep are adapted to a lower light regime and show less marked deleterious effects. There is evidence that 1 - 2 inches of sand have accumulated around the base of the octocorals, killing some few coral polyps but not the entire colony. This is also suggested by the lack of small hard coral growth on the surface, many dead small (e.g., 2" - 3" diameter) hard corals beneath the sand and a general lack of encrusting colonial organisms (sponges, tunicates, milleporine (fire) corals).

South Shore

There is intermittent coral kill on Acropora palmata (Elkhorn), Porites porites (Finger Coral) and their associated coelenterate communities. In the area immediately below Mt. Pleasant peak and west, Acropora shows partially dead colonies with sand size particles atop horizontal coral limbs. Immediately north of the small beach area west of Footer Point and on to the west for approximately 300 yards there is nearly complete extirpation of Acropora and almost equal kill of Porites. From the beach to Footer Point there is again the intermittent kill.

Benthic grasses in this southside of Water Bay are sparse. In those grass areas near the beach described above, the epiphytic algae in Thalassia are lightly coated with a fine clay silt. On the Thalassia patches immediately north of live Acropora this silt is less dense but still noticeable.

Benthic algae in the area follow the same pattern. The noncalcareous species (Caulerpa, Dictyota, Gigartina) are depleted or absent. In the area north of the beach visibility is reduced to 2 - 3 feet and virtually all algae are dead.

The apparent cause of this kill is twofold. The Acropora in the inshore (less than 10 feet) area to the west shows spotty coral kill with relatively large diameter algal sand particles still in place upon the Acropora branches. The entire area in deeper water , and also the area from the rock jetty at the beach to 300 yards west inshore, shows the effects of a very fine clay-silt which is causing coral death by all of the mechanisms.

North Shore

1. The corals in the shallow surge zone are dominated by Acropora palmata and octocorals (seafans, etc.). In this area there has been coral kill at about a level of 25 - 50% by the mechanism of large particle fall-out.

2. The area on the deep water side of the cut is covered with fine particles to a depth of 3 - 8 inches and vegetation is greatly reduced, or more frequently absent, buried by the silt.

VI. SUMMARY

It is clear that the bottom alteration this year in Water Bay has resulted in a major ecological disaster for the sub-littoral flora and sessile fauna. Relatively rapid extirpation of many of the corals, grasses, and algae resulted from disruption, covering, or siltation; the highly turbid water condition continues to destroy more.

This is a secondary effect of the dredging procedure. When the bottom cover of grasses and algae are removed the fine particles are no longer trapped by them and their associated epiflora and epifauna. Turbidity is thus increased. This works in a cycle, since turbidity reduces bottom light levels and marine grasses cannot carry on sufficient photosynthesis to rapidly recolonize the area. Thus a new community of non-photosynthetics may replace it, and an anaerobic condition might exist. The potential for this is already present in Water Bay where black sediments underlie the existing layers of light silt. At best, the photosynthetic community will take a long time to reestablish itself; thus successional process will take several years as the initial colonizers will have to stabilize the sediment with root system development and be replaced in time by other species. The marine grasses represent the "climax community" of clear inshore marine waters, and their success is the result of several modifications of the substratum by several preceding plant communities.

The kill of the coral animals is significant in terms of the long range health of the reef since big corals must grow from small corals. Those octocorals which have had their lower portions killed will not die immediately, but a primary means of the growth of fire corals is to utilize the dead lower surface areas of soft coral branches as an initial area of colonization. The fire coral then grows up the stem of the octocoral, killing the octocoral as it grows. Approximately 50% of the octocorals show the pattern of lower stalk death as a result of rapid sedimentation. If the sand now present is moved away, exposing the central axis, a prime habitat for fire coral colonization is opened, and probably most octocorals so damaged will die in the future by this mechanism.

The dredging was done without proper consideration of the nearshore dynamics. Removal of sand too close to the south shore of the bay caused downslope transport of the sand forming the beach, and subsurface clay deposits were exposed to the water currents. It goes without saying that sediment cores taken in the beach area before dredging would have shown the presence of clay close to the surface, and the present turbidity problem could have been anticipated or avoided. Now, it would seem prudent to survey the area much more extensively in order to fully assess the problem, and to learn more about the basic phenomenon of clay exposure so that mistakes will not be made in future operations. It would also seem appropriate to investigate as

soon as possible ways and means of remedying the present problem. This could conceivably involve covering the clay (zones 3 and 5, above) or removing it by specialized dredging.

VII. APPENDIX

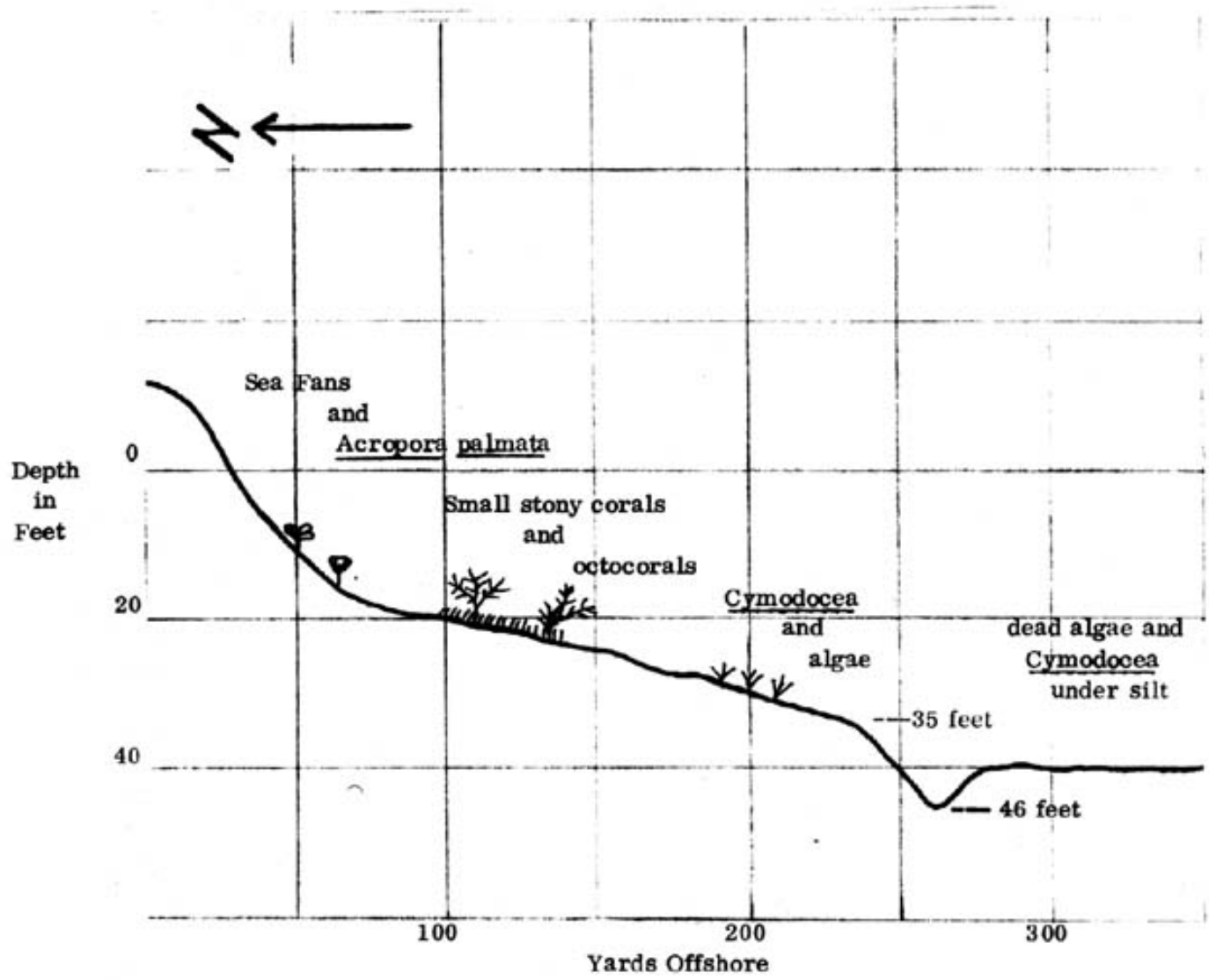

FIGURE I

WATER BAY, ST. THOMAS

SKETCH OF SUBMARINE TRANSECT