DRAFT

BLIND PASS
INLET MANAGEMENT PLAN

INTERIM REPORT NO. 2

(REVISED)

Submitted To:

CAPTIVA EROSION PREVENTION DISTRICT

February 1992

COASTAL PLANNING & ENGINEERING, INC.

GOALS OF THE INLET MANAGEMENT PLAN

The following goals are a composite of goals suggested by the State program and local governments.

A. Mitigate erosion caused by the inlet.

B. Re-establish littoral drift to downdrift beaches that are being affected by the existence of the inlet.

C. Maintain flushing and navigation to pre-1988 levels.

D. Protect the evacuation route from storm damage.

E. Control erosion north and south of the pass to protect County parks and private homes.

F. Accomplish goals A - E addressing long term environmental impacts.

G. Accomplish goals A - F in an economically responsible manner.

H. Quantify the impacts that the 1972 groin built by Lee County may have had on the beach in northern Sanibel Island.

I. Quantify impacts that the 1988/89 Captiva beach restoration/groin extension project may have had on the beach in northern Sanibel Island.

J. Develop intergovernmental programs to implement the Inlet Management Plan.

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HISTORICAL SHORELINE AND VOLUME CHANGES

Historical shoreline and volume changes both reflect the overall forces and processes acting on the shoreline. However, the two types of data differ in terms of their reliability, accuracy and significance on coastal processes.

Modern surveying methodology is much more effective than the older surveys in quantifying volume changes. One disadvantage in using shoreline positions is that they change seasonally and due to profile flattening and steepening which usually occur in winter and summer months, respectively. Shoreline changes may occur without a corresponding change in profile volume. A second disadvantage is that a small datum error (reference elevation) can yield significant error in the position of the mean high water line.

Usually if one is interested in short term changes, it is necessary to carry out careful and tightly controlled measurements of volumetric changes (profiles) since shoreline changes can occur simply due to seasonal or unusual storm effects. If data are available over a long period, shoreline changes will usually be reasonably representative of volumetric changes and may be more accurate than profile comparisons when the offshore portion of the profiles show divergence and significant closure error.

Beach cross-sections measure the change in the entire profile and directly represent volume changes although offshore measurement accuracy can affect volume estimates. Cross-sections are less dependent on the profile shape than volume estimates based on shoreline position. The profile does not have to remain in equilibrium to develop an accurate volume measurement. However, offshore profile data can be a source of error. Offshore profiles are measured by a fathometer and corrected for tide. The accuracy of the offshore reading is less than the onshore measurements and small differences can result in large volumetric change estimates. Longer term comparisons are better indicators of volume change rates as errors in the offshore record can be less significant when compared to large long term changes. Also, long term comparisons avoid development of cumulative errors that can occur when comparing sequential surveys.

Considering the merits of shoreline and profile surveys, the best understanding of shoreline processes or impacts will usually be provided by an analysis which includes consideration of both shoreline and volume changes with careful scrutiny of the data for indications of accuracy and consistency. In the following sections, analyses are presented for both shoreline and volumetric historical changes in the Captiva-Sanibel vicinity with special emphasis in the Blind Pass area. The long term results will first be presented followed by an analysis for the period 1988 to the time of the most recent available data.

LONG TERM HISTORICAL DATA

<u>Shoreline Changes</u>

The Division of Beaches and Shores (DBS) of the Florida Department of Natural Resources

(FDNR) maintains an excellent data base around the sandy shorelines of the State of Florida. For Captiva Island, data are available for 1859, 1941, 1951, 1956, 1961, 1972, 1974, 1979, 1985, 1988, 1989, 1990, and 1991. For Sanibel Island, data are available for 1859, 1941, 1951, 1956, 1961, 1972, 1974, 1979, 1985, 1988, 1989, 1990, and 1991.

For each of the times for which data are available, the shoreline changes at each monument were calculated relative to the initial survey. These were then summed over approximately one-mile intervals, weighting each change by the appropriate alongshore spacing of the monuments at which the data are available. These results are shown in Figure 1 and 2 for Captiva and Sanibel, respectively. These results are discussed in the following paragraphs.

Captiva Island Shoreline Changes

The total length of Captiva Island as represented by the monument weighing values is 26,169 ft. or 4.96 miles. Therefore, Captiva Island was divided into five equal segments of 5233.8 ft. each. Referring to Figure 1, it is seen that the northerly two segments (mile 1 and 2) have experienced general retreat over the period of record. This is undoubtedly due to the opening of Redfish Pass in 1921. The shorelines represented by Miles 3 and 4 advanced until 1951, then experienced general retreat. The southerly mile (Mile 5) has generally retreated over the period of record with increased recession rates commencing in 1951 and 1972. The effects of the beach nourishment projects conducted in 1981 and 1988-1989 are evident in Figure 1.

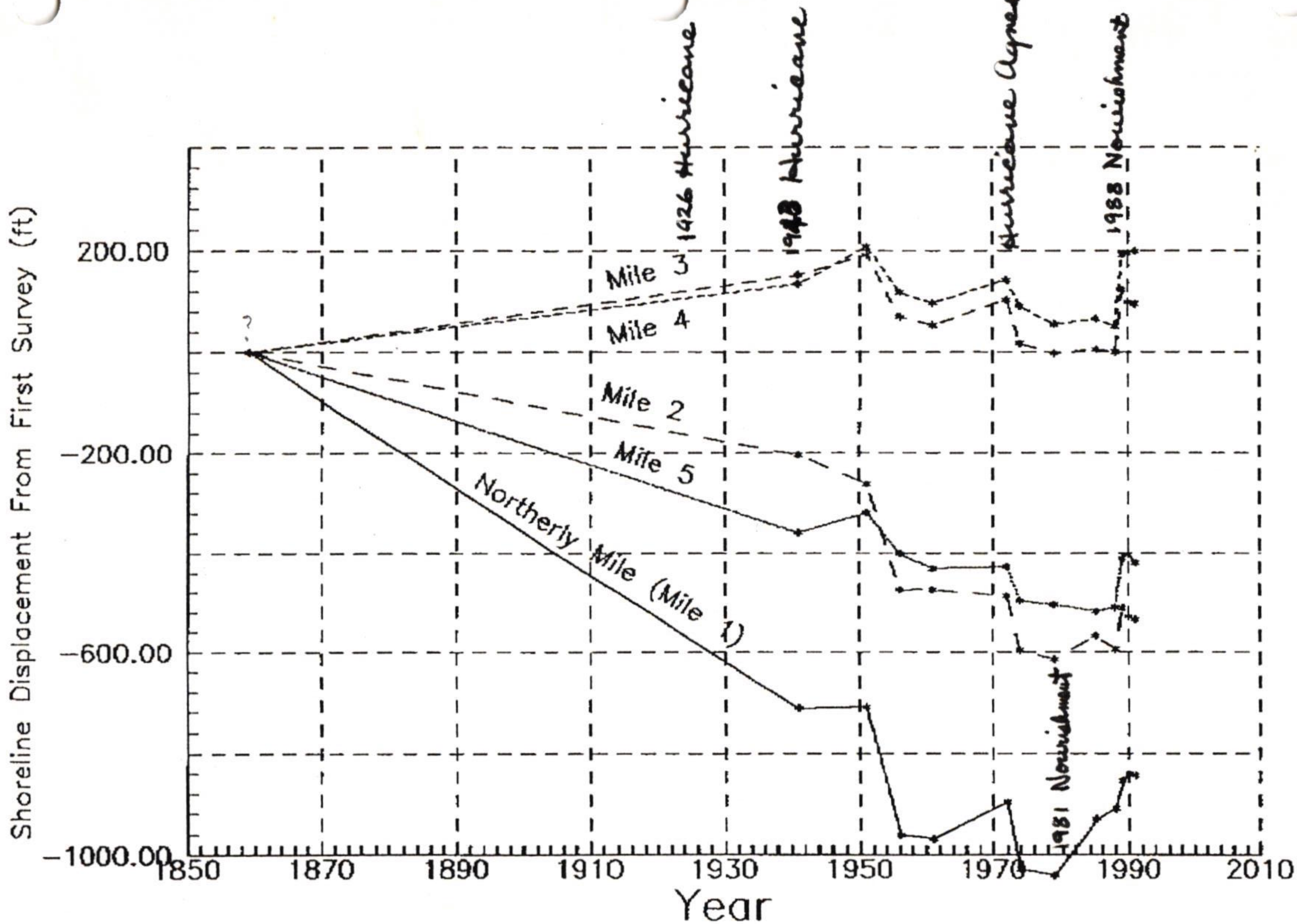


Figure 1. Shoreline Positions on Captiva Island Averaged Over Approximately One-Mile Intervals.

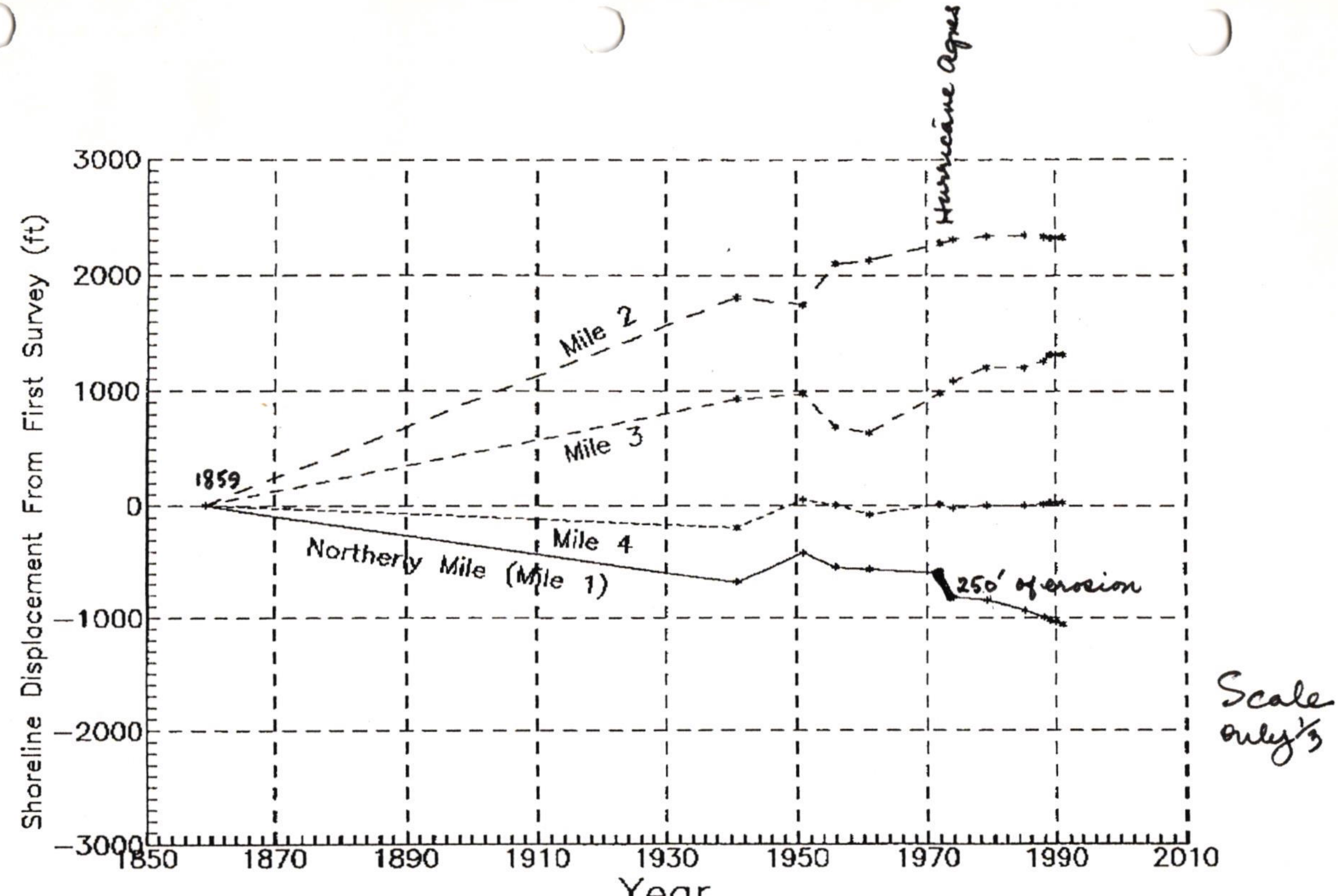


Figure 2. Shoreline Positions on Sanibel Island Averaged Over Approximately One–Mile Intervals.

Sanibel Island Shoreline Changes

The data analyzed on Sanibel extended from DNR monument R-110 immediately south of Blind Pass to monument R-130. The overall length represented by these monuments is 21, 062 ft. or 3.99 miles. Thus, this area was divided into four equal segments, each of 5265.5 ft. in length. The changes in average shoreline positions for each of these four segments has been shown in Figure 2. The northerly mile experienced retreat from 1859 to 1941, then stability and/or advancement from 1941 to 1972 followed by a steady recession after 1972. Miles 2 and 3 show general accretion over the period of record whereas Mile 4 has been generally stable.

Captiva Island Volume Changes

Volumetric changes on Captiva Island were estimated based on the historical record of shoreline changes and profiles. Two evaluations of volumes were made with the data taken after 1985 using shorelines and profiles (cross-sections) measured during twice a-year monitoring surveys.

Shorelines can be converted to volume changes using conversion factors that are based on total depth of change. In Captiva Island the active profile is assumed to extend from the +6 foot contour on the beach to the -12 foot contour offshore. This would suggest a conversion factor of 0.67 c.y./ft. (18 ft. $\div$ 27 c.y./ft.^{3} x 1 ft.). For each foot of advance or retreat of the shoreline, the beach gains or loses 0.67 c.y. This conversion assumes that a profile maintains the same shape but translates uniformly in retreat or advance. This is a good assumption for long term comparisons but is less accurate on short term comparisons.

To minimize error in the profile comparisons, long term comparisons were chosen from the data sets that demonstrate good offshore closure. The volume change above the 12 ft. contour was reported as the volume change. The change between the 12 ft. and 18 ft. contour was noted as a measure of offshore closure. The closer the volume change was to zero, the smaller the closure error.

Volume changes on Captiva Island were computed for three time periods using shoreline changes. Table 1-A presents the results of this analysis from 1941 through 1985.

Table 1-A

Annual Volume Change Rates
Captiva Island
Based on Shoreline Changes 1941-1985
(cubic yards x 1000/yr.)
Based on a Conversion Factor of 0.67 c.y./ft.

Reach	1941-55	1955-74	4/74 - 4/85
Mile 1	-55	-11	+5
Mile 2	-79	-28	-17
Mile 3	-17	-7	-3
Mile 4	-5	-5	-9
Mile 5	-9	-17	-6
	-165,000	-68,000	-30,000

After 1985, the beaches of Captiva and northern Sanibel were monitored twice/year. An analysis of the data sets showed good offshore closure between August 1985 and August 1988 profiles with a less than 3% change in volume from the 12 ft. to the 18 ft. depth contours (when compared to the total volume change above the 12' depth contour). The erosion rate as shown on Table 1-B of Captiva Island between 1985 and 1988 was 85,000 cubic yards/year.

Table 1-B

Captiva Island Volume Change Rates
Based on Beach Profile Comparisons
(In Thousands of Cubic Yards)

Mile	Aug. '85 - Aug. '88 Total	Annual	Aug. '88 - Dec. '91 (Above 12' Contour)	Placed Volume	Aug. '88 - Dec. '91 Net Erosion
1	-63	-21	+130	+113	+17
2	-79	-26	+324	+392	-68
3	-46	-15	+321	+384	-63
4	-61	-20	+301	+342	-41
5	-8	-3	+299	+362	-63
	-256	-85	+1,376	1,594	-218

Annual Erosion Rate
(Thousands of Cubic Yards/Year)
Aug. '88 - Dec. '91

Mile 1	+5
Mile 2	-21
Mile 3	-19
Mile 4	-12
Mile 5	-19
Total	-66, 000

The next profile comparison chosen was August '88 through December '91. This comparison shows less than a 5% change between the 12 ft. and 18 ft. depth contour, an indication of good offshore closure. The volume change above the 12 ft. contour was a gain of 1,376,000 cubic yards of buildup and reflects the beach nourishment construction of 88/89. When placed volumes are deducted from measured quantities, a total erosion of 218,000 cubic yards is estimated over the 3.3 year time period or 66,000 c.y./yr.

The time period of 1974 through 1988 is an important pre-construction time period for later analysis. The following volumetric composite was generated for the '74 - '88 time period using both shoreline and profile data.

Table 1-C

Composite Based on Shoreline Changes and
Profile Comparisons
Captiva Island Volume Change Rate
(In Thousands of c.y./yr.)

	4/74 - 8/88
Mile 1	+5
Mile 2	-18
Mile 3	-7
Mile 4	-9
Mile 5	-9
Total	-38

From 1974 through 1988 Captiva Island eroded at 38,300 cubic yards/year.

Volume Changes in Northern Sanibel

Volume changes on the northern 4 miles of Sanibel Island were estimated from 1941 through 1985 using shoreline changes. The conversion factor used varied with the amount of island rollover/overwash estimated.

On Sanibel Island, segments of the shoreline are backed by water. When these segments retreat, the upper portion rolls over into the bay and does not erode. For those segments the volume conversion is smaller (0.33 c.y./ft.) than for non rollover segments. To establish the amount of overwash shoreline in each mile of northern Sanibel, inland water bodies were measured and compared to land areas. The conversion factors for each mile are shown in Table 2. Table 2 shows computed conversion factors for miles 1 through 3 based on land and water areas. Mile 4 conversion factor is assumed to be 0.67 c.y./ft.

Table 2

Conversion Factor for Volume Changes
in Northern Sanibel From 1941-1985

	% Water	% Land	% Water (0.33)	% Land L (0.67)	Conversion Factor
Mile 1	48	52	0.16	0.35	0.51
Mile 2	33	67	0.11	0.45	0.56
Mile 3	7	93	0.02	0.62	0.65

Table 3A shows the volumetric changes in northern Sanibel based on shoreline changes. The north mile erosion rate changed from a strong accretion of 53,000 c.y./yr during the 1940's and '50's to an erosion of 39,000 c.y./yr in the late 1970's and early '80's, based on shoreline change data.

1974 - 1988 - Why did erosion rate on Captiva lessen?
revetments ?

DNR - requirement tied to shoreline change not to volumetric change

Hans Wilson

1. Profiles - tied to volumetric changes?
   42,000 CY lost per year
2. 1955 - 1958 - Shoal part of sediment budget? Check?
3. Shoreline hardening on Captiva restricted flow from C to Sanibel
4. Alignment of Blind Pass affects Sanibel like Redfish Pass affects Captiva?

Table 3A

Annual Volume Change Rates
(Northern) Sanibel Island
Based on Shoreline Changes 1941-1985
(In Thousands of Cubic Yards)

Reach	1941-1955	1955-1974	1974-1985	1974-1988
Mile 1	+53	-35	-43	-39
Mile 2	+16	+50	N/A	+13
Mile 3	-29	+50	N/A	+30
Mile 4	+39	-4	N/A	+4

Boundary condition - southern 8 miles of Sanibel.

Since 1985, profiles have been measured twice/year along the first mile of Sanibel Island. Aug. '85 vs. Aug. '88 and Aug. '88 through Dec. '91 have been compared to analyze volumetric changes (Table 3-B). Both of these comparisons show good offshore closure in Sanibel.

To account for sand stored in the ebb shoal of Blind Pass (a sediment sink) the offshore changes of the first 1200 feet of beach have been subtracted from the direct profile comparison. This assures that any loss of sand to the ebb shoal will not be counted as an increase of sand to the beach system.

To account for volumes of sand that moved into Clam Pass Bayou that were not computed by direct profile comparison, estimates have been made of those quantities. Overwash and shoreline retreat in the vicinity of R112.5 and R114 has extended landward of the 1985 and 1988 survey limits. Sand has moved into Clam Pass Bayou that was not directly accounted for by direct profile comparison. These volumes have been estimated by extending historical profiles landward and estimating the depth in Clam Pass Bayou to be -3 NGVD.

Table 3-B shows the measured volume and the net changes that have occurred from 1985 through 1991.

Table 3-B

Volume Changes on the Northern One Mile of Sanibel
Based on Profile Surveys

	8/85 - 8/88	8/88 - 12/91
A - Measured Volumes	-148,053	-100,738
B - Shoal Change	-4,897	+53,042
C - Overwash Not in "A"	+3,100	+54,000
	-140,056 c.y.	-99,780 c.y.
Annual Change	-46,685 c.y./yr.	-30,236 c.y./yr.

Table 3-C

Volume Change Northern Sanibel From 1974-1991
Based on Shorelines and Profile Surveys
(In Thousands of c.y./yr.)

	1974-1988	Aug. '88 - Dec. '91
Mile 1	-44^{1}	-30^{3}
Mile 2	$+13^{2}$	$+2^{4}$
Mile 3	$+30^{2}$	-23^{4}
Mile 4	$+4^{2}$	$+45^{5}$

1 Based on profiles and shorelines composite
2 Based on shorelines
3 Based on profiles from Table 3-B
4 Based on '89-'91 shorelines
5 Based on '89-'90 shorelines

Table 3-C shows the composite volumetric change estimates in northern Sanibel from 1974 through 1991. Since August of 1988 the northern one mile has eroded at 30,000 c.y./yr. or about 30% slower than the erosion rate of the previous period.

ANALYSIS OF RECENT DATA

Sanibel Island Shoreline Changes

Prior to the 1988/89 nourishment project on Captiva Island, a retreat rate for shoreline positions along northern Sanibel Island was established by the DNR. The weighted average retreat rate was 13.3 ft./yr.

Data available from August 1988 to December 1991 extend from DNR monument R-110 located immediately south of Blind Pass to R-116 located approximately 6314.6 ft. south of Blind Pass. The analysis method consisted of weighting the shoreline positions by shoreline distances appropriate to the spacing of the adjacent monuments. The results are presented in Figure 3 and the interpretation is discussed in the following pages.

Tropical Storm Keith occurred in November 1988 and has caused some difficulty in interpretation. It appears that Keith caused some irreversible shoreline retreat through overwash and possibly anomalous longshore sediment transport. However, referring to Figure 3 it is clear that as of the April 1989 survey, significant shoreline recovery following Keith has occurred.

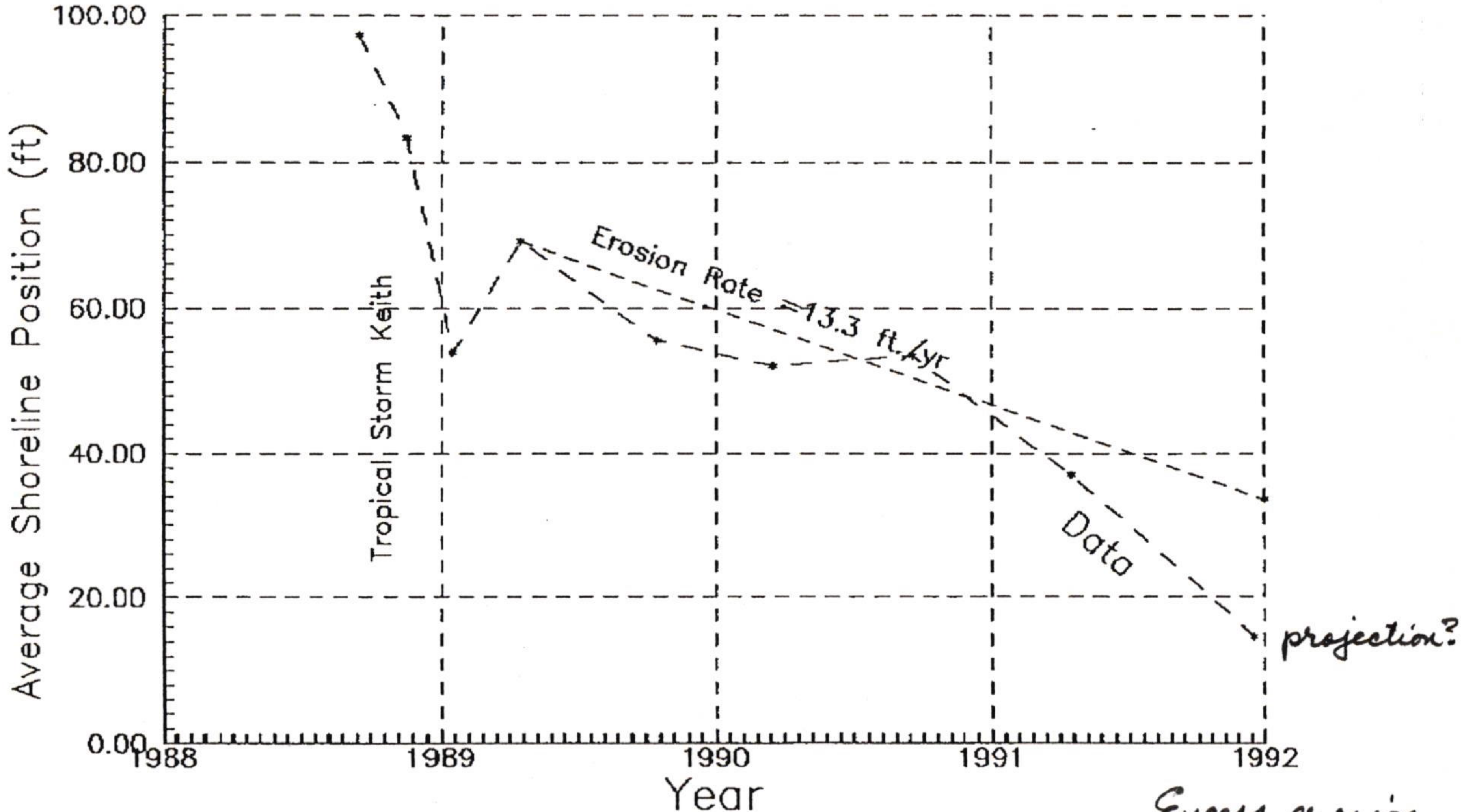


Figure 3. Weighted Average Shoreline Positions Along The Northerly Mile of Sanibel Island. Data Furnished Predominantly by the Department of Natural Resources.

Excess erosion of about 7 feet per year.

Using the adopted pre-groin extension erosion rate of 13.3 ft./yr., the projected shoreline position in December 1991 would have been at station 34.1 ft. versus a measured average station of 14.6 ft. This represents an excess recession of 19.5 ft., which over the 2.63 year period averages to an excess recession rate of 7.4 ft./yr. This excess recession may represent an impact of the 1988/89 Captiva Beach Restoration and Groin Extension Project.

Sanibel Island Volume Changes

The erosion rate of northern Sanibel (6300 ft.) has averaged 42,500 c.y./yr. from April 1974 through August 1988. In the time period from August 1988 through December 1991 the erosion rate was only 30,000 c.y./yr. This represents a reduction of 30% over the previous time period. This reduction in erosion rate could represent a positive impact of the 1988/89 Captiva Island Beach Nourishment/Groin Extension Project.

II. LITTORAL BUDGET ANALYSIS

The littoral budget is a balance of sand movement during specific time periods over discrete segments of coast. It is generally accepted that the net littoral drift is south on Captiva and Sanibel Islands as is evidenced by the creation of Captiva and Sanibel Islands through southerly sand migration over the past 5000 years (Missimer). The erosion response of Captiva Island to the opening of Redfish Pass is further indication of a strong net south drift.

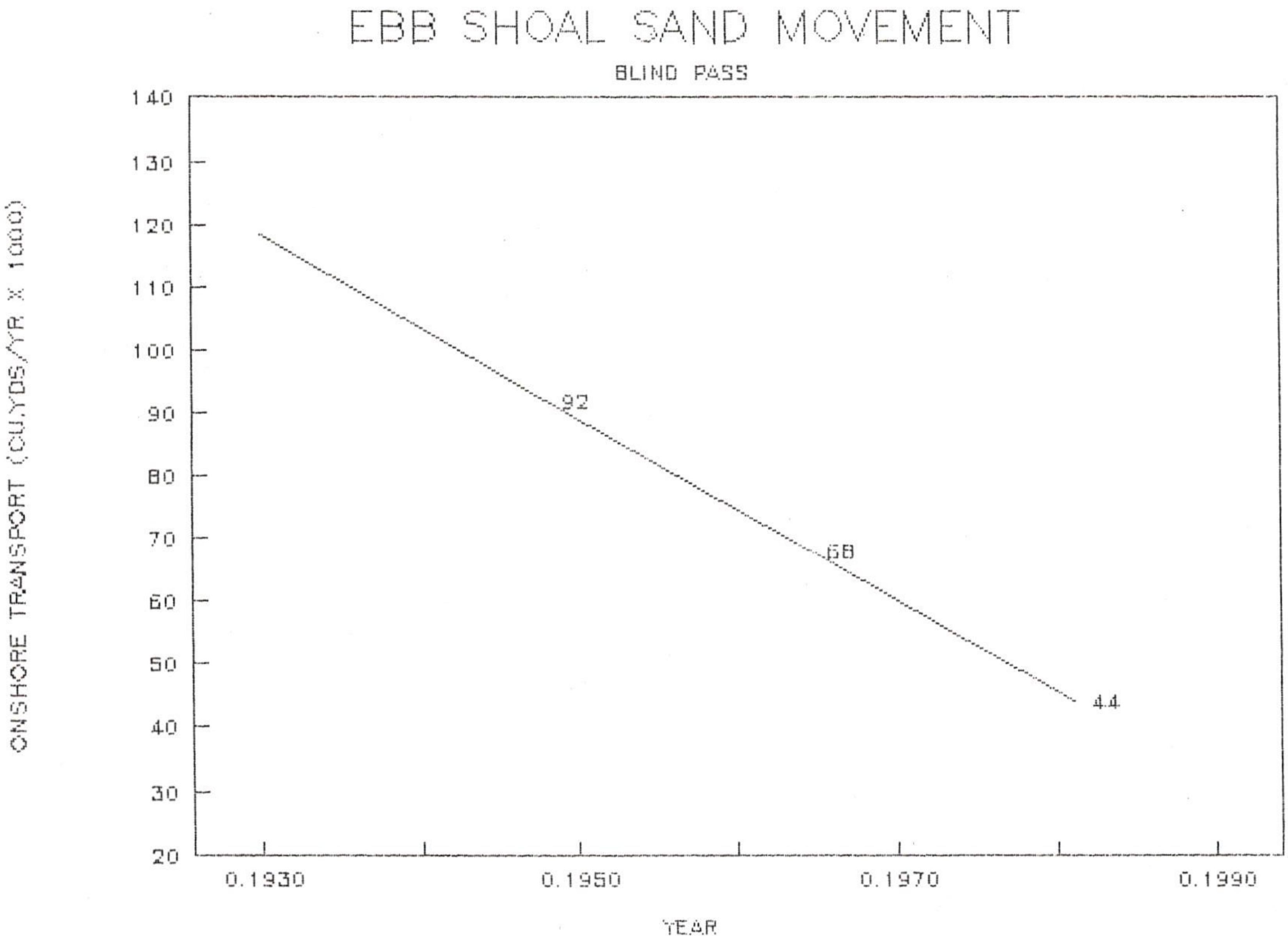
The southern boundary of the littoral budget is the south end of Sanibel Island where net littoral drift is assumed to be zero. The northern boundary, Redfish Pass, is not assumed to be fixed in any way.

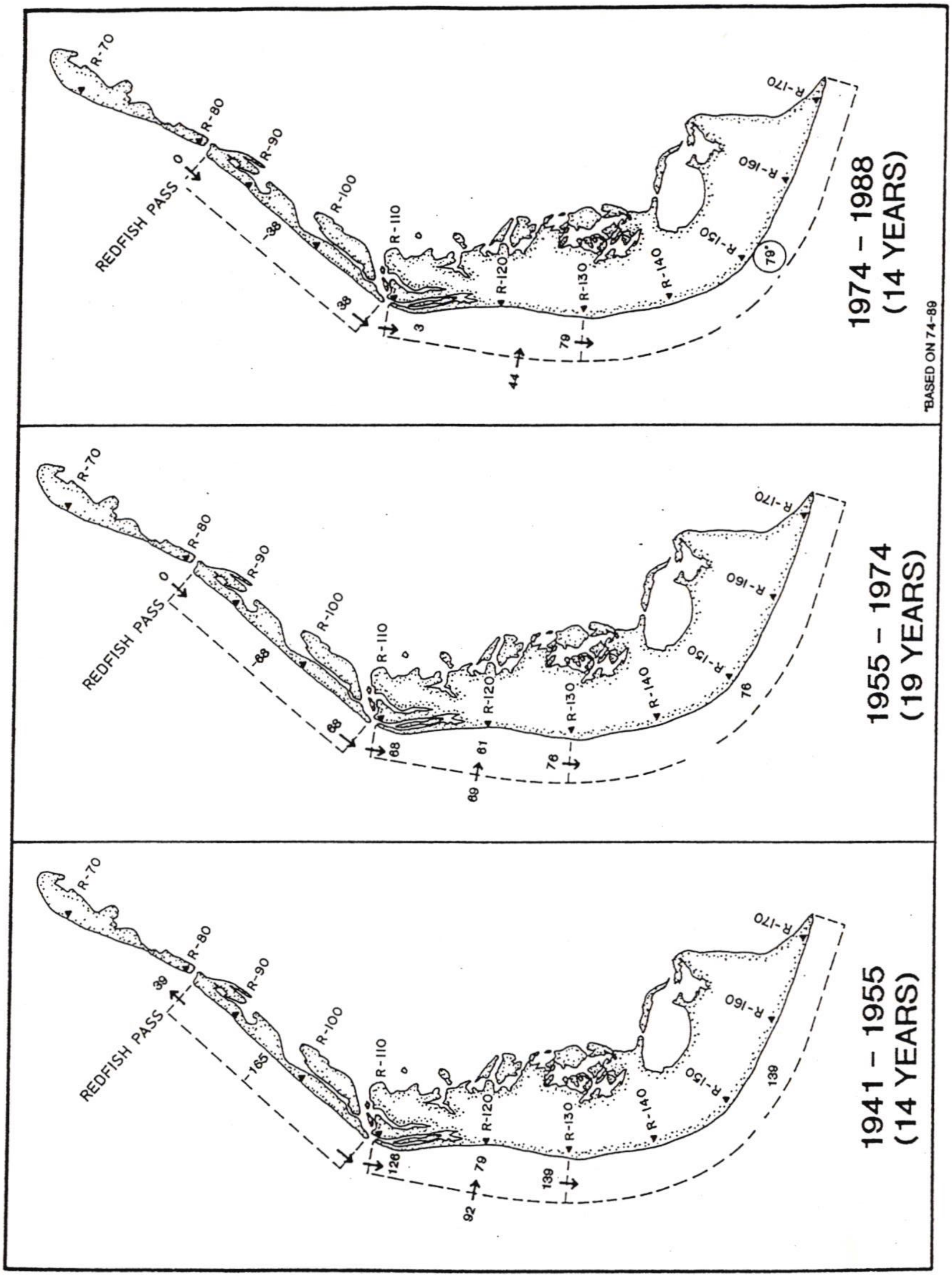
The shoreline evolution along the southern 8 miles of Sanibel Island provides important information on the rate of sand movement from northern Sanibel Island. Based on shoreline changes we find that southern Sanibel has been actively accreting (building up) since 1941.

The rate of buildup in southern Sanibel is faster than the rate Captiva Island and northern Sanibel lose sand because sand is coming in from offshore. From 1941 through 1955 the rate of accretion was a rapid 139,000 cubic yards per year (Figure 7). In the later time periods (1955-1974 and 1974-1989) the rate slowed to 76,000 and 79,000 cubic yards/year, respectively. These rates of buildup exceed the supply of sand from the north; therefore we conclude that the buildup on Sanibel is partially due to onshore movement of sand from the ebb shoal of the historic Blind Pass (pre-1920).

Table 8 and Figure 8 were used to determine the rate of onshore transport. We assumed that the amount of transport linearly decreases with time and that transport into Redfish Pass was negligible during the later two time periods. Figure 7 shows the estimated onshore transport at northern Sanibel for the 1941-1955 time period was 92,000 cubic yards/year.

Based on this analysis, the onshore transport from the historical shoal would be 32,000 for the August 1988 through December 1991 time period.


EBB SHOAL SAND MOVEMENT
BLIND PASS
ONSHORE TRANSPORT (CU.YDS/YR X 1000)
140
130
120
110
100
90
80
70
60
50
40
30
20
92
68
44
0.1930
0.1950
0.1970
0.1990
YEAR



CAPTIVA – SANIBEL SEDIMENT BUDGET

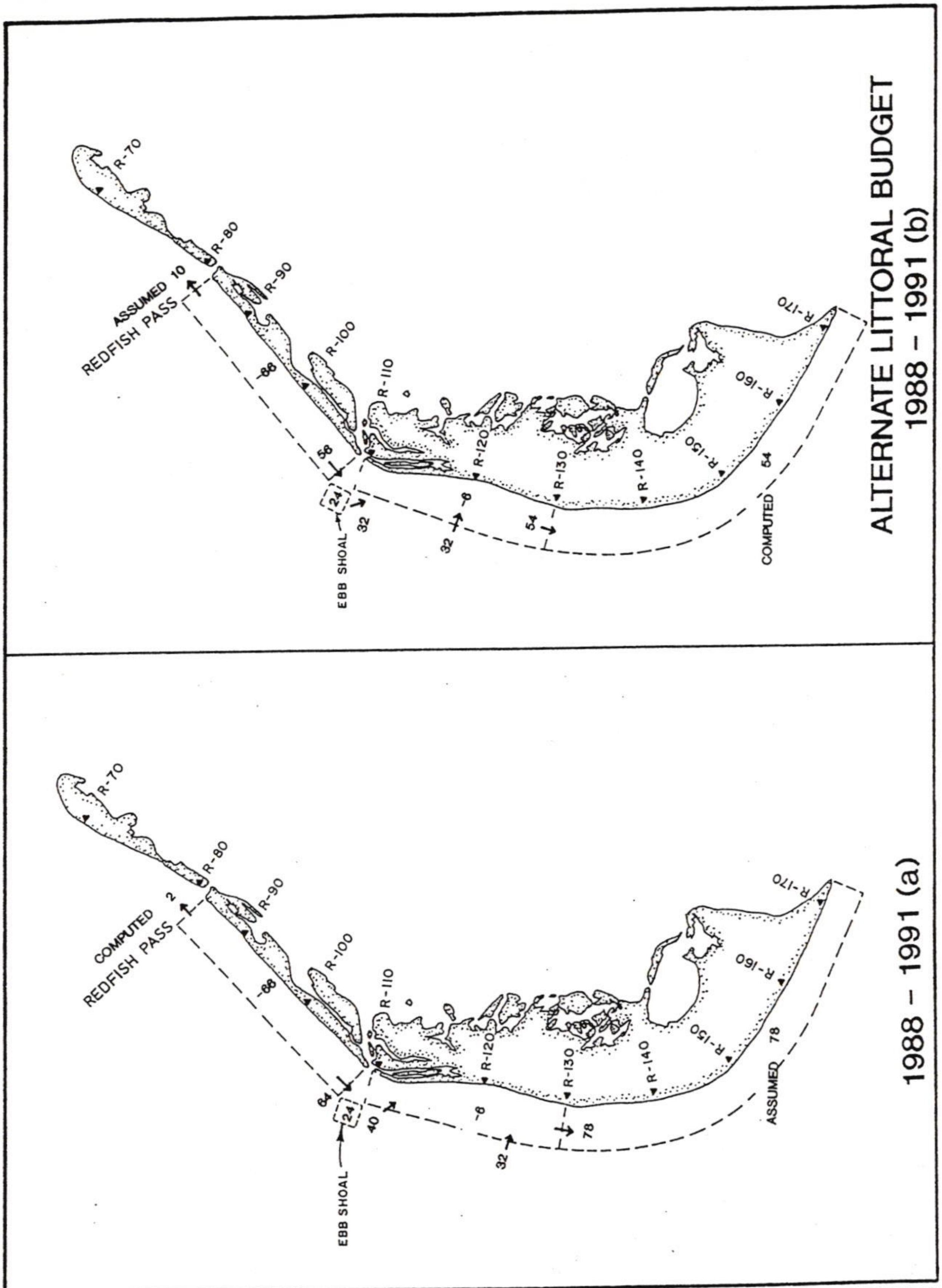


FIGURE 8

CAPTIVA – SANIBEL SEDIMENT BUDGET

1988 – 1991
(2 YEARS)

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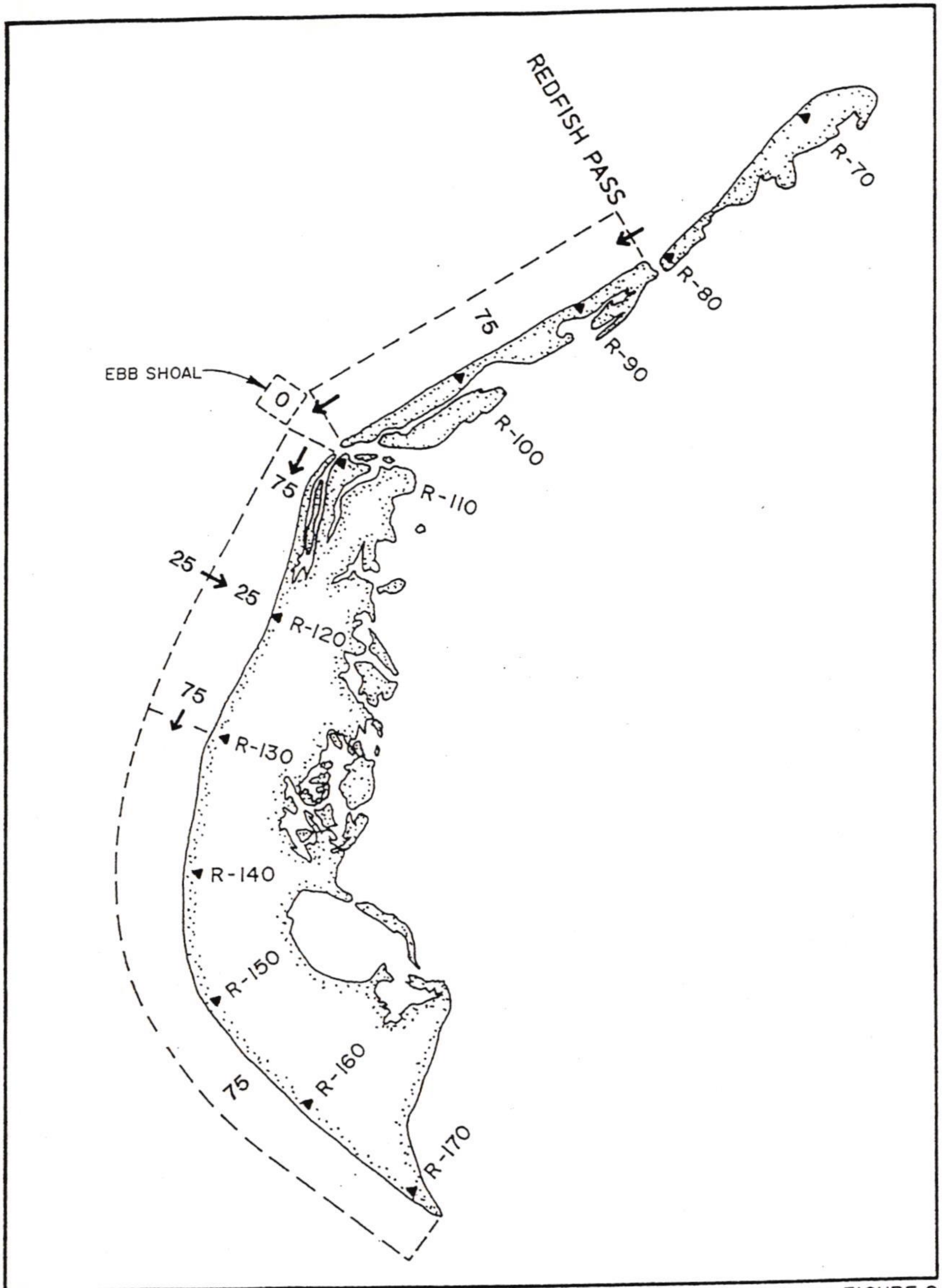


FIGURE 9

CAPTIVA - SANIBEL FUTURE SEDIMENT BUDGET

Table 8

Annual Volumetric Changes in Captiva and Sanibel
(cu. yds. x 1000/yr.)

	1941-1955	1955-1974	1974-1988
Captiva	-165	-68	-38
N. Sanibel (4 miles)	+79	+61	+3
S. Sanibel	+135	+76	+79
Totals	+49	+69	+44

The ebb shoal has built up from August 1988 through December 1991. To estimate the quantity of sand in the entire shoal we compared surveys from August 1988 and December 1991. We found that approximately 79,000 cubic yards (39,500/year) of material built in the shoal area from the jetty extending 1400 feet down the beach (Table 9).

Sediment budgets for the 1941-1955, 1955-1974 and 1974-1988 time periods are presented in Figure 7.

During the 1941 through 1955 time period, we can assume that the Redfish Pass shoals had not fully developed and were not providing protection for the northern shore of Captiva Island. This would partially account for the high total erosion rates of Captiva Island. During this time period, 39,000 cubic yards was being lost into Redfish Pass annually and 126,000 cubic yards was leaving the island to the south.

Table 9

VOLUME CHANGE - SHOAL OPPOSITE INLET 8/88-12/91

PROFILE NAME	VOLUME CHANGE ABOVE -18 FT.	VOLUME CHANGE ABOVE 0 FT.	SHOAL BUILDUP/ LOSS	EFFECTIVE DISTANCE (FT.)
R110	40,913	43	40,870	620.8*
110.5	25,605	1,493	24,112	511.7
R111	11,701	-1,881	13,582	241.0
			78,564	1373.5

*Effective distance was extended north to the jetty.

During the next time period, 1955 to 1974, the erosion rate of Captiva Island reduced by more than half from 165,000 cubic yards/year to 68,000 cubic yards/year. The reduced erosion can be partially explained by a more developed ebb shoal of Redfish Pass which limited the losses into Redfish Pass.

The movement of sand to Sanibel Island from Captiva Island reduced by 46% during this period (from 126,000 to 68,000 cubic yards/year). During this time, 134 groins were installed on Captiva Island (including 2 wooden groins) and portions of the road revetment were constructed. It is likely that these structures slowed north and south littoral drift along Captiva Island. The most likely reason for the reduction in south drift was the reorientation of segments of the island as a result of major recession of the northern beaches. The northern segment was pinned by the wooden groins and revetment at the north bend of Captiva Drive. The southern segment was first pinned by the county terminal groin at Blind Pass (1972), then by a revetment built 1200 feet north of the groin during the 80's. The northern 4 miles of Sanibel accreted 61,000 cubic yards from 1955 through 1974.

The movement of sand from Captiva Island further reduced between 1974 and 1988 from 68,000 to 38,000 cubic yards/year. This represents a reduction of 30,000 cubic yards/year. This reduction in transport was partially due to the terminal groin constructed by Lee County in 1972. The groin was constructed to protect the approach road to the bridge and evacuation route. Further hardening of the island combined with erosion of shore segments updrift of structures also served to reduce drift during the 1974-1989 time period. It is estimated that the county terminal structure caused one-half the reduction in drift or 15,000 cubic yards/year.

During the post-construction time period, 1988 through 1991, the Captiva beaches lost 66,000 cubic yards/year while northern Sanibel's beaches (R-110 to R-130) lost 6,000 cubic yards/year of sand in the north 4 miles. During this same period of time, 40,000 cubic yards/year built up in the ebb shoal of Blind Pass. The total change of volume in northern Sanibel including the ebb shoal build-up is 34,000 cubic yards/year accretion from 1988/1991.

A littoral budget was established based on these findings assuming that south Sanibel accreted as it had in the previous time period (Figure 8, 1988-1991 (a)). If we hold this assumption then 2,000 c.y. would have moved into Redfish Pass.

An alternate littoral budget for 1988-91 was developed based on observations and surveys. The 1989/91 time period was an atypical period of stronger north littoral drift. As evidence of this, the beach was eroded north of the Blind Pass groin (on southern Captiva Island) for the first part of 1991, contrary to what would be expected during the winter months. An alternate littoral budget was established for this time period (see Figure 8). This littoral budget suggests a stronger north drift and higher losses of sand into Redfish Pass. Based on this alternate budget, 32,000 cubic yards was transported to Sanibel Island. The author feels that this budget better represents the conditions experienced on Captiva and Sanibel Islands during the 1988-1991 time period.

During a more typical time period the littoral drift will move south from Captiva Island to Sanibel Island at a higher rate. Figure 10 shows an estimate of the future littoral budget during average wave conditions.

IMPACTS OF BLIND PASS ON ADJACENT BEACHES

Before 1926 Blind Pass was a larger inlet, similar in size to Redfish Pass. At that time the inlet contained large ebb tidal shoals commensurate with the amount of water going in and out of the inlet, the tidal prism. Since the inlet was relatively old (more than 500 years old), the ebb shoals were probably well developed and sand that was moving down from Captiva was bypassing the inlet.

When Redfish Pass opened in 1921 to 1926, it captured a large portion of the tidal prism from Blind Pass. Subsequent to 1926, sand from the ebb shoal of Blind Pass started to migrate to the beach and attach itself to the beach within the northern four miles of Sanibel Island.

Redfish Pass also stopped the flow of sand from North Captiva Island to Captiva Island, creating an erosional condition on Captiva, especially focused on the northern beaches. The littoral drift deficiency created by Redfish Pass stayed primarily on Captiva Island up through 1955, as evidenced by the high erosion rate from 1941 through 1955 when the island lost 165,000 cubic yards per year.

The littoral budget suggests that during that time period (1944-1955)as much as 126,000 cubic yards was leaving the south end of Captiva Island and going to northern Sanibel. At the same time, ebb shoal sand migrating to the shore at the rate of 92,000 cubic yards created a strong accretional trend along the northern four miles of the island. This was especially true in the first mile where the beaches built up at a rate of 53,000 cubic yards per year.

In the late 1950's through the early 1970's the erosion rate of Captiva Island reduced. Some of that reduction was due to the ebb shoal building at Redfish Pass which limited or eliminated the losses at the north end of the island. The remaining reduction was due to reorientation of shoreline segments along the island and the hardening of portions of the island. The amount of sand leaving Captiva Island reduced from 126,000 cubic yards in the 1940's and early 1950's to 68,000 cubic yards per year, a reduction of almost 58,000 cubic yards per year. At the same time, onshore movement of sand from the ebb shoal to northern Sanibel Island reduced from 92,000 to approximately 69,000 cubic yards per year.

Although the northern 4 miles was still accreting, the northern mile of Sanibel Island went from a strongly accretional trend to an erosion trend, losing 35,000 cubic yards per year during the

1955-1974 time period. This is probably due to a combination of two effects. One is the loss of protection from the ebb shoal in the immediate vicinity of Blind Pass did not allow that portion of the island to sustain its seaward position. Secondly, the reduction of sand quantity moving from Captiva and from the ebb shoal contributed to the strong erosional trend.

After 1974, sand availability again reduced for northern Sanibel. Sand from Captiva reduced from 68,000 to 38,000 cubic yards. An offshore-onshore movement reduced from 68,000 to 44,000 cubic yards per year. During this time period southern Captiva (the last 8 miles) continued to accrete at around 79,000 cubic yards per year. The northern 4 miles of Sanibel Island went from a strong accretional trend of 61,000 cubic yards per year to a slow accretional trend of +3,000 cubic yards per year.

The most noticeable effect of the reduced transport during this later time period (1974-1988) was in the first mile where erosion rates increased from 35,000 c.y./yr. in the 1954-1974 time period to 39,000 c.y./year after 1974 through 1988. This increased erosion was smaller in magnitude than the decrease in sand resources coming to the area. A possible explanation for this is that the major retreat of the shores from 1955 through 1974 decreased the erosional stress on the area because is was no longer relatively as far seaward than the adjacent shores. However, the reduction in littoral drift and sand moving to the area, resulted in a moderate increase in the erosion rate after 1974 mile.

A groin was built by Lee County in 1972 to protect the evacuation route and the bridge approach road. This was apparently successful at providing protection for that area. This structure was also partially responsible for the 30,000 c.y. reduction in drift from Captiva to Sanibel after 1972. Part of that reduction in drift was also due to continued hardening of the shorelines on Captiva and the reorientation of shoreline segments to yield less littoral drift along Captiva Island. It is estimated here that the County structure, built in 1972, would have accounted for half of the littoral drift reduction that occurred after 1972.

Blind Pass was closed between 1977 and 1982. When it reopened in 1982, the erosion rates of Captiva Island increased from 1982 through 1985. Surveys from 1985 through 1988 indicate an erosion rate of almost 85,000 c.y./yr. on Captiva Island. It is probable that the deterioration of the County groin during the post groin construction time period allowed a higher erosion rate on Captiva Island during that time period. That effect was not evident from 1977 through 1982 because Blind Pass was closed and the combination of sand in the inlet channel and the existing structure was a more effective sand barrier.

In 1988 and 1989, the beaches of Captiva Island were restored and the groin at the south end of Captiva Island was rebuilt and extended 100 feet. The purpose of the groin extension was to prevent rapid loss of material at the south end of the nourishment project and to provide further protection for the evacuation route by holding larger amounts of sand in front of the Captiva Road approach to the Blind Pass bridge. This is also an area where a public beach exists (Turner Park).

Subsequent to the construction of the Captiva project, monitoring has shown that the shorelines have retreated faster than the historical trend through December of 1991, but that the erosion rate of the area has been slower from a volumetric standpoint (after excluding volumes that have built up in the shoal area).

A review of the profiles indicates a substantial flattening of the upper beach portion of the profile and the very nearshore portion of the profile especially in the vicinity of Clam Pass Bayou. In the Clam Pass Bayou area significant overwash has occurred and a large volume of sand (approximately 50,000 c.y.) has built up on the landward portion of the profile in the pass. The pass itself has remained open for most of the time period subsequent to the beach nourishment project. (This pass was only intermittently open in the past.)

It has also been noted that during the 3.3 year data set (1988-1991), two unusual weather events occurred. The first was Tropical Storm Keith which significantly altered the shoreline south of Blind Pass by causing extensive overwash and lowering of the barrier island in the vicinity of Clam Pass Bayou. In the shoreline analysis the effects of this storm have been discounted and only the shoreline retreat rates after Keith have been counted.

The second event that should be noted is that during the winter of 1990-1991, there appeared to be an atypical northward sand movement, as evidenced by the lack of buildup of sand north of Blind Pass jetty during that winter time period. This may have affected the rate of erosion that has been measured in the vicinity of northern Sanibel.

An ebb shoal feature has formed seaward of Blind Pass which was not present in 1988. The ebb shoal extends from the mouth of the inlet south, approximately 1400 feet. The shoal contains approximately 80,000 cubic yards and has built up over the 3.3 year time period subsequent to the beach nourishment project. Most of the building of the shoal occurred in the first two years after nourishment. Recent surveys indicate that the shoal building process has slowed or reversed in the last 6-month time frame.

It is not clear at this time whether the shoal represents a permanent feature or will move in and attach itself to the beach as has happened in the past. The building of the shoal at this seaward location is probably an effect of the groin extension and beach nourishment project.

The existence of the shoal has caused a wave shading and wave refraction effect at the very north end of Sanibel Island. This has caused a littoral drift reversal and a nodal point to be established at or about Clam Pass Bayou. The nodal point creates a zone of high erosional stress at this location. This area has retreated 224 feet since the beach nourishment project. This high retreat rate has distorted the average shoreline retreat rates.

Although shoreline retreat rates have been faster than average, volumetric changes have been slower. This is partially due to the increased sand transport from Captiva Island subsequent to the nourishment. That rate of sand transport has increased from approximately 38,000 c.y./yr (pre-project) to between 56,000 and 66,000 c.y./yr., an increase of 15,000 to 25,000 cubic yards. This has resulted in a reduction of the erosion rate in the first mile from approximately 40,000 c.y./yr. to approximately 30,000 c.y./yr. This rate reduction might also be affected by the stronger northern littoral drift during the winter of 1990-91 as mentioned above.

We can conclude from the above analysis that the groin to date is bypassing as much or more sand than it had bypassed before the nourishment and groin extension project. Physical changes of the shoreline planform have occurred in response to an ebb tidal shoal building which have resulted in higher shoreline retreat rates along the fist mile of Sanibel.

It can be concluded that these higher rates are related to the beach nourishment and groin extension project, but are affected by other physical parameters, the most important of which is the opening of Clam Pass and the rollover of the shoreline in its vicinity.

Since shoreline retreat has been faster than the historical average of 13.3 feet set by the DNR prior to the beach nourishment project, mitigation for the retreat is a requirement of the DNR permit.

Once the condition stabilizes at Clam Pass (Clam Pass closes) the lower erosion rates of northern Sanibel should moderate the retreat rate below the historical retreat rate of 13.3 feet. Until that happens, however, the retreat in the vicinity of Clam Pass will be rapid and the average shoreline retreat rate will be higher than the historical rate.

VI. ENGINEERING ALTERNATIVES

INTRODUCTION

This section of the management plan involves the evaluation of engineering alternatives that achieve the goals of the plan. The design of the alternative is preliminary and sufficient to develop an estimate of the cost of each alternative. The cost estimates include contingencies and engineering costs. For purpose of comparison, each alternatives' costs are annualized over a 50 year project life. Annualized costs are determined using interest rates of 8 5/8% and 3%. Advantages and disadvantages of each system and their impact of the inlet-beach system are discussed.

The alternatives that are considered are classified as either relating to closing Blind Pass or sand bypassing (as required by the State format). The alternatives are described in detail in the following sections. The alternatives are:

A. Close the Inlet.

  1. Remove the jetty.
  2. Remove the jetty and fill the inlet.

B. Erosion Control/Re-establish Littoral Drift.

  1a. Beach nourishment of Northern Sanibel.

  1b. Beach nourishment using Captiva Island's renourishment schedule.

2. Groin field with initial fill.

3. Remove jetty extension and place extra fill on Captiva Island.

4. Restore Northern Sanibel and overfill South Captiva Island.

5. South jetty and beach nourishment on Northern Sanibel.

6. Purchase homes in road section and reroute road.

7. Purchase homes in road section and revet road.

8. Dredge the flood shoal.

9. No action.

10. County builds limited road revetments (1992), then nourish road section (1993), and renourish with Captiva project.

11. Beach nourishment and segmented offshore breakwater.

C. Experimental Systems

1. Mobile jet pump system.

2. Jet pump in ebb shoal with fluidizer collector.

3. Nourish road section and dewater beach.

Alternatives are evaluated as to technical feasibility and environmental permittability. The effects on the Clam Bayou System (currently open) are discussed.

<u>Alternatives</u>:

A. Close the Inlet.

1. Remove the jetty.

This alternative involves the removal of the 1988 jetty extension and the 1972 jetty constructed by the County on the north side of Blind Pass. This would allow nature to move sand from Turner Beach into Blind Pass. Blind Pass should close over a period of weeks or months. The south end of Captiva will recede until a new equilibrium shoreline is established (Figure 4).

During storms it is expected that some sand will be overwashed at the Blind Pass bridge area and result in sand lost from the active littoral zone. There is also the possibility that a storm could reopen Blind Pass in the future. If beach erosion is severe, the north end of the bridge could be undermined. The cost of this alternative involves the removal of all rock and filter fabric associated with the jetty. The cost is estimated at $746,000. The annual cost over the project life is $65,000 per year. Because this alternative would threaten the road and bridge and fails to maintain water quality within Blind Pass, this alternative is not recommended.

2. Remove jetty/fill the inlet.

This alternative is similar to alternative 1 in that the 1988 jetty extension and 1974 jetty are removed. Blind Pass is then intentionally closed and protected by constructing a rock revetment in front of the bridge. Initial closure of the pass would be accomplished by driving a temporary sheet pile wall to interrupt the flow

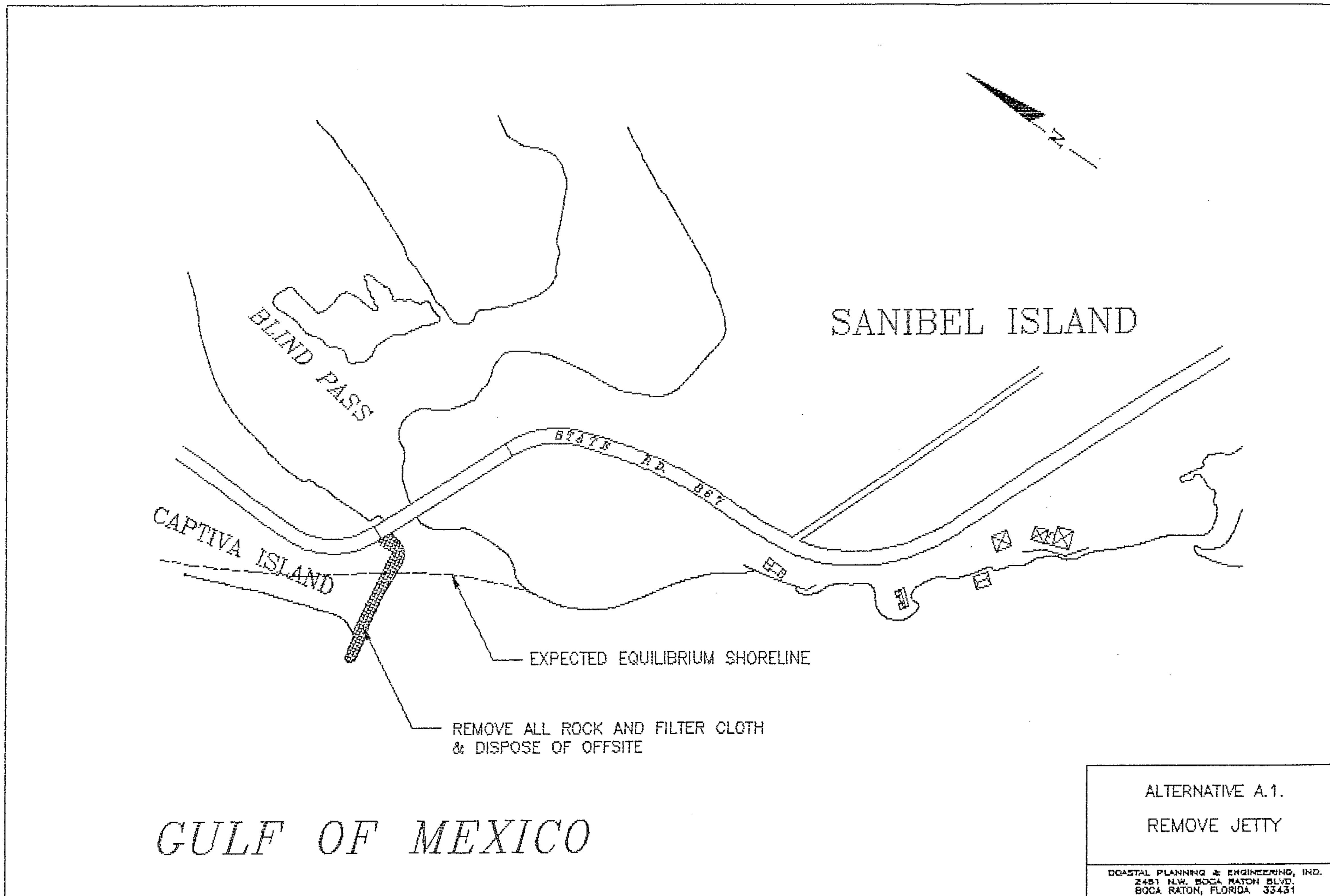

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
EXPECTED EQUILIBRIUM SHORELINE
REMOVE ALL ROCK AND FILTER CLOTH
& DISPOSE OF OFFSITE
GULF OF MEXICO
ALTERNATIVE A.1.
REMOVE JETTY
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 4

while a sand core and the rock revetment are constructed (Figure 5). Sand will erode off of Turner Beach which will result in the loss of public beach area and deposit on Sanibel.

The advantages of this option over Alternative 1 is that by creating a rock revetment in front of the bridge, loss of sand from the littoral system by overwash is prevented and the bridge itself will be protected. The initial cost of this alternative is $1,202,000. The annual cost of this alternative is $105,000 over the life of the project. While this option will bypass the full amount of littoral drift to Sanibel, water quality problems will result in Blind Pass and a public beach will be eroded. The north bridge approach would become vulnerable to storm impact as the sand north of the pass would erode. Therefore, this alternative is not recommended.

B. Inlet Bypassing Systems

1.a. <u>Beach Nourishment of Northern Sanibel</u>.

This alternative involves the restoration of the beach along 3,700 feet of northern Sanibel (Figure 6). Fill would be placed in order to realign the shoreline between the pass and the beach south of Clam Bayou. It is estimated that 320,000 cubic yards of sand would be required. In addition, six years of advanced nourishment would be placed in order to protect the restored beach. The erosion rate of the

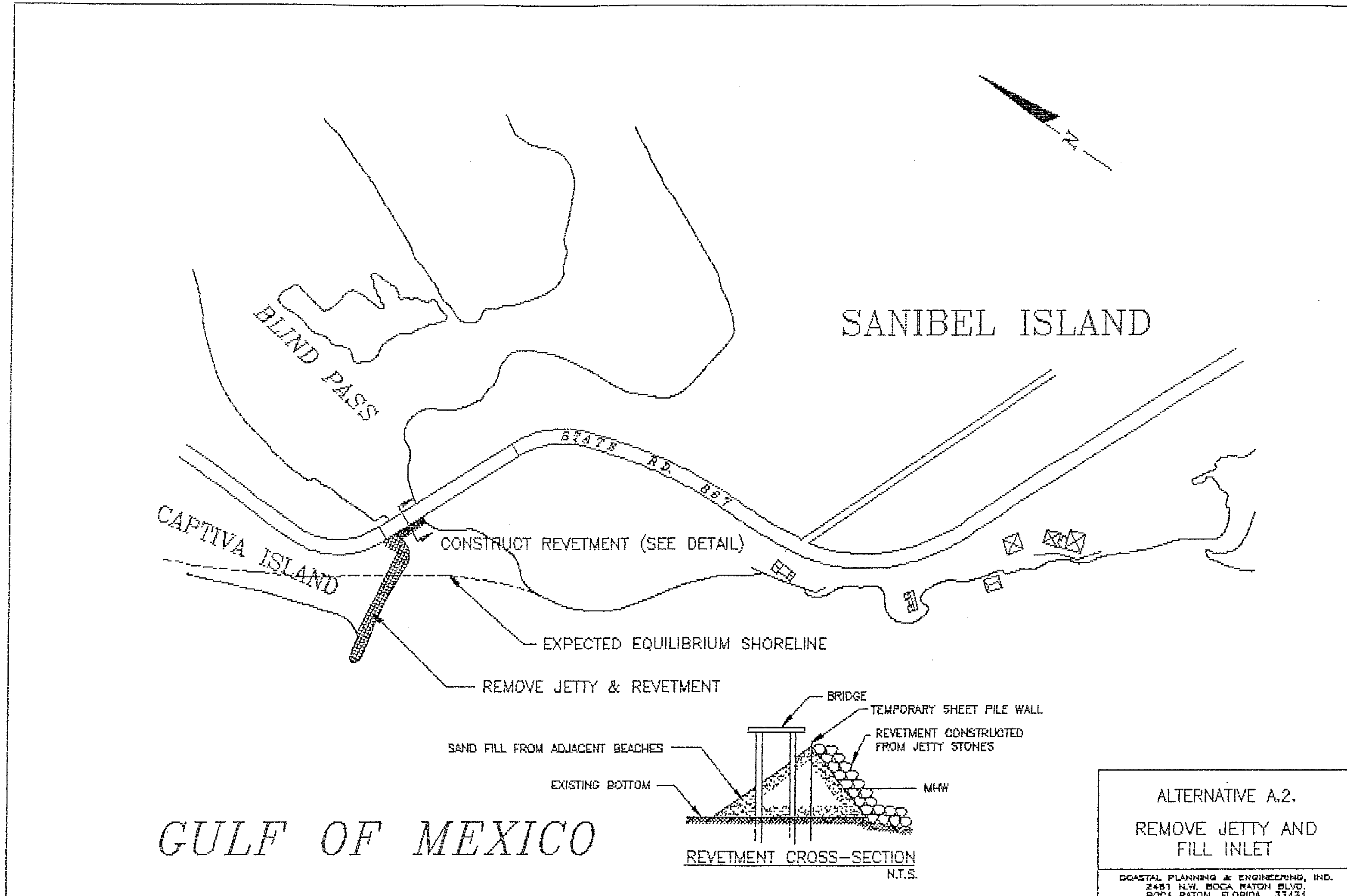

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
CONSTRUCT REVETMENT (SEE DETAIL)
EXPECTED EQUILIBRIUM SHORELINE
REMOVE JETTY & REVETMENT
BRIDGE
TEMPORARY SHEET PILE WALL
REVETMENT CONSTRUCTED FROM JETTY STONES
SAND FILL FROM ADJACENT BEACHES
EXISTING BOTTOM
MHW
REVETMENT CROSS-SECTION
N.T.S.
GULF OF MEXICO
ALTERNATIVE A.2.
REMOVE JETTY AND FILL INLET
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 5

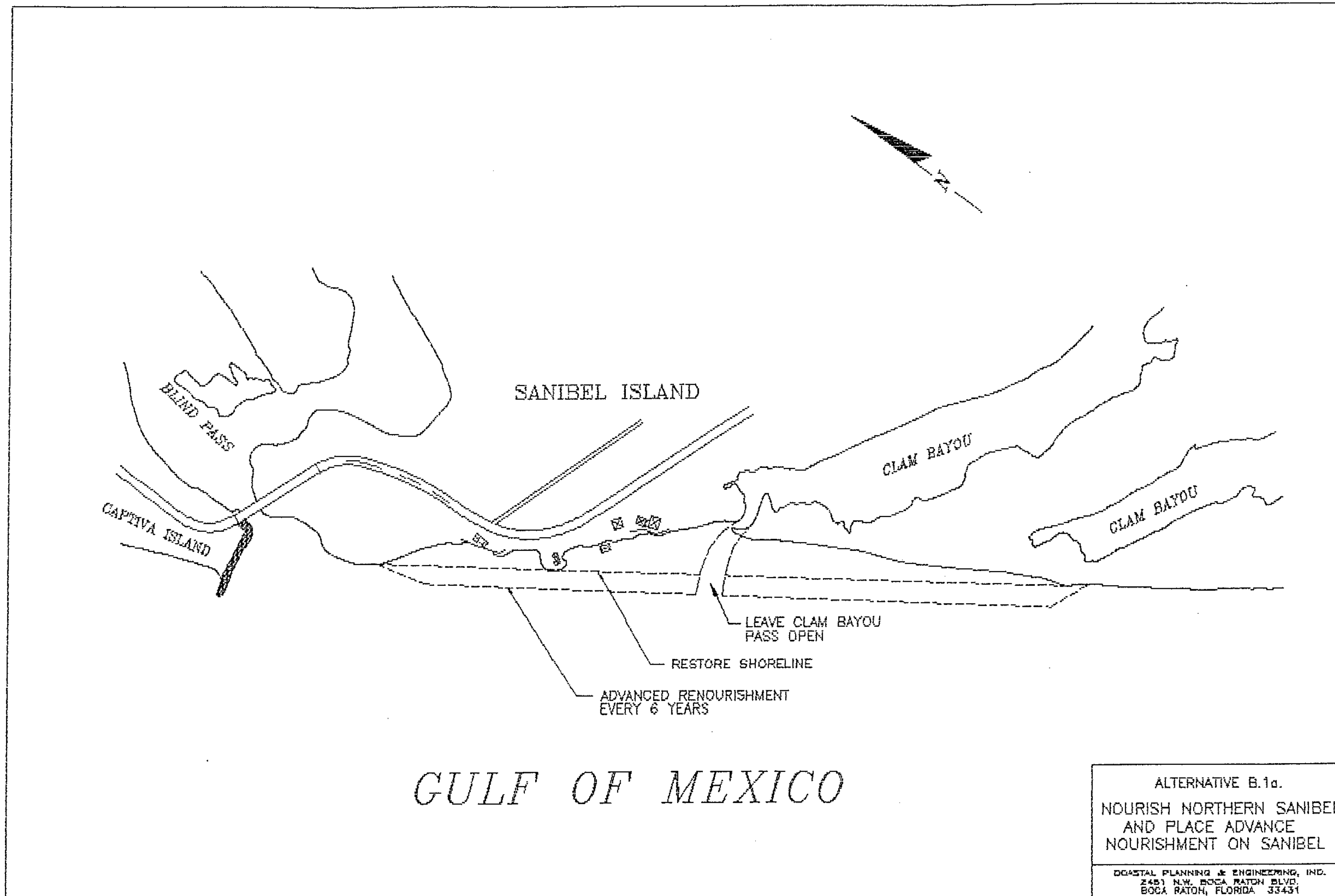

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
CLAM BAYOU
CLAM BAYOU
LEAVE CLAM BAYOU PASS OPEN
RESTORE SHORELINE
ADVANCED RENOURISHMENT EVERY 6 YEARS
GULF OF MEXICO
ALTERNATIVE B.1a.
NOURISH NORTHERN SANIBEL AND PLACE ADVANCE NOURISHMENT ON SANIBEL
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 6

project would be on the order of 35,000 cy/yr; 210,000 cubic yards would be placed as advanced nourishment. An additional 9,250 c.y. of fill would be used to construct a dune section.

A gap would be left in the fill in the vicinity of Clam Pass Bayou to allow for intermittent flushing of the water in the pass. It is likely that this gap will fill in with sand and reopen only after storm action. This is consistent with the historical performance of Clam Pass Bayou.

The total initial cost of this alternative is $5,629,000. The annual cost including maintenance nourishments of six year intervals is $728,000.

1.b. <u>Beach Nourishment with Maintenance on Captiva Island's Renourishment Schedule</u>

This alternative contains the same components as alternative 1a. with the following exceptions. The volume of the initial advanced nourishment is reduced from six years to only two years. The placement of future advanced fill at northern Sanibel is then scheduled to coincide with the Captiva Island restorations. This reduces costs because separate mobilization charges are not incurred. The initial cost of this alternative is $4,566,000 and the annual project cost is $642,000. This represents a significant drop in annual cost if the dredging is scheduled to coincide with Captiva's renourishment.

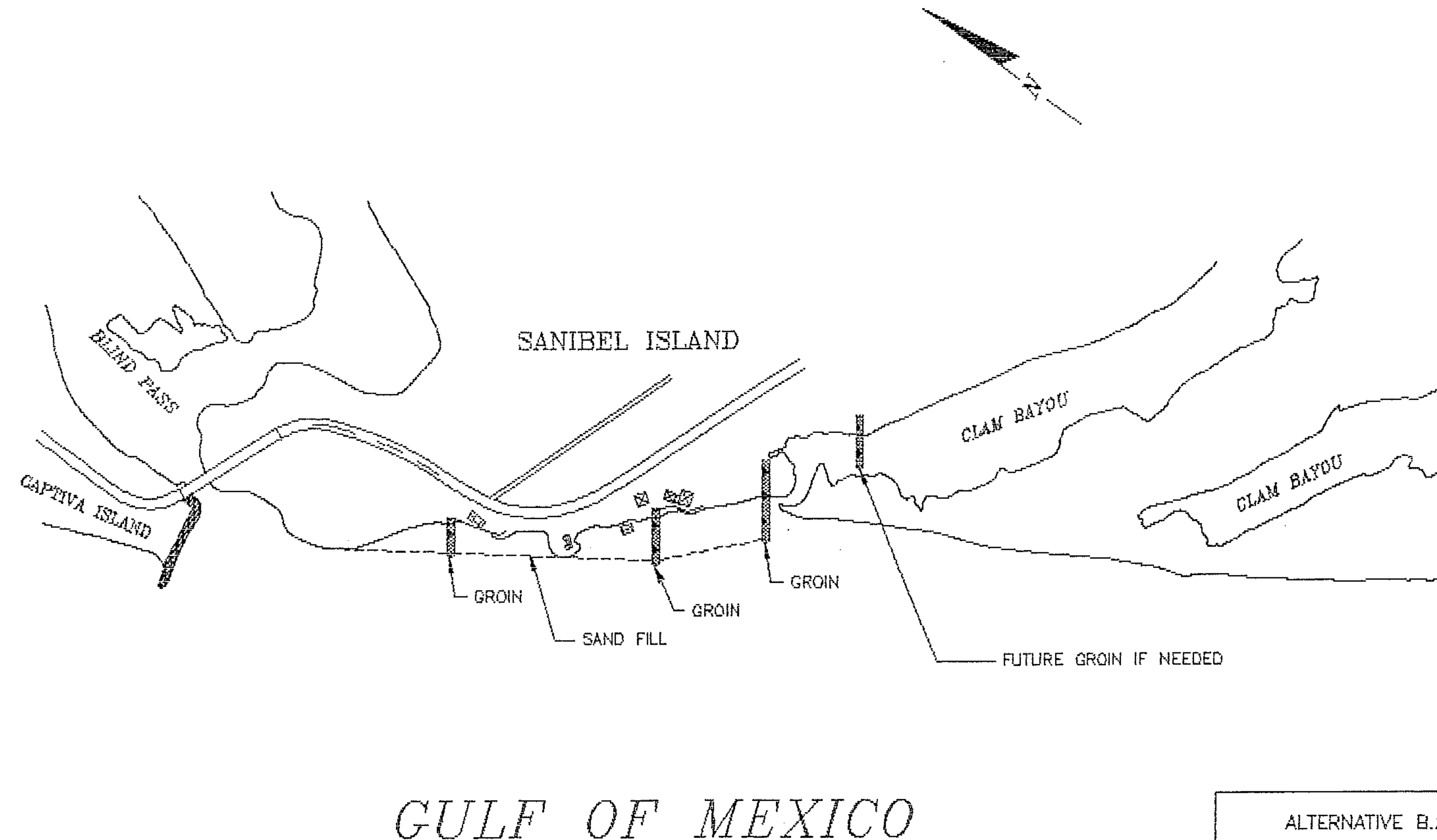
2. Restore Northern Sanibel and Stabilize with Groin Field

This alternative involves the construction of three rubble mound groins along the road section of northern Sanibel (Figure 8). The groins are of variable length and would hold the same design shoreline that was assumed in the preceding alternatives. The groins would eliminate the need for advance fill.

No fill is placed south of the groins. As a result Clam Bayou should remain open and the beach adjacent to Clam Bayou will continue to overwash. Significant changes in the shoreline south of the groin field could be expected. Unlike the other alternatives, this alternative attempts to protect a limited section of beach. Due to continued overwash, additional erosion may be experienced along the developed section of Sanibel. A fourth groin was planned to be constructed, if needed, in project year five.

The rubble mound groin design and cost estimates are based on the costs of the 1988 terminal groin extension. It is estimated that 138,000 cubic yards of sand would be needed to initially fill the groins. The initial cost of this alternative is \$3,970,000. The annual cost of this alternative is \$351,000.

3. Restore Northern Sanibel, Remove the Jetty Extension and Place Extra Fill on Captiva Island, Renourish Captiva and Northern Sanibel Together



ALTERNATIVE B.2.

GROIN FIELD W/SAND FILL

COASTAL PLANNING & ENGINEERING, INC.
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BOCA RATON, FLORIDA 33431

FIGURE 8

Under this option, the northern 1800 feet of beach on Sanibel would be restored in 1993 with 180,000 cubic yards of sand at the same time the 100 foot groin extension was removed from Blind Pass (Figure 10). When fill is placed on Sanibel, sand would also be placed on the southern beaches of Captiva Island to compensate for high erosion rates expected there.

When the groin was first removed, the beach adjacent to the groin would retreat by 100 feet in the first few months, with the beach losing about 30,000 cubic yards of sand. Subsequent losses of sand would be about 15,000 cubic yards/year higher than current rates. If we assume Captiva will be renourished in 1995, then the placement of sand on southern Captiva should be 60,000 cubic yards in 1993 to compensate for expected excess erosion before renourishment.

In 1995, both Captiva and Sanibel would be renourished. To account for expected losses at Blind Pass, an extra 90,000 cubic yards would be placed on Captiva (over and above expected renourishment quantities of 600,000 c.y.). Nourishment quantities on Sanibel would be 30,000 cubic yards in 1995 and 120,000 cubic yards every 6 years thereafter.

The initial cost of this option is $3,279.00. The annual cost at 8-5/8% interest would be $538,000.

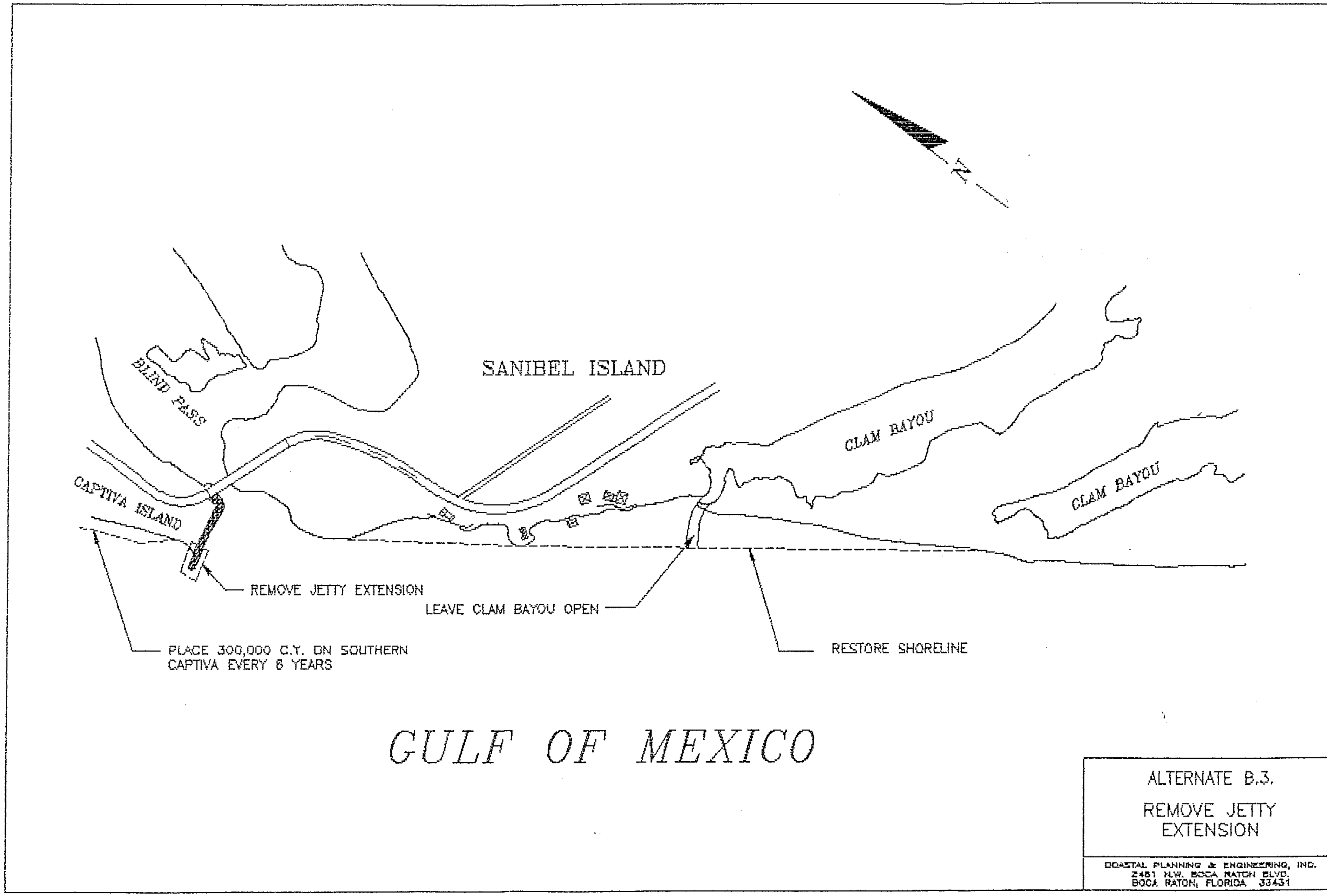

N
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
CLAM BAYOU
CLAM BAYOU
REMOVE JETTY EXTENSION
LEAVE CLAM BAYOU OPEN
PLACE 300,000 C.Y. ON SOUTHERN
CAPTIVA EVERY 6 YEARS
RESTORE SHORELINE
GULF OF MEXICO
ALTERNATE B.3.
REMOVE JETTY
EXTENSION
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 10

Under this program the southern beaches of Captiva Island would lose all of the nourishment sand before the next nourishment. The county park at Turner Beach would be eroded during the end of the nourishment period. The approach road north of the Blind Pass bridge would be vulnerable to damage in a major storm.

Northern Sanibel would erode at a slower rate and provide more protection to the evacuation route. The road would be vulnerable to storm damage at the end of the nourishment interval.

More sand would move into Blind Pass annually without the jetty extension. Blind Pass would be less stable than conditions that prevailed before 1988 and have more of a tendency to close and remain closed for longer periods of time.

Because this option does not meet the goals of erosion control or evacuation route protection, or Blind Pass stability, it is not recommended.

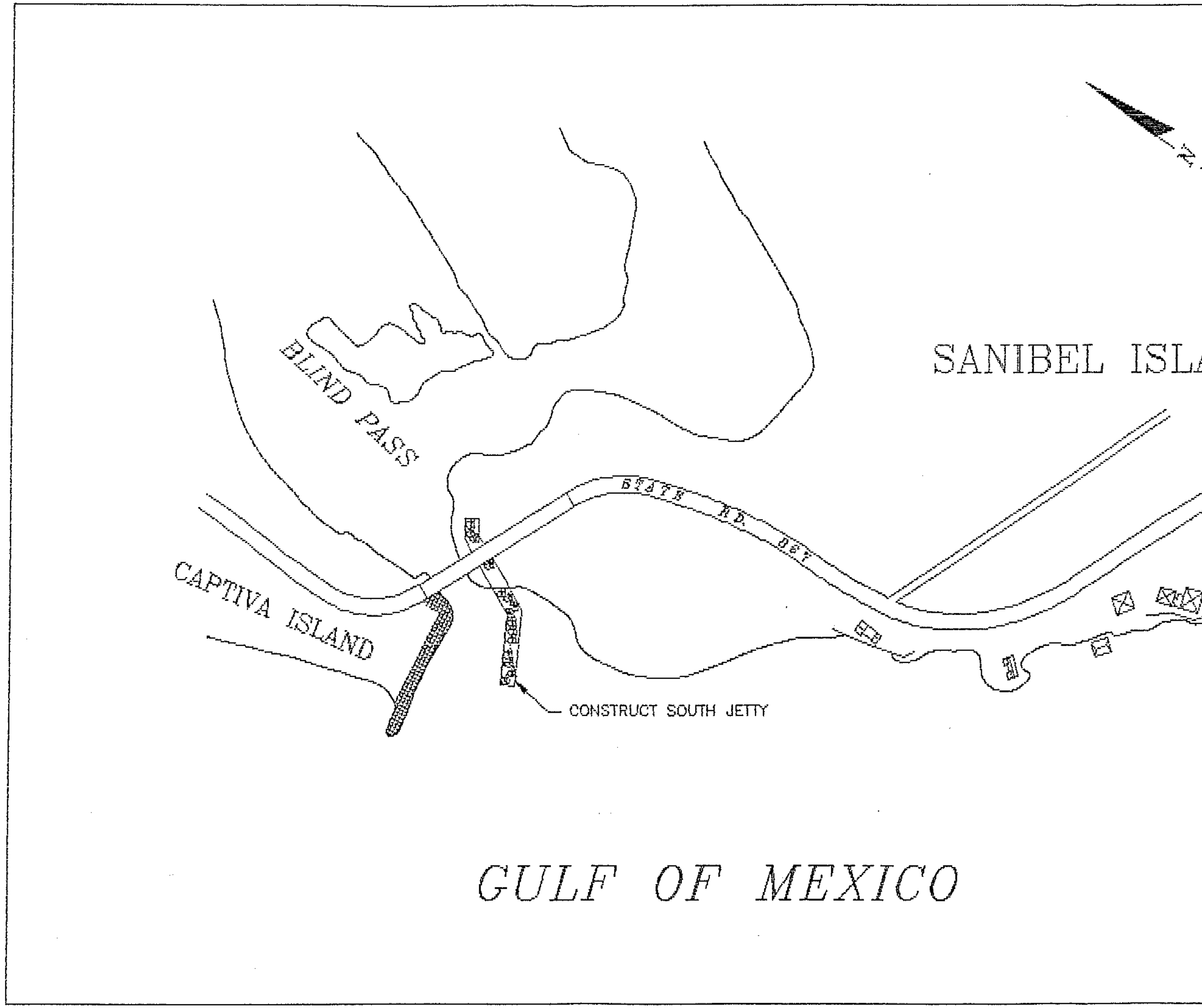
4. <u>Restore Northern Sanibel and Overfill South Captiva Island</u>

This alternative is a variation of Alternative 1b. The northern end of Sanibel is restored for a distance of 3,700 feet with 320,000 cubic yards of sand. The difference in this alternative is that 210,000 cubic yards of advanced nourishment is placed on southern Captiva as a feeder beach. The alternative has the advantages of increasing sand bypass from Captiva Island while maintaining a wide protective beach at Turner Beach.

Potential disadvantages include the possibility of destabilizing Blind Pass with sand from the feeder beach. The other disadvantage is that the advanced nourishment is not placed directly to protect the restored beach. Since a delay could occur because the ebb shoal may store sand prior to bypassing, some of the restored Sanibel beach may periodically erode. This would not be unlike the historical performance of the northern Sanibel beaches. The initial cost of this alternative is $4,566,000. The annual cost of this alternative is $641,000.

5. <u>South Jetty and Beach Nourishment on Northern Sanibel</u>

This alternative includes the components of alternative 1a. and also includes the construction of a south jetty at Blind Pass (Figure 11). One purpose of the jetty would be to improve the inlet stability by reducing the amount of drift into Blind Pass from the south. A second purpose of the jetty would be to better direct currents in the vicinity of the pass. This would cause the sand bypass along the ebb shoal to be better behaved. Sand would move along a better defined ebb shoal as opposed to cyclical build-up and subsequent attachment of the shoal to the beach. The beach at Sanibel would be restored and renourished at a regular interval. The initial cost of this alternative is $5,903,000. The annual project cost is $750,000.



ALTERNATIVE B.5.

CONSTRUCT SOUTH JETTY

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 11

The south jetty would provide better protection for the road as it would moderate the cyclical nature of the erosion/accretion patterns to the inlet and provide for a more stable beach configuration.

The ebb shoal would initially move further offshore as a result of the better directed currents. Sand would be captured in the ebb shoal before it bypassed the inlet, potentially causing erosion of the beach.

The amount of sand needed to nourish the northern Sanibel beaches would not be significantly reduced by the south jetty. Studies have indicated that very little sand is currently entering the inlet.

6. <u>Purchase Homes and Reroute Road</u>

This alternative consists of purchasing the five homes that are in most danger of storm damage or undermining and rerouting S.R. 867 to the east (Figure 12). This is a retreat type of option and involves allowing nature to continue to erode the shoreline.

The cost of purchasing the five homes/cottages through a condemnation process is estimated to be $2,350,000. This cost includes the purchase and demolition of the existing structures. Since these properties are protected by seawalls, and

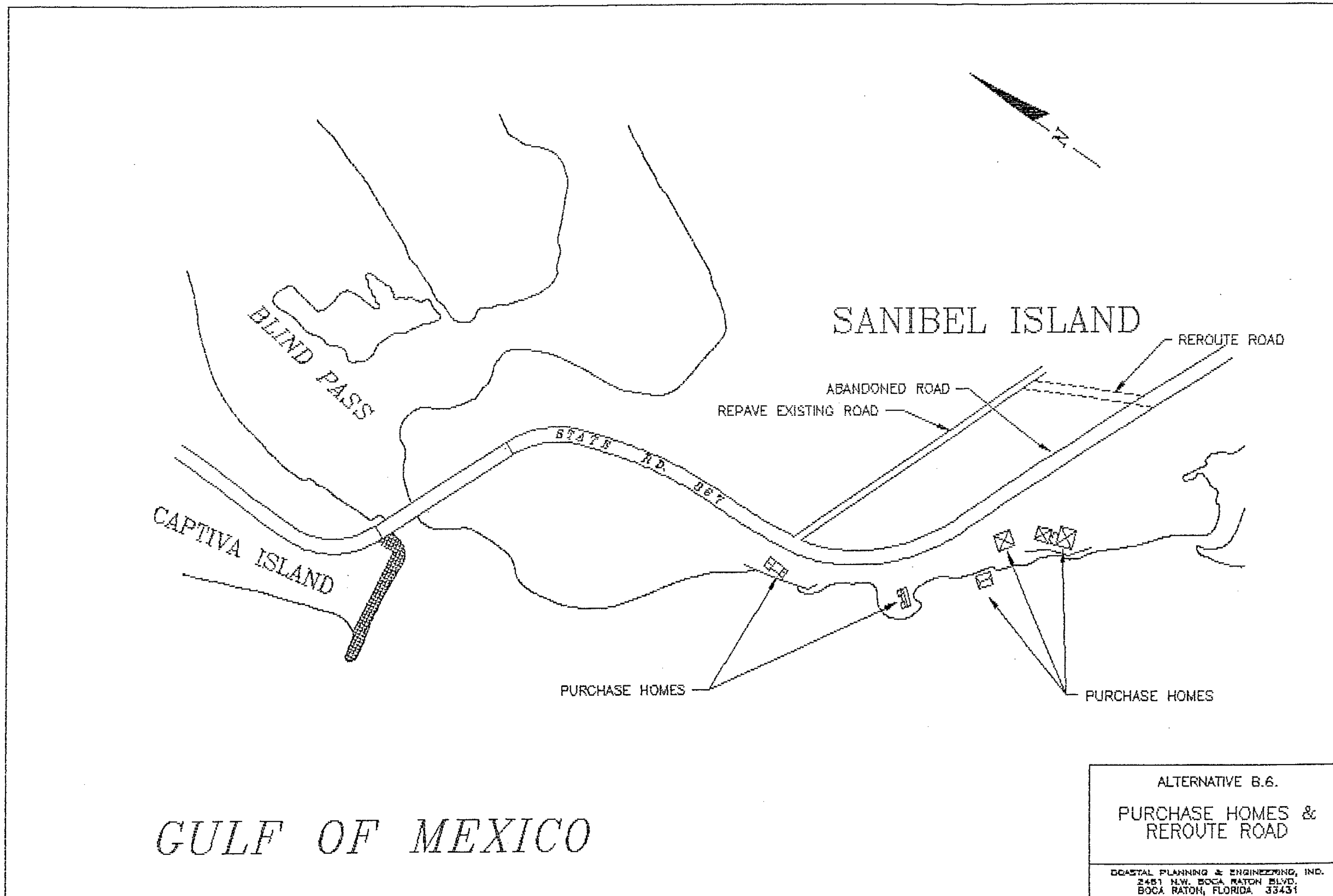

SANIBEL ISLAND
REROUTE ROAD
ABANDONED ROAD
REPAVE EXISTING ROAD
BLIND PASS
STATE RD. 867
CAPTIVA ISLAND
N
PURCHASE HOMES
PURCHASE HOMES
GULF OF MEXICO
ALTERNATIVE B.6.
PURCHASE HOMES & REROUTE ROAD
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 12

revetments, the FDNR many require the removal of the abandoned shore protection structures. This removal cost was not included.

The cost of rerouting the road is approximately $625,000. This includes the repaving of a two lane road for a length of approximately one half mile (Figure 12). Since telephone, electric and water utilities run parallel to the existing road, they will have to be relocated as well. The utility cost accounts for an estimated $125,000 of the road relocation cost. The cost for this component of this alternative is preliminary and may increase depending on how much land, right of way, or easement is necessary.

The total initial cost of this option is $3,493,000. The annualized cost is $306,000 per year. This option allows the ongoing erosion problem to continue and the erosion would eventually get back to portions of the rerouted road and again threaten the access road. For this reason, this option is not recommended.

7. Purchase Homes and Revet Road

This alternative involves the purchase of the five homes and construction of a revetment adjacent to S.R. 867 (Figure 12a). This alternative has the advantage over rerouting the road because a fewer number of people are impacted. The revetment is to be built along 700 feet of road. As this solution does not mitigate the littoral drift deficit, additional sections of revetment may need to be added. For

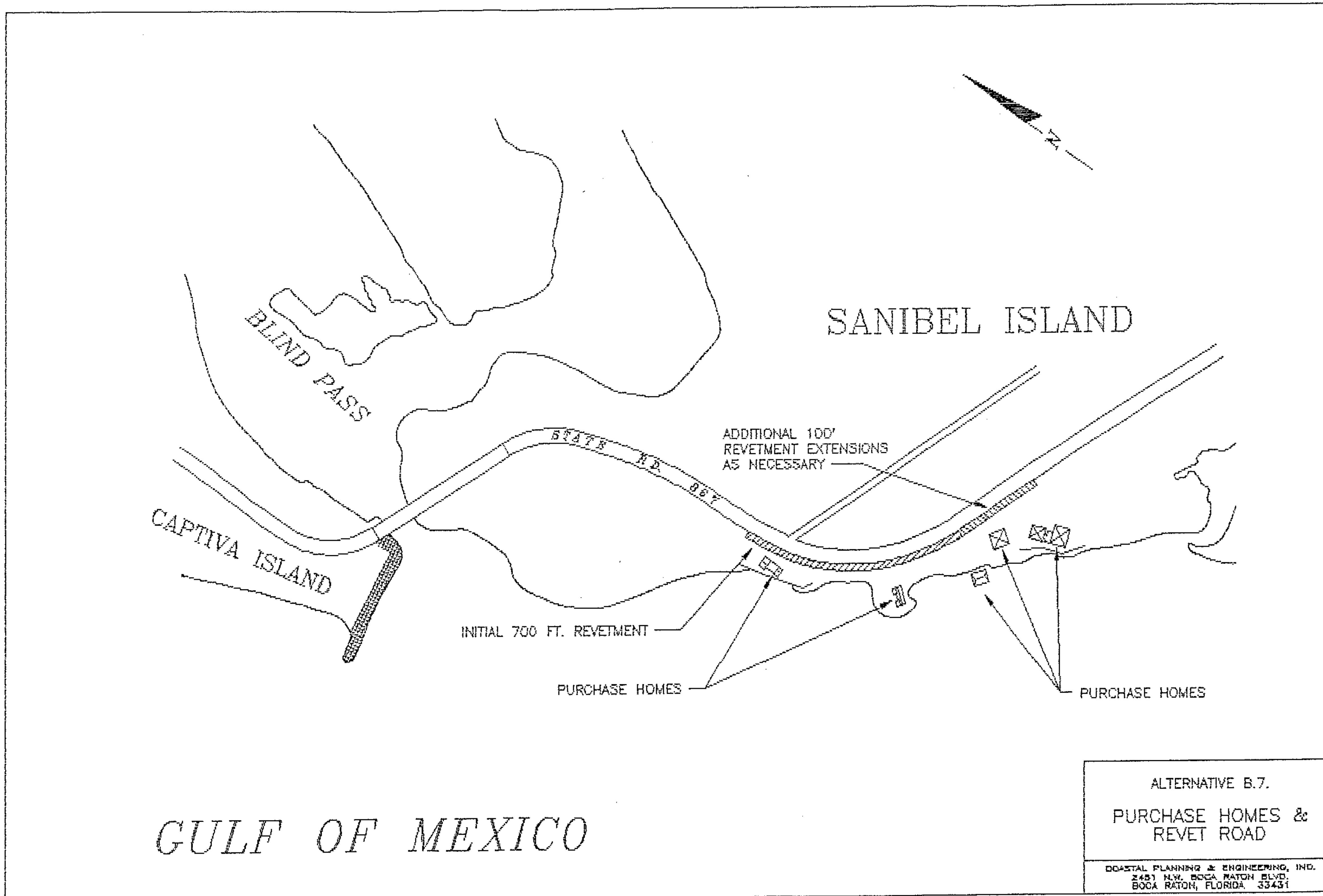

N
SANIBEL ISLAND
BLIND PASS
STATE RD. 867
ADDITIONAL 100'
REVETMENT EXTENSIONS
AS NECESSARY
CAPTIVA ISLAND
INITIAL 700 FT. REVETMENT
PURCHASE HOMES
PURCHASE HOMES
GULF OF MEXICO
ALTERNATIVE B.7.
PURCHASE HOMES &
REVET ROAD
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 12a.

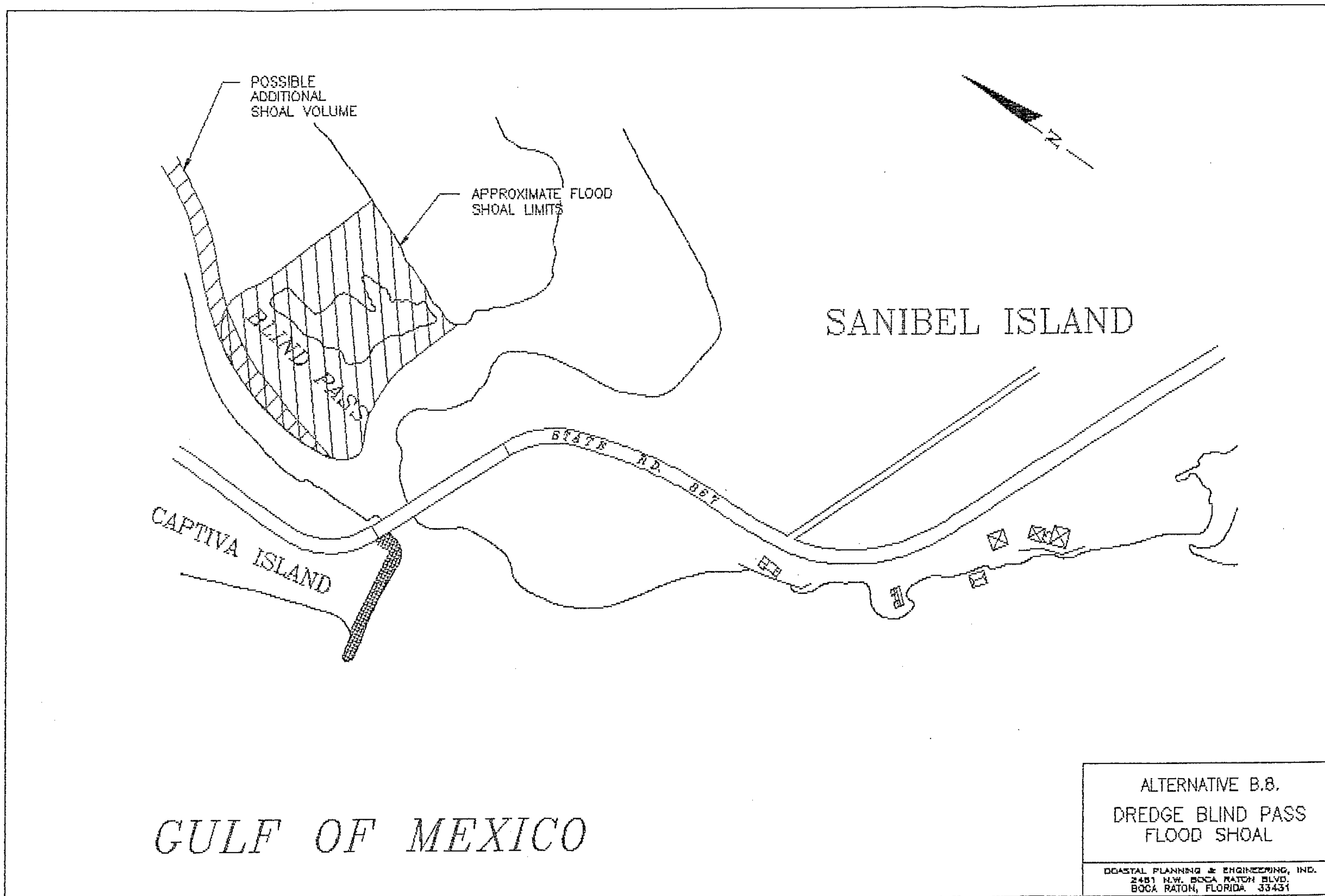
cost estimating purposes, an additional 100 feet of revetment is assumed to be constructed every five years until project year 15.

Discussions with Lee County Department of Transportation and their consultants indicate that plans to revet the road have been deleted from their construction plans to raise the approaches. The reason given was the difficulty to permit revetments with the State and their concern about anti-shore hardening policies of the City of Sanibel. It may be possible for the County to re-include the revetment as part of a comprehensive approach to inlet management.

The initial cost of this alternative, including buying the houses/cottages is \$3,588,000. The annual cost for this alternative is \$330,000. The cost of removing abandoned shore protection structures is not included in the above estimates.

8. Dredge Flood Shoal

This alternative involves dredging available sand from the flood shoal of Blind Pass and placing it on the beach (Figure 13). According to CPE (1990), the flood shoal contains approximately 60,000 cubic yards of beach compatible sand. Both Dr. Mehta and Dr. Dean indicate that shoaling may be taking place along the inlet channel all the way back to Pine Island Sound. Additional material may be available from these areas. Dr. Mehta also feels that dredging a wider channel



ALTERNATIVE B.8.
DREDGE BLIND PASS
FLOOD SHOAL

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 13

would make the inlet more stable and improve natural sand bypassing over time. The initial cost of this alternative is $379,500. The annualized project cost is $33,000.

The disadvantage to this alternative is that dredging the shoal would be difficult. A small dredge would have to enter from Pine Island Sound in order to reach the site along the shallow channel. Environmental constraints, such as adjacent sea grass beds, will probably make this alternative unpermittable by the state agencies. This alternative is not recommended.

9. No Action

This alternative is included for comparison with the other plans. Continued erosion of northern Sanibel is expected to continue. Additional hardening of the shoreline may be undertaken by private property owners. Clam Bayou will probably stay open due to the small supply of available sand. The overwash processes in the vicinity of Blind Pass are expected to continue. This option does not achieve the sand bypassing and erosion control goals. There is no construction cost associated with this alternative, but it is not recommended.

10. County Builds Road Protective Revetment, Nourish North Sanibel (2000 ft), Renourish with Captiva Project.

This alternative is a beach restoration and maintenance plan for Sanibel (Figure 14). Initially, 138,000 cubic yards will be placed on the beach north of Clam Bayou. Additional fill will be placed at six year intervals beginning in 1995 with sufficient sand to maintain the shoreline.

It is estimated that the initial erosion rate will be 45,000 cy/yr. As the fill spreads, the erosion rate should reduce to 35,000 cy/yr.

This option is an erosion control and storm protection option. Erosion is controlled through beach nourishment; conditions are not allowed to get worse than present day. Storm protection is provided to the road by a revetment. Property owners provide their own storm protection (see rest of this plan).

This alternative is combined with the construction of an initial revetment fronting the threatened road sections. The initial cost of this alternative is $2,410,000. The annual cost over the project life is $468,000 based on the projected erosion rates.

11. Segmented Breakwaters with Initial Fill

This alternative consists of constructing five (5) emergent breakwaters along 2000 feet of northern Sanibel. Approximately 90,000 cubic yards of sand would be placed on the beach to restore the shoreline. The goal of this alternative is to reduce the wave energy reaching the shoreline, thus reducing the erosion of the

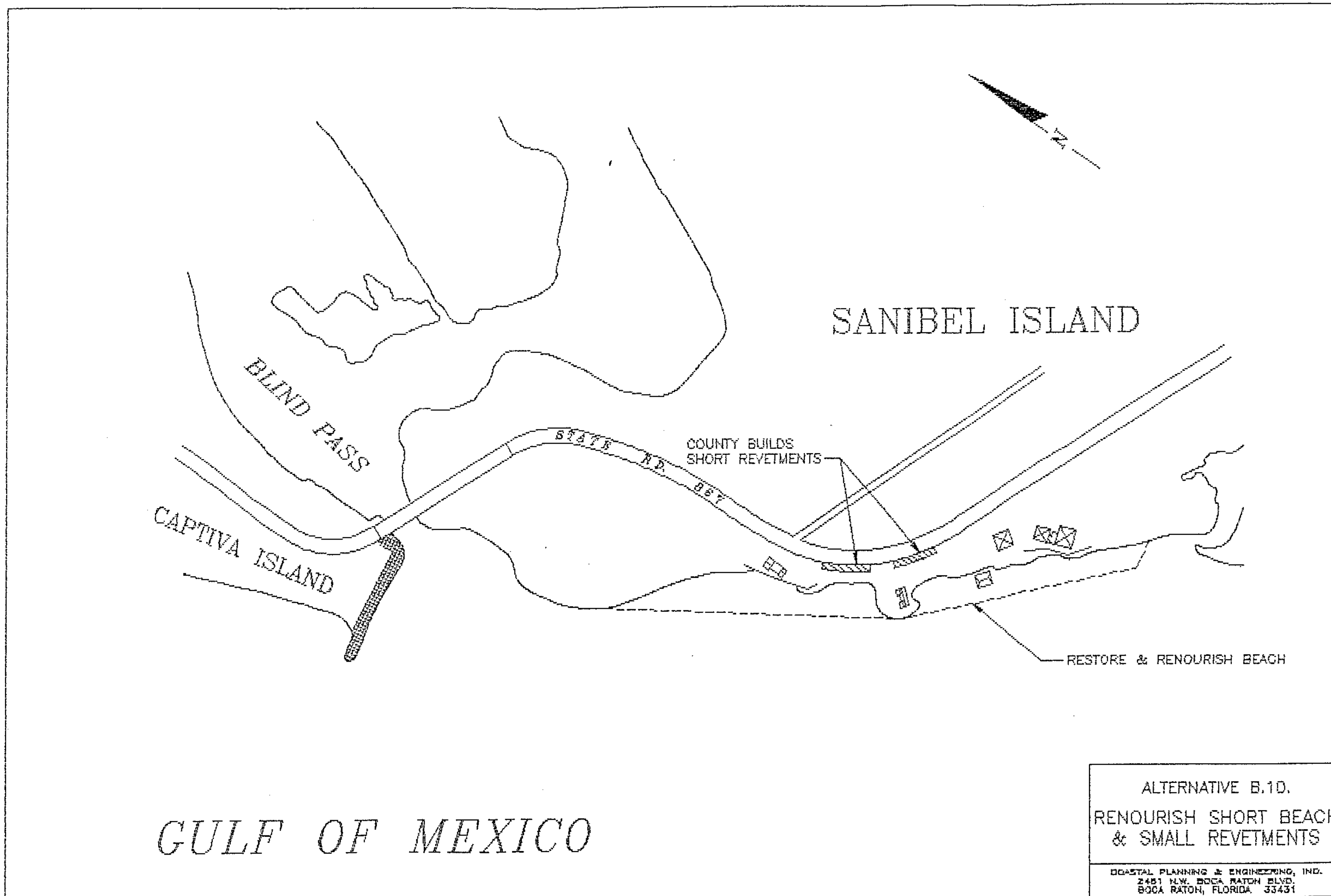

SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD 867
COUNTY BUILDS SHORT REVETMENTS
RESTORE & RENOURISH BEACH
N
GULF OF MEXICO
ALTERNATIVE B.10.
RENOURISH SHORT BEACH & SMALL REVETMENTS
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 14

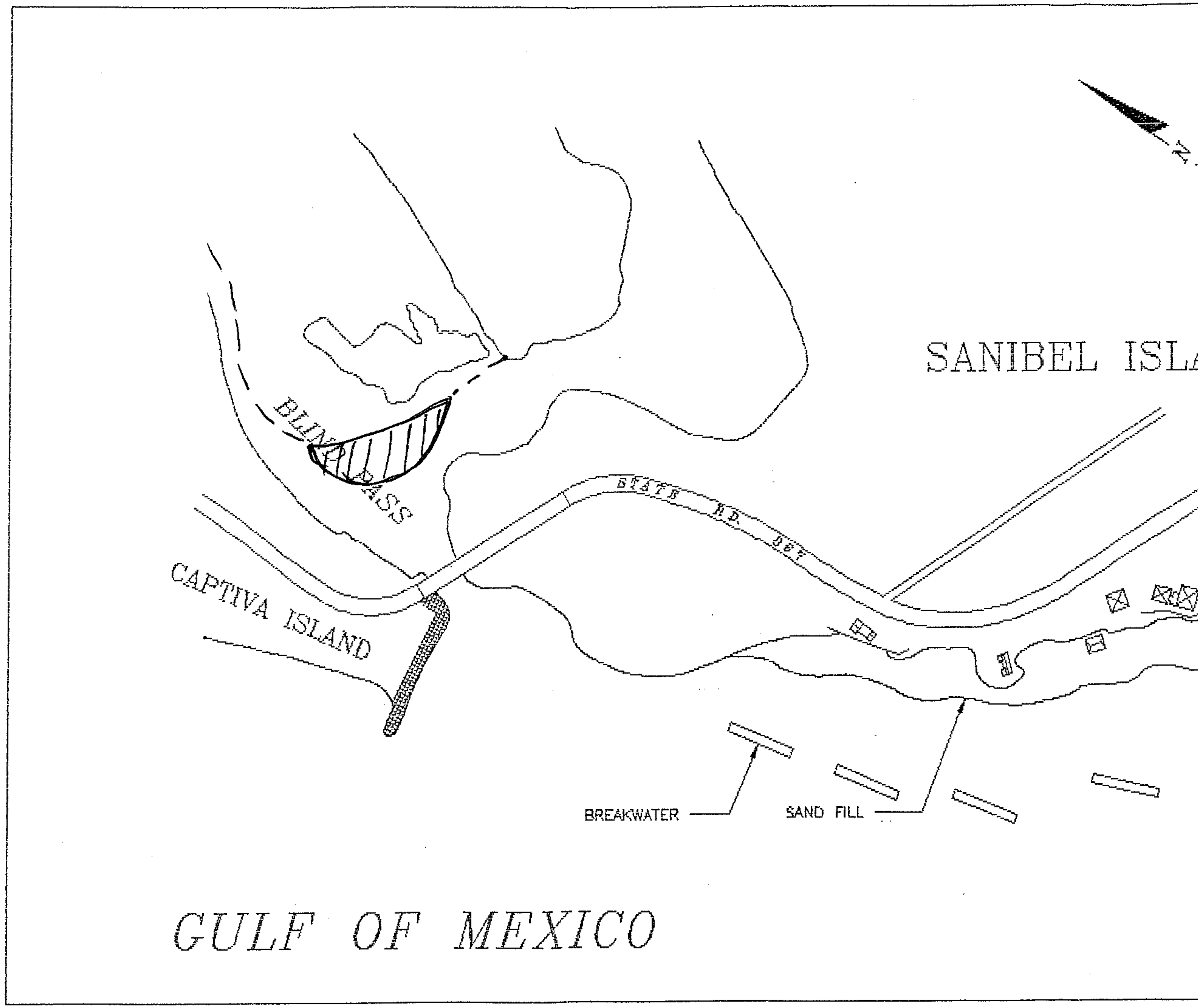
developed shoreline. No modifications to Clam Bayou inlet or to the beach south of Clam Bayou are included in this alternative.

The schematic layout of this alternative is shown in Figure 15. The breakwater placement was developed using the guidelines of Dally and Pope (1986). The breakwaters are 200 foot long segments with 150 foot gaps and are located approximately 400 feet offshore. The configuration should prevent tombolo formation which would interrupt the littoral drift. Detailed engineering, including computer shoreline modeling is required to optimize the placement and size of the breakwaters.

Based on the preliminary design, the initial cost of the breakwaters and initial fill is $5,237,000. The annual cost of this alternative is $423,000. This does not include any future renourishment of the beach which may be necessary.

A potential drawback to this alternative is the impact to the natural ebb shoal bypassing. As sand accumulates in the ebb shoal, some sand will be naturally bypassed along the bar back to the downdrift beach. With the presence of the breakwaters, the natural bypassing may be disrupted. Further analysis is required in order to understand the impacts to the littoral drift system.

C. Experimental Systems



ALTERNATIVE B.11
SEGMENTED BREAKWATERS W/SAND FILL

COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE 15

1. <u>Mobile Jet Pump System</u>

This system is intended to mechanically bypass sand from the south end of Captiva Island to the northern end of Sanibel. The system consists of a jet pump mounted on a crane connected to a pipe which crosses Blind Pass and discharges the sand approximately 2,000 feet south of Blind Pass (Figure 16). The project includes an initial restoration of Northern Sanibel involving 160,000 cubic yards of fill. This alternative is combined with the construction of an initial revetment fronting the threatened road sections. The initial cost of the fill and revetment is $2,077,000.

The advantage of this system is that the jet pump is mobile; therefore, more sand is available to be transferred to the downdrift beach. The system would operate only when there is sufficient sand available.

Several disadvantages to the system exist in this application. The crane would be operating near the water line in Turner Beach Park. This would disrupt the activities on one of the two public beaches on the island. Due to the limited littoral drift on the island, the system would not run continuously. As a result, the owners of the system would have to find employees to work part time. The system would increase erosion of the Captiva Project by 11,000 cy/yr. The jet pump would have to be oversized in order to bypass the large shell component of Captiva's beach. Although this is not a significant problem, the use of jet pumps to bypass shelly sand has been limited.

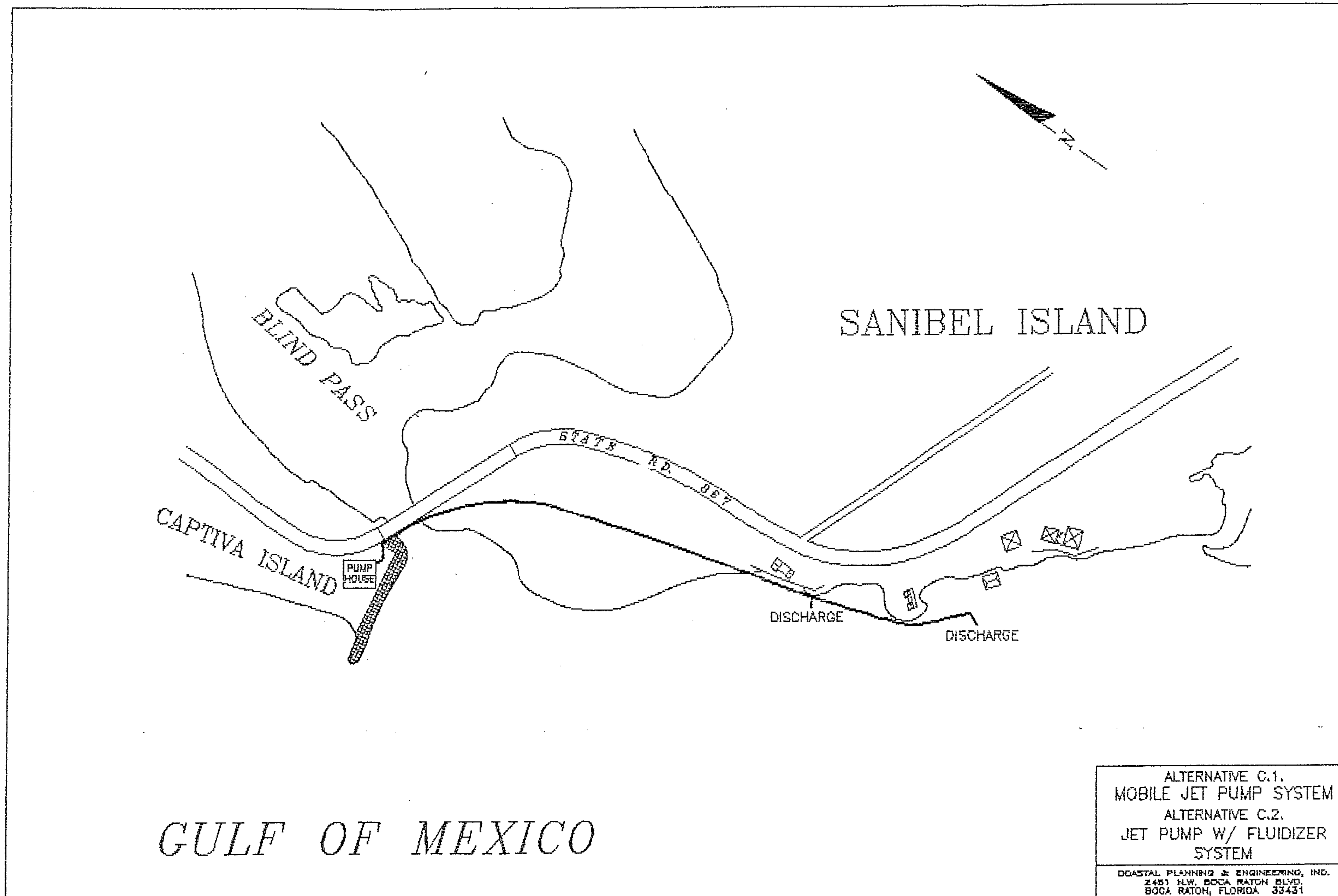

SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
PUMP HOUSE
DISCHARGE
DISCHARGE
N
GULF OF MEXICO
ALTERNATIVE C.1.
MOBILE JET PUMP SYSTEM
ALTERNATIVE C.2.
JET PUMP W/ FLUIDIZER SYSTEM
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE ~~15~~ 16

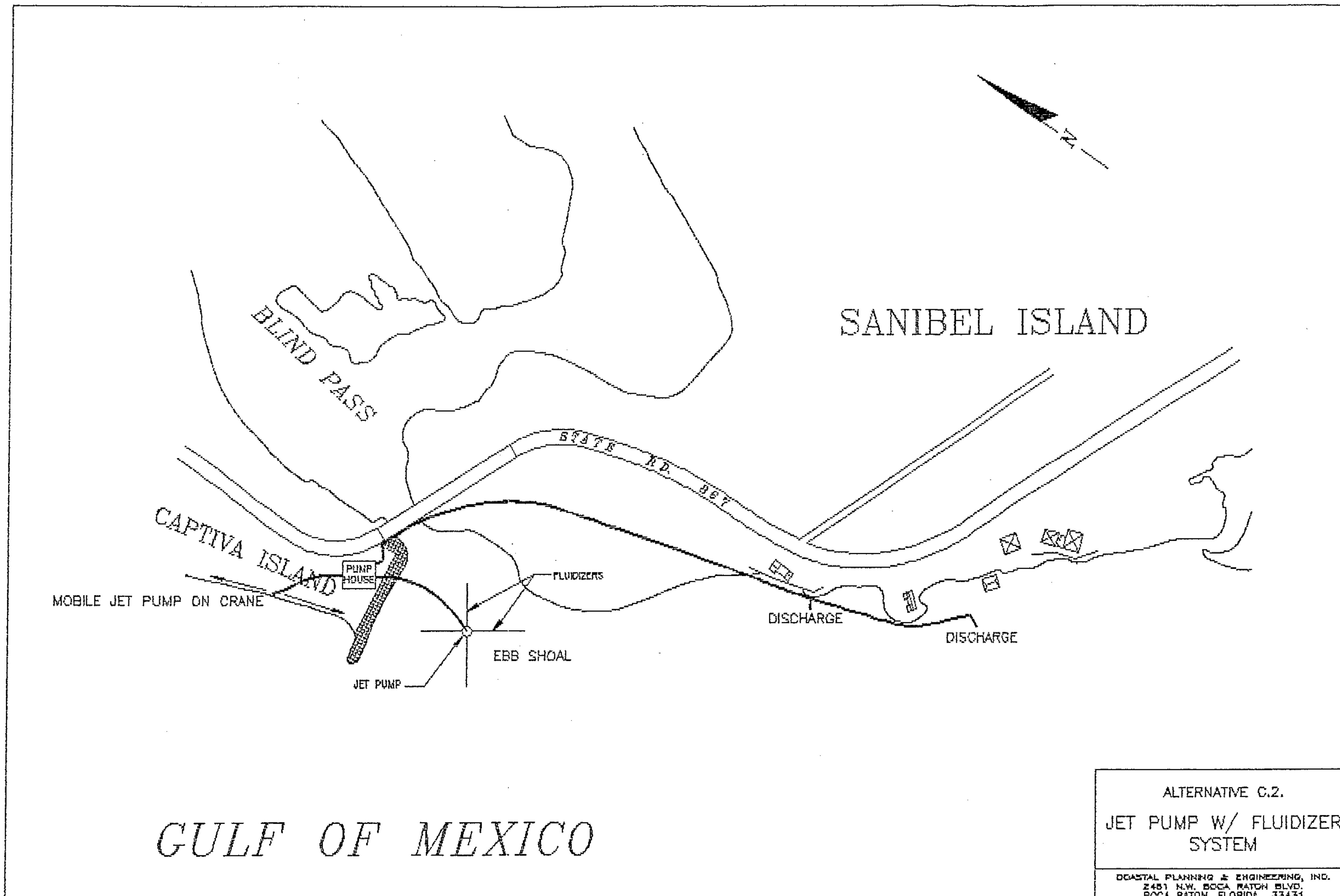
The initial cost of the system is estimated to be $3,010,000. Annual operating costs which include fuel, materials, maintenance, component replacement, and labor are $234,000. The total annual cost of this system over a 50 year life is $547,000 per year.

Due to the impact on the use of the public beach and high annual costs, the system is not recommended for use at Blind Pass.

2. Jet Pump in Ebb Shoal with Fluidizer Collector

This system of bypassing sand to Sanibel Island is similar to the previous jet pump system except that the jet pump is not mobile. The jet pump is placed on the ebb shoal where sand has been found to accumulate. In order to expand the area which the pump can capture sand, a system of fluidizing pipes is installed to move sand to the jet pump (Figure 17). The fluidizing pipes operate by having water pump through them and out small jet ports. The water exiting the ports liquifies the sand and allows gravity to move the liquefied material to the jet pump for transfer.

While the system is technically feasible, the only operating system in use is in Oceanside Harbor, California. It is operated by the Corps of Engineers and is considered experimental. A drawback to this system at Blind Pass is that by operating the system, the natural bypassing of the shoal (bar) would be interrupted. Since the ebb shoal does not store significant quantities of sand, most of the sand



ALTERNATIVE C.2.

JET PUMP W/ FLUIDIZER SYSTEM

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BOCA RATON, FLORIDA 33431

FIGURE ~~15~~ 17

is naturally bypassed to Sanibel. Therefore, it does not appear to be warranted to implement this system.

The initial cost of the system including the first year operation is $1.26 million. Annual operation and maintenance will be approximately $234,000 per year. The total annual cost of this system is $341,000 per year.

3. <u>Restore Developed Section of Northern Sanibel, Maintain with Dewatering System</u>

This experimental alternative involves the placement of sand on the northern section of Sanibel (north of Clam Bayou) and maintaining the restored beach with a beach dewatering system (Figure 18). Beach dewatering involves the lowering of the water table within the beach in order to slow or reverse the erosion process. This experimental system has been installed at Sailfish Point, Florida on a beach that is semi-protected by an offshore reef.

The dewatering system consists of a series of pipes buried within the beach that are connected to a pump. The pump draws water from within the beach and discharges the water offshore. The pump would run on a regular basis in order to maintain the beach. Annual maintenance to the pump is required.

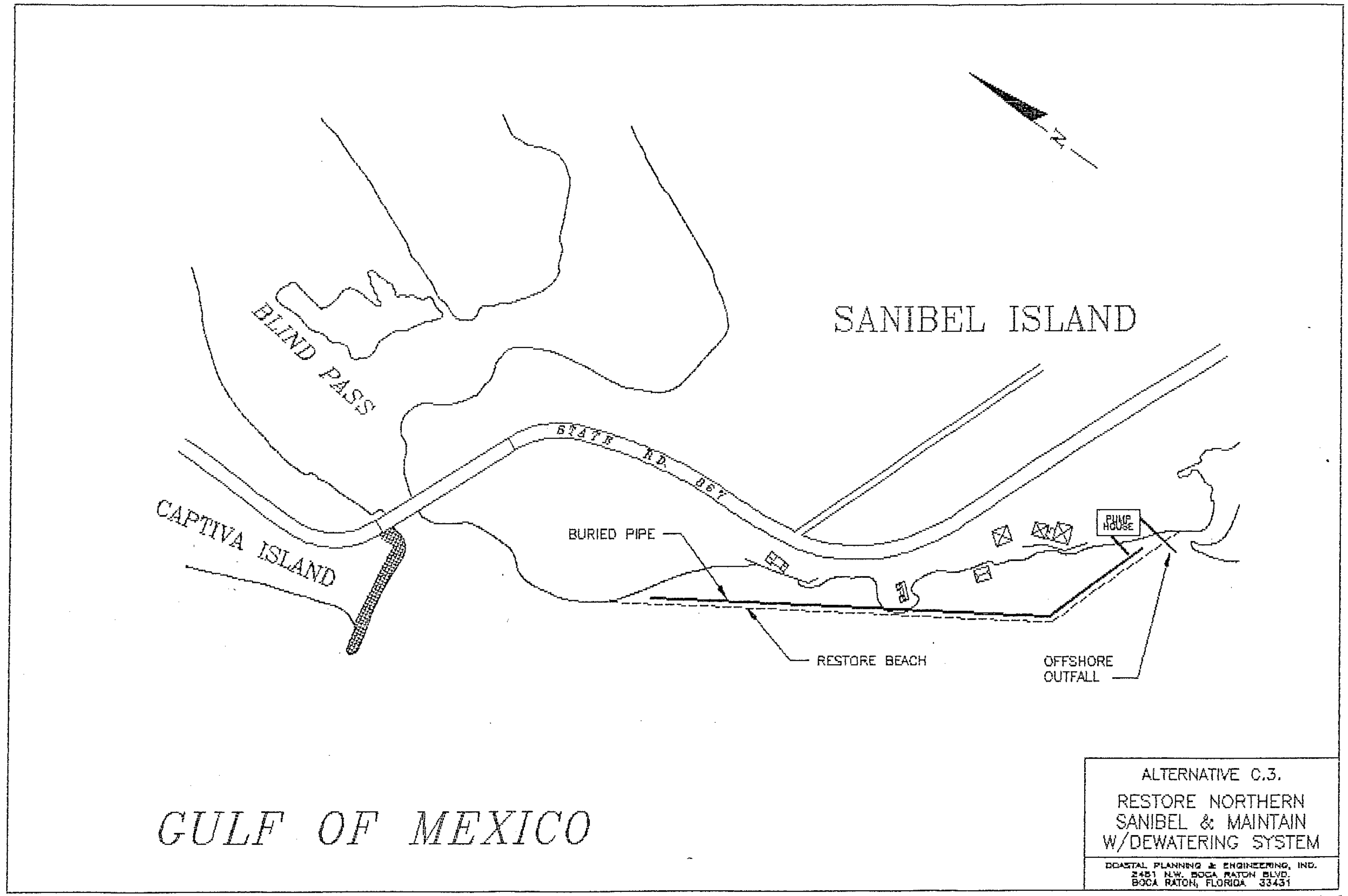
SANIBEL ISLAND
BLIND PASS
CAPTIVA ISLAND
STATE RD. 867
N
BURIED PIPE
PUMP HOUSE
RESTORE BEACH
OFFSHORE OUTFALL
GULF OF MEXICO
ALTERNATIVE C.3.
RESTORE NORTHERN SANIBEL & MAINTAIN W/DEWATERING SYSTEM
COASTAL PLANNING & ENGINEERING, INC.
2481 N.W. BOCA RATON BLVD.
BOCA RATON, FLORIDA 33431

FIGURE ~~15~~ 18

The DNR considers these dewatering systems experimental and may require that ongoing tests at Fort Pierce be completed before a second experiment is undertaken (Clark letter, November 14, 1991).

The initial cost of the sand system is $3,067,000. The annualized project cost is $295,000. Of the experimental alternatives, this option appears to hold the most promise.

TABLE
BLIND PASS(LEE COUNTY) MANAGEMENT PLAN
COMPARISON OF ALTERNATIVES

NUMBER	NAME OF ALTERNATIVE	TECHNICAL FEASIBILITY (YES/NO)	PERMIT-ABILITY (YES/NO)	INITIAL CONSTRUCTION COST($)	ANNUAL PROJECT COST @ 8.625%	ANNUAL PROJECT COST @ 3.0%	DIRECT SEDIMENT BYPASSING	ANNUAL DOWNDRIFT EROSION MITIGATION	MAINTAIN OPEN BLIND PASS	CLAM BAYOU IMPACT	REC
I. CLOSE THE INLET											
1	REMOVE NORTH JETTY AND REVETMENT	YES	MAYBE	$746,000	$65,000	$29,000	53,000	YES	NO	CLOSURE POSSIBLE	NO
2	REMOVE JETTY, REVETMENT AND CONSTRUCT DIKE	YES	MAYBE	$1,202,000	$105,000	$47,000	53,000	YES	NO	CLOSURE POSSIBLE	NO
B. INLET BYPASSING SYSTEMS											
1 A.	NOURISH 3700 FT OF N. SANIBEL, CLOSE CLAM BAYOU	YES	YES	$4,655,000	$650,000	$504,000	NO	YES	PROBABLE	CLOSED	
1 B.	SAME AS 1 A. EXCEPT RENOURISH AT CAPTIVA'S INTERVAL	YES	YES	$3,663,000	$569,000	$403,000	NO	35,000	PROBABLE	CLOSED	
2	INITIAL 2000 FT BEACH RESTORATION W/ 4 GROIN FIELD	YES	YES	$3,970,000	$351,000	$170,000	53,000 ?	NO ?	PROBABLE	OPEN W/ OVERWASH CONTINUING	
3	REMOVE JETTY EXTENSION, RESTORE 3700 FT OF SANIBEL & PLACE ADVANCED FILL ON S. CAPTIVA	YES	YES	$3,279,000	$538,000	$388,000	50,000	YES	UNSTABLE	CLOSURE POSSIBLE	
4	RESTORE 3700 FT OF SANIBEL PLACE ADVANCED FILL ON S. CAPTIVA	YES	YES	$3,663,000	$569,000	$403,000	50,000	NO ?	UNSTABLE	CLOSED	
5	BUILD S. JETTY AND NOURISH 3700 FT OF SANIBEL CLOSE CLAM BAYOU	YES	YES	$5,000,000	$677,000	$453,000	NO	35,000	YES	CLOSED	
X 6	PURCHASE AND DEMOLISH 5 HOMES & REROUTE RD.	YES	YES	$3,493,000	$306,000	~~$136,000~~	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING	NO
X 7	PURCHASE AND DEMOLISH 5 HOMES & REVET ROAD	YES	YES	$3,588,000	$330,000	~~$151,000~~	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING	NO
X 8	DREDGE FLOOD SHOAL OF AVAILABLE SAND EVERY 30 YR. ?	YES	NO	$379,500	$33,000	~~$20,000~~	NO	SOME	YES	OPEN W/ OVERWASH CONTINUING	
X 9	NO ACTION: ALLOW SANIBEL TO ERODE	N.A.	N.A.	$0	$0	$0	NO	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING	
10	RESTORE 2000 FT OF SANIBEL; COUNTY BUILDS 400 FT REVETMENT; RENOURISH SANIBEL AT CAPTIVA'S INTERVAL	YES	YES	$2,410,000	$468,000	$355,000	NO	YES ?	PROBABLE	CLOSURE POSSIBLE	
11	CONSTRUCT 5 SEGMENTED BREAKWATERS; RESTORE BEACH	YES	YES	$5,237,000	$422,000	$198,000	NO	SOME	PROBABLE	OPEN W/ OVERWASH CONTINUING	
C. EXPERIMENTAL SYSTEMS											
1	MOBILE JET PUMP SYSTEM ON CAPTIVA, DISCHARGE ALONG 1000 FT OF SANIBEL	EXPERIMENTAL	EXPERIMENTAL	$3,010,000	$547,000	$419,000	53,000	NO	PROBABLE	OPEN W/ OVERWASH CONTINUING	
2	FIXED JET PUMP IN EBB SHOAL W/ FLUIDIZER DISCHARGE ALONG 1000 FT OF SANIBEL	EXPERIMENTAL	EXPERIMENTAL	$1,267,000	$341,000	$279,000	53,000	NO	YES	OPEN W/ OVERWASH CONTINUING	
3	RESTORE 1800 FT OF SANIBEL & DEWATER THE BEACH Renourish @ Captiva's Interval	EXPERIMENTAL	EXPERIMENTAL	$3,067,000	$295,000	$145,000	NO	NO ?	PROBABLE	OPEN W/ OVERWASH CONTINUING	

DREDGE AND REVETMENT COSTS INCLUDE CONTINGENCIES(15%) AND ENGINEERING(10%) COSTS.
SAND TRANSFER SYSTEM COSTS INCLUDE CONTINGENCIES(25%) AND ENGINEERING(10%) COSTS.

TABLE
BLIND PASS(LEE COUNTY) MANAGEMENT PLAN
COMPARISON OF ALTERNATIVES

NUMBER	NAME OF ALTERNATIVE	ENVIRONMENTAL CONCERNS	HURRICANE EVACUATION ROUTE PROTECTED	RECOMMEND (YES/NO)	DISTRIBUTION OF LOCATION OF WORK BETWEEN: CAPTIVA (%)	SANIBEL (%)
I. CLOSE THE INLET						
1	REMOVE NORTH JETTY AND REVETMENT	WATER QUALITY & SEAGRASS DIMINISH IN BLIND PASS	REDUCED PROTECTION ON CAPTIVA	NO	100%	0%
2	REMOVE JETTY, REVETMENT AND CONSTRUCT DIKE	WATER QUALITY & SEAGRASS DIMINISH IN BLIND PASS	REDUCED PROTECTION ON CAPTIVA	NO	75%	25%
B. INLET BYPASSING SYSTEMS						
1 A.	NOURISH 3700 FT OF N. SANIBEL, CLOSE CLAM BAYOU	INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	NO	0%	100%
1 B.	SAME AS 1 A. EXCEPT RENOURISH AT CAPTIVA'S INTERVAL	INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
2	INITIAL 2000 FT BEACH RESTORATION W/ 4 GROIN FIELD	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
3	REMOVE JETTY EXTENSION, RESTORE 3700 FT OF SANIBEL & PLACE ADVANCED FILL ON S. CAPTIVA	WATER QUALITY & SEAGRASS DIMINISH IN CLAM BAYOU	PROTECTION INCREASED ON SANIBEL PROTECTION DECREASED ON CAPTIVA	NO	50%	50%
4	RESTORE 3700 FT OF SANIBEL PLACE ADVANCED FILL ON S. CAPTIVA	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	40%	60%
5	BUILD S. JETTY AND NOURISH 3700 FT OF SANIBEL CLOSE CLAM BAYOU	WATER QUALITY & SEAGRASS DIMINISH IN CLAM BAYOU	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
6	PURCHASE AND DEMOLISH 5 HOMES & REROUTE RD.	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	PROTECTION INCREASED ON SANIBEL	NO	0%	100%
7	PURCHASE AND DEMOLISH 5 HOMES & REVET ROAD	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	SANIBEL ROAD DIRECTLY PROTECTED	NO	0%	100%
8	DREDGE FLOOD SHOAL OF AVAILABLE SAND EVERY 30 YR.	LOSS OF EXISTING VEGETATION & POSSIBLE SEAGRASSES	AS EXISTING	NO	0%	100%
9	NO ACTION; ALLOW SANIBEL TO ERODE	LOSS OF SANIBEL BEACH & POTENTIAL LOSS OF MANGROVES	REDUCED PROTECTION ON SANIBEL	NO	0%	0%
10	RESTORE 2000 FT OF SANIBEL; COUNTY BUILDS 400 FT REVETMENT; RENOURISH SANIBEL AT CAPTIVA'S INTERVAL	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	SANIBEL ROAD DIRECTLY PROTECTED	MAYBE	0%	100%
11	CONSTRUCT 5 SEGMENTED BREAKWATERS; RESTORE BEACH	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%
C. EXPERIMENTAL SYSTEMS						
1	MOBILE JET PUMP SYSTEM ON CAPTIVA, DISCHARGE ALONG 1000 FT OF SANIBEL	LOSS OF TURTLE HABITAT ON CAPTIVA	REDUCED PROTECTION ON CAPTIVA	NO	90%	10%
2	FIXED JET PUMP IN EBB SHOAL W/ FLUIDIZER DISCHARGE ALONG 1000 FT OF SANIBEL	MINIMAL	AS EXISTING	NO	60%	40%
3	RESTORE 1800 FT OF SANIBEL & DEWATER THE BEACH	SMALL INCREASE TURTLE NESTING HABITAT ON SANIBEL	PROTECTION INCREASED ON SANIBEL	MAYBE	0%	100%