EVALUATION OF BEACH NOURISHMENT OPPORTUNITIES WITH DREDGED MATERIAL: GALVESTON HARBOR

There is a potential to use material routinely dredged from the Galveston Ship Channel to nourish the nearby beaches of Galveston Island. The channel is dredged on the average every 2 years, removing over 1 million cubic yards of material from the inner bar, outer bar and entrance channels. Maintenance dredging has been accomplished by hopper dredging, however cutterhead dredging may be accomplished in the inner and possibly outer bar channels. Several factors will be important for a successful beach nourishment from any dredging project. They include; compatibility of the borrow material with the native beach, quality of material (color, texture, specific gravity etc.), quantity of material and the pumping distance which directly effect costs.

<u>Material Compatibility.</u> Williams, Prins and Meisburger (1979) describes borrow material quality requirements as, "Borrow material should be at least the same size or, preferably slightly coarser than native material on the beach to be nourished. Borrow material that is significantly finer in grain size than native sand will probably be less stable than the natural material and hence more easily eroded. The net effect would be an accelerated retreat of the beach in an attempt to readjust nearshore profiles which would require considerably larger volumes of initial fill as well as more frequent nourishment. If the borrow sand does not have the same grain-size characteristics as the native beach sand, the grain-size population of the borrow sand should have a greater variation in grain size than the native beach sand. However, the borrow sand should not contain large amounts of fine-grained silts and clays (§ 0.063 mm) which, if placed on the beach, would soon be introduced to the nearshore zone. Turbidity caused by the solids could have a detrimental impact on native marine fauna and also be esthetically displeasing. Borrow material should also be composed of hard, chemically and physically resistant minerals (e.g., quartz) which will not readily degrade in high-energy nearshore beach dune environment."

The median grain size of the native beach sands along Galveston Island range from 0.130 mm to 0.140 mm (Hsu, 1960). Most beach sand is moderately sorted (0.71 to 1.0 mm) to very well sorted. Table 1 shows the grain size analyses conducted for the inner and outer bar channels in 1990 and 1988. Figure 1 shows the location for the sediment samples. As shown in Table 1 the grain size can vary considerably between stations and sampling period in the inner and outer bar channels. In 1990 stations in the inner bar channel (Stations 2 through 5) had around 60% sands with the median grain size varying between 0.093 mm and 0.149 mm. In the 1988 sampling effort the inner bar stations had around 90% sands and the median grain size was about 0.16 mm. It is difficult to make a design recommendation on the data presented here. The material represented in the 1988 sampling period represents material which may be suitable for beach nourishment if a large percentage of fines can be tolerated (a minimum of 1 out of 10 cubic yards will be immediately washed away and possibly create water quality problems). The 1990 sediment samples represent an extremely low quality beach fill with a very high percentage of fines. A large portion of this material will be susceptible to erosion and potential for water quality problems is very high. Several reasons could account for the difference in grain size including; number of storms/rainfall in the area, location in the channel were sample was collected, time of year, type of sample collector used and weather conditions during sample collection. Whatever the reason for the difference, a detail study of the area should be conducted prior to any material being pumped onto the beach.

Costs. Table 2 shows the cost comparison of placing the dredged material on the beach, at approximately 25 th Street, for 500,000 and 1,000,000 cubic yards of material. Costs per cubic yard are $4.01 and $3.45, respectfully. The price per cubic yard is reduced by the amortization of the costs over larger volumes of material. Estimates were based on dredging the inner bar channel and anchorage area, pumping the material via pipeline along the seawall to approximately 25 th Street. Since this represents a distance of almost 27,000 ft (see Figure 1) a separate charge for pipeline and handling was warranted. Since funding for any additional costs for the project must be borne by the requesting agency, government historical costs were calculated to establish a comparison. Since 1980, five dredging jobs have removed 12,805,362 cu yds of material from the Galveston Harbor Entrance Channel at a total cost of $26,594,894 for a cost/cu yd of $2.10. All the dredging was conducted by a hopper dredge with costs remaining relatively constant throughout the decade with the latest job costing $1.84/cu yd and the 1980 job costing $2.02/cu yd. Table 2, (HISTORICAL column), represents the average cost to remove 1 million cubic yards of material since 1980. Based on this preliminary analyses, the additional dredging costs to remove 500,000 and 1 million cubic yards would be $955,000 and $1,350,000 respectfully.

REFERENCES

Williams, Prins and Meisburger, "Sediment Distribution, Sand Resources, and Geologic Character of the Inner Continental Shelf Off Galveston County, Texas," MR NO. 79-4, Coastal Engineering Research Center, 1979

Hsu, "Texture and Mineralogy of the Recent Snads of the Gulf Coast," Journal of Sedimentary Petrology, Vol. 30, No. 3, 1960

Table 1: Galveston Harbor Channels Grain Size Distribution

GALVESTON HARBOR (Sampled June 1990)

Station	% Gravel	% Sand	% Silt	% Clay	d_{50} mm	d_{85} mm	d_{30} mm
1	34.28	64.3	0.9	0.6	1.026	2.0	0.28
2		50.8	16.9	32.3	0.093	0.22	0.004
4		59.9	13.4	26.7	0.121	0.24	0.007
5		65.6	16.2	18.2	0.149	0.29	0.049
9		36.3	20.5	42.9	0.08	0.19	0.002
10		49.8	13.4	13.5	0.139	0.24	0.015

GALVESTON HARBOR (Sampled April 1988)

Station	% Gravel	% Sand	% Silt	% Clay	d_{50} mm	d_{85} mm	d_{30} mm
1	28.65	49.9	15.0	6.2	0.68	4.7	0.15
3		87.9	9.9	2.2	0.17	0.2	0.15
5		90.5	8.1	1.4	0.16	0.21	0.15
9		13.3	64.5	22.5	0.012	0.06	0.006
11		15.4	67.7	16.9	0.016	0.07	0.007

Table 2: Cost Comparison for Beach and Offshore Placement of Dredged Materials.

ITEM	500,000 cu yds	1,000,000 cu yds	HISTORICAL (1 million cy yds)
Mobilization and Demobilization	$ 217,000	$ 217,000	$ 170,000
Dredging	1,460,000	2,900,000.	1,930,000
Pipelines	330,000	330,000	----------
Total	$2,007,000	$3,447,000	$2,100,000
Price per cubic yard	$4.01	$3.45	$2.10

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