10 Conclusions

The report by Quammen and Onuf (1993) that an appreciable area of Lower Laguna Madre became bare sometime between a seagrass survey in 1965 and the subsequent survey in 1974 raised much environmental concern for seagrass ecosystems. This concern has led to speculation that increased turbidity and decreased light penetrations resulting from dredged-material disposal from GIWW placement areas and subsequent dispersion were the cause of the seagrass decline. Field information, however, is insufficient to support this allegation.

It should be noted that the 1965 data were not extensive or well documented, nor were they collected specifically to examine the effects of dredged-material dispersion. Also, annual channel shoaling near the area in question, which is also sensitive to TSM and turbidity, has been consistently high and has shown no overall upward trend (see Figures 3 and 4). Likewise, monitoring data going back to the early 1970s do not show an upward trend in TSM near the bare area (see Figure 88). Further, LANDSAT images show that the bare, high turbidity area had appeared by 1972, and a seagrass survey in 1988 showed no appreciable increase in total bare-bottom area . Some areas, such a Emmord's Hole described in Chapter 9, have, over the years, alternated between bare and vegetated areas. Because of the number of factors that affect the growth of seagrass, field data do not provide a strong basis for separating and identifying the effects that specifically result from dredge-material resuspension.

Observations have shown that wave action is primary to the resuspension of sediments. Wave action is affected by wind, atmospheric drag coefficient, water depth, and dissipation rate. Wind waves tend to be depth-limited and fully-developed. Wind-wave heights and periods depend on the water depth (the distance between the surface to the bottom or from the surface to the top of the seagrass canopy), on the atmospheric drag coefficient, and to a lesser degree on the fetch of the wind. Wave dissipation is caused by bottom friction, seagrass friction, and white-capping (which also depends on wind speed and water depth). These factors are important in the shallow areas of Laguna Madre, where an assessment of wave-prediction techniques indicated observed waves did not follow previous analytic relationships, perhaps because of high wave dissipation. The partitioning of atmospheric shear stress between waves and currents depends on wind speed, and, hence, on wave white-capping. Atmospheric drag coefficient depends on wind speed and effective water depth and, hence, on the presence of seagrass. The presence of seagrass strongly affects not only waves but also TSM and turbidity in Laguna Madre.

Measurements made of suspended-sediment concentrations and suspended floc-size distributions show suspended-sediment concentrations vary both spatially and temporally and overall from about 5 to 500 mg/l. A spatial delineation based on the presence of seagrass is apparent. Kilometer-scale spatial variability within the bare area of Lower Laguna Madre was found to be surprisingly high (see Figure 86 and Table 38). An appreciable fine suspended-sediment fraction, inversely related to TSM concentration, is composed of calcium carbonate. Near dredged-material pipeline disposal operations, TSM concentrations were found to range to over 1,000 mg/l (see Figure 61). A plume of 200 to 500 mg/l above ambient concentrations occurred above, but not much outside of, the underflow footprint. Near dredging and disposal operations, TSM concentrations in the GIWW were found to be elevated (see Table 23).

Erodibility of dredged material depends upon the dredging and disposal procedures as well as upon sediment properties. Field sampling around a working dredge indicated the fluid-mud-gravity underflow and the water-column plume formed by the disposal extended about 500 m from the pipeline disposal point. Median fluid-mud thicknesses were 0.45 m, of which the top 60 percent was interpreted as underflow, and the remainder was deposit. Laboratory erosion experiments determined that erosion parameters, changed over time-scales of several weeks as simulated dredged-material slurries were allowed to settle and consolidate, and the material became less erodible.

Bed sediments are sands over most of Laguna Madre with some limited areas of fine-grained sediments. One important area of finer sediments is near the bare area in Lower Laguna Madre.

Physics-based hydrodynamic and sediment models were applied, with and without dredged-material disposal, to gauge the water-column TSM effects from disposal area resuspension and, thereby, to eliminate the variability in other environmental conditions. The two-dimensional, depth-averaged TABS-MDS numerical models required enhancement to include the feedbacks between seagrass and resuspension. Model equations based on conservation of mass and momentum (shallow water wave equations) include non-linear advective and friction effects. The latest bathymetry was compiled and used to develop the model mesh. Assignment of model roughnesses was based on the sediment type, bed roughness features, depth, and the species of submersed aquatic vegetation. The effects of aquatic vegetation on hydraulic roughness and bed sheltering were obtained from literature. Precipitation and evaporation were included in model simulations.

While sufficient information was available to estimate numerical model parameters related to seagrass and resuspension, there still are areas which might benefit from further research. The effect of seagrass density is one such issue which intuitively should be related to frictional and bed sheltering effects but which lacks conclusive data.

After the model adjustment, the ability of the model to predict suspended-sediment concentrations was quantified by comparing its data to field data. Field data included twice-a-day TSM information near the PA 233. Long-term TSM data, channel deposition, and overall PA erosion/dispersion rates were also used in the comparisons. The validation task demonstrated that the model produced TSM distributions whose medians were generally within 25 percent of the field values. The initial model scenarios included annual simulations with and without dredged material disposal. Six PAs were simulated. Results were used to gauge water-column impacts of the dredged material as it dispersed in the year following disposal. Near the PA 233 site, dredged-material disposal increased annual median TSM levels by only 7 mg/l (Table 42). During periods of greater resuspension, the TSM difference between scenarios with and without disposal was more pronounced. However, the frequency of these events is small (less than about 15 percent), and TSM levels during these events are high, relative to light penetration for seagrass, both with or without dredged-material disposal.

Several plans for alternate PA locations were tested with the model. In Lower Laguna Madre, PA 233 and 234 (located about 12 km north of Port Isabel) have received the highest dredged-material volumes in all of Laguna Madre, and the adjacent channel area has long been identified as one of the major deposition and channel maintenance problems along the Texas GIWW. Model tests were performed, and these PAs were relocated to the west into deeper water. Channel shoaling was reduced, and more material was retained with the proposed sites. A confined site configuration was also tested for the PAs.

Slightly to the north, PA 232, which has shoaled up over the years, was moved from the west to the east side of the GIWW in the model. Model results indicated that in the new location channel shoaling was slightly decreased. Subsequent investigation indicated that seagrass was growing at the proposed relocation site and the ICT rejected the relocation proposal.

In Upper Laguna Madre, PA 186 to 189 were combined into a site on the west side of the GIWW at a relatively deep area known as Emmord's Hole. The intent was to concentrate immediate water-column impacts into an area that has no vegetation at the present time. During the month of disposal, the model indicated that an area about 700 m long would have TSM increased by 26 mg/l. During the subsequent 11 months, TSM increased by no more than 7 mg/l outside of Emmord's Hole.