

RESULTS FROM CSMW TASK 3

(Beach Nourishment Projects – Performance and Sediment Characteristics)

TASK 3 – Compile known and available information on: the types and grain size distribution of sands that have been used for nourishment projects along the important California beaches; observed end results of nourishment projects; the basis for limitation placed on the percentage of allowable finer grained materials in nourishment projects. Include any information gathered on existing grain size distributions at those important beaches.

BACKGROUND

There are many variables that affect the success or failure of beach replenishment/nourishment projects. One of the main criteria for defining the “success” of such projects is the longevity of the “fill,” or borrow material, placed during individual episodes of nourishment. For example, given a volume of fill emplaced in a beach system, managers and engineers want to know what percentage of that fill is retained in the littoral cell after a given period of time. How a fill performs with time is a function of the interaction of several conditions and properties. Some of these include local wave and current conditions; technique and location of fill placement; and the reliability of the monitoring method. The interactions will determine if a fill remains in the system longer or shorter than expected.

One property of interest in the performance of fills is the physical compatibility between the fill material and the “native” material of the beach where the fill is to be placed. “Compatibility” refers to the degree of similarity of the two materials and includes the size, type (mineralogy), color, density, and shape of the component sediment grains. Typically, size is the most commonly evaluated in trying to match a fill material with a native material mainly because of its potential mechanical performance within the dynamics of the beach environment. Grain type and color can locally be important because of aesthetic or health/safety concerns. A textbook on beach nourishment and protection published by the National Research Council (1995) presents a brief discussion of sand compatibility; various papers are cited that discuss the pros and cons of continued use of grain-size comparisons between fill and native materials as measures of beach performance. Also, the Coastal Engineering Manual (U.S. Army Corps of Engineers, 2002) has sections on beach-fill design and performance.

There are three main concerns with grain size. First, if the percentage of fines (clay- and silt-sized grains) in the fill is too high, a correspondingly larger volume of fill material must be emplaced in the beach system to allow for loss of the fines with time caused by winnowing action of the waves. Second, too high of a percentage of fines in a beach sand is recreationally undesirable – there may be clumping of the material, for example.

Third, fines can harbor or attract contaminants, which may be hazardous to humans and sea life; placement of a contaminated material on a beach system can be detrimental.

Beach Replenishment/Nourishment in California

Beach replenishment/nourishment began in California at least as early as 1919 (Coyne, 2000). Several hundred episodes of replenishment and periodic nourishment have occurred at several dozen beach systems along the coast. Most of these have been in southern California, particularly in the Santa Barbara and Ventura areas, and along the coastlines of Santa Monica Bay, Orange County, and San Diego County.

Currently (2004), there is reportedly only one beach replenishment/nourishment project currently underway in the San Francisco District of the U.S. Army Corps of Engineers, which extends from the Oregon border to just north of the San Luis Obispo-Monterey County line. This project consists of disposal of dredge material at Ocean Beach in San Francisco. In the Los Angeles District, which covers the remainder of the coast to the Mexico border, there are many on-going projects. Some are related to harbor maintenance: those at Santa Barbara, Ventura, Channel Islands, and Oceanside are done annually, while those at Morro Bay, Playa del Rey, and Mission Beach are done infrequently. As an example unrelated to disposal of dredged material, nourishment was recently accomplished at Goleta in Santa Barbara County.

Tracking the history and performance of these projects and individual episodes of replenishment/nourishment is a challenge largely because of the inconsistent documentation and because the information is commonly in unpublished files or reports. Through sponsorship of the California Coastal Commission and California Department of Boating and Waterways, Melanie Coyne, a National Oceanographic and Atmospheric Administration (NOAA) Fellow, researched and compiled the most comprehensive list of beach nourishment projects along the coast of California (Coyne, 2000). Presented here in modified form as Table 2, this list covered projects up to the year 2000. Also included here as Table 3 is Coyne's list of references that she consulted to compile the data and information. As an update to the list since 2000, we have added the individual replenishment/nourishment episodes of the SANDAG Regional Beach Sand Project as documented by Coastal Frontiers Corporation (2004).

Historically, most of the replenishment/nourishment activities in California have been pursued as local, rather than regional, projects. They have been dominantly "opportunistic" projects, meaning that beach restoration was not the primary purpose of the placement of fill. Rather, the beach systems were the receiving (disposal) sites for dredged material from other primary activities such as harbor construction or channel maintenance. Only in recent years has the number of "deterministic" projects become more common. In these projects, beach restoration through replenishment and nourishment is the primary purpose. The recently instituted Regional Beach Sand Project of the San Diego Association of Governments (SANDAG) is the first regional deterministic beach-nourishment program on the Pacific Coast of the United States.

CHARACTER OF FILL MATERIAL AND NATIVE MATERIAL

Data and information on the physical character of sediment involved in beach replenishment/nourishment projects along the coast of California range from sparse to well-documented. One of the main influences on documentation is whether a project is deterministic or opportunistic. Deterministic projects generally have greater testing of materials because of regulatory or economic considerations and requirements; the fill materials are commonly taken for a fee from virgin sources, which have unknown or poorly known characteristics. In contrast, testing is commonly less rigorous in opportunistic projects, particularly if a source for the fill material has been used previously and there are few or no reported problems of compatibility with the native material. The receiver beaches are generally very close to the sources of fill (e.g., bypassing operations) because of the desire to minimize transportation costs. Consequently, the fill material may be very similar in character to what would have been deposited naturally at the receiver beach.

Another factor that affects documentation of the physical character of sediment is the age of the projects. Older projects were under less regulation and thus may not have the quantity and quality of test data like those of modern projects.

Types of information reported for replenishment/nourishment projects can include size, type, color, density, and shape of the component grains. Grain size is by far the most dominant characteristic analyzed and reported; results are typically presented as percentage distribution of sizes within each sediment sample based on sieve analysis. In some reports, the percentage composition by mineral type is presented.

Regarding the character of native material on beaches, many pure- and applied-research studies have been conducted at several sites along the coast of California. Some of these studies are published and thus readily available (e.g., Hutton, 1959; Trask, 1952). Other sources include more-obscure or less-easily obtained reports (e.g., Straughan, 1981; reports of the Hydraulic Engineering Laboratory at the University of California, Berkeley). As a group, this category of studies is neither systematic nor consistent in content and presentation because of differences in researchers' purposes and interests. Nonetheless, they can provide background and baseline information, particularly at beaches that have not yet been replenished.

Regarding the character of both fill materials and native materials, much data and information are also available in geotechnical reports prepared for specific replenishment/nourishment projects. For example, data on grain characteristics are commonly presented in documents, such as environmental impact reports, submitted to the California Coastal Commission as part of its permit process. Also, the U.S. Army Corps of Engineers conducts detailed sampling and analyses of sediments, which are presented in its geotechnical reports (e.g., U.S. Army Corps of Engineers, 1989; 1995; 2002b). Some of its reports are readily available, while others are not; some reside in

the project files of the geotechnical branches of both the Los Angeles and San Francisco District offices, while others are at archive centers in Laguna Niguel (Los Angeles District) and San Bruno (San Francisco District).

The character of fill material and, to a much lesser extent, native material at some of the replenishment/nourishment projects in California is summarized in Table 2 (modified from Coyne, 2000) under the column heading of “dredge/fill characteristics.” These entries were extracted from research of a few hundred reports. Most are qualitative descriptions rather than quantitative data.

It is worth noting that at many southern California beaches (Santa Barbara County to the Mexico border) there is probably not much truly pristine, “native” material still present. Episodes of nourishment have diluted the original natural character of the beaches, particularly where nourishment has taken place frequently over many decades. Also, because of the inherent variability in the physical nature of natural sediments, it is difficult to generalize or define representative grain characteristics for individual beaches and fill material.

To prepare a comprehensive list of grain characteristics of fill material and native material will require systematic, detailed research of published literature as well as unpublished reports and files in agencies such as the U.S. Army Corps of Engineers and the California Coastal Commission, among others.

RESULTS OF BEACH REPLENISHMENT/NOURISHMENT IN CALIFORNIA

Of paramount importance in a replenishment/nourishment project is how well the emplace material performs compared to the engineering specifications of the project. To make reliable comparisons requires the use of systematic, quantitative monitoring of the performance of beach fills. Unfortunately, it was not until about 10-20 years ago that monitoring became more routine (Leonard and others, 1989; Komar, 1997). Up to the end of the 1980s, performance data for projects on the Pacific Coast of the U.S. were less prevalent than for those for the Atlantic Coast (Leonard and others, 1989). Since then, agencies in California have been taking more coordinated, regional approaches to protecting beaches. Part of this process has been institution of monitoring programs. One example is the Regional Beach Monitoring Program of the San Diego Association of Governments (SANDAG), which began in the middle 1990s (Coastal Frontiers Corporation, 2004). Associated with this project is the Southern California Beach Processes Study (Guza and others, 2002) at Torrey Pines State Beach, which is attempting to improve understanding of how and where a recent beach fill there is being transported by waves and currents. What is learned here could be applied to design and maintenance of replenishment/nourishment projects else where along the coast of California.

Historically, written documentation of the results of beach replenishment/nourishment projects along the coast of California has been inconsistent. Commonly, results have

been reported from a site-specific perspective, with an emphasis on qualitative rather than quantitative observation and measurement. Examples are presented in Cahill (1989), Clayton (1989), Leonard and others (1989), Leidersdorf and others (1993, 1994), Mesa (1996), California Department of Boating and Waterways and State Coastal Conservancy (2002), U.S. Army Corps of Engineers (2002b), and Coastal Frontiers Corporation (2004). Important overview papers for results and performance in California include those by Hall (1952), Shaw (1980), Herron (1987), Clayton (1989), and Leonard and others (1989).

The performance of beach fills at various sites in the state is briefly summarized in Table 2 (modified from Coyne, 2000) under the column heading “duration of fill.” Similar to the entries in the table for “fill characteristics” described earlier, the reported results are largely qualitative descriptions rather than quantitative measurements. Many cells in this column are blank, either because monitoring was not conducted or because the research did not discover pertinent documents with recorded results.

To date, the overall results of beach nourishment in California have been mixed. As a current example of performance and monitoring of beach fills, Coastal Frontiers Corporation (2004) recently reported results of monitoring of a major nourishment program in San Diego County. In this program, administered by the San Diego Association of Governments, twelve beaches received nourishment in 2001. During the 2003 monitoring year, the performance of the individual fills at the twelve beaches reportedly varied considerably; at some beaches, previous gains in shorezone volumes persisted, while at others, the gains were short-lived.

Despite the spotty record of documented results of replenishment/nourishment projects in California, Leonard and others (1989) attempted to determine the overall success of various projects as of the late 1980s. As part of this determination, they also evaluated how five physical parameters might influence the success of fill episodes as measured by longevity, or “durability,” of the emplaced fills. Some of their major conclusions for Pacific Coast beaches (nearly all are evidently in southern California) were:

- Longevity of fills at Pacific Coast beaches has overall been higher than those at Atlantic Coast and Gulf Coast beaches.
- Of those beaches measured, 48% were successfully maintained, 15% were not, and 36% were unknown.
- The Pacific Coast management philosophy of nourishment by periodic “maintenance” was advantageous over the Atlantic/Gulf Coast management philosophy of nourishment by “crisis.”
- Project monitoring must be a mandatory part of each replenishment project.

Regarding replenishment parameters:

- **Length:** There was no relationship between longevity of replenished beaches and their lengths.
- **Density:** Pacific Coast beaches had higher cumulative densities of fill than Atlantic Coast and Gulf Coast beaches. For the Pacific Coast, there didn't appear to be a correlation between fill density and fill durability.
- **Grain Size:** The data suggested that grain size was not of particular importance in determining durability.
- **Groins:** These structures have aided stabilization of certain nourished beaches on the Pacific Coast.
- **Storms:** There was a correlation between high erosion rates on nourished beaches of the Pacific Coast and the passage of major storms.

CGS RECOMMENDATIONS TO THE CSMW

- With some editing and modification, use Coyne's (2000) spreadsheet (Table 2) as a foundation to annually compile data and information on all beach replenishment/nourishment projects along the coast of California. Georeference this table so that it can be incorporated into the GIS of the CSMW Master Plan.
- Determine if the influence of grain-size on fill performance is significant enough to devote CSMW resources to the task of compiling detailed data on grain-size characteristics of fill materials and native materials for beach-nourishment projects along the coast of California.

CSMW TASK THREE

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