

Southern California Beach Processes Study

Torrey Pines Field Site



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to

California Resources Agency
and
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BACKGROUND:

The objective of the Southern California Beach Processes Study is to develop an improved understanding of how sand is transported by nearshore waves and currents, thus improving the technical basis for the design of beach nourishment projects. Simultaneous observations of nearshore waves and sand level changes at the SANDAG-sponsored beach nourishment project at Torrey Pines State Beach will be used to calibrate and evaluate existing computer models for the wave-driven evolution of a nourished beach, and eventually for the development and testing for new models. Torrey Pines Beach, located at the border between the cities of San Diego and Del Mar, was nourished during April 2001 with nominally 250,000 cubic m of sand. The material was deposited on the beach above the low tide level and over a 500 m alongshore span.

SAND LEVEL SURVEYS:

Five comprehensive surveys of sand level in the vicinity of the nourishment site have been acquired. A pre-nourishment survey was completed at the end of March 2001, shortly before the nourishment began. Post-nourishment surveys were acquired 27-29 April (immediately after completion of the nourishment), and on 4-5 May, 10-12 May and 21-23 May 2001. Results are attached for each survey (Figures 1-5, 1b-5b). Cross-shore survey lines in all surveys extend from the shoreward limit of the beach (e.g. Highway 101 or the Torrey Pines cliffs) to at least 8-m water depth. The alongshore spacing between cross-shore survey lines is 20 m over the 500 m alongshore span of the nourished region, and 100 m over approximately 1.2 km up- and down-coast from the edges of the nourishment. In total, there are 56 cross-shore lines. Prior to nourishment, the shoreline (e.g. 0 and +1m above mean sea level) depth contours are relatively smooth in the alongshore direction (Figure 1, 1b). After nourishment, the +2m depth contour bulges seaward between alongshore coordinates 6.6 and 7.3 km (Figures 2-5, 2b-5b). A preliminary map of the differences between the first and third postnourishment surveys indicates redistribution of the nourishment sand in both the alongshore and offshore directions (Figure 6). Sand levels above and below the water line were measured with GPS-based systems mounted on a pushcart and a jet ski, respectively. To minimize the cross-shore extent of the unsurveyed region between the push cart (done at low tide) and jet ski (done at high tide) the pushcart is rolled as far seawards as wave conditions permit. Low waves and Spring tides allow overlap between the jet ski and dolly surveys, and we have conducted several dolly surveys between 0200-0600 to utilize extreme tides. The quality of the surveys also depends on the temporally variable number and position of GPS-satellites. The survey quality is degraded when the number of accessible satellites is low, owing both to the limited number of satellites above the horizon. This is aggravated by the Torrey Pines cliffs, which block the line-of-sight between our survey vehicles and satellites that are low on the eastern horizon. Several cross-shore transects near the northern boundary were lost on 5 May (Figure 3) owing to poor satellite coverage. Subsequent surveys were planned to optimize the tidal stage and satellite coverage subject to the constraint that we cannot (for safety reasons) operate the jet ski during weekend daylight hours in the most heavily used section of Torrey Pines State Park. The unpredictability of wave conditions has required flexibility in our scheduling.

A GPS-equipped ATV under construction will facilitate dry beach surveys, but completion has been delayed by the need to survey the nourishment and the receipt of funds only one month before the beginning of the nourishment. Despite intensive efforts to improve the performance of the jet ski survey system, by increasing the ability of the sonar depth-finder to penetrate bubbles in the surf zone and improving the accuracy of the corrections for jet ski pitch and roll, accurate surveys are still limited to low wave conditions. High waves both limit the area of survey coverage (the surf zone is excluded owing to bubbles) and introduce errors in the regions that can be surveyed. Despite these limitations, the surveys we have acquired (Figures 1-5, 1b - 5b) are the most comprehensive monitoring of a nourishment site of which we are aware.

WAVE MEASUREMENTS AND MODELING:

Measured wave conditions will be used to test models for the wave transformation across the narrow Southern California continental shelf and to drive sediment transport models that will be tested by comparison to the observed sand level changes. Directional wave buoy measurements about 13km offshore of the nourishment site (Torrey Pines Outer Buoy, 550m depth) began 29 Jan01, prior to the nourishment. Buoy measurements about 1.4 km offshore (Torrey Pines Inner Buoy, 20 m depth) began 30 Apr01, immediately after nourishment was completed. These wave observations are available through the main CDIP website <http://cdip.ucsd.edu>. The first collocated pressure-current meter measurements, also used to estimate directional wave properties, were obtained about 0.5 km offshore in 7.5m depth between 4-14 May01. Pressure measurements, yielding wave energy but not wave direction, are being acquired continuously in 7.5m depth. An experimental 5-day wave and wind forecast web page for the Torrey Pines buoy sites is at <http://cdip.ucsd.edu/sand/waves> (Figure 7). This is a temporary website, not available to the public. A public website is under development and is expected to be made generally available, with appropriate notices, in the near future.

SAND CHARACTERISTICS:

Prior to nourishment, surface sand samples were obtained at 9 locations on each of 3 cross-shore transects in between 8 m depth and the shoreward limit of the beach (Figure 8). These samples are being analyzed by a commercial company to characterize the size distribution of the existing sand prior to nourishment. Immediately after nourishment, 8 cores of the nourishment sand were obtained, and a total of 21 sand samples (0.3, 2 and 3m below the sand surface) are being analyzed for size and porosity.

MODEL EVALUATION:

The CEDAS suite of numerical modeling tools has been acquired and installed in a Windows environment. This suite includes the GENESIS model for shoreline evolution (as well as a large number of supporting programs for gridding, entering wave inputs, etc.) and STWAVE, which predicts cross-shore transport under storm wave conditions. These programs will be calibrated with the SCBPS data sets and their ability to predict the measured responses will be evaluated during the program. GENESIS predicts only the mean sealevel shoreline

position and assumes a constant beach slope, so that the present condition of the site with a large and steep berm face is expected to produce poor estimates until the berm disappears.

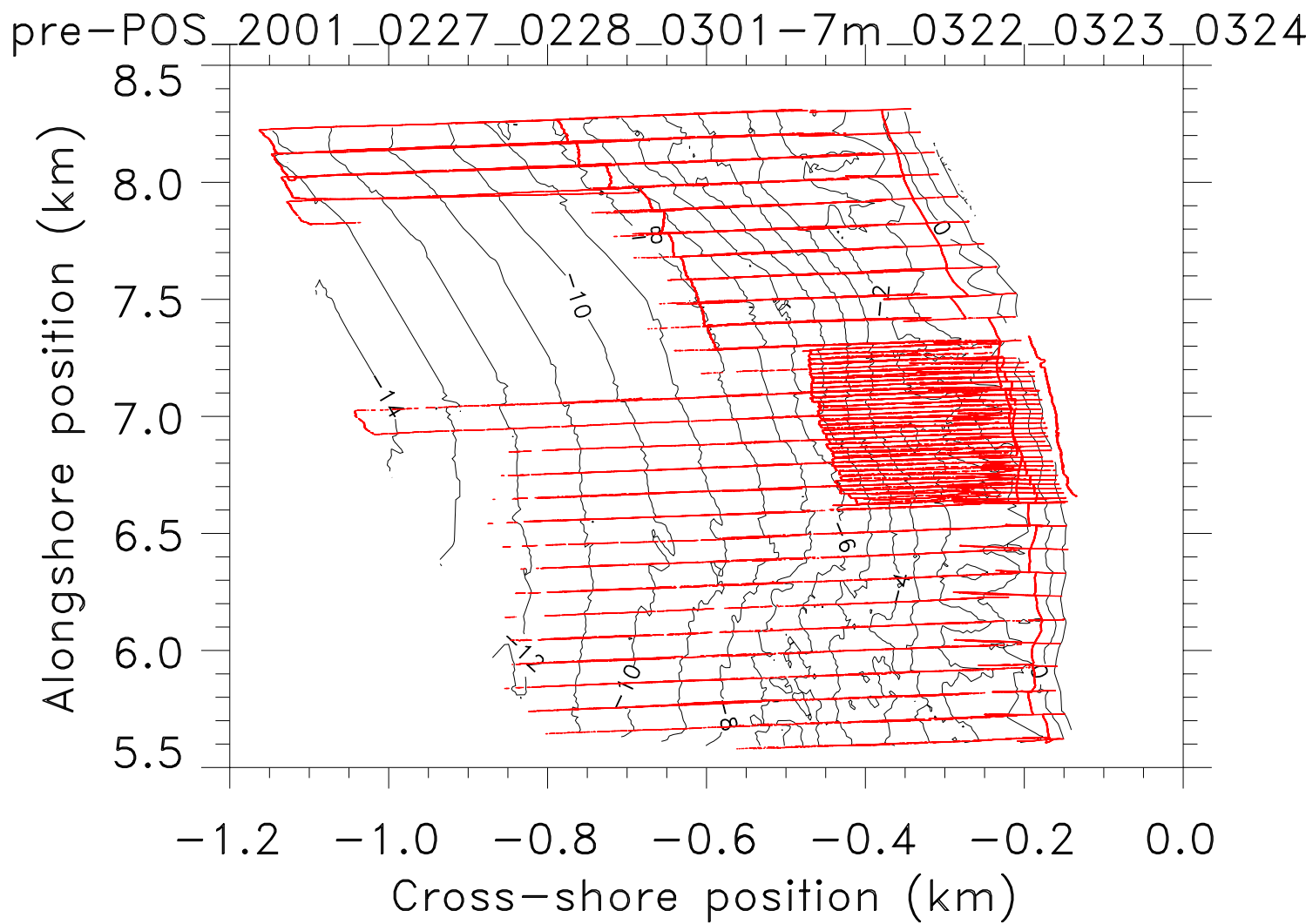


FIGURE 1 : Prenourishment Survey. Straight lines are survey tracks and wiggly lines are depth contours in meters (relative to mean sea level).

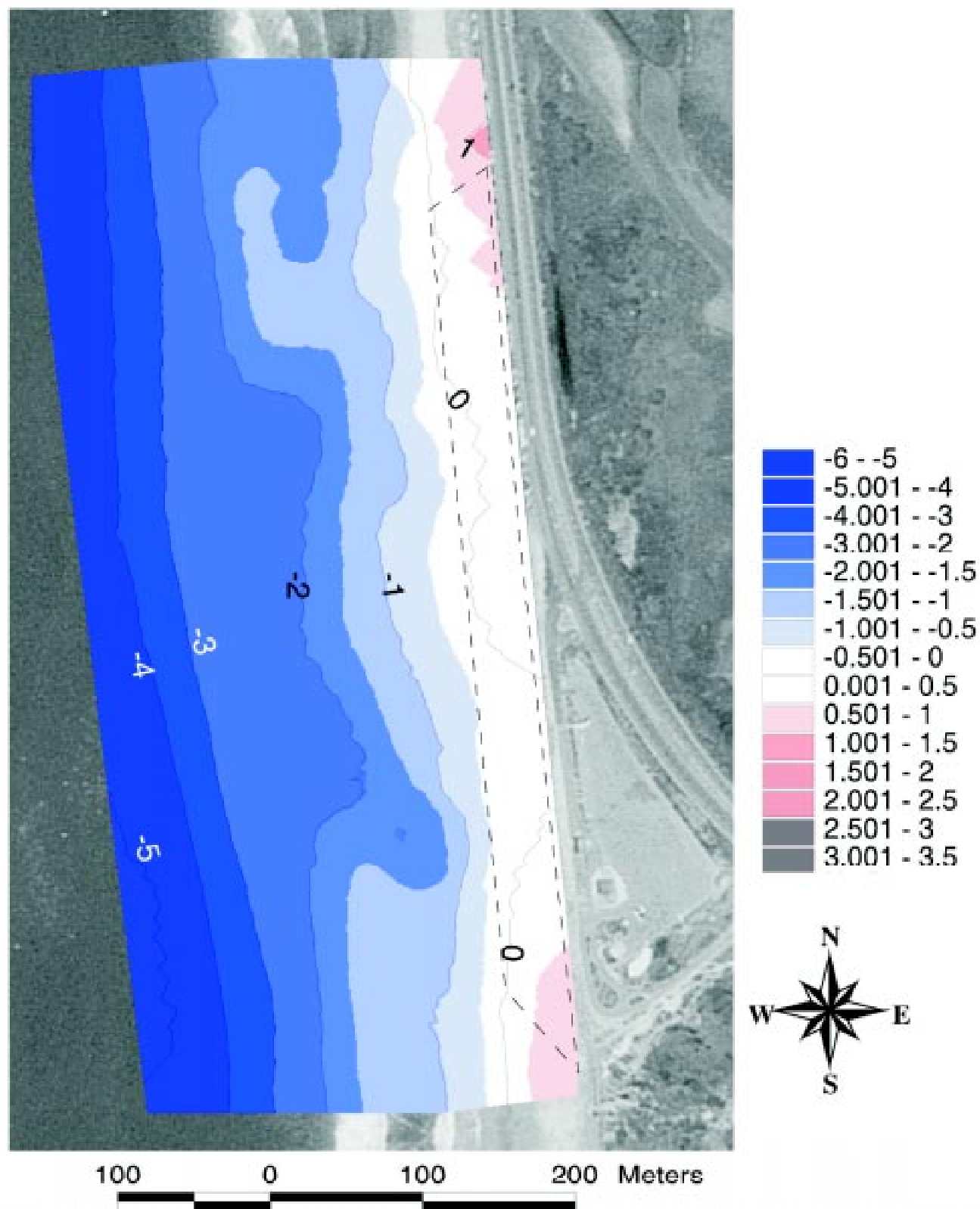


FIGURE 1b: Detail contour map of pre-nourished site. Surveys starting 27 February and 22 March. Contours in meters.

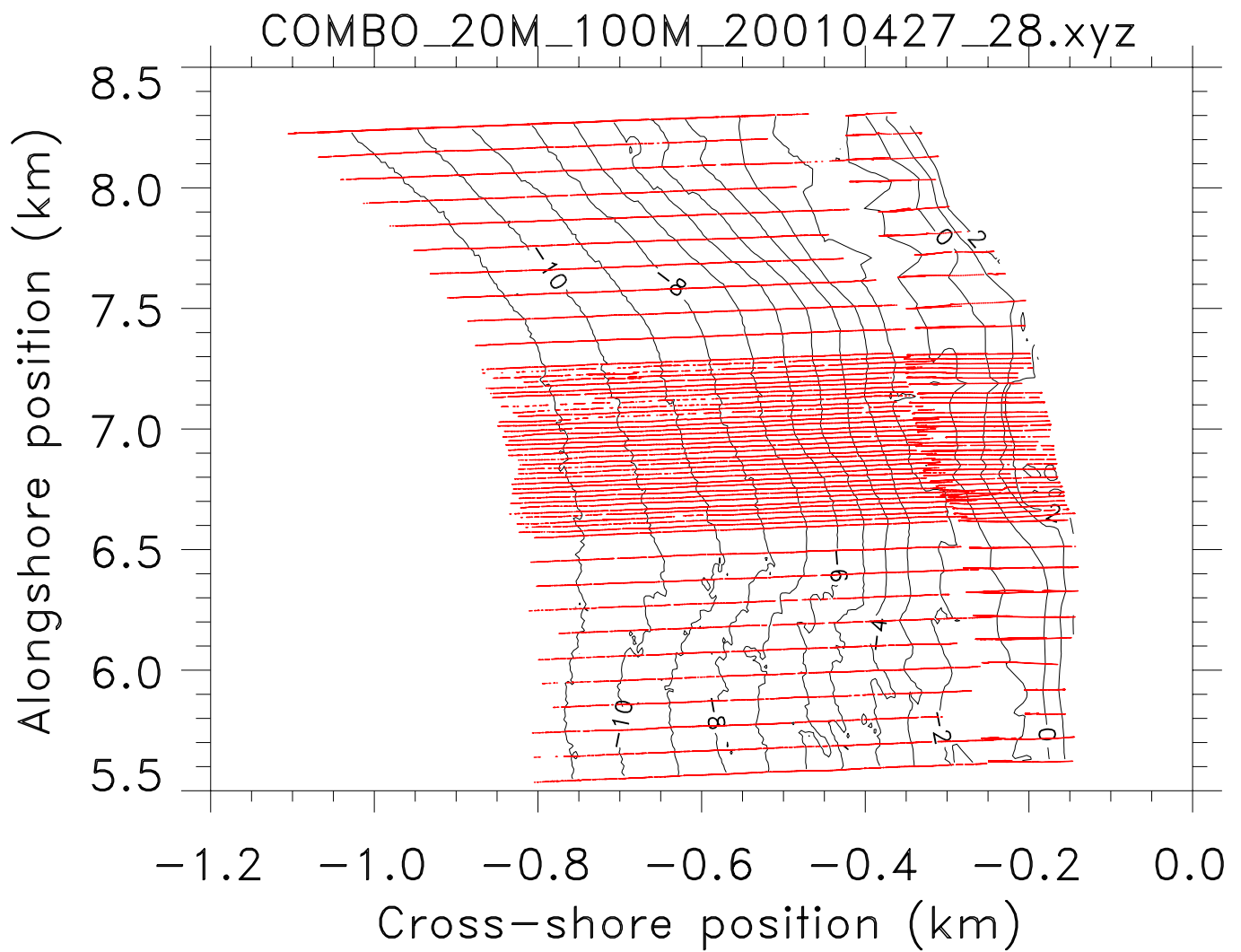


FIGURE 2 : Survey starting 27 April. Straight lines are survey tracks and wiggly lines are depth contours in meters (relative to mean sea level).

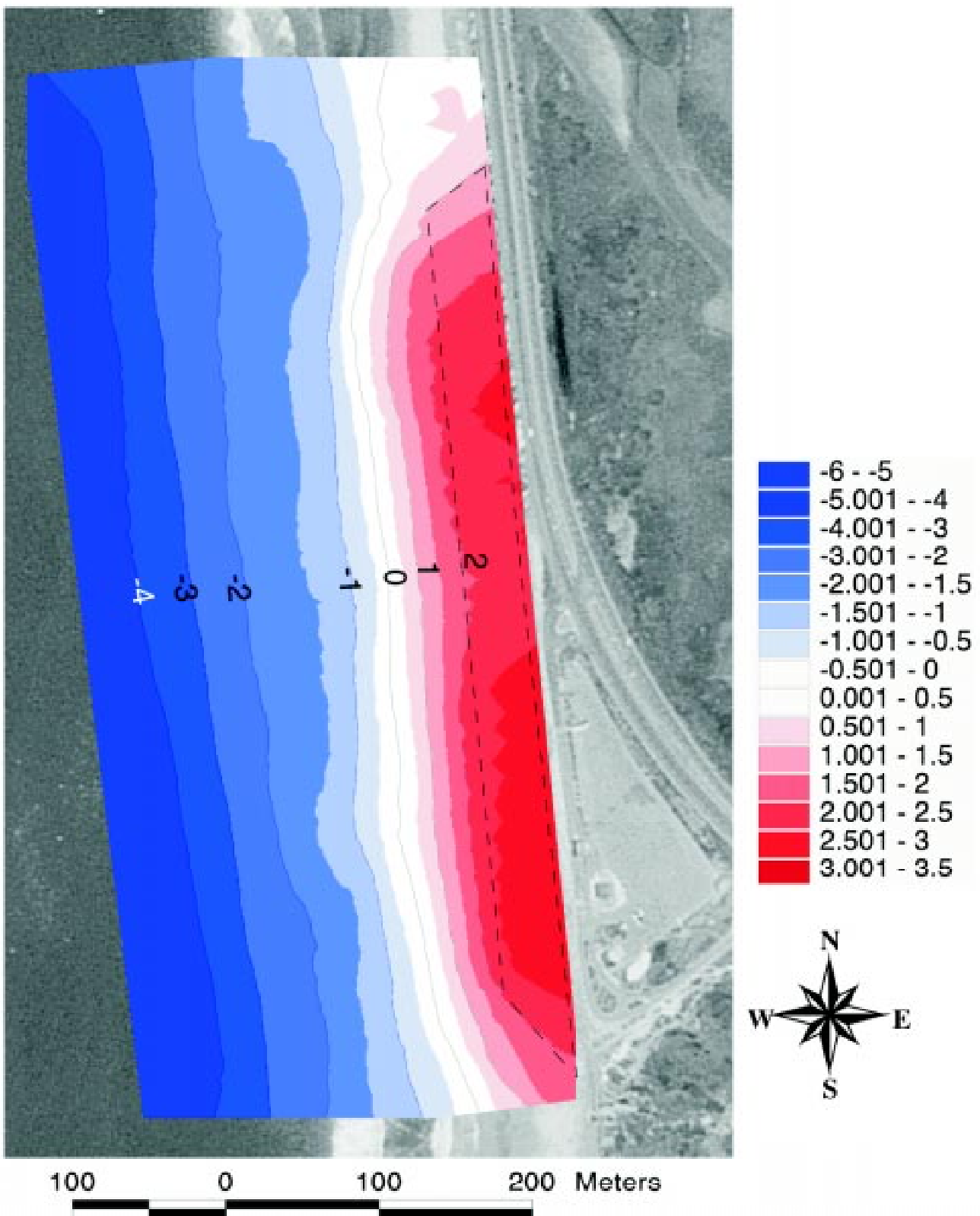


FIGURE 2b: Detail contour map of nourishment site. Survey starting 27 April. Contours in meters.

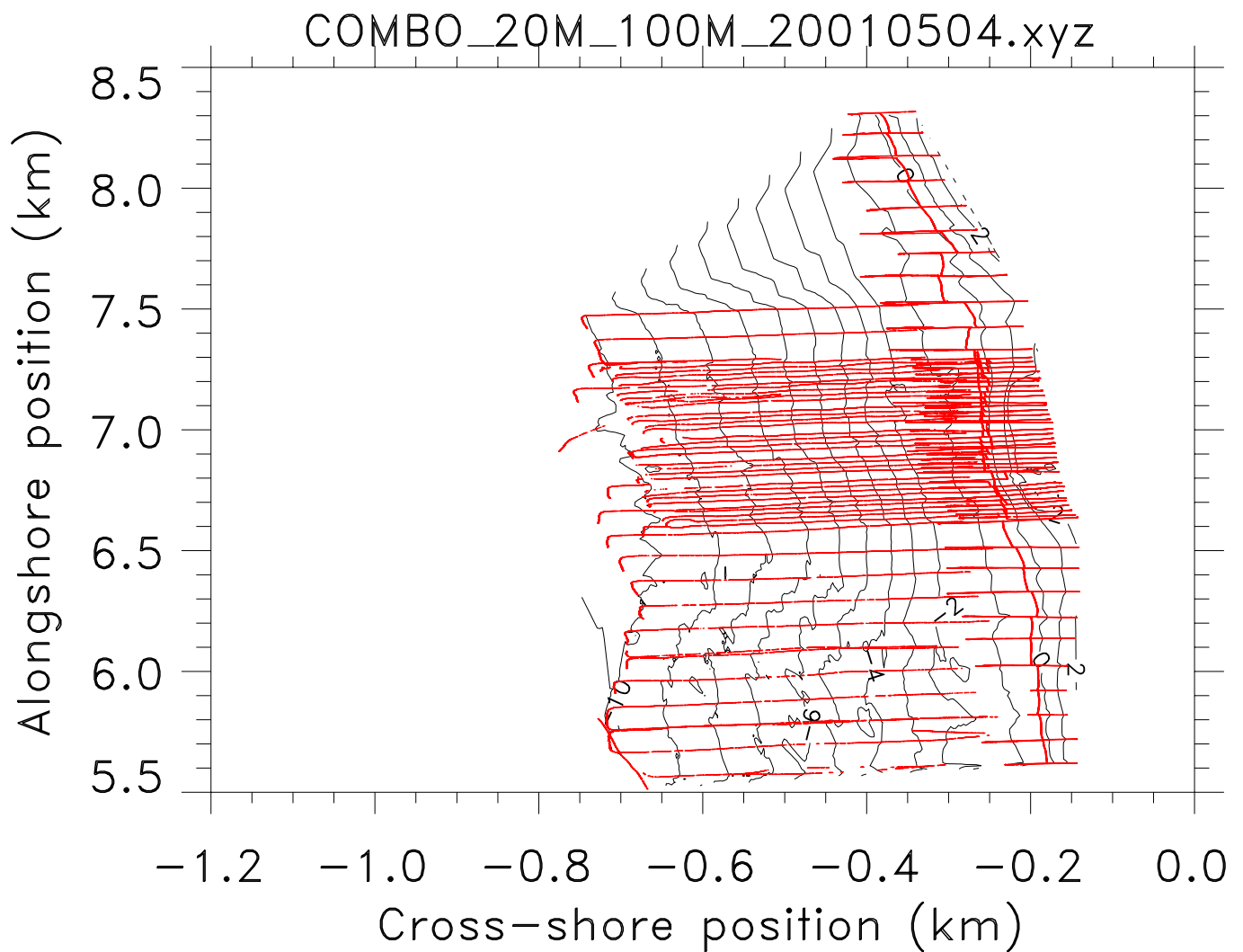


FIGURE 3 : Survey starting 4 May. Straight lines are survey tracks and wiggly lines are depth contours in meters (relative to mean sea level).

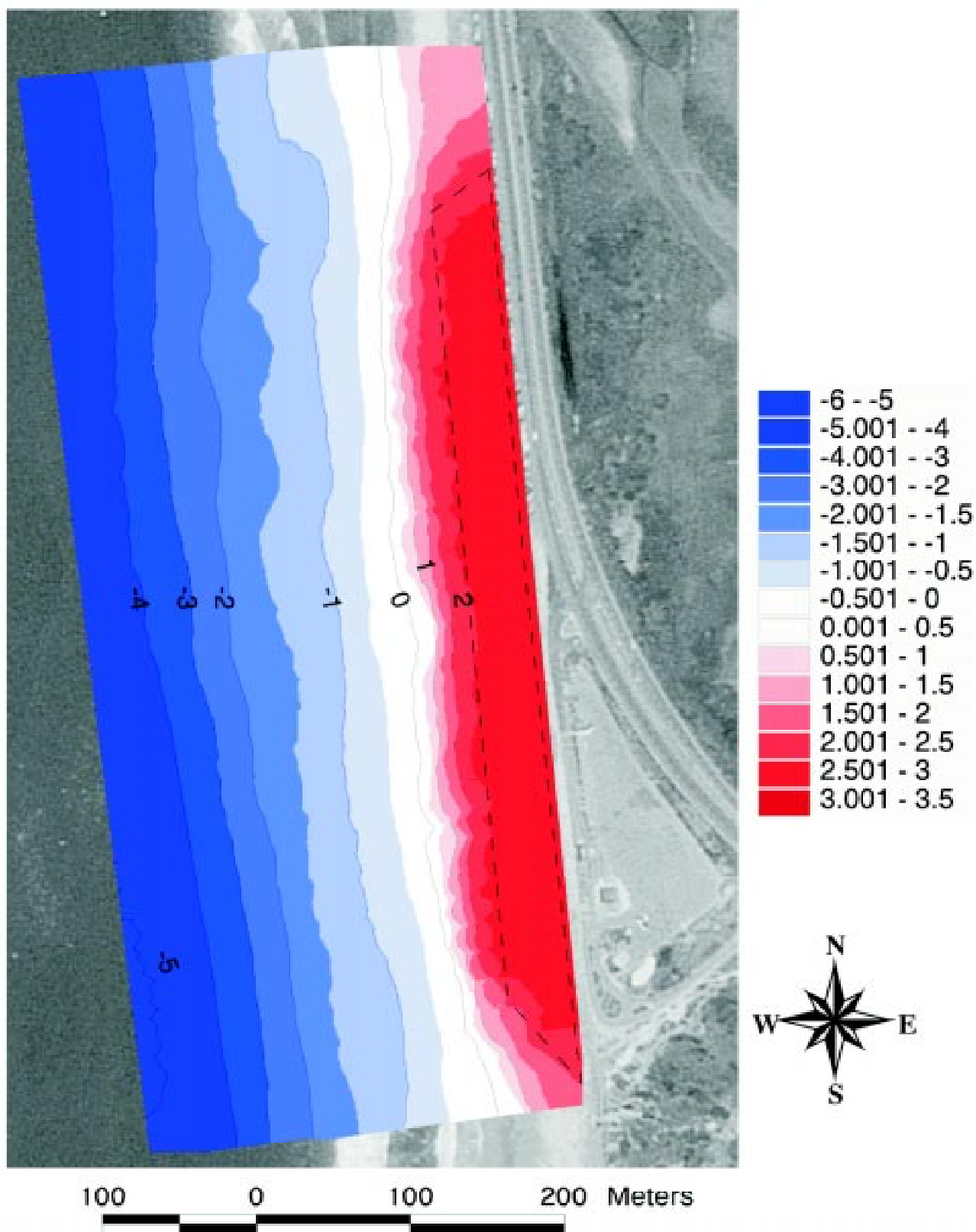


FIGURE 3b: Detail contour map of nourishment site. Survey starting 4 May. Contours in meters.

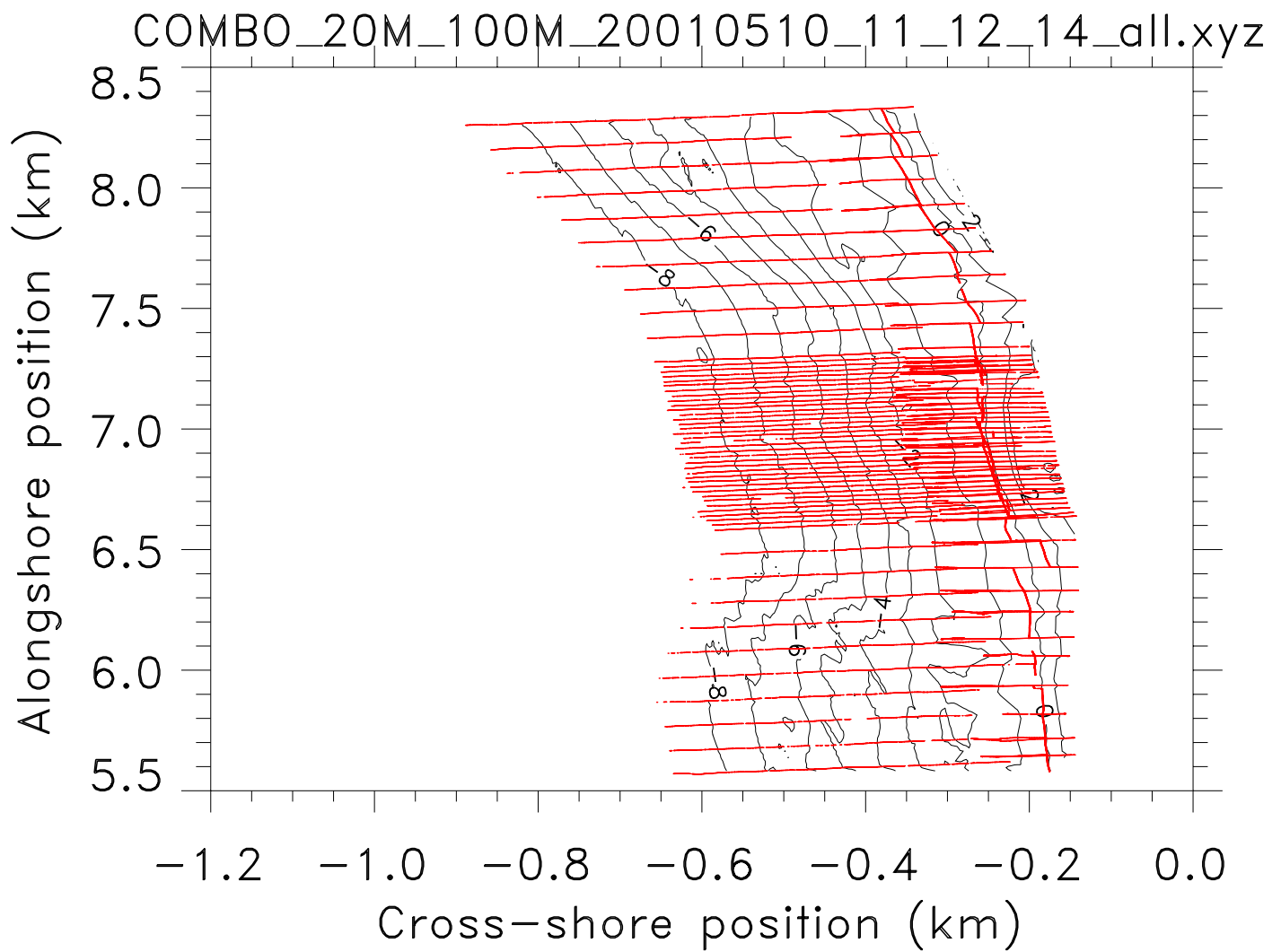


FIGURE 4 : Survey starting 10 May. Straight lines are survey tracks and wiggly lines are depth contours in meters (relative to mean sea level).

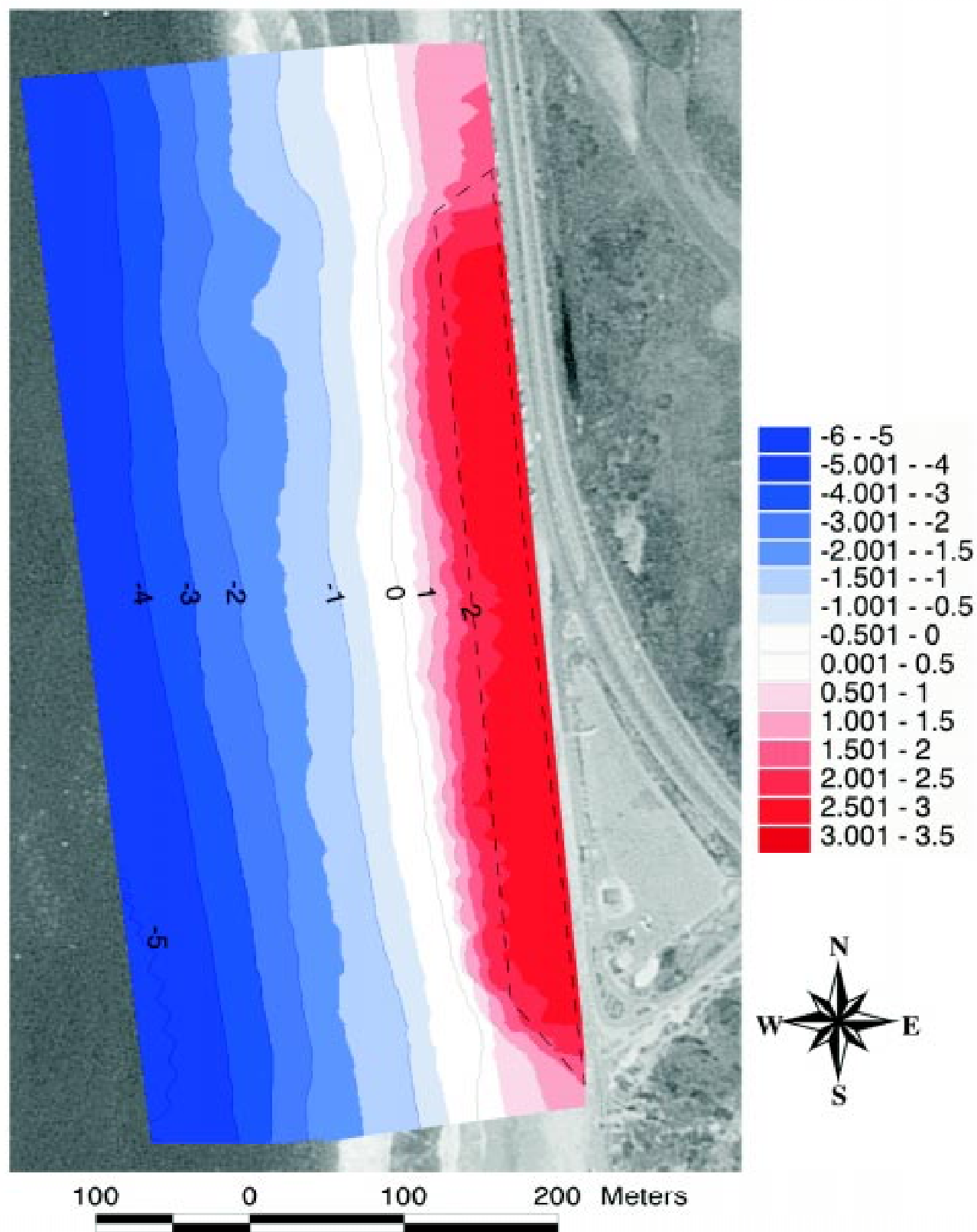


FIGURE 4b: Detail contour map of nourishment site. Survey starting 10 May. Contours in meters.

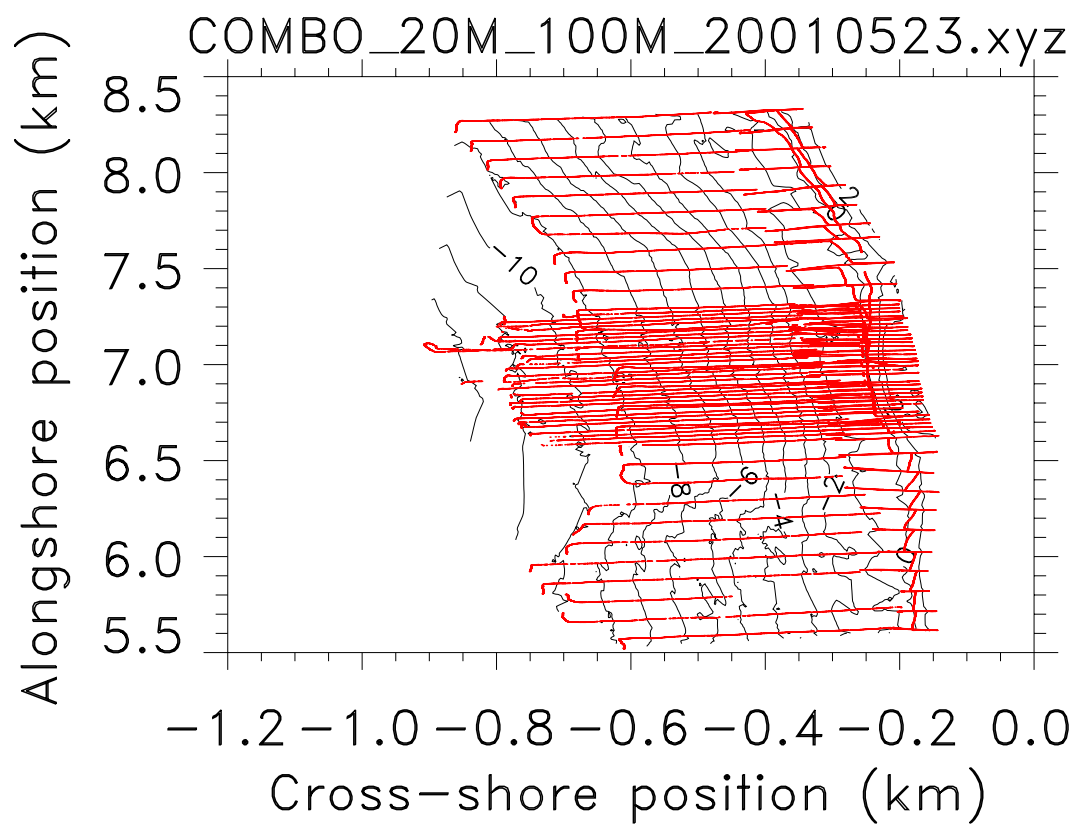


FIGURE 5 : Survey starting 23 May. Straight lines are survey tracks and wiggly lines are depth contours in meters (relative to mean sea level).

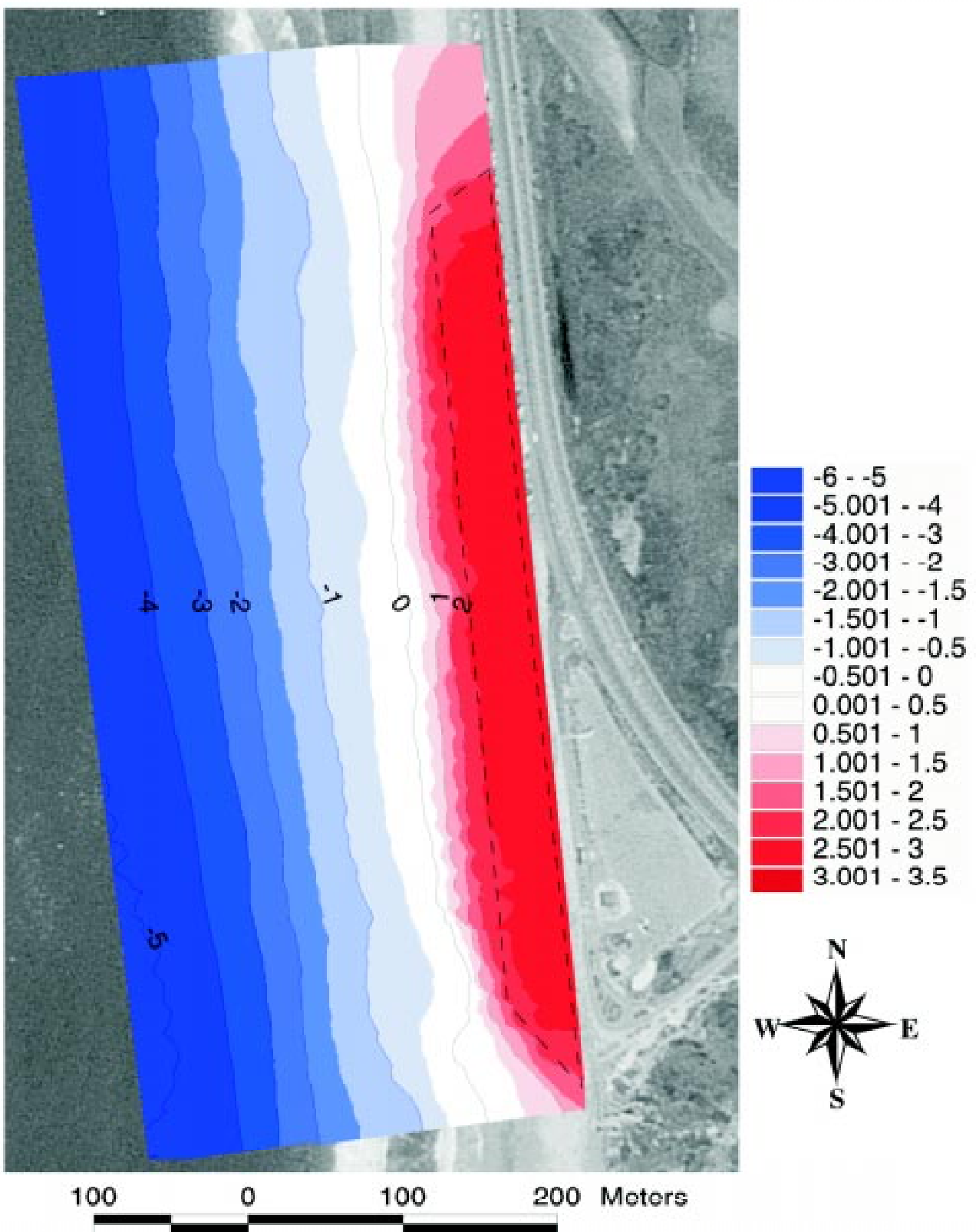


FIGURE 5b: Detail contour map of nourishment site. Survey starting 23 May. Contours in meters.

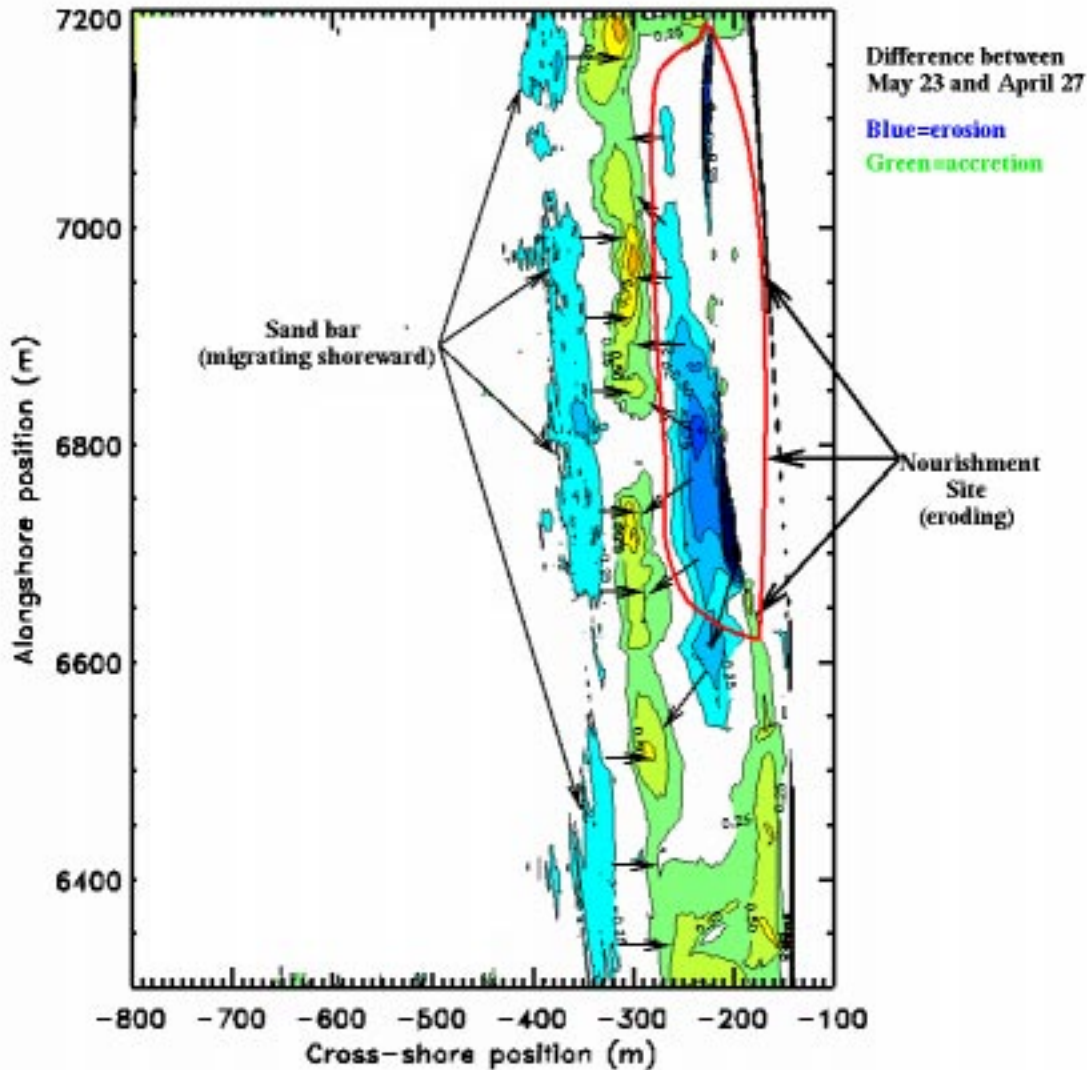


FIGURE 6 : Differences between the postnourishment surveys of 27 April and 23 May, in the vicinity of the nourishment site (bounded by the red curve). The maximum erosion (between .5 and 1 m, dark blue) occurs near cross-shore location -200 m where the steep shoreward scarp of the nourishment is eroding and retreating landward. Onshore migration of a sand bar results in an additional alongshore band of lesser erosion (.25 m, light blue) near cross-shore location -350 m. Accretion (between .25 and .75 m, green) occurs alongshore and offshore of the nourishment site, and may be the result of both onshore bar migration and dispersal of the nourishment sand.

Experimental Wave/Wind Forecasts : SIO and Torrey Pines

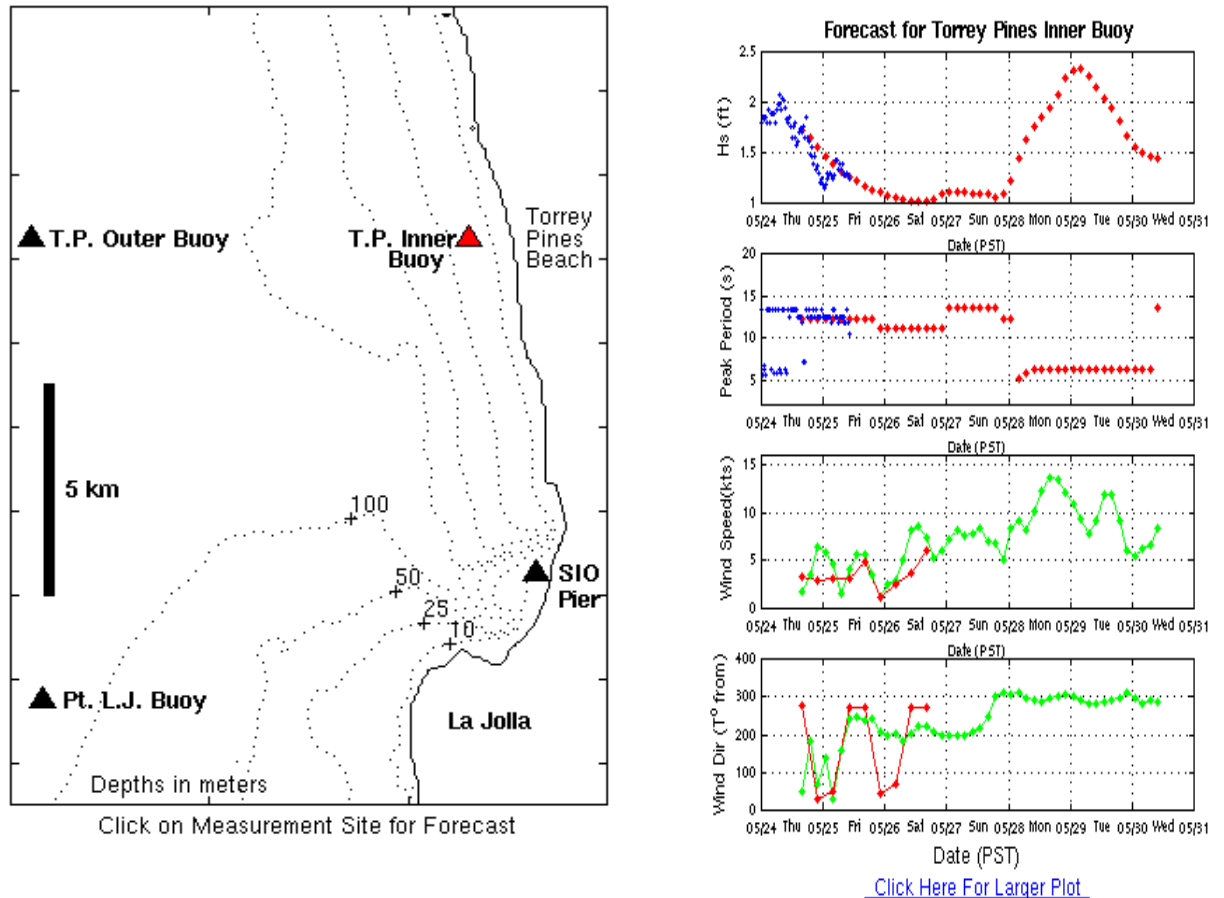


FIGURE 7 : Locations of directional wave buoys near the Torrey Pines Beach nourishment site (left) and 5-day wind and wave forecasts for the Torrey Pines Inner Buoy (right). In the upper two right panels, the symbols (red) spanning 5 days are predictions and the symbols (blue) spanning 1 day are observations.

Regional Beach Sand Project

Core and Sand Sample Locations

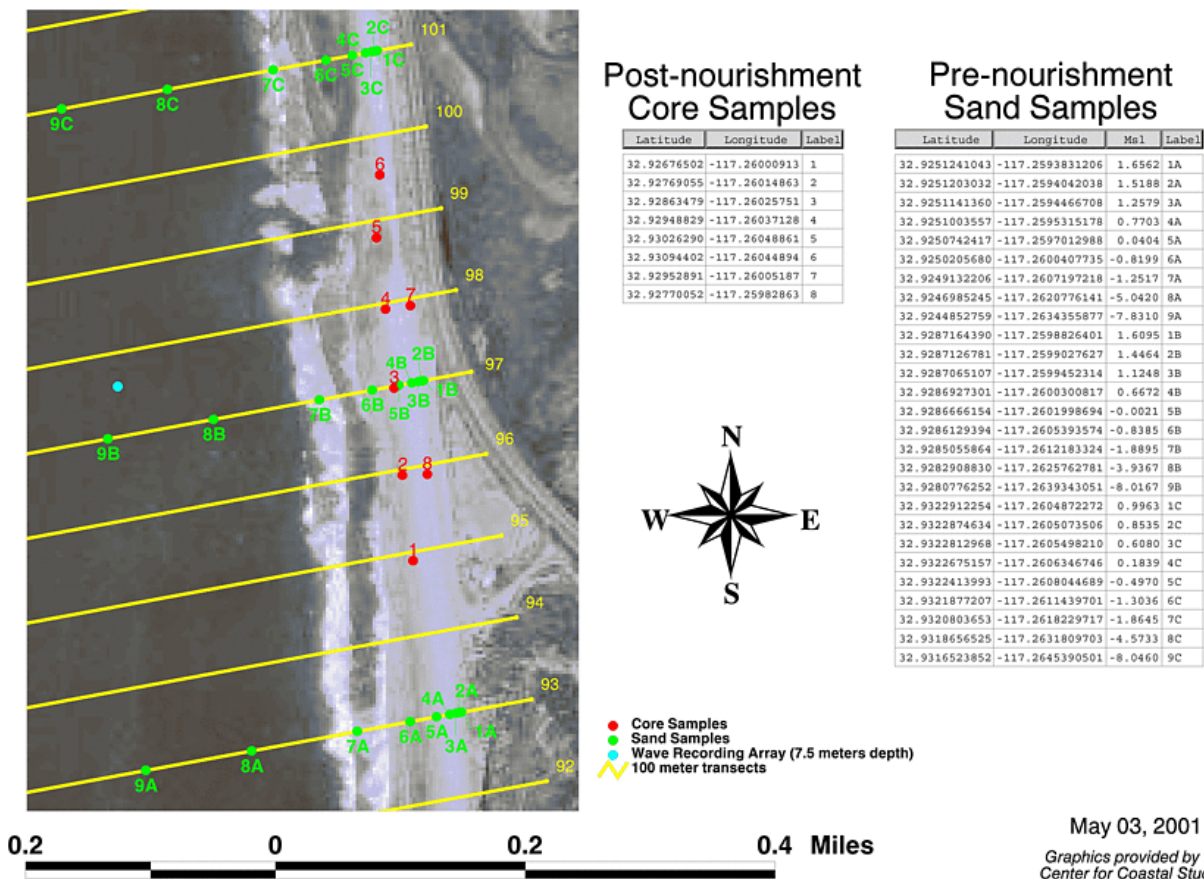


FIGURE 8 : Locations of core and surface sand samples.