EVALUATION OF COASTAL CHANGE AND THE POTENTIAL FOR EROSION DURING EXTREME STORMS AT CRISSEY FIELD, SOUTHERN OREGON COAST:

TECHNICAL REPORT TO THE OREGON PARKS AND RECREATION DEPARTMENT

By

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Cover Photo — Northward looking view along Crissey Field beach. The dark line of vegetation on the right of the photo depicts the approximate position of the shoreline in 1967, while the lighter colored vegetation to the west of it reflects the region of shoreline progradation since 1967 and its subsequent stabilization by European beach grass (*Ammophila arenaria*). Photo taken in March 2005 by J. C. Allan.

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Vicki S. McConnell, State Geologist

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EXECUTIVE SUMMARY

The Oregon Parks and Recreation Department (OPRD) is proposing to develop a state recreation site at Crissey Field, located west of Highway 101, north of the Oregon/California border, and south of the town of Brookings. Due to the proximity of the proposed "Welcome Center" to the Pacific Ocean, the Oregon Department of Geology and Mineral Industries (DOGAMI) was commissioned to provide an assessment of the coastal geomorphology of the Crissey Field littoral system, to determine the susceptibility of the proposed "Welcome Center" site, located some 61 to 76 m (200 to 250 ft) from the beach, to a variety of coastal geologic and oceanographic hazards. The data and analyses undertaken as part of this study reveal a number of important findings that include:

- The Crissey Field littoral cell, bounded in the north by Brookings and Crissey Point in the south, forms a subcell within a much larger littoral system that extends all the way to Point St. George adjacent to Crescent City located in northern California. The total length of the littoral cell is approximately 34 km (21 mi). Although sediments derived from the erosion of coastal bluffs and dunes provide some of the sediment that feeds the littoral cell, the bulk of the sand input is likely derived from three predominant sources: the Chetco, Winchuck, and Smith Rivers. Of these, the Smith River probably supplies the largest volume of sand to the beach sediment budget. The exact quantities of sand from these various sources are unknown;

- Beach sand at Crissey Field is characterized by coarse sand with a mean grain size of 0.57 mm; grain sizes range from 0.31 to 0.99 mm. As a result, the slope of the beach at Crissey Field is steeper (~3.5° in the summer, increasing to ~5.1° to 5.7° in the winter) when compared with beaches on the central to northern Oregon coast. These beaches are classified as intermediate to reflective using the nomenclature of Wright and Short (1983) and are thus capable of responding extremely rapidly to large storm wave events;

- Estimates of the seasonal variability of the beach at Crissey Field indicate that it varies by some 7–20 m (23–66 ft). Thus, it can be expected that the beach will erode landward and rebuild seaward by this amount over the course of several normal seasons. During periods of heightened storm activity, however, it can be expected that the response will be significantly greater. Unfortunately, there is no quantitative information on how the beach responded to the most recent extreme storms that impacted much of the central to northern Oregon coast during the 1997-98 El Niño and 1998-99 winters. Nevertheless, the response was probably not the same. For example, although the extreme March 2-3, 1999 storm generated 14.1-m (47.6-ft) significant wave heights offshore from Newport, measurements made at the Eel River buoy (south of Crissey Field) indicated that the wave heights did not exceed 6.7 m (22 ft). As a result, the response of the beach for this event alone was likely much less when compared with beach responses on the northern Oregon coast. Certainly, there is no field evidence (e.g., erosion scarps) to indicate the effects of the 1997-98 and 1998-99 extreme winter storms. This contrasts with sites along the central to northern Oregon coast, which continue to be characterized by the effects of those two extreme winters;

- Analyses of the spatial variability of historical and contemporary shoreline positions derived from aerial photographs (effectively the wet-dry sand line in the imagery) indicate that the Crissey Field shoreline has prograded (advanced) seaward by some 70 m (230 ft) since 1967 (Figure 17). As a result, the area characterized by the 1967 statutory vegetation line is now depicted by an established backdune that has been stabilized by the growth of European beach grass, stands of Sitka spruce, and Salal. It is speculated in this study that this phase of shoreline progradation may be due to the passage of sand around Pyramid Point, adjacent to the mouth of the Smith River, where the sand is then redistributed to the north toward Crissey Field as well as south toward Crescent City. Periodically, these processes may be further enhanced by the occurrence of an El Niño, which can result in much larger volumes of sand being transported northward along the littoral cell. However, the effects of El Niños on the dynamics of the Crissey Field beach and its adjacent subcells remain unknown;

- Apart from a brief phase of erosion during the mid 1980s that may be due to the 1982-83 El Niño, the shoreline has continued to fluctuate about its present position (Figure 17), which remains some 30 to 40 m (100 to 130 ft) seaward of its position in 1967. During this latter period of change, the dune crest did not recede landward, although its crest elevation was lowered slightly, suggesting that the crest of the dune was overtopped;

- In March 2005, a beach profile monitoring network was established adjacent to the proposed Welcome Center site. This initial network consisted of four profile sites and was eventually expanded to include six additional sites in June 2005. Presently, the network covers the entire shore between Crissey Point and the Winchuck River. Information from these sites and from a Real-Time Kinematic Differential Global Positioning System (RTK-DGPS) survey of the beach-dune junction elevation (akin to the most current vegetation line) along the entire shore indicate that the beach in the north has a mean elevation of 5.1 m (16.7 ft), whereas the southern two thirds of the shore has a mean elevation of 6.02 m (19.8 ft).

Coastal erosion hazard estimates of the beach in response to an extreme event was undertaken using a geometric model developed by Komar and others (1999). The model requires knowledge of the offshore wave climate (specifically, the deepwater significant wave height and the peak spectral wave period) and the slope of the beach to calculate the runup of the waves at the shore. These data are combined with a tidal component to yield a total water level at the shore. Three scenarios that account for different combinations of wave and tidal statistics unique to the area were developed for modeling the extent of dune erosion. Scenario 1 includes the occurrence of a 50-yr storm wave (H_S = 12 m [39.4 ft]) characterized by a 20-s peak spectral wave period occurring over the course of an average higher high tide (2.095 m [6.87 ft]), a monthly increase in mean sea level (MSL) of 0.173 m (0.57 ft), and 0.5 m (1.64 ft) storm surge component. Scenario 2 incorporates the same parameters as above, with the inclusion of an increase in MSL due to an El Niño, while the scenario 3 incorporates a larger wave height (14 m [47.3 ft]), a shorter wave period (17 s), and a larger storm surge component (1.0 m [3.3 ft]). Results from the geometric dune modeling reveal the following:

- A HIGH-risk erosion estimate (scenario 1) that ranges from 36 m (118 ft) at the south end of the Crissey Field subcell to as much as 93 m (305 ft) adjacent to the Winchuck River (Figures 25 and 26). The average maximum potential erosion distance estimated for this subcell is 47 m (154 ft). Immediately adjacent to the proposed Welcome Center site, the HIGH-risk erosion hazard zone (scenario 1) is approximately 54 m (178 ft) wide;

- The HIGH-risk scenario 2 estimate yields a hazard zone that is approximately 2.5 to 5.8 m (8.2 to 19 ft) wider than the scenario 1 estimate;

- The MODERATE-risk scenario 3 estimate yields a hazard zone that is marginally smaller than that predicted under scenario 1, despite the larger wave height used in the modeling. This result is due to the shorter wave periods used in the modeling (17 s as opposed to 20 s used in scenario 1);

- On the basis of these results, the proposed "Welcome Center" site lies approximately 18 and 15 m (59 and 49 ft) outside of the HIGH-risk scenario 1 and 2 estimated erosion distances, respectively. Given the amount of conservatism that has been incorporated into these calculations, it appears that the proposed "Welcome Center" site is safe from the effects of dune erosion that may be caused by an extreme storm event;

- Field visits to the site did, however, indicate that portions of the backshore located between the 1967 vegetation line and today's active dune remain subject to periodic wave overtopping, inundating the backshore with seawater and woody debris. Accordingly, this designated zone of storm wave penetration should be free of infrastructure due to the ongoing dynamic nature of this portion of the beach.

Finally, consideration should also be made of three other hazards that could impact the area. First, a large portion of the Crissey Field area falls within the 100-year Winchuck River flood boundary. Second, the mouth of the river can fluctuate by some 150 to 200 m (492 to 656 ft) — the river's southernmost position occurred in 2000, and its northernmost position occurred in 1928 (Figure 17). As a result, such fluctuations may locally exacerbate the erosion of the beach that could have an impact on infrastructure constructed near the river mouth. Nevertheless, there is no field evidence to indicate that the migration of the river mouth to the south has occurred to such an extent that it directly impacted the beach immediately in front of the proposed "Welcome Center" site. Third, the area is well within the Senate Bill 379 tsunami inundation line. Accordingly, consideration of these additional hazards should be incorporated into the design and siting of the Welcome Center building and its accompanying infrastructure. In addition, due to some level of uncertainty in the long-term response of this shore, we recommend adopting some additional safety measures. These include:

- Designing the structure so that the center is located at an elevation above the 100-year flood boundary level (e.g., on pilings);

- Possibly incorporating some design aspects that would allow the building to be pulled off its foundations and relocated to an alternate site should the need arise (e.g., accelerated erosion due to an increase in mean sea level associated with climate change);

- Placing the proposed building landward of a line drawn between the following points: 1192426.043E and 44253.819N, and 1192462.664E and 44152.159N. These points are in the Oregon State Plane Coordinate System (meters), southern zone;

- Incorporating suitable information on the risks of tsunamis, including installing appropriate tsunami evacuation signs; and,

- Commissioning the Oregon Department of Geology and Mineral Industries to undertake periodic updated surveys of the beach profile network established in the area. These surveys should be done at least once every 5 years, and/or after a major storm or storms in series, or a major El Niño winter.