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June 1, 2022

DRAFT

Mr. Jon Reimann
8827 Spyglass Lane
Manzanita, OR 97130

RE: Addendum to the Manzanita Foredune Management Plan (June 1995)- additional background information based on recent publications and documentation of foredune grading projects from 2008 to 2017.

Dear Mr. Reimann:

Grading of the foredune in Manzanita has followed the Foredune Management Plan of Marra (1995) for more than 20 years. The plan includes a Background Report that discusses the role of physical factors, including sources of sand, ocean flooding, seismicity and tsunami, patterns of accretion and erosion, and current-driven process. Also addressed are human factors, such as recreation and commercial uses, as well as the role of jetties, armoring, and foredune grading. From this, Management Strategies for discrete Management Units have been developed, with certain parts of the beachfront having differing issues than others, based on natural processes and characteristics, plus the height of the foredune and whether FEMA flood standards allow grading or other activities. The Management Plan is supplemented with Appendixes and Attachments. This document is intended as an Addendum to the Foredune Management Plan.

The Foredune Management Plan uses a design foredune configuration that calls for a dune crest at 33 ft NGVD and a secondary bench at 25 ft NGVD above the 12 to 18 ft NGVD upper beach. The bench at 25 ft is designed to catch windblown sand with beach grasses and focus dune growth west of the primary foredune crest. The foredune crest elevation is based on the FEMA rule that limits dune modification to the 100-yr flood elevation plus 4 ft (FEMA + 4 ft), as required by the FEMA Coastal Construction Manual (2011).

Comments provided herein are based on research published subsequent to 1995, and also from experience gleaned from several dune grading projects in the North and South Manzanita Management Units that have been carried out from about 2008 to about 2017 by Horning Geosciences.

<u>Dune Growth</u>

Marra (1995) demonstrates that the foredune complex grows vertically and horizontally by annual entrapment of sand principally by European beach grass. The rate of growth varies along the beachfront, but it reaches its maximum in the North and South Manzanita Management Units. Marra (1995) shows that the foredune has expanded to the west from 100 to 250 ft and vertically as much as 25 ft from 1967 to 1995. This is shown with numerous dune-beach profiles that are included within this addendum. Subsequent dune surveying by Horning Geosciences has found similar results, as posted on the same profiles. These are shown in Figures Based on comparisons with similar dune growth in the north part of Cannon Beach, net sand influx amounts to an average of about 1000 cubic yards per 100 ft of beach frontage, including years of severe net erosion during the El Nino Southern Oscillation years of 1997 to 1999. The rate of dune growth is dependent on the power and frequency of both winter southwesterly storms and dry northwest breezes of summer.

Dune Grading & Sand Disposal

Excess sand above 33 ft NGVD has been graded into depressions on the west face of the foredune complex and to the upper beach, where the sand is used to build a bench at 25 ft that is planted with beach grasses that serve to capture wind-blown sand and prevent continued growth of the primary dune crest. In practice, the existing 25 ft NGVD benches have been extremely successful in capturing sand, leading to their wholesale burial, as shown in a dune profile in Figure 12. Restoring the design foredune configuration to its original shape by grading sand to the intertidal zone has been expensive, leading to abandoning the original bench under at least 8 ft of accumulated dune sand, while grading the excess to the intertidal zone.

In practice, bulldozers have been used to move the sand from the dune to the surf. Part of the dune sand has usually been left on the upper beach as a gently inclined ramp that descends to about 8 ft NGVD (Mean Higher High Water) from the dune-beach interface at about 18 ft NGVD and sometimes from the western edge of a newly graded bench at 25 ft NGVD.

Experience from past dune grading activities has shown that European beachgrass will sprout from bulldozed sand left on the upper beach west of the dune toe and will develop an unintended foredune. This converts barren recreational space of the upper beach into vegetated foredune, expanding the new foredune as much as 120 ft beyond its planned boundary. As a result, recreational space for the public has been unintentionally converted to new foredune that likely will not wash away soon, if ever. Examples of how this has happened is illustrated in Figures 13 and14. This poses a hazard to life in the event that storm surges cut an unclimbable sand cliff that prevents escape from large waves.

The initial profile of the upper beach should be restored as a part of grading sand to the upper inter-tidal zone. No excess sand should be left on the upper beach. Sand should only be deposited on the beach between 6 ft and 12 ft NGVD.

It is recommended that excess sand from grading be pushed to the intertidal zone, to no lower than 6 ft NGVD, which is the upper limit of red worm habitat zone of the intertidal zone, following recommendations from Oregon Fish and Wildlife biologists. The sand should be deposited a few days before the highest tides of the month, so waves can pull the sand into the surf to nourish the sand supply of the littoral zone. This methodology of sand disposal has been tested in Cannon Beach and found to be a success. Photos of intertidal zone sand disposal are provided in Figures 27 through 29.

Beach Grass Disposal Management

Beach grasses can be stripped from the foredune area to be graded and the grasses used to revegetate the graded area. Excess grasses not needed for revegetation should be set aside and buried into the foredune prior to replanting. Excess grass roots and stems may litter the beach after sand has been reclaimed by the surf. This debris should be raked up and removed from the beach as a part of the project.

Shoreline Erosion & Retreat

According to Priest and Allan (2001), long-term sea level rise, coupled with increasing storminess, rip cell development, temporary rises in sea level from El Nino Southern Oscillation events, and the effects of coseismic subsidence as a result of great earthquakes within the Cascadia Subduction Zone all contribute to long-term shoreline retreat, particularly along dune-backed stretches of shoreline. Shoreline positions have been moving westward through time due to currents and wind effects, as shown in Figure 16. It is expected that, at some point, these processes will be overwhelmed by the effects of rising sea level, and this will cause the shoreline to retreat eastward. Also shown in Figure 16 is the result of erosional sensitivity modeling that breaks out projected long-term shoreline retreat for periods of time that range up to 120 years. The models are for High, Medium, and Low Risk scenarios, of 0 to 60 years, 60 to 120 years, and 120 years including coseismic subsidence of the next subduction zone earthquakes. These models optimistically assume that enough time will be available for all potential erosion to take place. It is likely that this is not the case and that these models are overly liberal in their projects. However, should the next subsidence event occur sooner rather than later, the worst-case shoreline retreat event will occur, leading to at least a partial erosion of the foredune.

Recommendations

The following conditions should be met when grading dunes in the South and North Manzanita Management Units.

1. Grade the dune to an elevation that is no lower than "FEMA + 4 ft, plus 1 ft", where "FEMA" is the V-Zone elevation of shoreline reach, as shown in FEMA Flood Insurance Rate Map 41057C0204F, effective Sept. 28, 2018. The additional foot of elevation is designed to offset future sea level rise.

2. Ensure that at least 1100 sq ft of cross sectional area is retained for the minimum frontal dune reservoir, as recommended in Section 3.6.8 of the FEMA Coastal Construction Manual, 4th Edition (August 2011), page 3-64.

3. Bulldoze and slope graded areas according to the clients' wishes to enhance views and control costs, subject to Conditions 1 and 2, above. Finished cut banks should be no steeper than 50 percent (2 Horizontal to 1 Vertical). It is not necessary to bench the final graded area, as dune growth will ultimately bury the bench. Irregular or uniform slopes are acceptable. Leaving undulations to mimic natural dunes is optional.

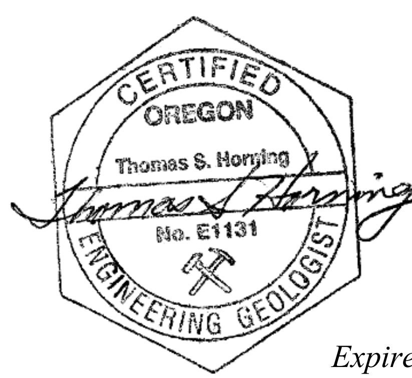
4. Bulldoze sand onto the upper intertidal zone of the beach to elevations between 12 and 6 ft NGVD. This protects blood worm habitat below 6 ft, as indicated by worm trails in the wet sand. Deposit sand within this elevation range during the week of the highest tides of the month, so that storm waves may pull the sand into the surf, usually within 48 hours.

5. Strip existing beach grass prior to bulldozing and salvage clumps for replanting. Plant beach grass using the clump method (at least 10 culms per clump) on 18-inch centers for maximum survival and quick recovery. Complete grass plantings between October 15 and May 1. Dispose of excess European beach grass by burial of remaining plants in the core of the foredune.

6. Maintain the upper beach elevation profile from the base of the dune to 12 ft NGVD that existed prior to the commencement of dune grading. Leave introduced sand only between elevations of 6 to 12 ft NGVD for reclamation by the surf.

7. Rake up and dispose of beach grass debris that is exposed by winnowing along the shoreline within two weeks of completion of the grading project.

Please feel free to call if you have questions.



Thomas S. Horning, CEG E1131
Horning Geosciences

Expires: 7/1/22

References

Allan, J.C., and Priest, G.P., 2001, Evaluation of Coastal Erosion Hazard Zones Along Dune and Bluff Backed Shorelines in Tillamook County, Oregon: Cascade Head to Cape Falcon- Preliminary Technical Report to Tillamook County; Open-File Report O-01-03; 126 p.

Horning, T.S, 2017, Dune Management Annual Report; from March 2015 to March 2016; Presidential Streets Sand Management Unit, from Jefferson to Jackson Streets, Cannon Beach, Clatsop County, Oregon; dated August 20, 2017; 23 p.

Horning, T.S., 2017, Annual Dune Monitoring Report for 2015-17; from Pacific Lane south to Glenesslin Lane, south end of Manzanita/Necarney City, Tillamook County, Oregon; dated May 5, 2017; 6 p.

Marra, J., 1995, Manzanita Foredune Management Plan, prepared for the Manzanita/Neahkahnie Dunes Management Association, Inc.; Shoreland Solutions.

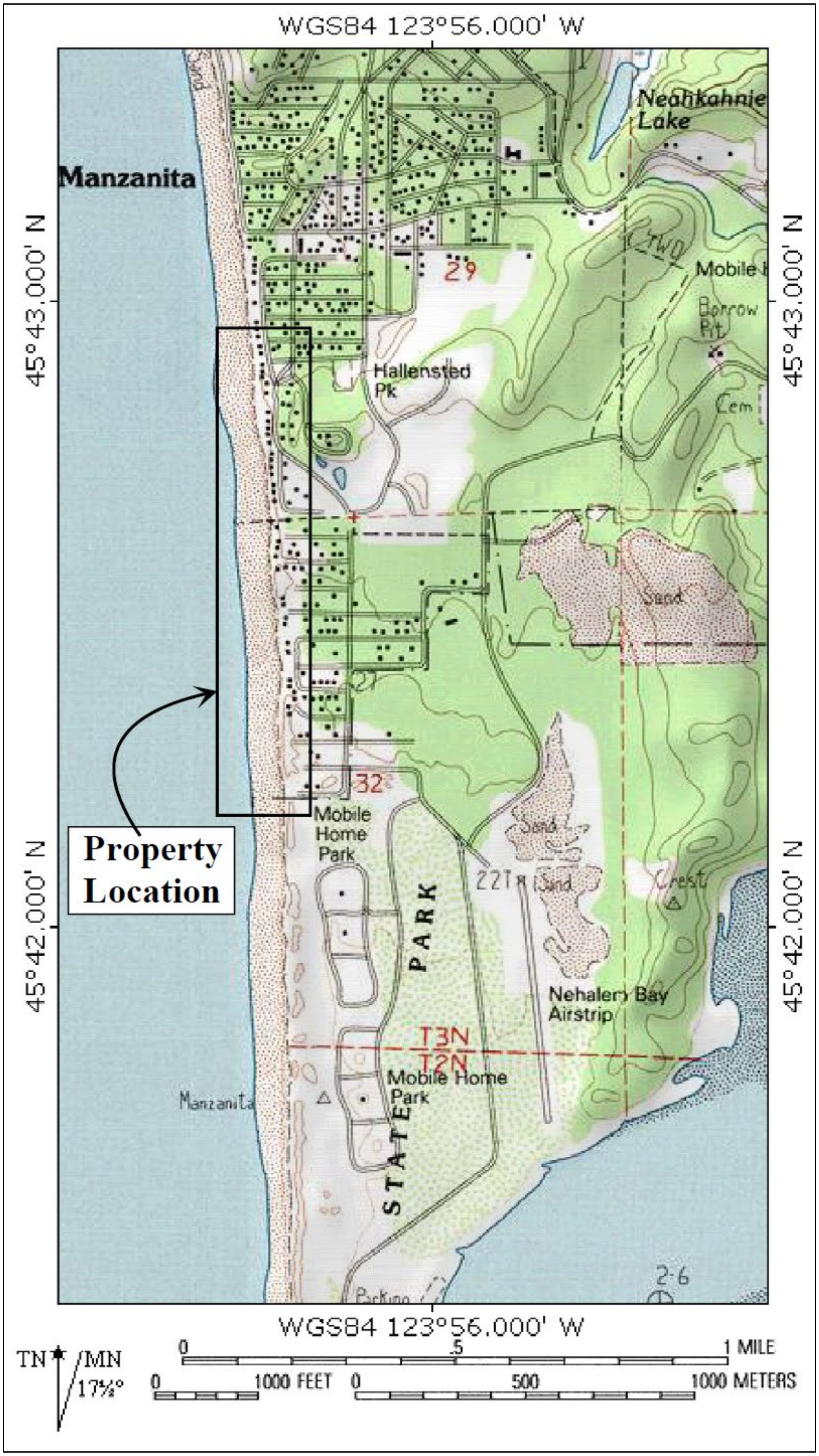


Figure 1: Property location map for the North and South Manzanita Management Units.

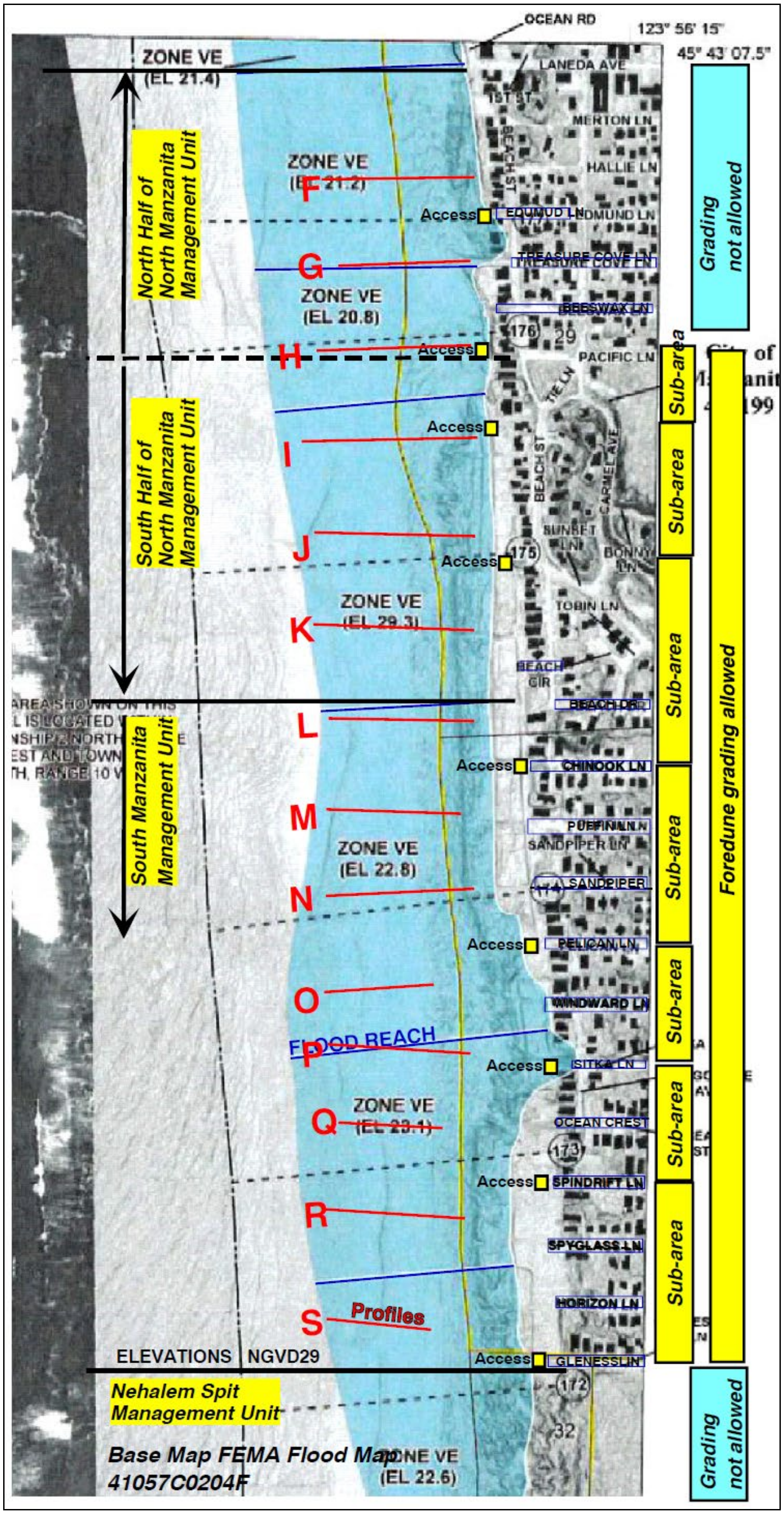


Figure 2: Flood hazard map for the southern part of Manzanita showing different flood reaches and height of the V-Zone in ft NGVD29. Also superimposed are recommended access points, proposed sub-areas, locations of topographic profiles used in this report, the boundaries of Management Units and whether or not dune grading is allowed, based on work by Marra (1995).

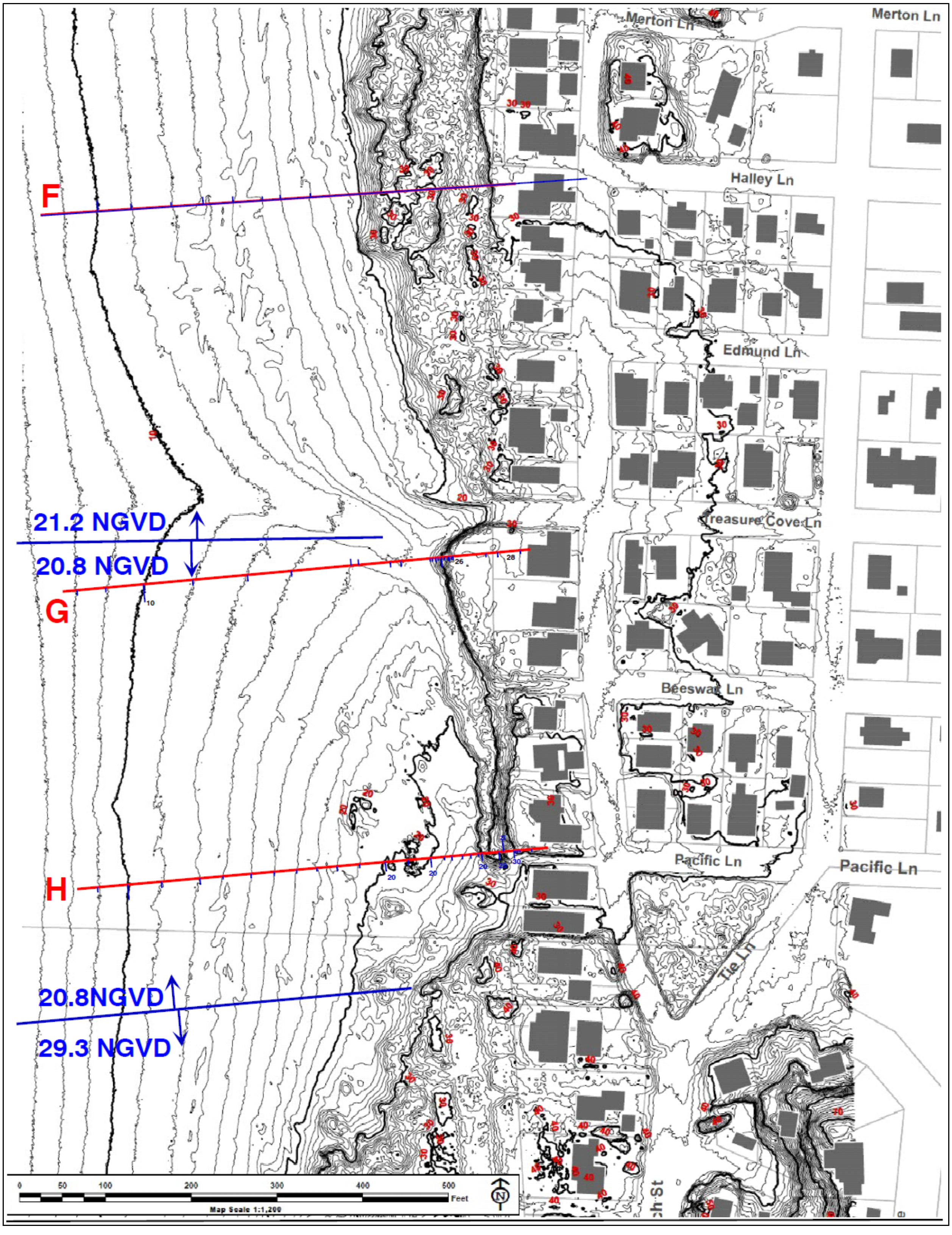


Figure 3: LIDAR topographic map with 1-ft contours for Halley Lane to Pacific Lane. Flood reaches are in blue and referenced to NGVD29, as are the topographic contours. An aerial photographic view of this map is shown in Figure 4. A modified rip cell embayment lies in the middle of this map. It forms where an intermittent stream flushes an open channel way. Known as a barrage creek, it can be buried by sand for up to several years.

Figure 4: Aerial view of beachfront from Halley Lane to Pacific Lane (profile H). Compare with Figure 3. Courtesy of Google Earth.

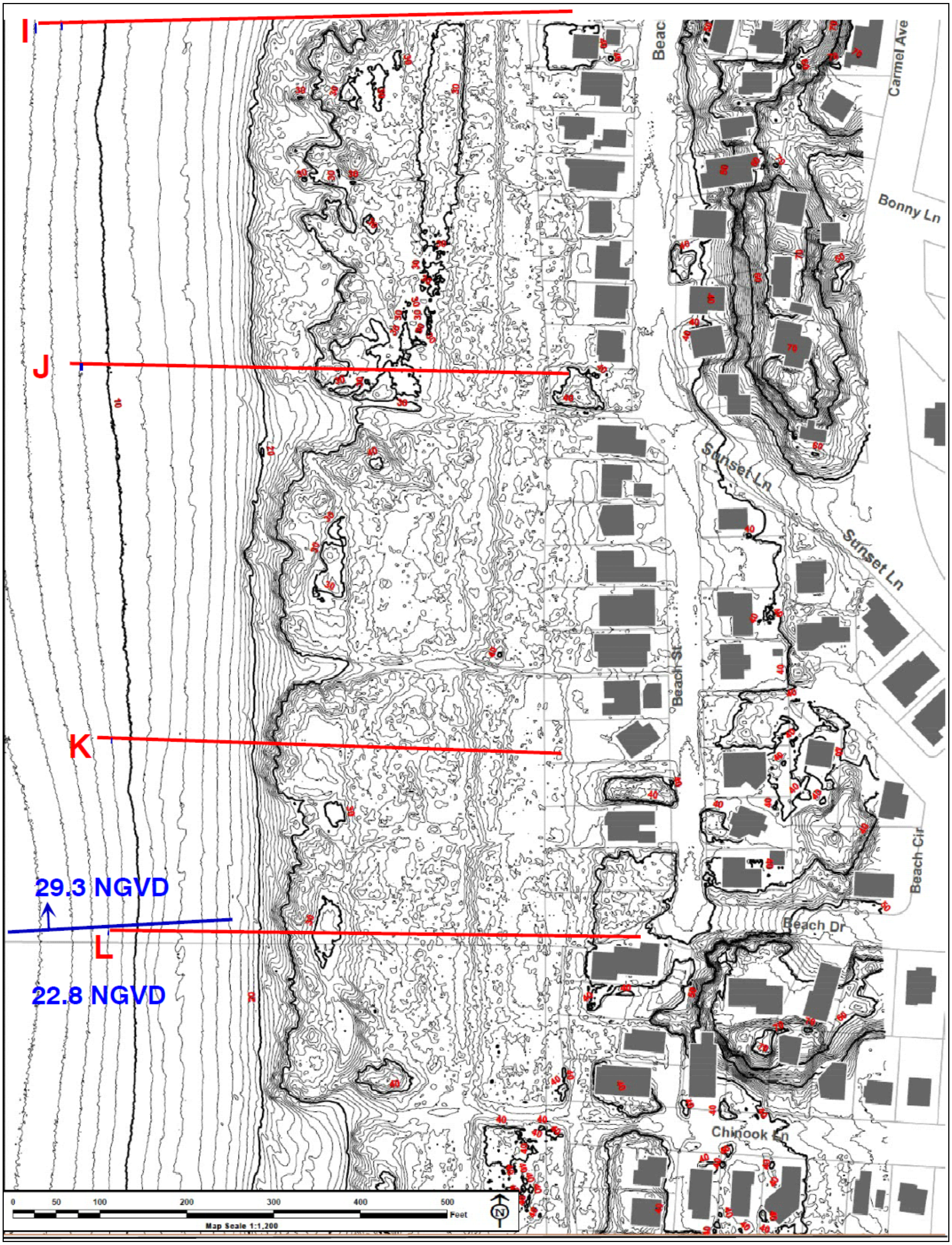


Figure 5: Topographic map, on 1-ft contours, from Beach Street to Chinook Lane. Compare with Figure 6.

Figure 6: Aerial photographic view from Beach Street to Chinook Lane. Compare with Figure 5. Courtesy of Google Earth.

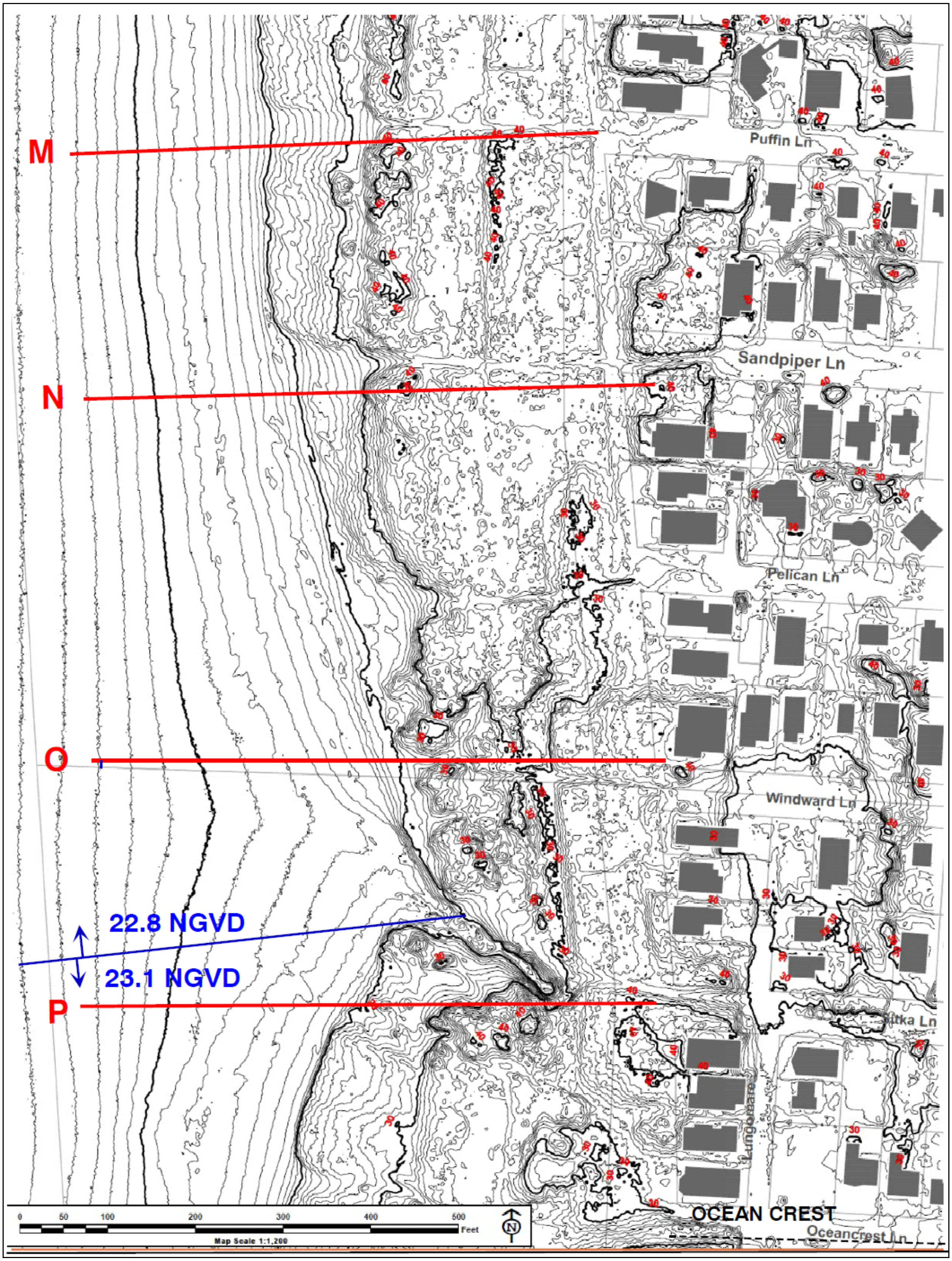


Figure 7: Topographic map, on 1-ft contours, from Puffin Lane to Ocean Crest Lane. Compare with Figure 8.

Figure 8: Aerial photographic view from Puffin Lane to Ocean Crest Lane. Compare with Figure 7. Courtesy of Google Earth.

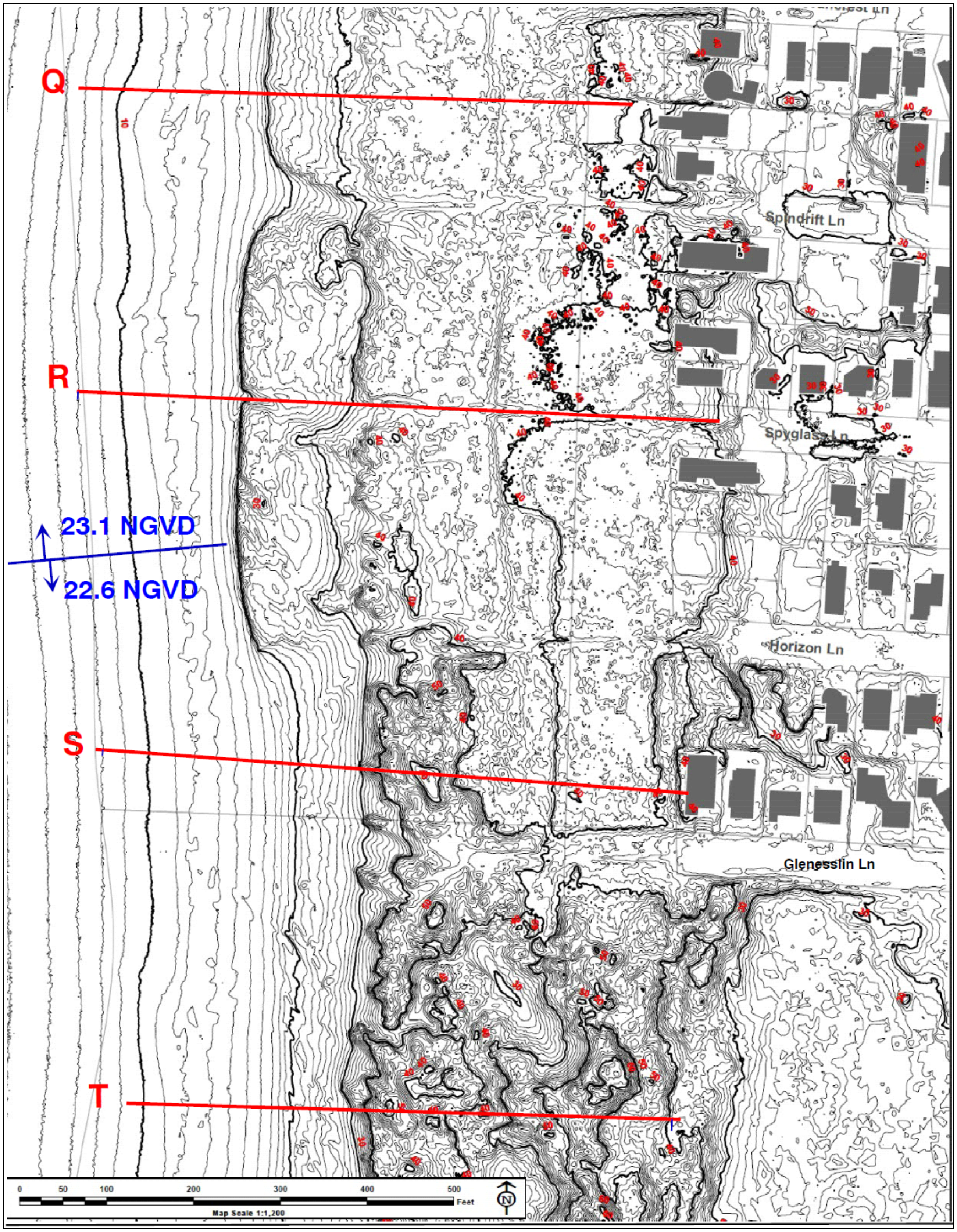


Figure 9: Topographic map, on 1-ft contours, from Spindrift Lane to Glenesslin Lane. Compare with Figure 10.

Figure 10: Aerial photographic view from Spindrift Lane to Glenesslin Lane. Compare with Figure 9. Courtesy of Google Earth.

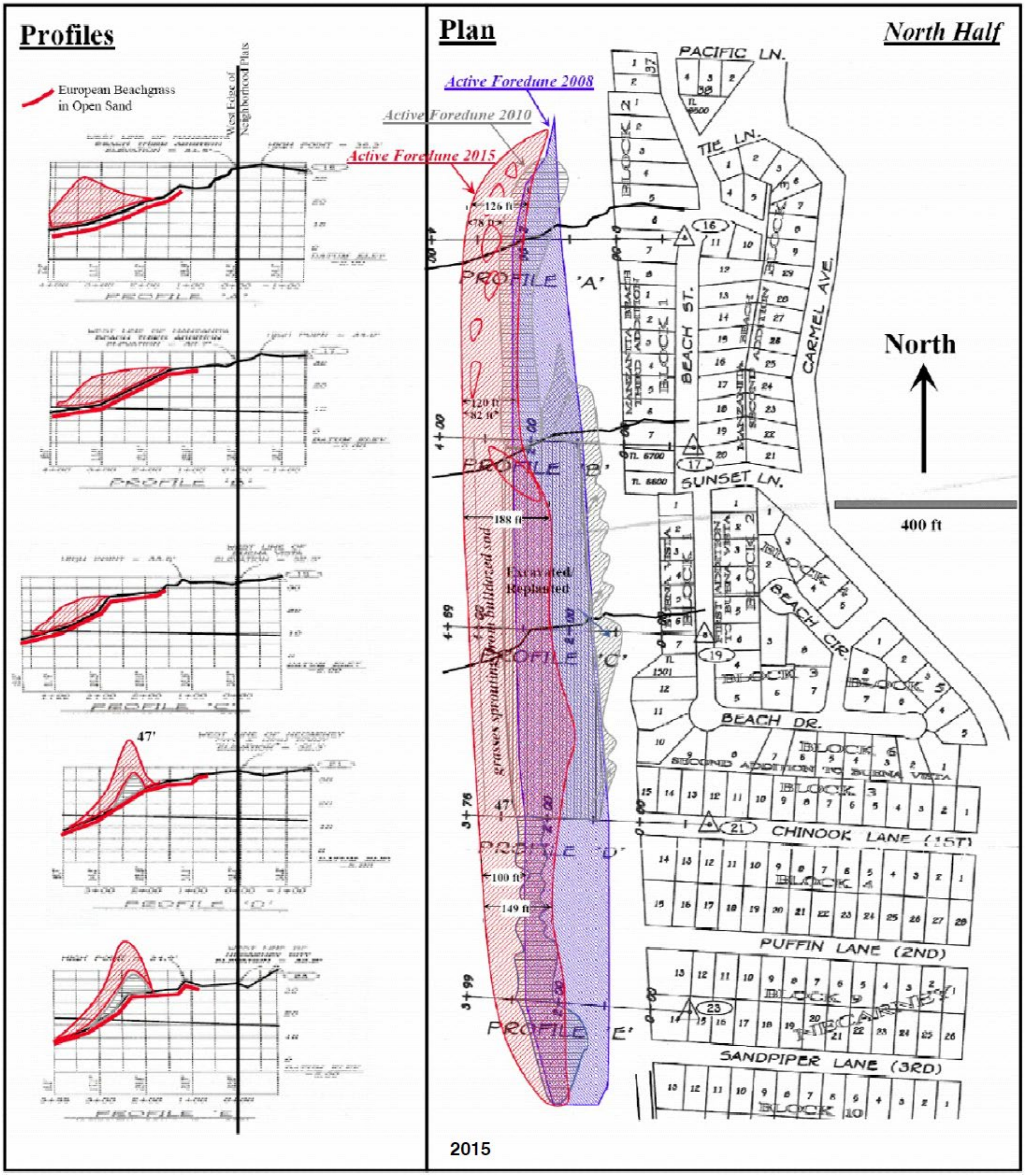


Figure 11: Cross sectional profiles and plan view of sand dune growth and inundation from 2008 to 2015 for the area near Chinook Lane; after Horning (2015). Note that foredune has grown vertically about 22 ft in 7 years, and that sand accumulation has shifted from 100 to 120 ft to the west over the same time period. This is consistent with previous findings that

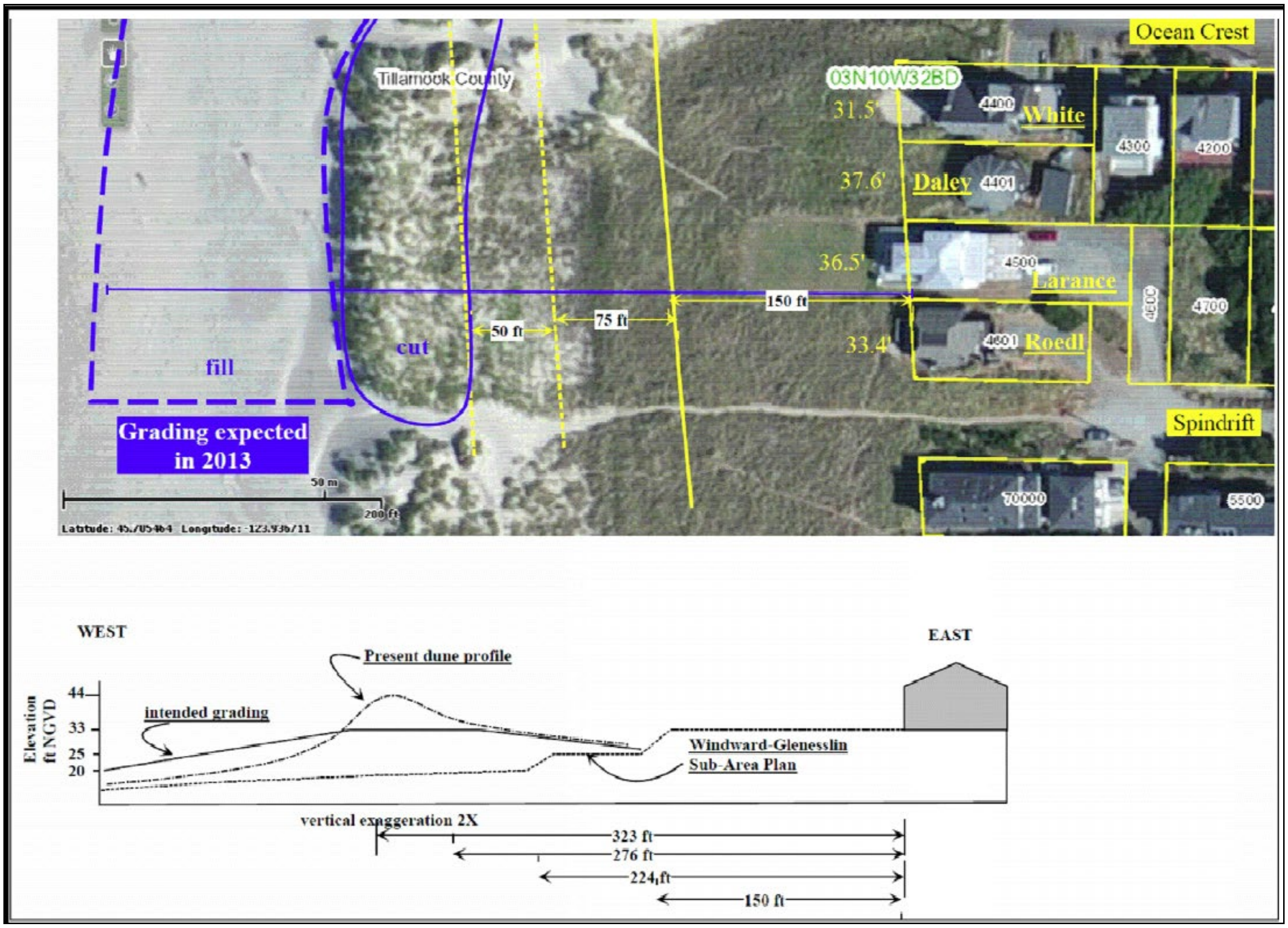


Figure 12: Grading plan for the area near Spindrift Lane in 2013; after Horning (2013). Shown in the lower profile is the design foredune excavation that has been buried by 6 to 8 ft of dune sand. European beachgrass has intercepted the majority of windblown sand and developed a new foredune crest about 140 ft west of the secondary foredune crest (elevation 25 ft). The new foredune crest has grown 30 ft over about 10 to 15 years.

Figure 13: Natural foredune, on right, with barren upper beach in lower left foreground. New artificial foredune is growing at least 100 ft farther to the west, where dune sand with European beachgrass was bulldozed without first stripping out the grasses and then leaving the sand ramp on the upper beach. The density of beachgrass and undulating morphology indicates that the dunes will continue to grow unless storm waves wash them out. Note the seated woman at the left side of the new foredune. This sand is from the 2013 Riemann grading. Photo taken from just north of the extension of Glenesslin, looking northwest from a 50 ft high dune.

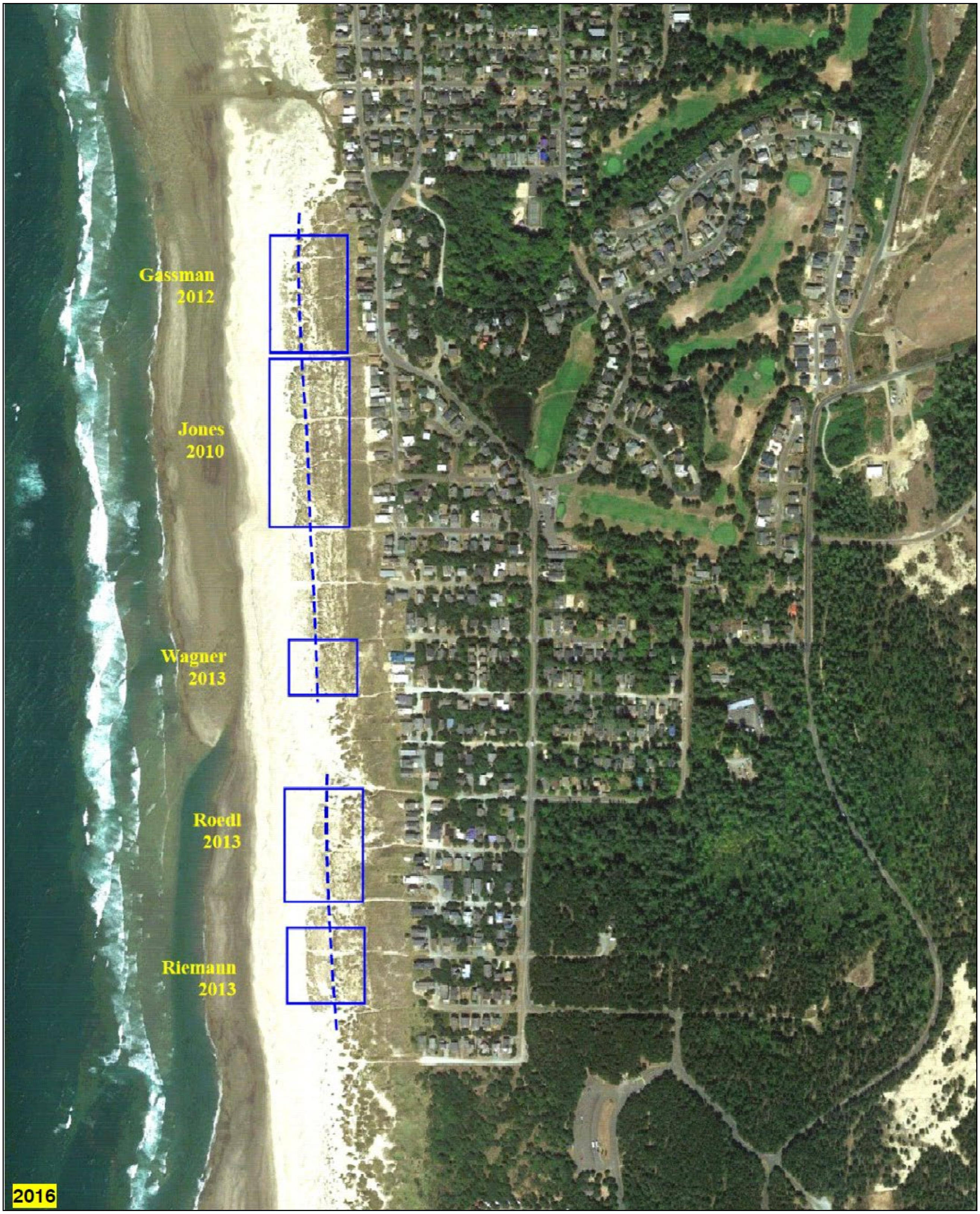
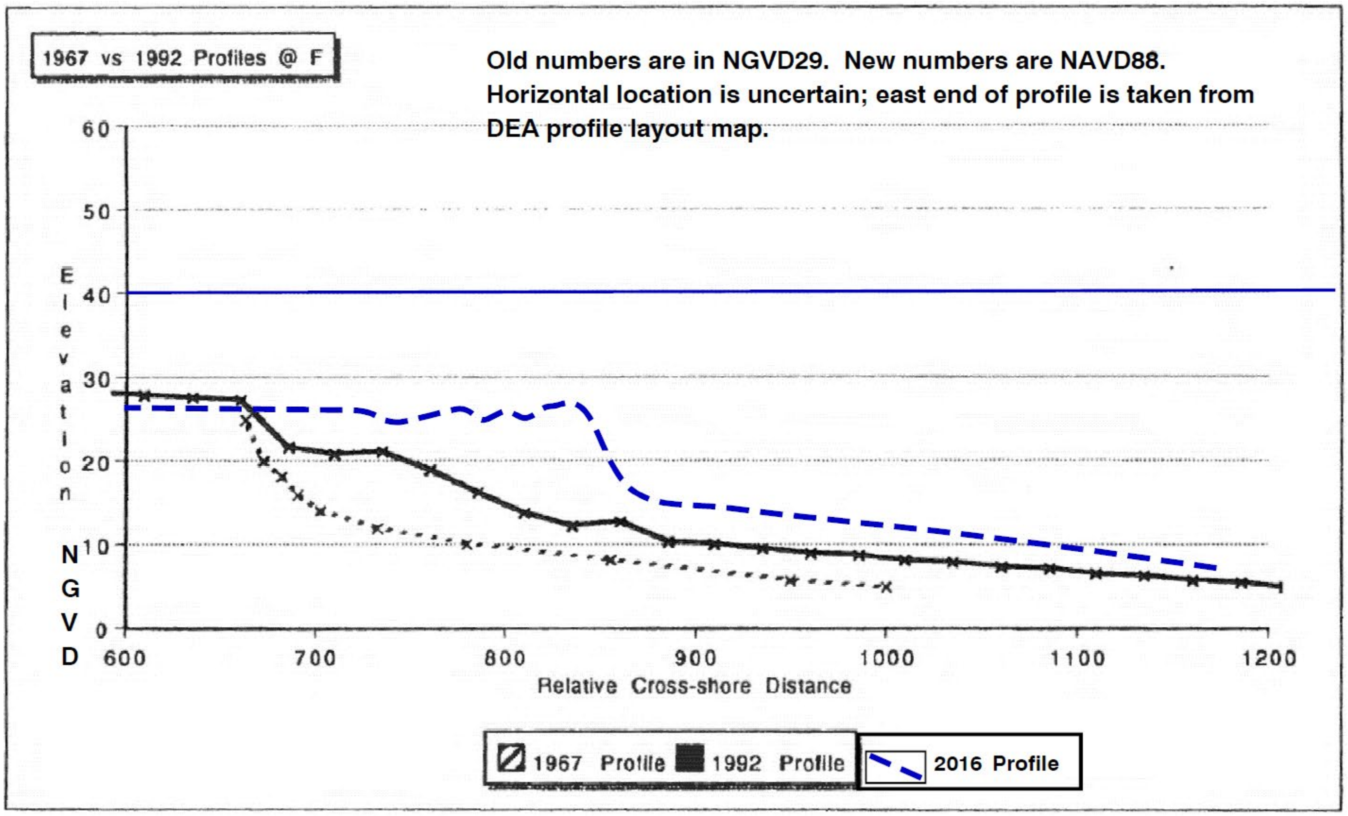


Figure 14: Aerial view of the North and South Manzanita Foredune Management area; image courtesy of Google Earth. Blue rectangles mark where grading has taken place. Grassy areas west of the blue dashed line have grown from grass roots in sand that was left lying on the upper beach, locally wider than 100 ft. These grassy areas will preferentially grow vertically, forming cliffs where eroded by storm waves. This could pose a hazard to beach strollers during periods of high waves.

Figure 15: Creek channels crossing the beach allow surf easy access to the upper beach and facilitate rip cell embayment formation, as shown in this aerial view. Note the northward deflection of the channels, caused by heavy sand deposition during winter southwesterly storms. The rip cells are as much as 1000 ft wide. The southern rip cell created a large open area where driftwood accumulated and is now buried by sand.

Figure 16: Shoreline erosion sensitivity model for the Manzanita dune-backed beachfront, after Priest and Allan (2001). Shoreline is expected to retreat eastward in response to increasing storminess, rising sea level, more powerful El Ninos, high tides, and vertical subsidence from a regional Cascadia earthquake. The Red zone has the highest risk of bluff retreat, and is for 60 years extending from 2001 to 2061. Orange is intermediate and is for the period from 60 to 120 years. Yellow is the expected erosion for 120 years with 3 to 5 ft of vertical subsidence. Colored lines mark shoreline positions through the time periods provided, illustrating that the beach-dune interface has shifted westward about 250 ft in the last 65 years. The model for shoreline retreat assumes that the maximum potential erosion will take place, which is not likely under many scenarios. Moreover, as beach erosion occurs farther to the south, available sand will migrate northward via the longshore current and build out the beaches, forestalling bluff retreat.



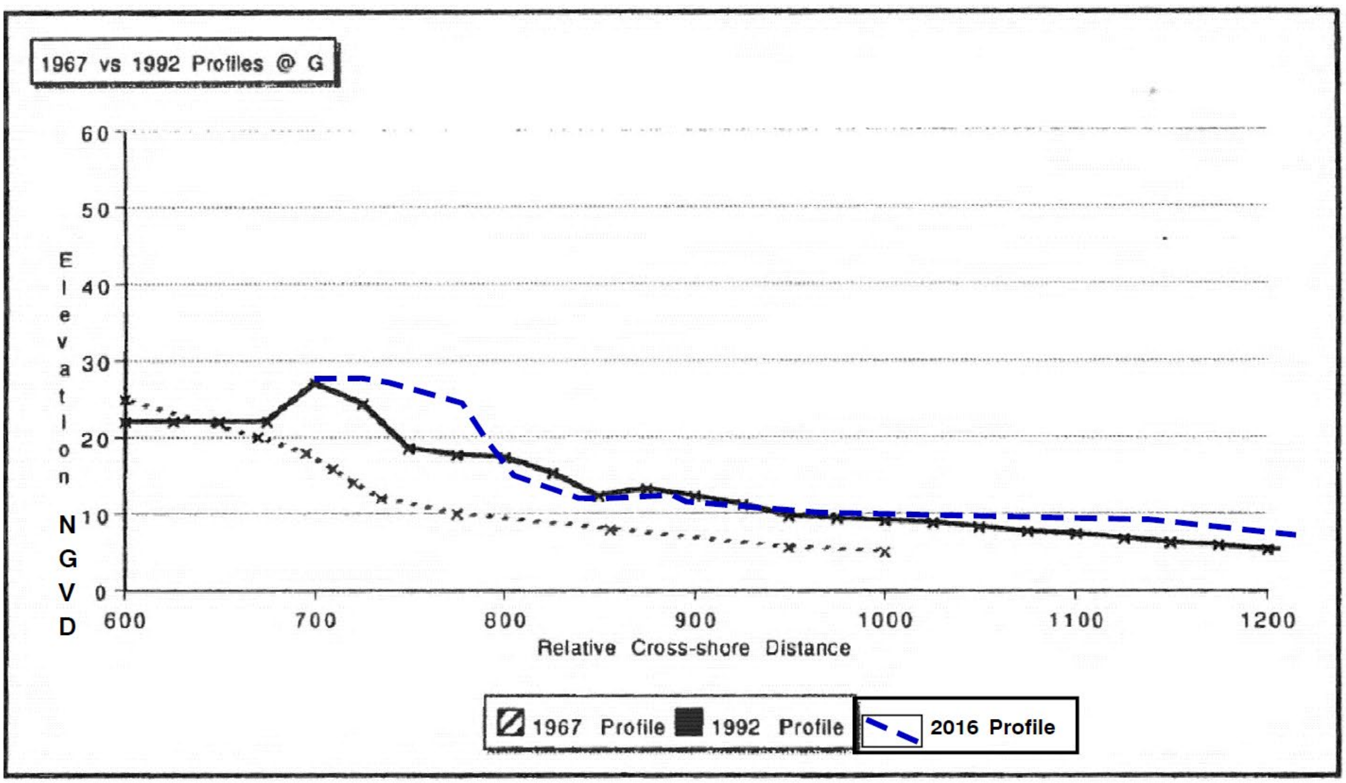
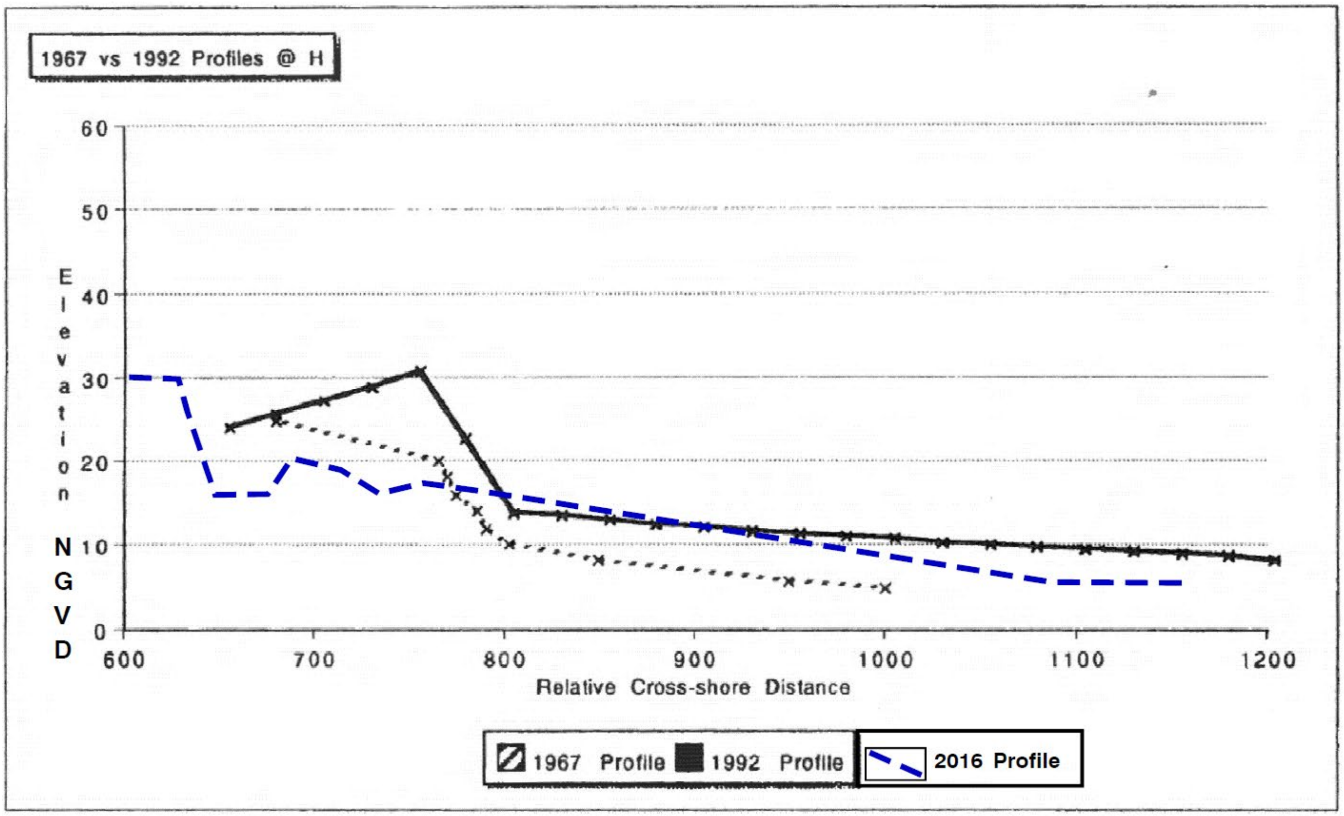


Figure 18: Dune profiles of Marra (1995), updated from the 2016 topographic map in Figure 3.



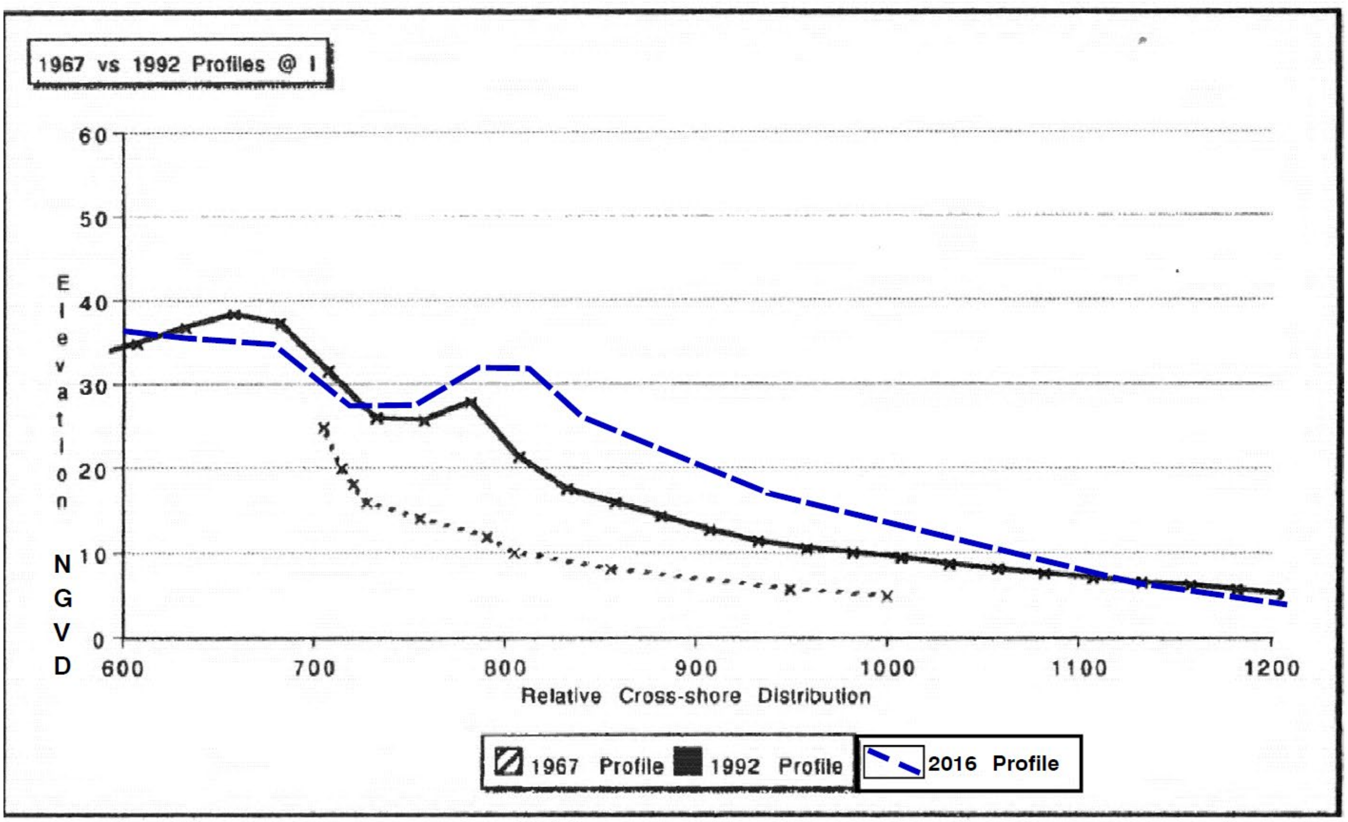
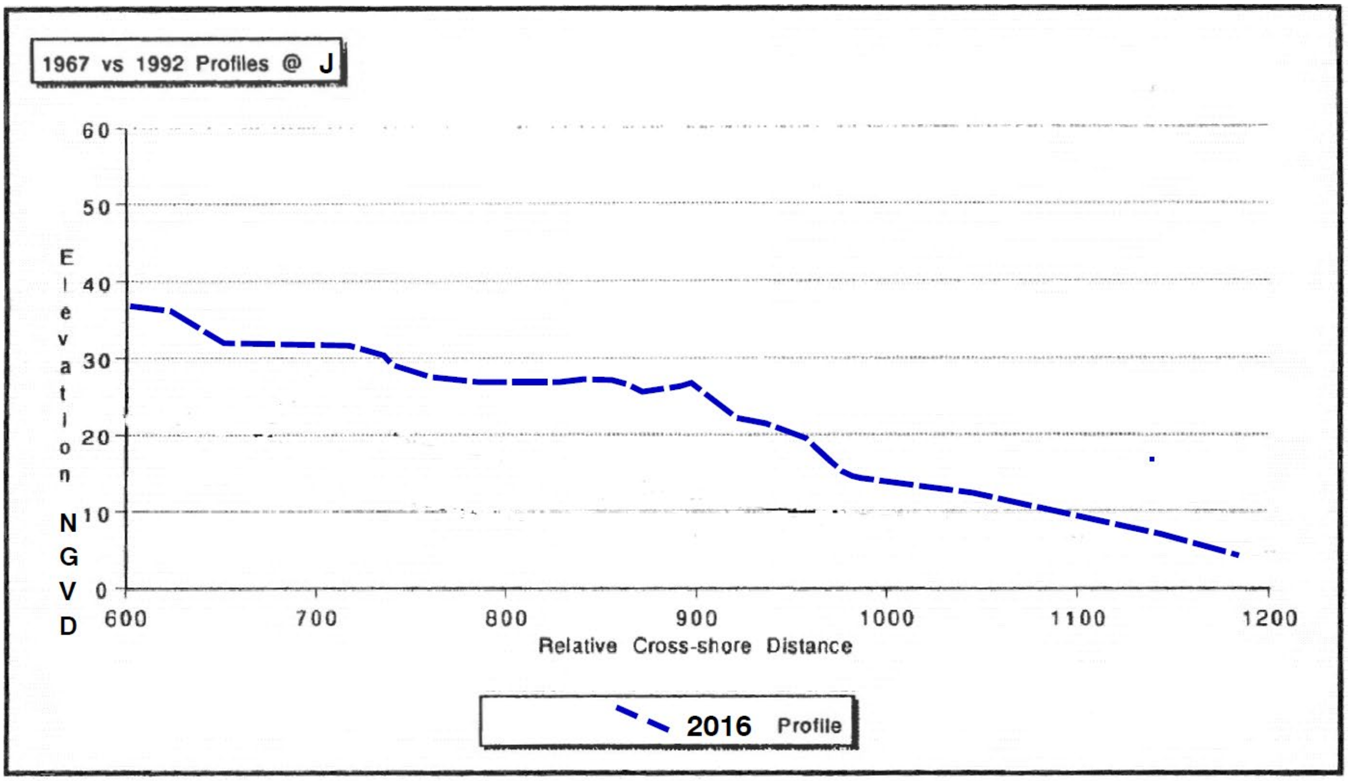


Figure 19: Dune profiles of Marra (1995) updated from 2016 topographic maps in Figures 3 and 5.



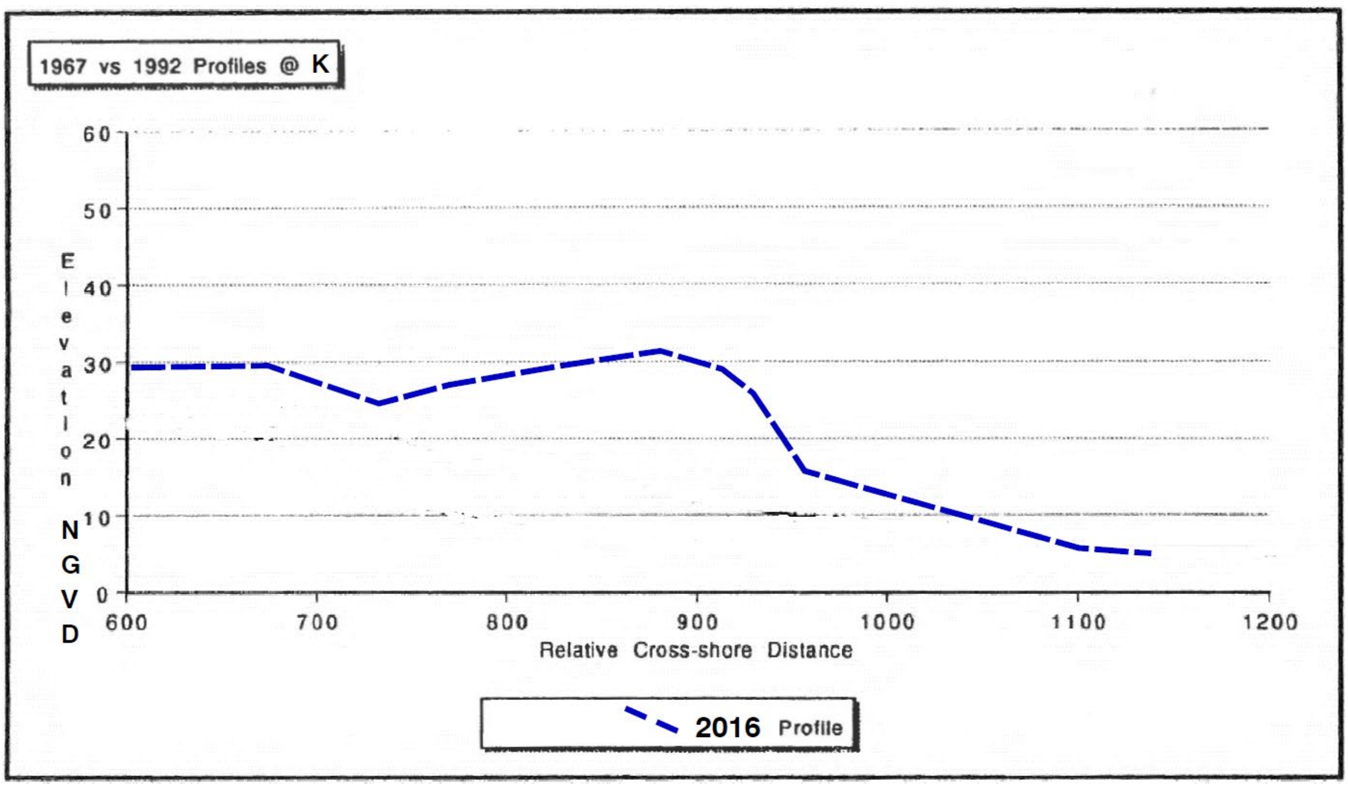
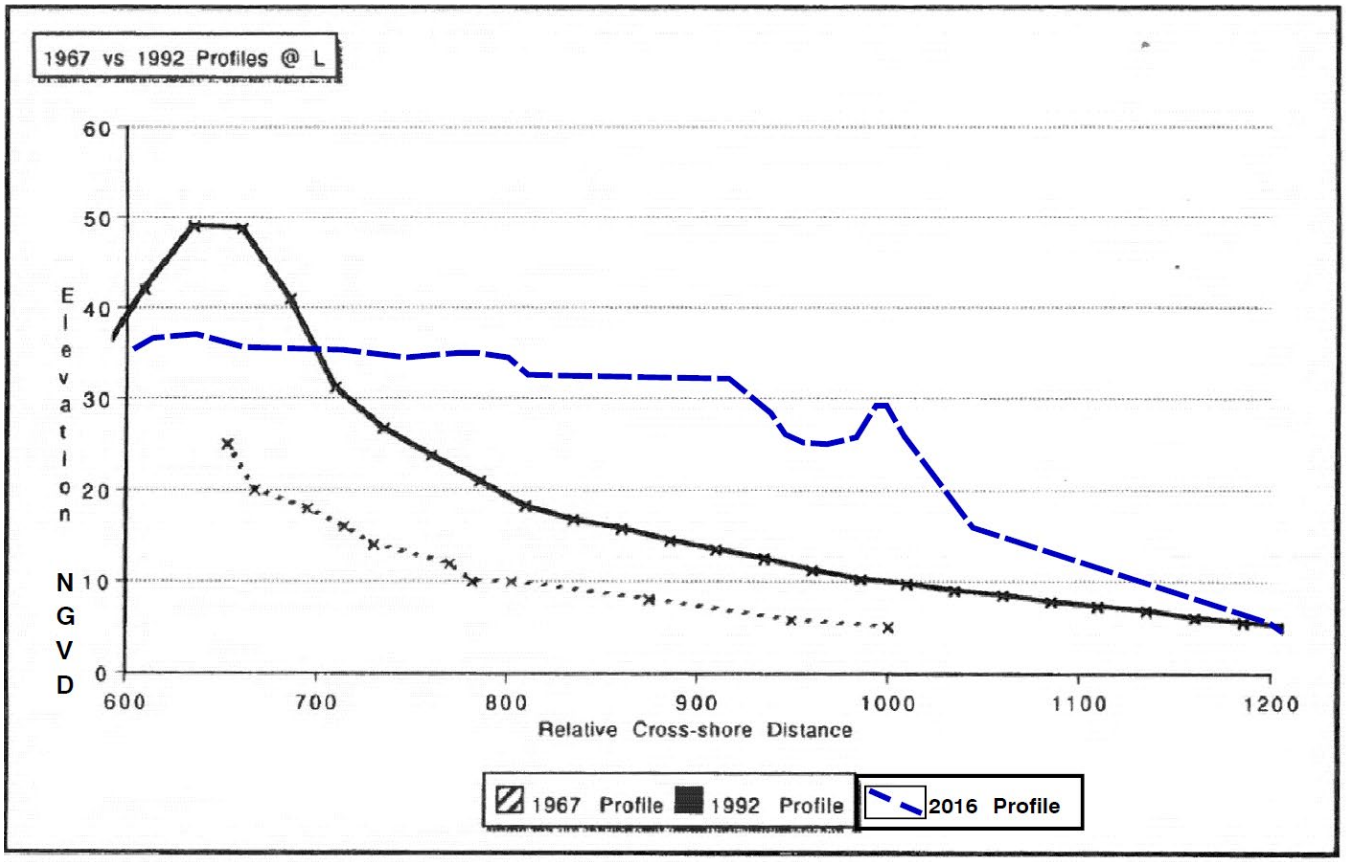


Figure 20: Dune profiles of Marra (1995) updated from 2016 topographic maps in Figure 5.



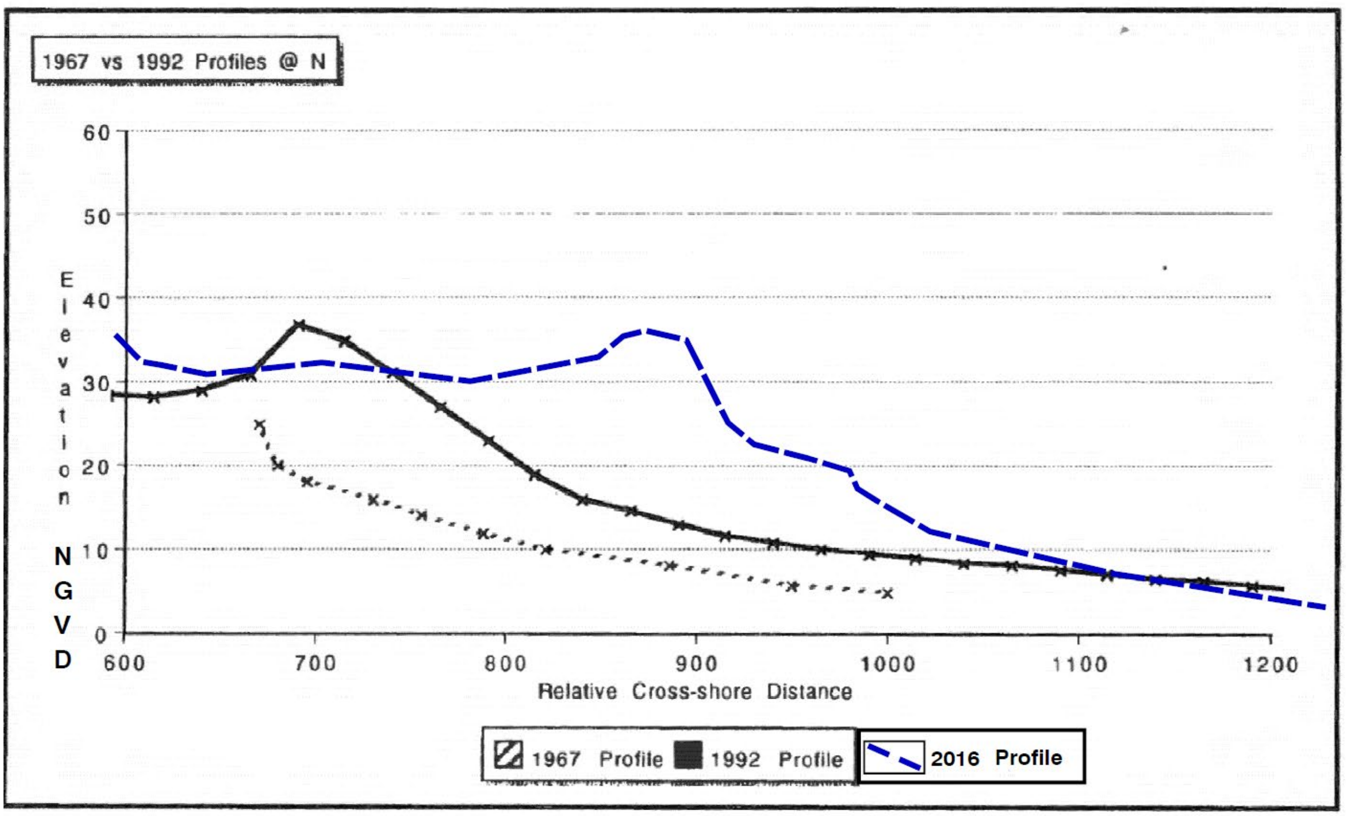
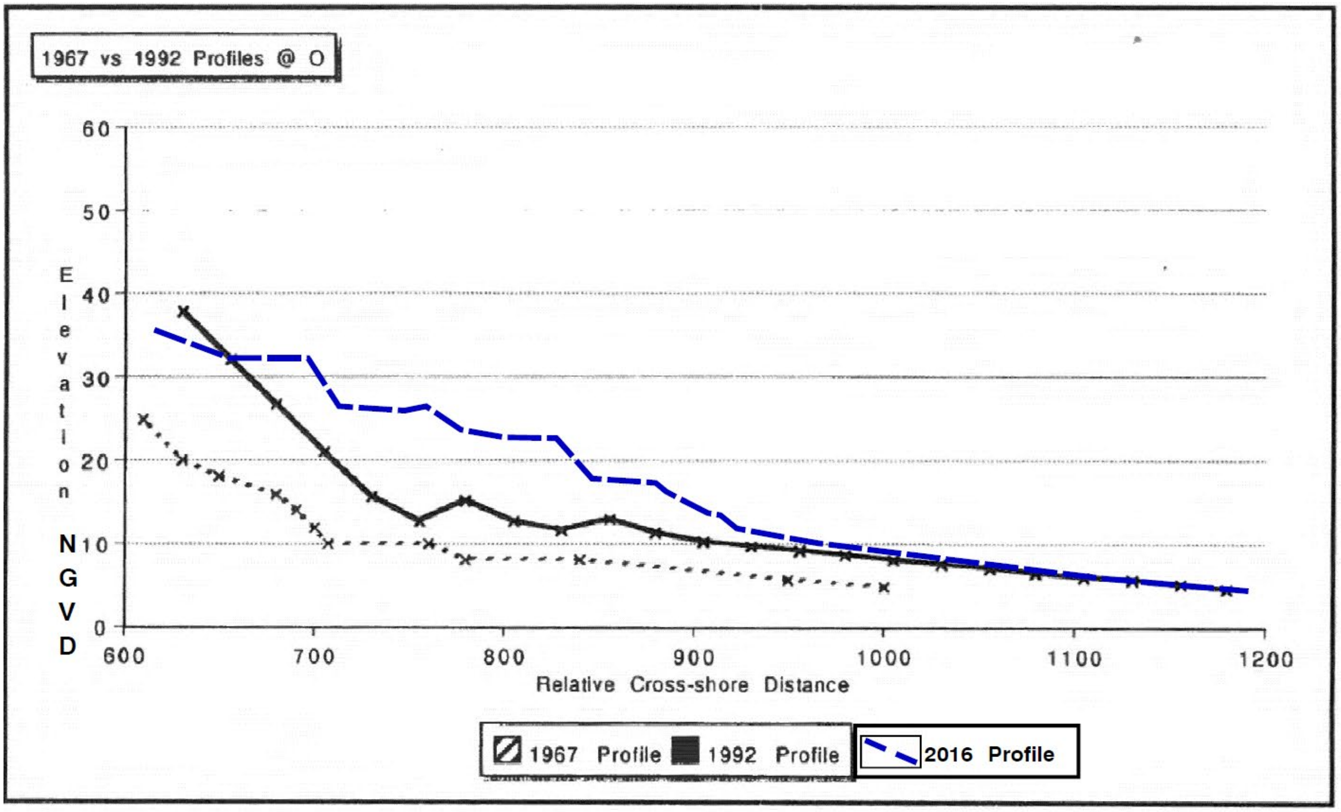


Figure 21: Dune profiles of Marra (1995) updated from 2016 topographic maps in Figures 5 and 7.



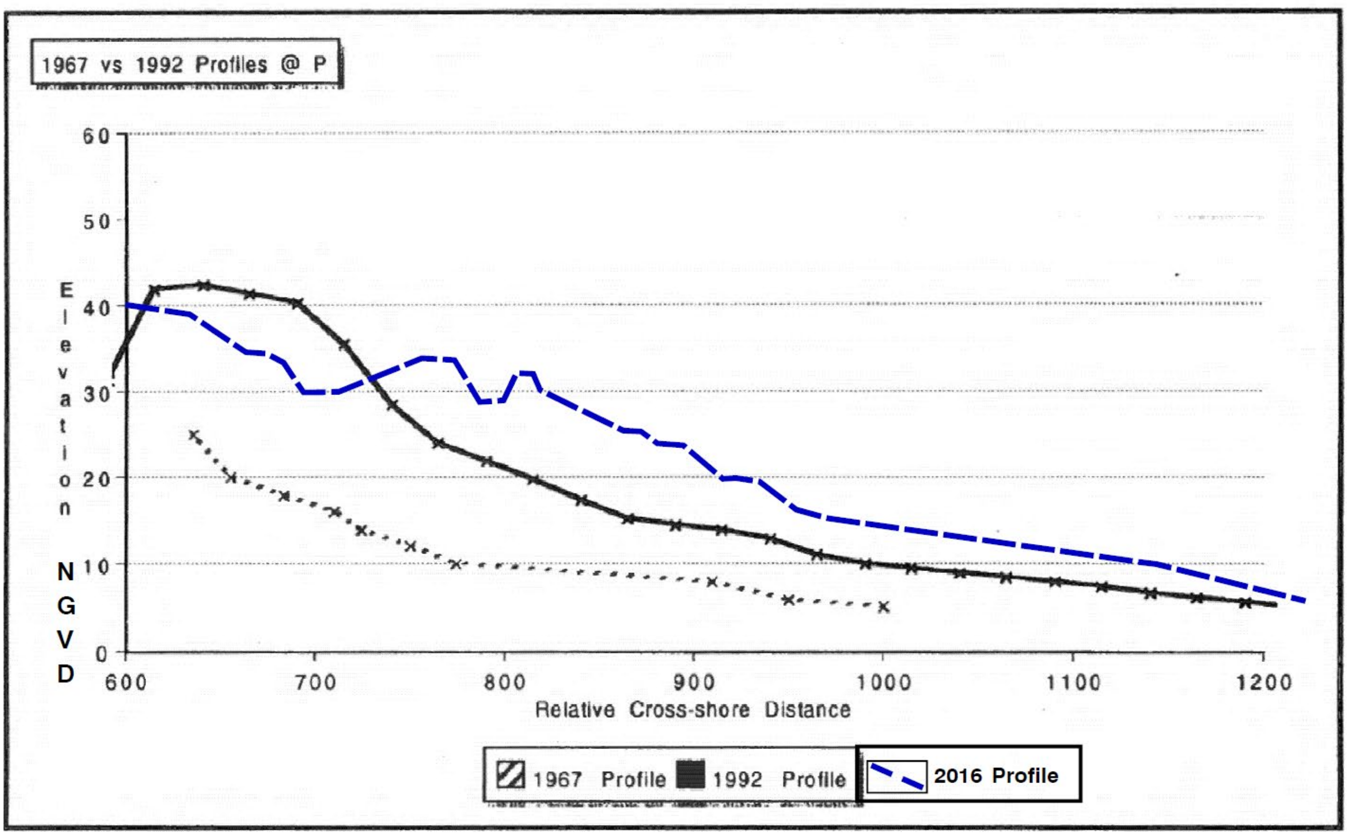
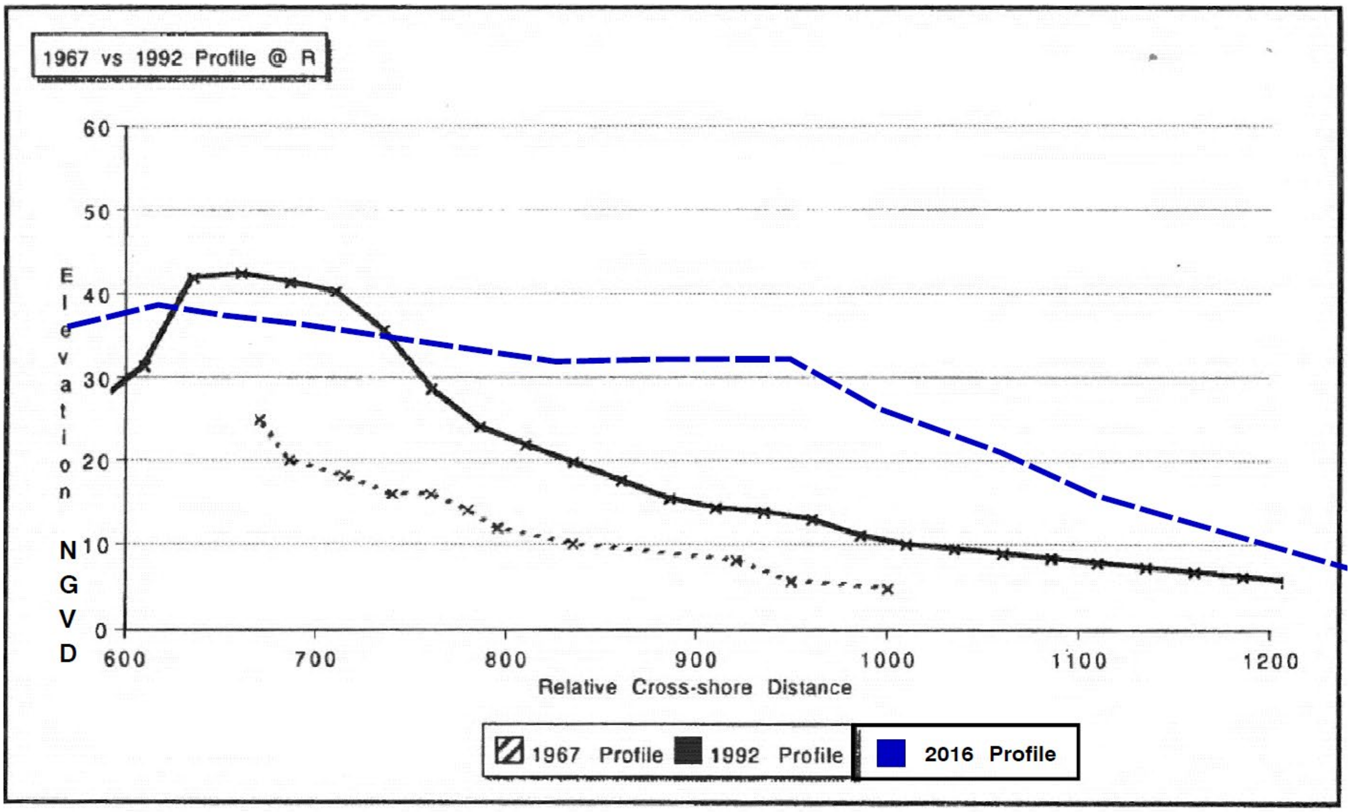


Figure 22: Dune profiles of Marra (1995) updated from 2016 topographic map in Figure 7.



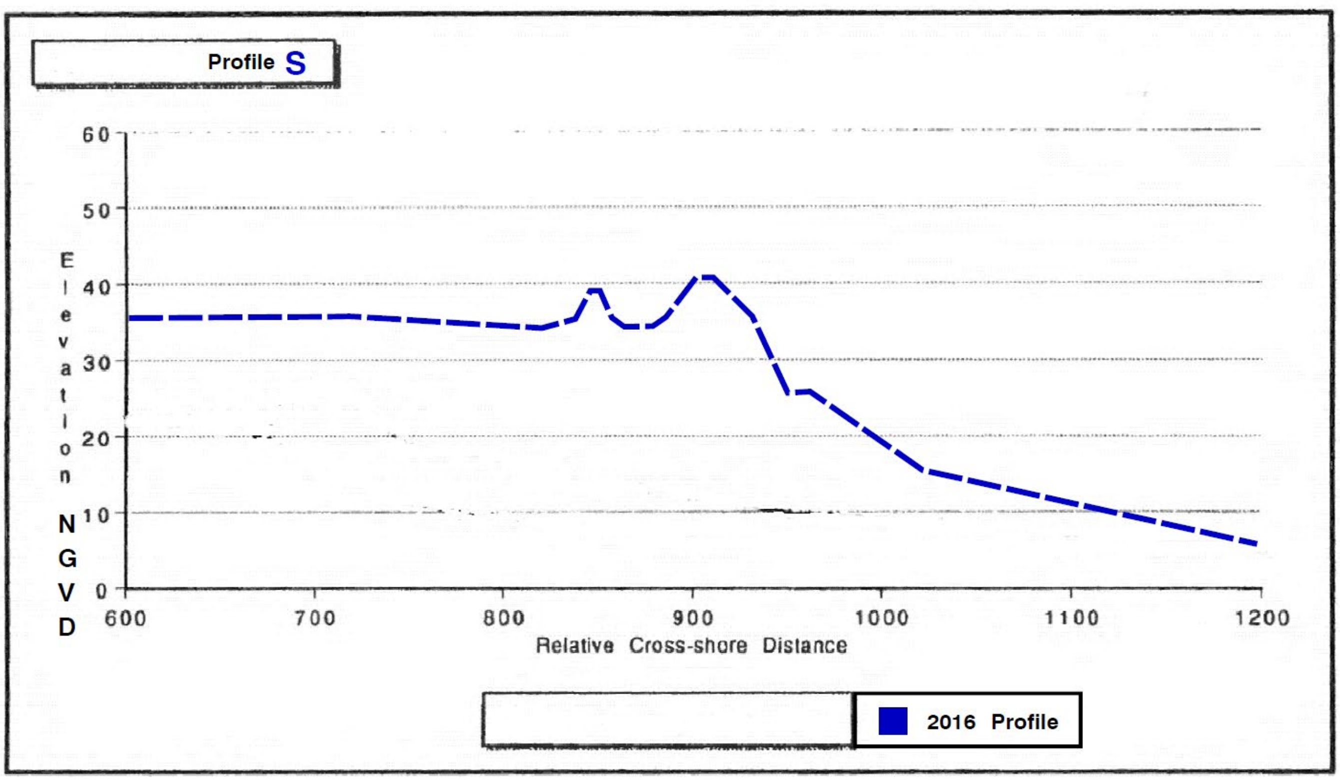


Figure 23: Dune profiles of Marra (1995) updated from 2016 topographic map in Figure 9.

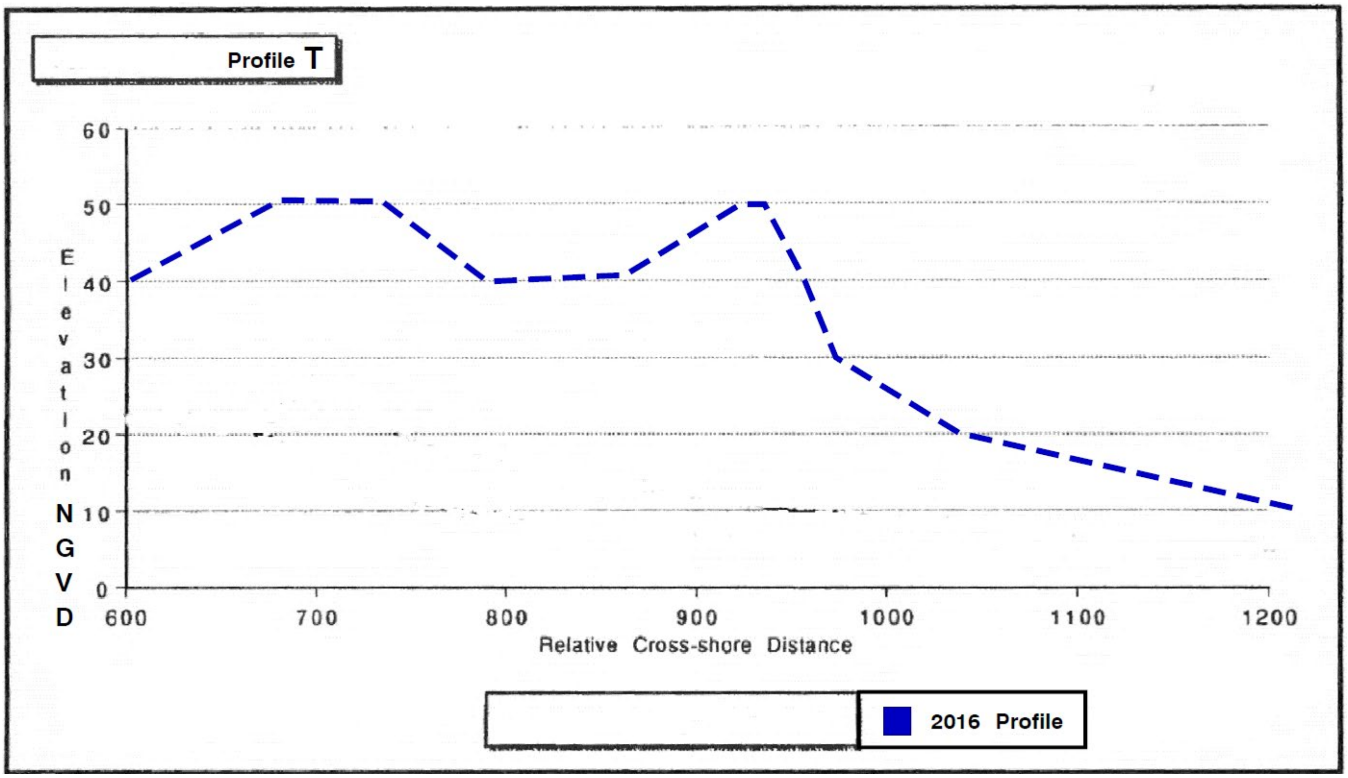


Figure 24: Blocks of weathered sandstone (ML-CL) in Text Pit TP1.

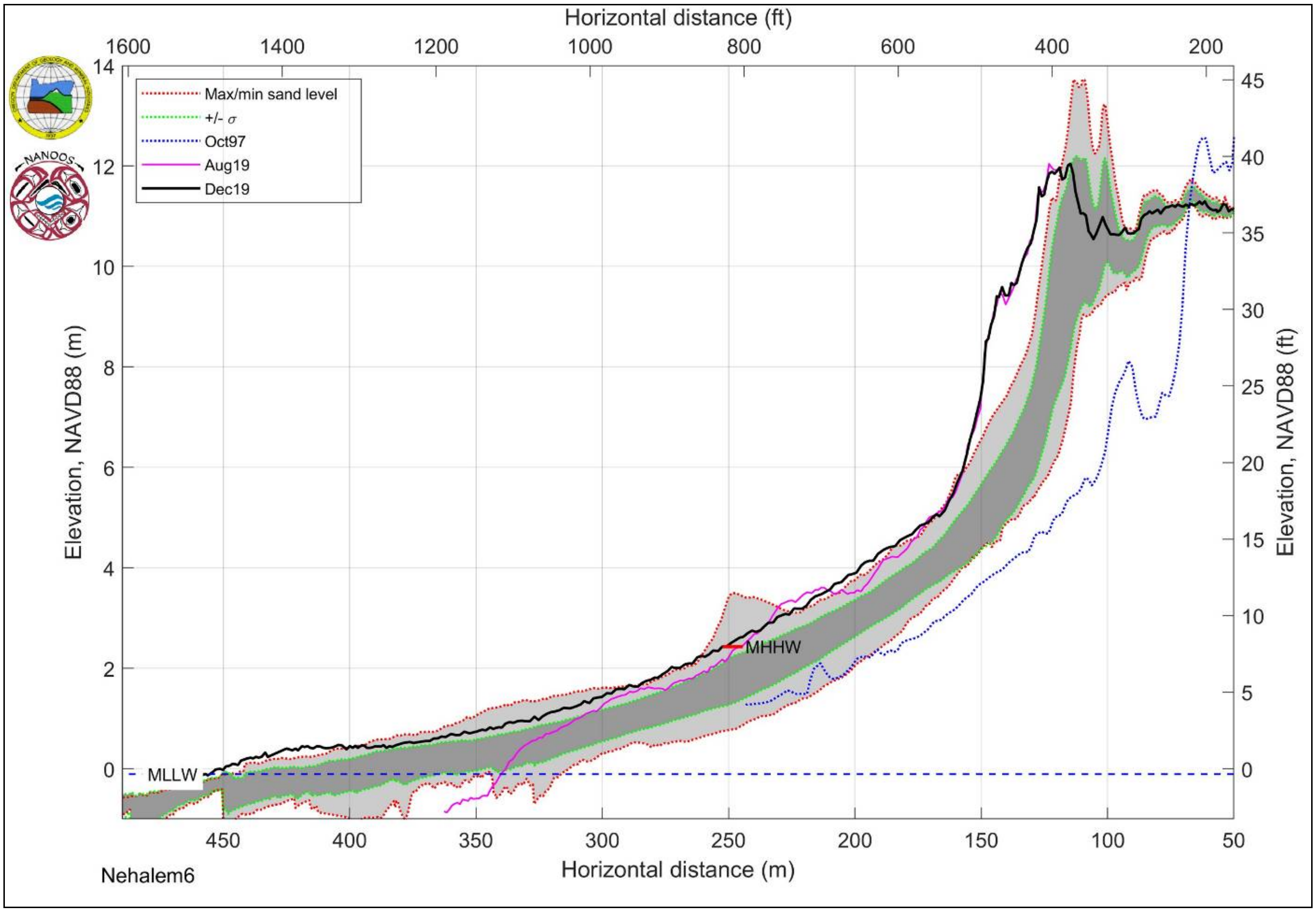


Figure 25: Compilation of beach profiles for Puffin Lane. The dune crest has shifted 200 ft to the west from 1997 to 2019, and 7 ft vertically, as measured at Mean Higher High Water (MHHW). This growth is due in part to the influx of sand by winds, but also by grading of the foredune crest and placement of sand on the west face of the dune complex. Elevations are referenced to NAVD88, rather than NGVD29, which is the datum used in this report. NGVD29 + 3.6 ft = NAVD88. The crest of the dune is 41 ft NAVD29. Profiles are courtesy of the NANOOS website and DOGAMI.

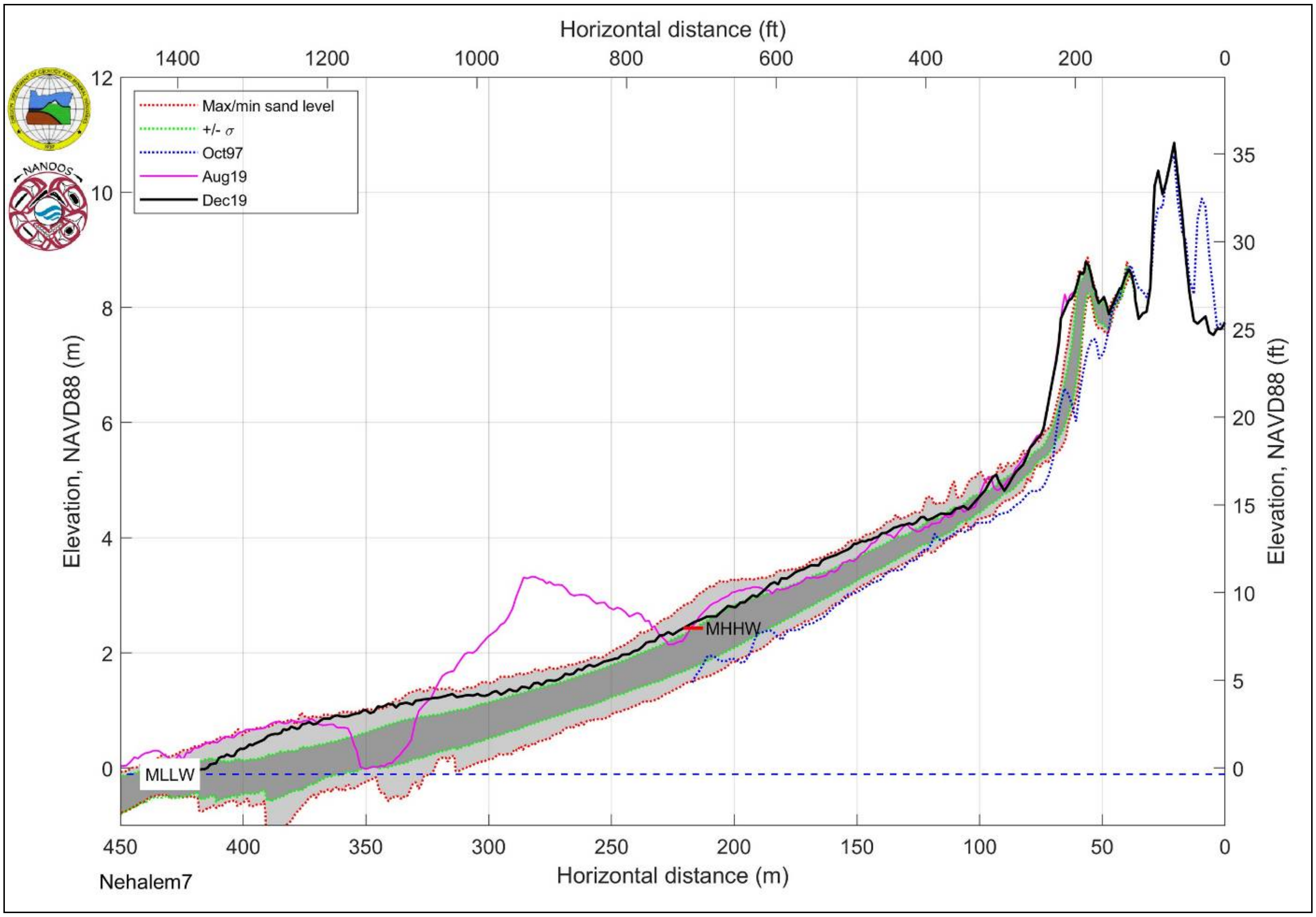


Figure 26: Compilation of beach profiles for Hallie Lane. The upper beach has expanded westward at Mean Higher High Water (MHHW) by about 170 ft and grown vertically about 4 ft, and the western dune shoulder has widened by about 40 ft and risen about 5 ft. The high elevation of the beach in December 2019 may reflect, in part, the limited storminess of Manzanita until January 2020, resulting in extended summer beach profiles. Elevations are referenced to NAVD88, rather than NGVD29 which most of this report references. NGVD29 + 3.6 ft = NAVD88. The crest of the dune is 31 to 32 ft NAVD29. Profiles are courtesy of the NANOOS website and DOGAMI.

Figure 27: Tide claiming dune sand that has been pushed into the intertidal zone. Photo taken April 14, 2015.

Figure 28: Bulldozed sand being claimed by waves during high tide. It took one day to smooth out the rough ridges of sand and from one to two weeks for the excess sand to be removed from the beach, based on elevation differences in dry and wet sand. Photo taken April 2, 2015

Figure 29: View south along middle to upper beach showing the smoothed bulldozer scars and abundant dry beach grass stems and roots. Photo taken April 17, 2015.

Figure 30: Design Foredune Configuration calls for the 25 ft NGVD bench (left). Sand ramp slopes down to the upper beach and becomes a grassy foredune unintentionally.