

MEMORANDUM – COASTAL ENGINEERING REVIEW FIIS – FIRE ISLAND INTERIOR ROADS FLOODING AND PONDING TAR 19774

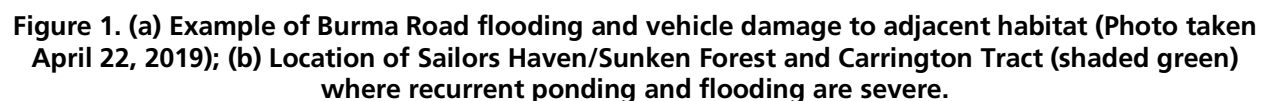
5 April 2021 (Revised 27 July 2021)

Project Background

Fire Island National Seashore (FIIS) is located on Fire Island, an approximately 30-mile-long barrier island south of Long Island across the Great South Bay, in New York State's Suffolk County. Piping plover (*Charadrius melodus*), a migratory shorebird that is federally listed as threatened and New York State listed as endangered, nests on the island's beaches. Driving on Fire Island is managed by the FIIS off-road vehicle (ORV) driving program, with permits required for vehicles other than NPS and emergency vehicles. Driving routes are limited to the beach and Burma Road, an interior route for driving when the beach is not available. Preference is for beach driving, but this is interrupted by closures for piping plover nesting (and occasionally closures for other listed species) and closures due to weather conditions and tides. Burma Road provides driving access for permitted drivers between Kismet and Watch Hill. This access road is prone to flooding and ponding in several areas, attributable to precipitation and storm impacts including nor'easters and tidal influence on the water table. Vehicles using Burma Road have caused significant damage to adjacent wetlands and vegetation by circumventing ponded areas. FIIS needs solutions that allow continued use of Burma Road during and after storms, especially when beach driving is restricted by high tides and/or piping plover nesting season. FIIS has requested a preliminary assessment of options to restore Burma Road and adjacent areas impacted by vehicles traversing off-road.

In recent years, some sections of Burma Road, especially in Sailors Haven/Sunken Forest and Carrington Tract, have experienced repeated and unprecedented flooding and ponding (Figure 1). Storms, flooding, and vehicles created permanent mud pits in the roadway and have degraded adjacent wetland in six different places. In 2019 NPS staff blocked the off-road vehicle trails, pumped the water out of the area and laid sand from a stockpile to repair the damage. During the nor'easter snowstorm of February 1, 2021, a combination of heavy snowfall and accumulation, snowmelt, storm-related groundwater rise, and high tides caused renewed flooding and ponding on Burma Road. Although vehicle traffic is typically light, closure of Burma Road is not a favorable option, as it is the only means of access at times.

This memo summarizes the review of the basic site characteristics, the existing condition of Burma Road and surrounding protected wetland habitat, possible future impacts due to climate change, and potential options to restore the functionality of the roadway and adjacent wetland. This review is limited to the information provided by NPS and any external reference material noted within this memorandum. EA was not tasked with, nor did the team review engineering calculations or similar background design information in detail.



Unpaved roads are vulnerable to rutting, depressions, and other surface deformations. Surface deformation problems are often the result of excessive moisture in the road fill and thus can be reduced with road surface and road ditch maintenance. Depressions are localized low areas one or more inches below the surrounding road surfaces caused by settlement, excessive moisture content, and improper drainage. Ruts are longitudinal depressions in the wheel paths caused by high moisture content in the subsurface soil or base, inadequate surface course thickness, and/or heavy traffic loads. Burma Road has both depressions and ruts holding water up to several inches deep, likely caused by a combination of the factors listed above. Based on a review of photos and documents provided by NPS, many sections of Burma Road appear bounded on either side by higher elevation land (either vegetated sand dunes or pine forest). Drainage ditches are either absent or not visible. A review of USGS topographic maps confirms that Burma Road traverses locally low land north of a string of sand dunes that rise as high as ten to twenty feet above the road elevation. Road materials appear to comprise only local material, with no addition of crushed surfacing aggregate or binder.

Finally, driving behavior is a factor that can exacerbate a surface deformation problem. Vehicles that attempt to circumvent a depression or rut by driving along its margin or avoiding it entirely may cause the

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deformation to widen and/or damage the off-road environment and natural resources, possibly dislodging loose material, and hardening the ground surface.

Sea Level Rise Impacts

Burma Road does not have a constant elevation, but in the Carrington Tract (north of Carrington House) it lies approximately at 2.23 ft relative to the North American Vertical Datum of 1988 (NAVD88).² This puts the road at 2.59 ft above mean tide level, or 1.27 ft above mean high tide. The NPS publication *Sea Level Rise and Storm Surge Projections for the National Park Service*³ provides sea level rise estimates for FIIS of +0.46 ft by 2030, +0.82 ft by 2050, and +2.03 ft by 2100. Another resource is the U.S. Army Corps of Engineers online tool,⁴ from which we used the NOAA intermediate values for sea level rise at the nearest tidal gauge (located at Montauk). NOAA provides sea level rise estimates of +0.29 ft by 2030, +1.05 ft by 2050, and +3.67 ft by 2100. The NOAA intermediate estimates are greater for the 2050- and 2100-year time horizons, therefore we used these more conservative values for the impact analysis as presented in the cross section below. This analysis produces a 100-year flood elevation (with wave runup) of 8.00 ft NAVD88 currently, 8.29 ft NAVD88 in 2030, 9.05 ft NAVD88 in 2050, and 11.67 ft NAVD88 in 2100. Refer to Figure 2 below for an elevation comparison.

The conceptual cross section of key elevations (Figure 2) brings into stark relief several issues currently faced by FIIS. Of greatest concern are the impacts due to SLR and the potential at this site for large portions of the barrier island to be submerged should the intermediate scenarios be exceeded in the next 30 years or so. While the barrier dunes show a significantly higher elevation relative to the SLR scenarios, the mainland facing side of the island will also be directly impacted by SLR and allow inundation to propagate across the island. This theoretical cross section is based upon a single location on the island. Conditions along Burma Road will vary due to local variations in topography and the groundwater system, which is expected to rise nearer to the ground surface as sea level rises (FIIS is already experiencing this).

² OCM Partners. 2021. 2020 USACE NAN Topobathy Lidar DEM: New Jersey and New York. Available at: <https://www.fisheries.noaa.gov/inport/item/58880>. Accessed in April 2021.

³ Caffrey, M. A., R. L. Beavers, and C. H. Hoffman. 2018. Sea level rise and storm surge projections for the National Park Service. Natural Resource Report NPS/NRSS/NRR—2018/1648. National Park Service, Fort Collins, Colorado.

⁴ US Army Corps of Engineers (USACE). 2019. Sea-Level Change Curve Calculator. Available at: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html. Accessed in March 2021.

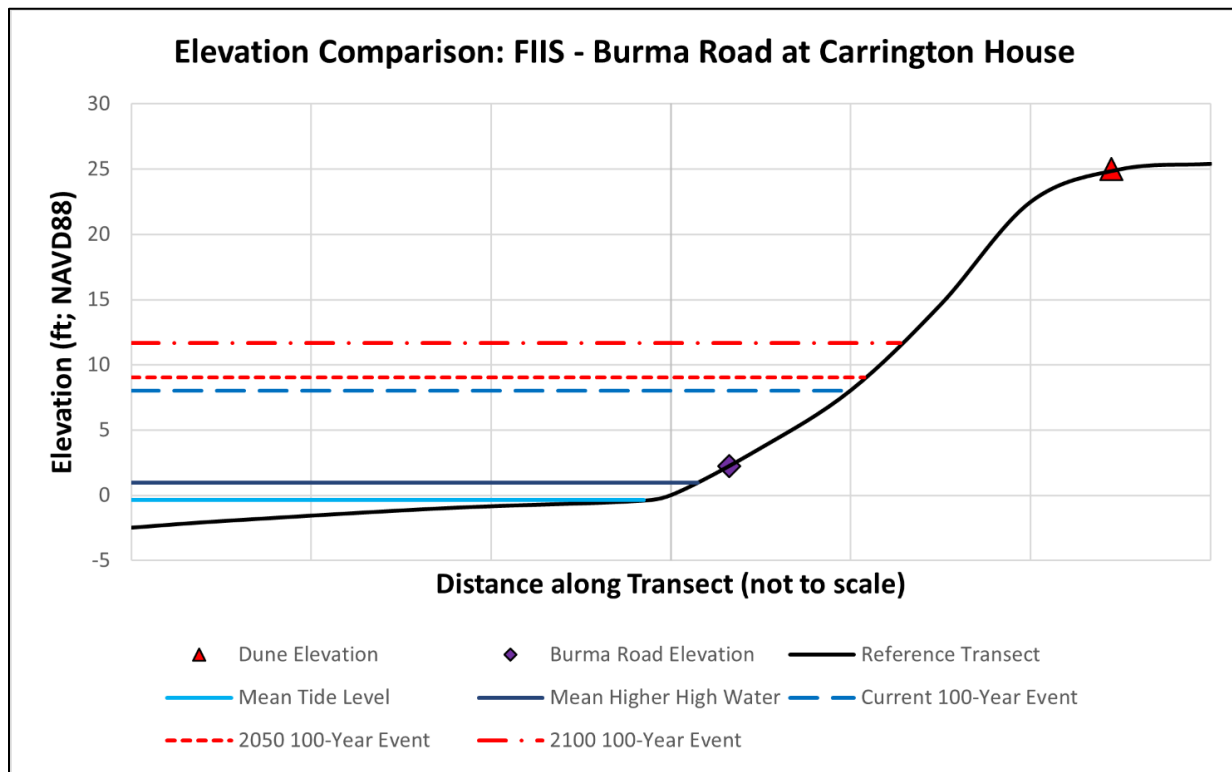


Figure 2. Conceptual cross section depicting a comparison of key elevations.

Potential Engineering and Restoration Options

Following further analyses specific to the sites where flooding has occurred, the following options may be considered to harden the road surface and/or improve drainage:

1. **Timber Cross Members.** A sand road will continue to erode and compact due to vehicle traffic, so further hardening could be conferred by laying large timber logs (6-inch diameter or larger) across these low spots along with and backfilling and compacting. The non-treated, rot resistant timber would provide a potential bridge effect during washouts, but a drawback is that the hard surface might increase washout frequency by conveying faster flows.
2. **Geosynthetic Stabilization Grids.** Grid, mesh, and textile products are available that add structure to stabilize the surface of unpaved roads, distribute vehicular weight, and enhance subsurface drainage. Pocketed, webbed material forming cells can be placed at or below the soil surface, filled with soil or other fill material, to provide improved strength and erosion resistance to the soil surface or profile. This approach usually requires specialized engineering and design. Often installed at the surface, cells are filled with soil and/or aggregate with a layer of topsoil added, then vegetated with seed or sod, or, filled with aggregate without vegetation to provide a non-erosive surface conducive to traffic or simply for reduced maintenance and/or aesthetics. These are available in various shapes, sizes, strengths, and configurations.
3. **Raised Roadway.** An elevated boardwalk style road constructed of timber and/or steel could provide vehicular passage during contemporary flooding events but may not remain usable in future climate scenarios of sea level rise. However, a raised roadway may be appropriate for particular sections of Burma Road. Due to the high cost of this option, it is likely not practical for

long stretches of road but may be optimal where nearby sensitive habitat is particularly valuable, where conditions make previous options unviable, or for high-traffic areas. For public education purposes, this option could also incorporate signage regarding road flooding issues and the predicted impacts to the Park from sea level rise.

Ideally, an unpaved road retains a 3 to 6% cross-slope when sloped in a single direction, or a 4-6% pitch when graded with a crown. Ensuring that water flows quickly off the road surface will avoid accumulations in the roadway. If a hardening option is selected, drainage methods are important to consider. Regrading and backfilling the existing ruts and depressions may be required to give the road either a crown or a graded slope to one side. Because the sand road is highly erodible, any conveyance feature such as a roadside ditch should be planted and maintained with local vegetation, and/or armored with stones or geotextile. Ditches can be strategically placed to convey water into turnouts and/or traps that retain large volumes of water away from the road. Drainage ditches may be used in combination with the above options presented.

There are several strategies to influence driving behavior that could prevent further degradation of the flooded Burma Road and the surrounding natural habitats. Installation of advance warning signs and public communication tools can discourage use of Burma Road by non-emergency vehicles (e.g. homeowners, contractors) when flooding is severe. Installation of high-visibility delineators that provide a visual “edge” to the roadway, especially surrounding areas prone to flooding, may prevent or discourage drivers from going off-road.

Comments

Based upon review of the provided data, the following comments are presented:

- Analyses of soils and topography, hydrology, hydrogeology, road material, etc. will help determine the relative importance of the immediate contributing factors considered above.
- Timber cross members could be a low-cost option for immediate and potentially long-term resolution while analyses are conducted to determine other feasible options.
- Monitoring of Burma Road rutting and depression sites should be continuous to determine erosion and compaction rates.
- Field cameras to remotely record (with dated timestamps) conditions during storms, potentially to be deployed prior to heavy forecast rain events in addition to coastal surge and high tide events, may provide further insight into the flooding mechanisms.
- Our preliminary sea level rise analysis indicates that by 2100, the road’s current elevation will be 1.8 ft lower than mean sea level. Investment in costly infrastructure, such as an elevated roadway, may not be practical.
- If there is additional information regarding overwash events from Superstorm Sandy that could be reviewed, it may be possible to qualitatively assess the resiliency of the presented options relative to predicted sea level rise, and this information could be included in any future engineering review.
- Vehicle mobilization mats, such as Mobi-mats could be utilized as another seasonal solution during the higher traffic summer months.⁵

⁵ Deschamps SAS & Deschamps Mats Systems Inc.2020.Vehicle roll out portable access mats - Mobi-Mat by DMS Inc. Available at: <https://www.mobi-mat-chair-beach-access-dms.com/vehicle-roll-out-portable-access-mats/#>. Accessed in April 2021.

Using the timber cross members to provide immediate relief for washout areas is likely the most expedient option and could be deployed and recovered should another option be desired. NPS could conduct value engineering of these options, coupled with a topographic analysis, to determine the full extent of SLR impacts based on the scenarios detailed above. If more detailed elevation data for Burma Road (and connecting roadways) becomes available, the creation of a preliminary flood impact model may help to indicate other areas at risk of flooding. This preliminary analysis would be helpful prior to investing in targeted infrastructure improvements.

References

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