ATKINS
Member of the SNC-Lavalin Group

Golden Gate National Recreation Area Preliminary Hydraulics Recommendations Report

CA FTNP FOPO 110(1) & GOGA 205(1)

Long Avenue, Stinson Beach Parking Area, Fort Funston Parking Area, Tennessee Valley Parking Area, and China Beach

Federal Highway Administration, Central Federal Lands Highway Division

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Table 6.5: Fort Funston Parking Area Preliminary Recommendations

Drainage Area ID	Recommendation
TV01	Improve existing drainage ditch to prevent breakout near bathrooms.
TV02	Improve existing drainage ditch to prevent breakout near bathrooms.
TV03	Flow is non-contributing and exits the site to the north.
TV04	Provide curb-cut in new curb to prevent ponding and allow flows to exit south.
TV05	Partially non-contributing; No improvements required—offsite basin contributing to eastern boundary of site.
TV06	No improvements required—offsite basin contributing to eastern boundary of site.
TV07	No improvements required—offsite basin contributing to eastern boundary of site.
Southern boundary of parking lot	Provide grading per EISA 438 requirements to mitigate pre vs post volume.

7. Stinson Beach Parking Area

7.1. Sub-Project Background

Stinson Beach is in Marin County approximately 10 miles northwest of the Golden Gate Bridge and is one of the most popular swimming beaches within the Golden Gate National Recreation Area. The beach is served by three parking areas. For purposes of this report, they are referred to as the north, central, and south lots.

The south lot is nearly 4 acres in size and is comprised of compacted earth with grass berms demarking 13 drive aisles with room for about 475 cars. The southwestern side is bordered by dunes and a small, flat, grassy ditch. Ponding occurs on the southwestern side of the parking area.

The central lot is nearly 1.5 acres in size and is comprised of asphalt paving and approximately 150 parking spaces.

The north lot is nearly 1.6 acres in size and is comprised of asphalt paving and approximately 190 parking spaces.

The entry road, north, and central lots will be improved by pulverizing existing asphalt and base course and regrading to drain. The central lot will implement a wide swale area to handle overtopping flows from Easkoot Creek and route them safely south to the beach. The north and central lots will provide for the removal and replacement of drainage inlets to maintain drainage patterns and to route flows to the new swale area. The north and central lots will be resurfaced with hot mix asphalt paving and deteriorated curbing and sidewalks will be replaced to meet ADA requirements. The lots will be restriped.

The south lot will be improved with a base course in the parking spots and asphalt paving in the drive aisles. The entire lot will be reconfigured to maximize parking by eliminating the wide berms. Drainage will continue southward to an expanded ditch that will handle EISA 438 volumes.

The goals for this location are to: (1) analyze and identify existing flow patterns, flow rates, offsite flows (other than Easkoot Creek), and ponding areas, (2) evaluate the quantity and primary spill-over location of the Easkoot Creek flows for the 100-year, 24-hour storm, and (3) list preliminary recommendations for the 30% design.

7.1.1. Site History

The north and central parking lots at Stinson Beach have been affected by historical flooding from storm flows overtopping Easkoot Creek. Marin County completed a thorough watershed study and alternatives assessment in May of 2014, which encompassed the site. The study focused on flooding, sedimentation, and habitat issues and included a thorough, calibrated hydrology model and a two-dimensional (2D) hydraulic model. The alternatives assessment was developed to support a community decision making process. Alternatives were selected from meetings with a stakeholder working group and presented at a public meeting in Stinson Beach on April 2012. These alternatives included bridge improvements, vegetative management, dredging, and wetlands creation. The study concluded that due to the alternatives requiring both public and private lands and lack of funding, further stakeholder and community involvement would be needed.

7.1.2. Flood History

Flood damage to the community and park areas near Stinson Beach has been recorded since 1954. Damages to the bridges over Easkoot Creek, flooding in the residential streets, and damage to the building currently occupied by the Parkside café all have occurred. Based on District records, floods of note occurred in 1972, 1973, 1982, 1986, 1997, 2005, and 2018. Sediment removal within Easkoot Creek at the bend toward Bolinas Lagoon is part of the County's annual budget under special permit with the NPS. Undermining failure to the north lot occurred during the 2018 storm (see Figure 7.1).

Figure 7.1: North Lot—Damage from Overtopping of Easkoot Creek

7.2. Existing Conditions Hydrology and Hydraulics

7.2.1. Drainage Patterns

The existing drainage patterns for the Stinson Beach lots are shown in Appendix E, Exhibits E.5.1A, B, and C. The north lot drains from southeast to northwest and has been damaged by storm flows overtopping Easkoot Creek, which spill into the ocean at the north end (see Figure 7.1). The north half of the central lot drains generally from northeast to southwest and then northwest along the dunes. The south half of the central lot drains from north to southeast and ponds near the dunes at the southeast corner. A portion of the offsite commercial, residential, and park maintenance areas between Highway 1 and Marine Way drain into the north half of the central lot through a long scupper near Marine Way (see Figure 7.2). The south lot does not receive any offsite flow. The lot generally drains from north to south into three ponding areas along the dunes (see Figure 7.3). Flows overtopping ponding areas would migrate to the southeast and onto the beach near the southeast corner.

Figure 7.2: Central Lot—Long Scupper

Figure 7.3: South Lot—Ponding Areas along the Dunes

7.2.2. Drainage Infrastructure

The three parking lots of Stinson Beach do not contain significant drainage infrastructure. The existing 3-foot x 68-foot x 6-inch scupper passes offsite flows through the central lot. This scupper has a longitudinal slope of 1.6% and is lined with asphalt and adjacent concrete curbs. It carries approximately 9.0 cfs. The existing grassy ditch along the dunes in the south lot ponds any flows not ponding on the access road. All the parking lots generally slope southwest toward the dunes.

7.2.3. Data Sources

7.2.3.1. Elevation Data

Elevation data sources onsite and offsite are summarized in Table 7.1, below.

Table 7.1: Stinson Beach Elevation Data Sources

Location	Onsite	Offsite	Raw Elevation Data Set (Produced For, Year)	Projected Coordinate System	Vertical Datum	NVA	VVA
Stinson Beach	X		Site Survey (Atkins by R.E.Y. Engineers LLC, 2020)	NAD83 California State Plane, Zone III US foot	NAVD88		
		X	Marin County LiDAR (GGNPC, 2019)	NAD83 (2011) UTM Zone 10 Meters	NAVD88	8.8 cm	20.0 cm

Abbreviations: GGNPC = Golden Gate National Parks Conservancy; NVA = Non-vegetated vertical accuracy; VVA = Vegetated vertical accuracy

7.2.3.2. Rainfall Data

Precipitation intensity and precipitation depth data for Latitude 37.8969 degrees, Longitude -122.6397 degrees obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 6, Version 2, are summarized in Table 7.2 and Table 7.3, respectively. Precipitation depth for the 2-year, 24-hour event is used in the computation for sheet flow (Appendix E). Precipitation intensity is used to develop the site-specific IDF curve (Appendix C).

Table 7.2: Stinson Beach Precipitation Intensity for a 10-Year Storm Event

Duration (minutes)	Duration (hours)	Intensity (inches/hour)
5	0.083	3.36
10	0.167	2.41
15	0.25	1.94
30	0.5	1.42
60	1	1.02
120	2	0.75
180	3	0.63

Table 7.3: Stinson Beach Precipitation Depth for a 2-Year, 24-Hour Storm Event

Event	Depth (inches)
2-Year, 24-Hour	3.42

7.2.3.3. Soil Data

The north and central lots currently are paved and will be replaced with new paving. The underlying soils at the south lot are primarily Dune land per the NRCS Web Soil Survey (Appendix B). There is no hydrologic soil group associated with this soil unit type; therefore, a C value representing existing, hard-packed dirt parking governs.

7.2.4. Drainage Area Calculations

7.2.4.1. Drainage Area Delineations

Drainage area delineations for each lot are shown in Exhibits E.5.1A, B and C in Appendix E.

7.2.4.2. Rational Method

The Rational Method estimates a watershed's peak flow based on inputs that include a dimensionless runoff coefficient (C), rainfall intensity (i), and the drainage area acreage (A). The C values and drainage areas are summarized in Appendix D. Peak flows are summarized in Table 7.4, and calculations are provided in Appendix E.5.2.

Table 7.4: Stinson Beach Parking Area 10-Year Peak Flows

Watershed ID	Peak Flow (cfs)
SB_N_01 (north lot)	6.3
SB_C_01 (central lot)	3.0
SB_C_02 (central lot)	2.5
SB_C_03 (central lot)	5.3
SB_C_01+ SB_C_03 (central lot)	8.3
SB_S_01 (south lot)	3.4
SB_S_02 (south lot)	3.1
SB_S_03 (south lot)	3.8

7.2.4.3. Time of Concentration

Pavement drainage areas assume a time of concentration of five minutes. Calculations are shown in Appendix E, Exhibit E.5.2.

7.2.4.4. Hydraulics

The site does not have any functioning drainage infrastructure. No hydraulics calculations were required.

7.3. 2D Modeling

Historic flooding has caused repeated damage to the central and north lots. To evaluate required mitigation measures, a 2D model was created using Aquaveo's Surface-Water Modeling System (SMS v.13.0). The purpose of the model was to determine the magnitude of storm flows overtopping Easkoot Creek near the pedestrian bridge at the corner of Calle del Mar and Arenal Avenue.

7.3.1. Model Input

Accompanying the SMS model is a model documentation memo that details model inputs. Below is a high-level summary.

7.3.1.1. Surface Data

Model elevations were created within SRH-2D using scatter data extracted from both the LiDAR and site topographic survey (see Section 7.2.3.1).

7.3.1.2. Model Boundary Conditions

The peak inflow boundary condition was on the hydrology results from the 2014 Marin County flood study. The 100-year, 24-hour peak flow from the study was approximately 500 cfs within Easkoot Creek at Arenal Avenue. A six-hour model duration was used to ensure all elements within the model reached full inundation at 500 cfs.

The downstream boundary condition encompasses the outflow along the western and southern limits of the model. A constant water surface elevation of 9.6 feet was determined using the scatter data interpolation tool within SMS.

7.3.1.3. Coverage Map and Mesh

The model area was selected to bracket the limits of the flows overtopping Easkoot Creek. The limits were set to cover the entire east to west portion of the reach, a portion of the creek extending up to Arenal Avenue, and the central and north lots (see Exhibit E.5.4A, Appendix E). Mesh elements and other required inputs were created using Aquaveo SMS v13.0. There are 82,146 mesh elements. Mesh size was increased or decreased for two reasons: (1) to characterize topography, and (2) to target key conveyances and concentrated flow areas. A grid-shaped mesh was used within Easkoot Creek. Mesh and grid sizes range from approximately 30 feet to 1 foot.

7.3.1.4. Materials Coverage

Land characterization shapes were prepared in ArcGIS v10.6.1. Each shape was assigned a material type and associated Manning's n value for populating spatially varied roughness into the model (see Exhibit E.5.4B). Manning's n values of 0.050, 0.035 and 0.022 were assigned to low shrubs/grass, the sandy bottom portion of the creek, and pavement, respectively.

7.3.1.5. Obstructions

Two bridges were modeled within Easkoot Creek: the bridge at the north park entrance and the pedestrian bridge near Calle del Mar. Bridge deck geometries were obtained from the site survey and coded into the model as blockages with drag coefficients. Additionally, 16 buildings were modeled as enclosed, vertical boundaries containing no mesh elements.

7.3.2. Results

Maximum flow depth results obtained from the model were exported to a raster and color-coded in GIS for easy visualization. Peak flow data were extracted at pertinent locations for facilitating design of an overflow channel (see Exhibit E.5.4C). The areas of concern include overtopping into Marine Way (Flow Location #6 = 65 cfs) and overtopping at the sedimentation basin (Flow Location #3 = 210 cfs). A total flow of 293 cfs was obtained from Flow Location #4. These peak flows will be used to implement design swales north of the new park entry road, a dip-crossing in the profile of the new entry road, and an overflow channel to safely pass flows to the beach before they reach Flow Location #5.

7.4. Proposed Improvements

Proposed improvements include new access road alignment, pavement, curb installation, striping, and grading. Additionally, in the south lot, the access road along the southern side of the lot will be cross sloped to eliminate ponding and allow flows to drain to the existing ditches and ponding areas near the dunes. The new access road profile along the central and north lots will incorporate a two-foot-deep, 300-foot-wide dip-crossing beginning near the existing pedestrian bridge. Grading along the north side of the new entry road will guide flows overtopping the creek to the dip crossing and then into a shallow, wide, turf-lined channel. A short, 2-foot to 2.5-foot-high retaining wall will be needed along the outside embankment of the creek to grade a flat slope toward the dip-crossing. Scour protection will be needed along the top and bottom of wall to handle higher velocities overtopping the creek embankment. The retaining wall will extend 3 feet below proposed grade. Turf and native landscaping are recommended to abut the wall and throughout the graded area north of the new access road. The landscaped area north of the access road will be graded toward the low point of the dip-crossing to allow side drainage to enter the channel. The channel will extend from south of the entry road dip-crossing and through the dunes. Channel hydraulic calculations will be included in the Draft Final Report. Curbs and sidewalks are to meet ADA requirements.

7.4.1. Impacts to Existing Drainage Patterns

7.4.1.1. Access Road, Pavement, Curbs and Channel/Swale

New pavement will maintain near existing grades to retain existing flow patterns and return flows to historical outflow locations. However, the central lot will be graded to incorporate the swale/channel. This will provide a positive outfall for flows that previously ponded against the dunes and handle offsite flows that damaged the north parking lot.

7.4.2. Preliminary Calculations

Calculations and sizing of items identified as preliminary improvements will be provided in the Draft Final Report.

7.4.3. Preliminary Recommendations

Recommendations are summarized in Table 7.5.

Table 7.5: Stinson Beach Parking Area Preliminary Recommendations

Parking Lot	Recommendation
North Lot	Ensure pavement grading maintains historical flow patterns; incorporate channel grading through picnic area and through the dunes to the beach.
Central Lot	Grade offsite flows from SB_C_03 toward north side of dip-crossing; re-aligned park entry road; incorporate swale/channel grading; ensure pavement grading to historical flow patterns.
South Lot	Eliminate ponding on access road to convey flows to existing ditch/ponding areas near the dunes.