



Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment for San Juan Island National Historical Park & Ebey's Landing National Historical Reserve

Summary of Results

NPS 438/199213, NPS 484/199213, March 2026



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Block House at San Juan Island National Historical Park

Photo credit: National Park Service

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Executive Summary

This document presents the results of the **Coastal Hazards & Sea-Level Rise (SLR) Asset Vulnerability Assessment (VA)** completed by Western Carolina University at San Juan Island National Historical Park (SAJH) and Ebey’s Landing National Historical Reserve (EBLA) in 2025. In this VA, we evaluate the vulnerability (as a combination of exposure and sensitivity) of NPS buildings and transportation assets¹ to identified coastal hazards and climate change factors, approximately to the year 2050 (for full methodology, see Peek et al. 2022).

We assessed 21 buildings (including a visitor center, comfort stations, maintenance buildings, and historic structures) and 53 transportation assets (roads, parking lots, trails/trail segments, and a dock) at SAJH. Less than one-quarter of the assets evaluated at SAJH have high (16%) or moderate (7%) vulnerability to the evaluated coastal hazards and SLR, while 5% have low vulnerability. Most assets (72%) have minimal vulnerability (outside of all hazard zones). Scoring details and results for all assets evaluated at SAJH are reported in the provided Excel sheets. We also assessed 30 buildings (including historic houses, sheds, and farm buildings), and 19 transportation assets (roads, parking lots, and trails) at EBLA. All assets have minimal vulnerability (outside of all hazard zones).

SAJH Exposure Results

Exposure is a measure of the character, magnitude, and rate of changes a target may experience (e.g., from the impacts of natural hazards or climate change; NPS 2021). In this VA, we evaluate the exposure of each asset to the following coastal hazard indicators: flooding potential, shoreline change, SLR inundation, extreme event flooding, and reported coastal hazards (Table 1).

Table 1. Exposure indicators and hazard data sources used for SAJH.

Exposure Indicator (Description)	Data (Citation)
Flooding potential (1% annual-chance)	Effective FEMA VE & A zones (FEMA 2018)
Shoreline change (coastal proximity)	25-m shoreline proximity buffer (Peek et al. 2022)
SLR inundation (2050)	NPS 2050 8.5 RCP SLR model; 0.16 m rise (Caffrey et al. 2018) NOAA 1 ft SLR inundation zone (NOAA 2022)
Extreme event flooding (tsunami)	Washington State DNR Tsunami Hazard Areas (WGS 2024)
Reported coastal hazards (historic flooding)	Questionnaire results & discussions (Peek et al. 2022)

¹ The NPS Facility Management Software System (FMSS) database defines assets as “...a physical structure or grouping of structures, land features, or other tangible property that has a specific service or function, such as a farm, cemetery, campground, marina, or sewage treatment plant. The term ‘asset’ shall also be applied to movable items, such as vehicles and equipment.”

Assets with high exposure are within at least four exposure indicator hazard zones. Assets with moderate exposure are within two or three exposure indicator hazard zones. Assets with low exposure are within only one exposure indicator hazard zone. The asset could still be seriously impacted by this hazard. Assets with minimal exposure are not in any exposure indicator hazard zone. This does not mean that the asset has no exposure to coastal hazards, but it is not within the exposure hazard data used in this study. Figures 1-2 illustrate the exposure hazard data for the primary areas of SAJH.



Figure 1. SAJH exposure hazard data in the English Camp: A) FEMA flood zones (AE zone shown as yellow shading), B) shoreline proximity (red striped), C) SLR (NOAA 1 ft shown as light blue shading and NPS 0.52 ft as dark blue), D) tsunami hazard (green shading). General areas in the English Camp are labeled. Background is 2021 ESRI world imagery.

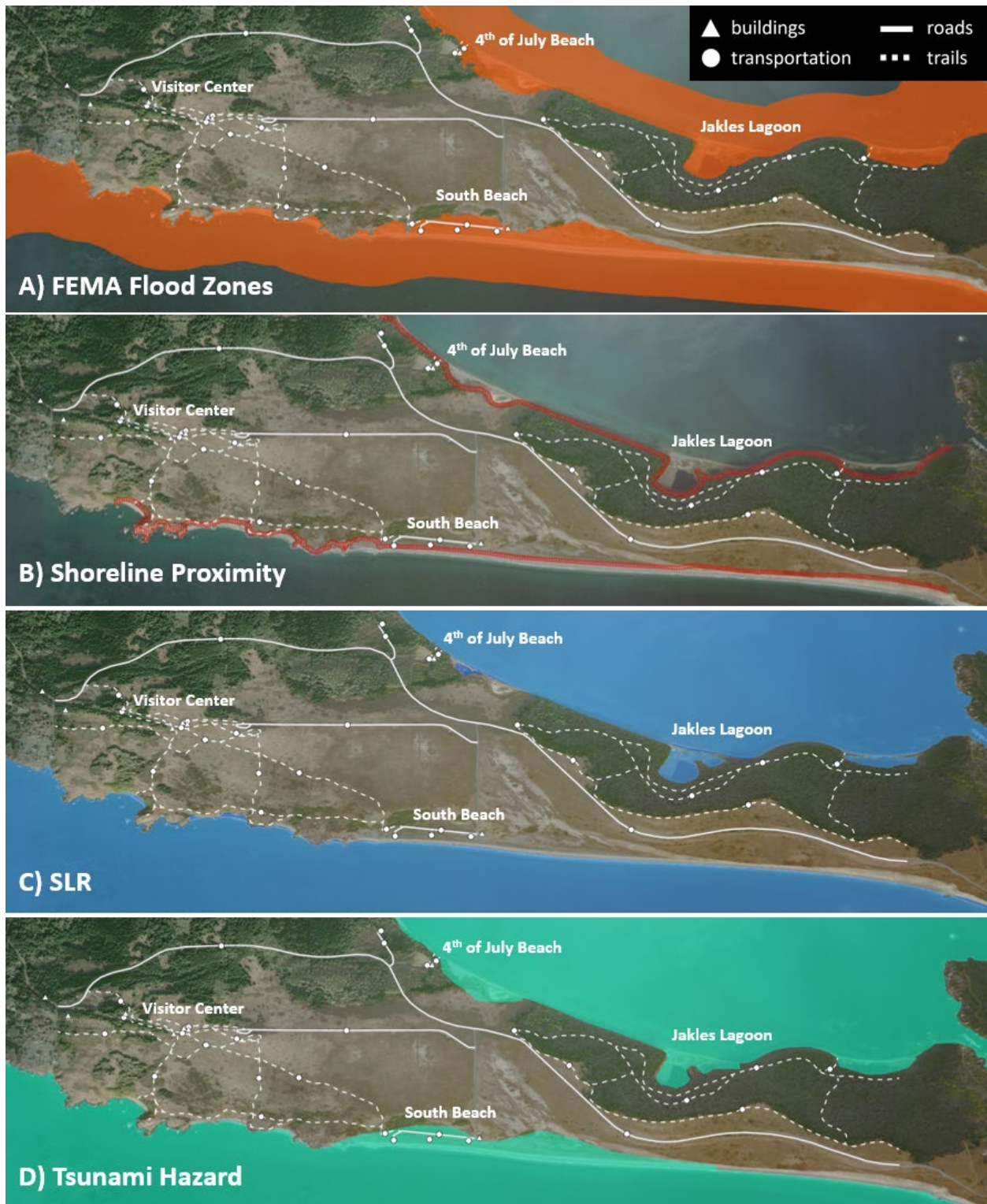


Figure 2. SAJH exposure hazard data in the American Camp: A) FEMA flood zones (VE zone shown as orange shading), B) shoreline proximity (red striped), C) SLR (NOAA 1 ft shown as light blue shading and NPS 0.52 ft as dark blue), D) tsunami hazard (green shading). General areas in the American Camp are labeled. Background is 2021 ESRI world imagery.

Twelve (16%) assets analyzed at SAJH have high exposure to the coastal hazards evaluated (Table 2). Transportation assets make up the majority of the high exposure assets across the park. Three assets are within all evaluated exposure zones: Blockhouse, EC Trails – Westcott Loop, and Dinghy Dock. Five assets (7%) evaluated at SAJH have moderate exposure and four (5%) have low exposure. Almost three-quarters (72%) of assets have minimal exposure, a result of the park’s higher elevation leading to lower exposure overall to coastal flooding and SLR (Figures 3-4).

Table 2. SAJH exposure results. Sum of percentages may not equal 100 due to rounding.

Assets	High Exposure		Moderate Exposure		Low Exposure		Minimal Exposure		Total
	#	%	#	%	#	%	#	%	
Buildings	3	14%	2	10%	2	10%	14	67%	21
Transportation	9	17%	3	6%	2	4%	39	74%	53
All Assets	12	16%	5	7%	4	5%	53	72%	74



Figure 3. SAJH exposure results for the English Camp. Background is 2024 ESRI world imagery.



Figure 4. SAJH exposure results for the American Camp. Background is 2024 ESRI world imagery.

SAJH Sensitivity Results

Sensitivity reflects the degree to which a resource is affected by exposure (NPS 2021). In this VA, we assess the following sensitivity indicators: flood damage potential, storm resistance and condition, historic damage, and protective engineering. In general, assets with high sensitivity have unfavorable determinations for 3 or 4 of these indicators, moderate sensitivity assets have unfavorable determinations for 2 indicators, and low sensitivity assets have unfavorable determinations for 0 or 1 indicator. Assets with minimal exposure are not analyzed for sensitivity (this is the case for 53 assets at SAJH).

Only two assets (Blockhouse and EC Trails – Westcott Loop) analyzed at SAJH have high sensitivity to the coastal hazards evaluated (Table 3), both of which received unfavorable rankings for all sensitivity indicators. Nineteen assets have moderate sensitivity, and no assets have low sensitivity. In most cases, assets had high sensitivity (versus moderate) due to the condition and historic damage indicators. No assets were reported to have effective protective engineering, and most are not storm resistant.

Table 3. SAJH sensitivity results. Sum of percentages may not equal 100 due to rounding.

Assets	High Sensitivity		Moderate Sensitivity		Low Sensitivity		Total Analyzed	Excluded*
	#	%	#	%	#	%	#	#
Buildings	1	14%	6	86%	0	0%	7	14
Transportation	1	7%	13	93%	0	0%	14	39
All Assets	2	10%	19	90%	0	0%	21	53

*Minimal exposure assets were excluded from the sensitivity analysis; total number analyzed is different for sensitivity.

SAJH Vulnerability Results

Vulnerability is a measure of the degree to which park resources and assets are “susceptible to harm from direct and indirect effects of climate change, including variability and extremes” (NPS 2021). In this VA, we evaluate the vulnerability of infrastructure assets as a simple combination of exposure and sensitivity ratings. It should be noted that the vulnerability of any asset can change with time (e.g., due to adaptation actions or the result of geomorphic change).

The vulnerability results at SAJH are identical to the exposure results, as the majority of assets evaluated for sensitivity were scored as moderate (Table 4, and Figures 5-6). This lack of variability in sensitivity means that the vulnerability of assets at SAJH is primarily controlled by exposure. The Blockhouse and EC Trails – Westcott Loop have both high exposure and high sensitivity (Figure 5). South Beach Parking and the Blockhouse have both high vulnerability and a high asset priority index (API ≥ 70 , as reported in FMSS).

Table 4. SAJH vulnerability results. Sum of percentages may not equal 100 due to rounding.

Assets	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		Total
	#	%	#	%	#	%	#	%	
Buildings	3	14%	2	10%	2	10%	14	67%	21
Transportation	9	17%	3	6%	2	4%	39	74%	53
All Assets	12	16%	5	7%	4	5%	53	72%	74



Figure 5. SAJH exposure and vulnerability results for the English Camp. Only high or moderate assets are labeled. Background is 2024 ESRI world imagery.



Figure 6. SAJH exposure and vulnerability results for the A) Fourth of July Beach, B) Third Lagoon, and C) South Beach areas of the American Camp. Only high assets are labeled. Background is 2024 ESRI world imagery.

SAJH Unique Considerations

FMSS and Linear Assets: In FMSS, all trails at SAJH are grouped into four assets: American Camp Historic Area Trails, American Camp Contemporary Trails, English Camp Historic Trails, and English Camp Contemporary Trails. Instead of using these FMSS designations, we segmented trails based on information provided by the park. Two of these trails (South Beach Trail and Bell Point + Spur) were further segmented based on exposure. In total, we analyzed 17 trails/segments in the American Camp area and 18 in the English Camp area. We evaluated each segment/trail individually for exposure, sensitivity, and vulnerability.

SLR Data: We used two sources for the SLR indicator: 1) National Oceanic and Atmospheric Administration (NOAA) 1 ft SLR model (2022), and 2) NPS 2050 8.5 Representative Concentration Pathway SLR projection and inundation model (Caffrey et al. 2018; 0.16 m or 0.52 ft rise for SAJH).

Natural and Cultural Resources: Although less than one-quarter of evaluated infrastructure assets at SAJH have high or moderate vulnerability, the park also has significant natural and cultural resources that are highly exposed to coastal hazards. For example, there are middens scattered across San Juan Island, many of which are near the shoreline and could be impacted by both flooding and erosion hazards. While this VA protocol (Peek et al. 2022) is designed to evaluate infrastructure, the hazard data can be used to highlight the coastal exposure of other resources.

EBLA Exposure & Vulnerability

All evaluated assets at EBLA have minimal exposure and vulnerability to the assessed coastal hazards, as much of Whidbey Island has significant elevation, and most assets are located well inland. EBLA also has numerous landscapes of importance, including scenic easements and fee simple areas (Figure 7). While this VA protocol (Peek et al. 2022) is not specifically designed to assess these landscapes, hazard data can be used to highlight the coastal exposure of an area. Most of these park landscapes are outside the evaluated coastal hazard zones.

The Bluff Trail and Ferry House areas of EBLA are the closest to the island shoreline and evaluated coastal hazard zones. Although the assets in these areas have minimal vulnerability using this VA protocol, approximately 300 feet of the Bluff Trail (near the parking lot) is highly exposed to coastal hazards (in the FEMA VE, shoreline proximity, SLR, and tsunami zones; Figure 8). However, most of the trail (over 97% by length) is outside of all hazard zones. The Ferry House is another significant asset to EBLA, and sits only a few feet from a small creek, and approximately 500 feet from the island shoreline. While the evaluated coastal hazard zones do not extend to this building, there is the possibility of flooding from this creek during heavy precipitation events, which is not reflected in the available FEMA maps.

There are also several non-NPS assets in this area that are highly exposed to coastal hazards, including the Bluff Trail Parking Lot and Restroom, as well as portions of Hill Road (Figure 8). While these assets are not listed in FMSS or maintained by NPS, they provide access and/or support to numerous EBLA resources, and therefore their exposure should be considered in future planning efforts.

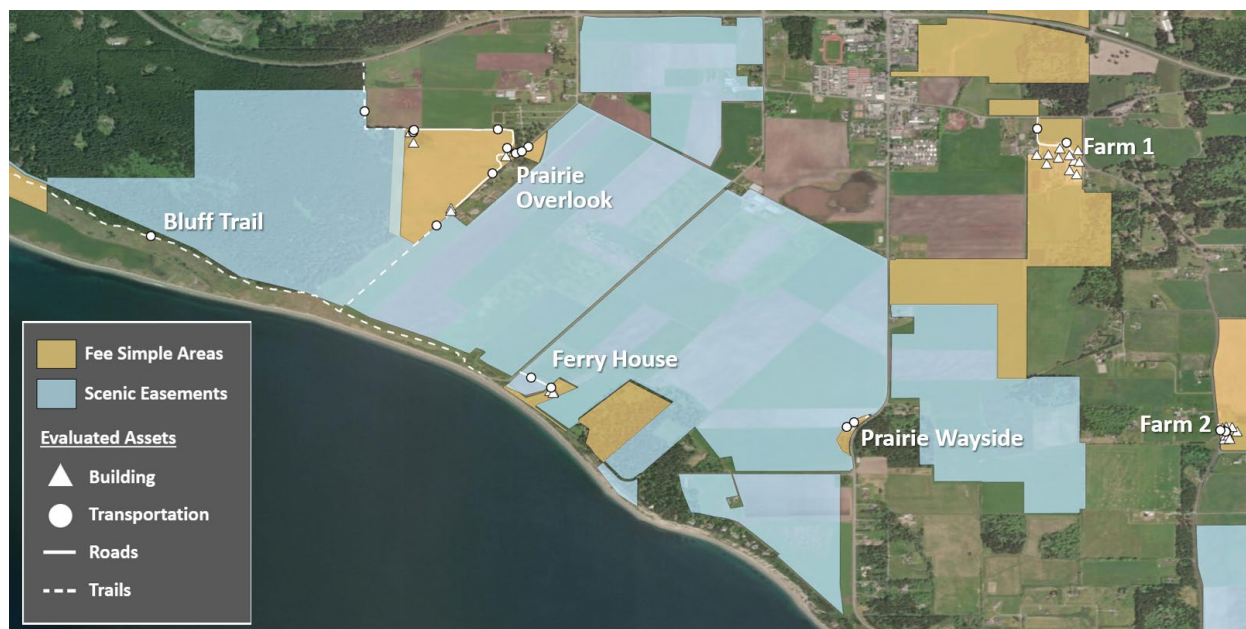


Figure 7. Map of EBLA assets with adjacent scenic easements and fee simple areas (general park areas are labeled). Background is 2021 ESRI world imagery.

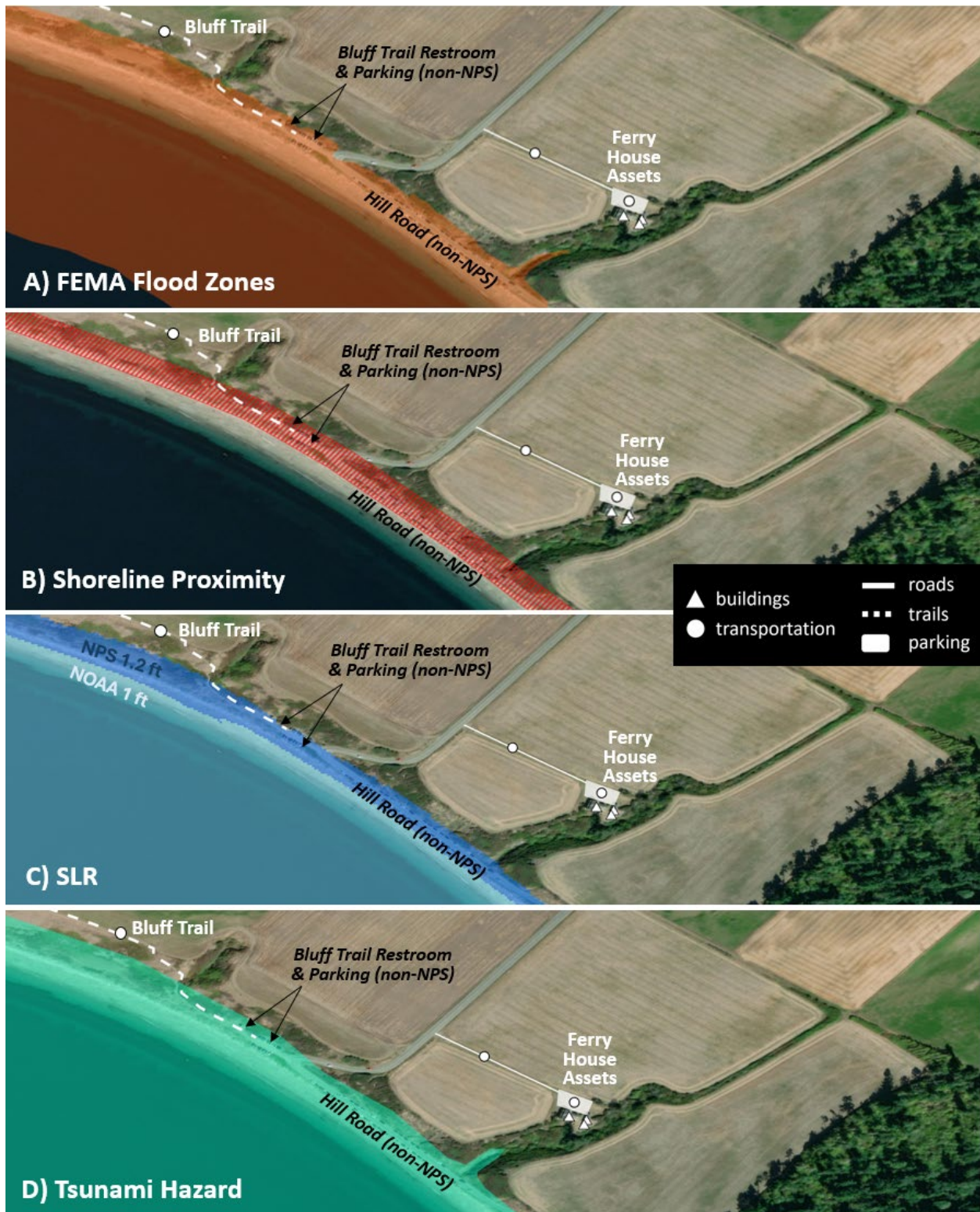


Figure 8. Exposure hazard data for the Bluff Trail and Ferry House areas of EBLA: A) FEMA flood zones (VE zone shown as orange shading), B) shoreline proximity (red striped), C) SLR (NOAA 1 ft shown as light blue shading and NPS 1.2 ft as dark blue), D) tsunami hazard (green shading). Background is 2021 ESRI world imagery.

References

- Caffrey, M., R.L. Beavers, and C. Hawkins 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.
- Federal Emergency Management Agency (FEMA). 2018. National Flood Hazard Layer. San Juan County, WA. <https://www.fema.gov/flood-maps/national-flood-hazard-layer>. Accessed December 2024.
- National Oceanic and Atmospheric Administration (NOAA). 2022. Sea Level Rise Viewer. Available at: <https://coast.noaa.gov/slr/>. Accessed December 2024.
- National Park Service (NPS). 2021. Coming to terms with climate change: Working definitions. National Park Service Climate Change Response Program, Fort Collins, Colorado.
- Peek, K.M., B.R. Tormey, H.L. Thompson, and R.S. Young. 2022. Coastal hazards & sea-level rise asset vulnerability assessment protocol: Updated project description & methodology. Natural Resource Report. NPS/NRSS/CCRP/NRR—2022/2427. National Park Service. Fort Collins, Colorado. Available at: <https://doi.org/10.36967/2293653>.
- Washington Geological Survey (WGS). 2024. Tsunami hazard--GIS data: Washington Geological Survey Digital Data Series 22, version 2.1, October 2024. Previously released December 2023 https://fortress.wa.gov/dnr/geologydata/publications/data_download/ger_portal_tsunami_hazard.zip. Accessed December 2024.



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