National Park Service
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Natural Resource Stewardship and Science

Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment for Petersburg National Battlefield

Summary of Results

NPS 325/187657, February 2023

PROGRAM FOR THE STUDY OF DEVELOPED SHORELINES
Western Carolina University

ON THE COVER
Old City Point Waterfront Park at Petersburg National Battlefield
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Program for the Study of Developed Shorelines
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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 Petersburg National Battlefield (PETE) in 2022. In this VA, we evaluate the vulnerability (as a combination of exposure and sensitivity) of NPS buildings and transportation assets[1] to identified coastal hazards and climate change factors, approximately to the year 2050 (for full methodology, see Peek et al. 2022).

We assessed 100 buildings (including a visitor center, retaining wall, seawall, vault toilets, housing, monuments, and numerous fortification-related assets), and 123 transportation assets (roads, parking, trails, bridges, and a pier) at PETE. Only 4% of assets (all in the City Point area) have high or moderate vulnerability to the evaluated coastal hazards and SLR, while the majority have minimal vulnerability (are not in any of the evaluated hazard zones). Scoring details and results for all assets evaluated at PETE are reported in the provided Excel sheets.

Exposure Results

Exposure is a measure of the character, magnitude, and rate of changes a target may experience (e.g., from the impacts of climate change or a natural hazard influenced by 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.

Exposure Indicator (Description)	PETE Data (Citation)
Flooding potential (1% annual-chance)	Effective FEMA VE & A zones (FEMA 2015)
Shoreline change (coastal proximity)	30-m shoreline proximity buffer (Peek et al. 2022)
SLR inundation (2050)	NOAA 2-foot SLR zone (NOAA 2022)
Extreme event flooding (category 3 surge)	NPS storm surge inundation model (Caffrey et al. 2018)
Reported coastal hazards (historic flooding)	Questionnaire results & discussions (Peek et al. 2022)

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

[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."

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.

Only nine assets in the City Point area of PETE have high or moderate exposure to the evaluated coastal hazards and SLR (Table 2). Two assets, the Seawalls and Shore Protection and the James River Waterfront Pier, are within all evaluated exposure zones. Fifteen assets at City Point have minimal exposure. Assets in all other areas of the park also have minimal exposure.

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

	High exposure		Moderate Exposure		Low Exposure		Minimal Exposure		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	2	2%	1	1%	0	0%	97	97%	100
Transportation	4	3%	2	2%	0	0%	117	95%	123
All Assets	6	3%	3	1%	0	0%	214	96%	223

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/elevated, 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 214 assets at PETE).

Three of the assets analyzed at PETE have high sensitivity to coastal hazards and SLR, while six assets have moderate sensitivity (Table 3). In general, the assets are not significantly elevated above local ground level, have been damaged by coastal flooding in the past, and have protective engineering. The Beach Access Road had unfavorable ratings for all sensitivity indicators.

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

	High Sensitivity		Moderate Sensitivity		Low Sensitivity		Total Analyzed	Excluded*
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**#**
Buildings	0	0%	3	100%	0	0%	3	97
Transportation	3	50%	3	50%	0	0%	6	117
All Assets	3	33%	6	67%	0	0%	9	214

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

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 PETE are identical to the exposure results, indicating that the vulnerability of these assets is primarily controlled by exposure. Six assets have high vulnerability and three have moderate vulnerability (Table 4, and Figure 1). The Beach Access Road, James River Waterfront Pier, and Waterfront Walking Trails have both high exposure and high sensitivity. The City Point Seawalls & Shore Protection have high vulnerability and a high asset priority index (API = 92, as reported in FMSS). The Retaining Wall has moderate vulnerability and a high API (93). Most assets (96%) at PETE have minimal vulnerability to the evaluated coastal hazards.

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

	High Vulnerability		Moderate Vulnerability		Low Vulnerability		Minimal Vulnerability		Total
Assets	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**
Buildings	2	2%	1	1%	0	0%	97	97%	100
Transportation	4	3%	2	2%	0	0%	117	95%	123
All Assets	6	3%	3	1%	0	10%	214	96%	223

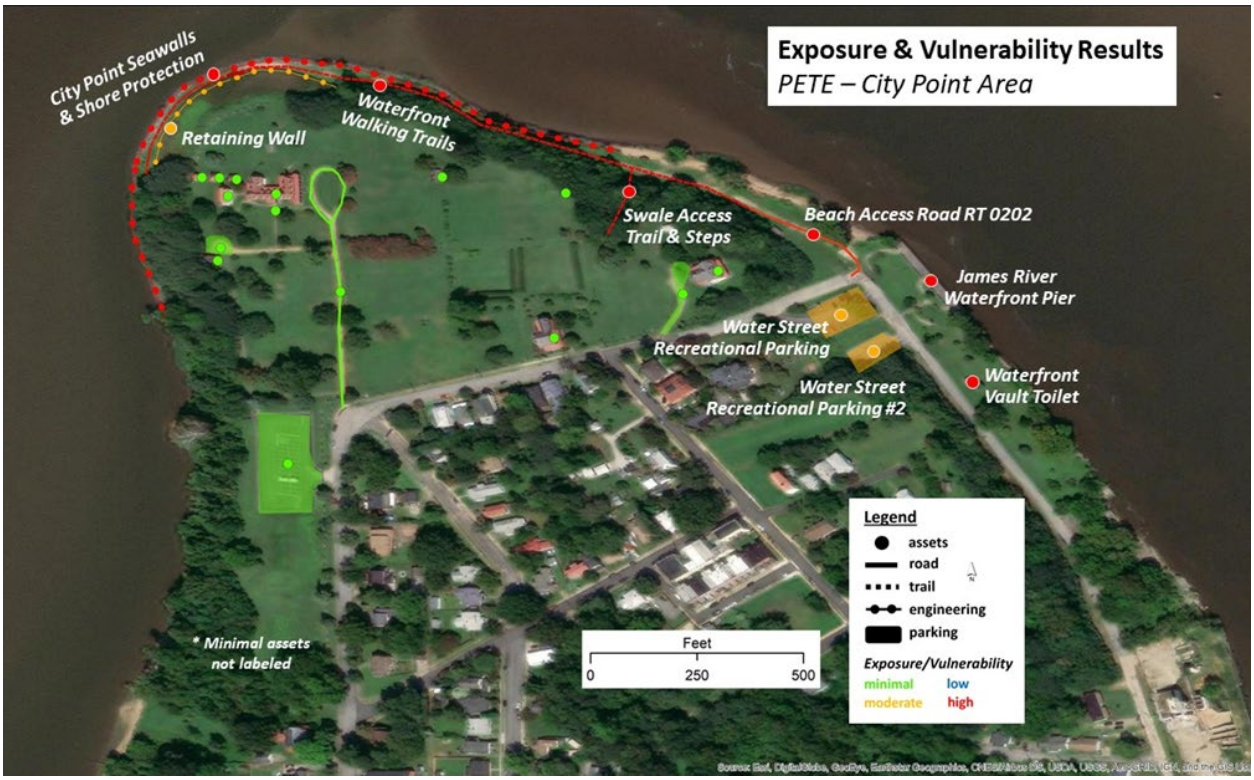

Figure 1. PETE exposure and vulnerability results summary. Only high and moderate assets are labeled. Background is ESRI streaming imagery.

PETE Unique Considerations

Shoreline change data: United States Geological (USGS) or other shoreline erosion rate data are not available for the coastlines within PETE. As a result, we used a simple coastal proximity buffer of 30 meters, which accommodates an erosion rate up to 1 meter/year and assumes that infrastructure near the coast is likely to experience multiple coastal hazards within the 30-year (2050) timeframe of this analysis (Peek et al. 2022).

SLR data: In most cases, we use the 2100 4.5 Representative Concentration Pathway (RCP) SLR projection and inundation model from Caffrey et al. (2018) developed specifically for NPS units to score exposure for this indicator. These data are not available for PETE, and therefore, we used the National Oceanic Atmospheric Administration (NOAA) 2 ft SLR layer (NOAA 2022) as a substitute for these assets.

Linear assets: Roads and trails at PETE were not segmented, as all are relatively short features (< 1 mile in length). Therefore, each road and trail has only one score for exposure, sensitivity, and vulnerability. Any statistics or estimates of value represent the entire asset, even if only a small portion has high exposure or vulnerability.

FMSS assets: The Retaining Wall in the City Point area of PETE is not listed individually within the FMSS database, but instead is part of the CP: Grounds @ GH Bluffs & Vistas location. Within this

VA, only the Retaining Wall portion of this asset is analyzed (grounds are not typically evaluated using this protocol, see Peek et al. 2022).

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