Union of Concerned Scientists

FACT SHEET

# The US Military on the Front Lines of Rising Seas

## *Exposure to Coastal Flooding at Joint Base Anacostia-Bolling and Washington Navy Yard, Washington, District of Columbia*


**HIGHLIGHTS**

*With seas rising at an accelerating rate, coastal military installations are increasingly exposed to storm surge and tidal flooding. The Union of Concerned Scientists (UCS) conducted analyses of this changing exposure for 18 military installations along the East and Gulf coasts. Analysis for Joint Base Anacostia-Bolling (JBAB) and Washington Navy Yard found that in the second half of this century, in the absence of preventive measures, this installation can expect the following: more frequent and extensive tidal flooding, loss of currently utilized land, and substantial increases in the extent and severity of storm-driven flooding to which it is exposed.*


The US Armed Forces depend on safe and functional bases, such as JBAB and Washington Navy Yard, Washington, DC, to carry out their stated mission: to provide the military forces needed to deter war and to protect the security of the country. A roughly three-foot increase in sea level would threaten 128 coastal Department of Defense (DOD) installations in the United States and the livelihoods of the people—both military personnel and civilians—who depend on them (NAS 2011). In the area of these two installations, seas are projected to rise between four and 6.4 feet by the end of this century.

To enable decision makers to better understand the sea level rise threat, and where and when it could become acute, UCS has performed a new analysis of 18 East and Gulf Coast military installations, including JBAB and Washington Navy Yard. These sites were selected for their strategic importance to the Armed Forces, for their potential exposure to the effects of sea level rise, and because they represent coastal installations nationwide in terms of size, geographic distribution, and service branch.

UCS projected exposure to coastal flooding in the years 2050, 2070, and 2100 using the National Climate Assessment's midrange or "intermediate-high" scenario (referred to here as "intermediate") and, in light of the low tolerance for risk in some of the military's decisions, a "highest" scenario with a more rapid rate of

US Navy

**THE INLAND MARCH OF HIGH TIDE**

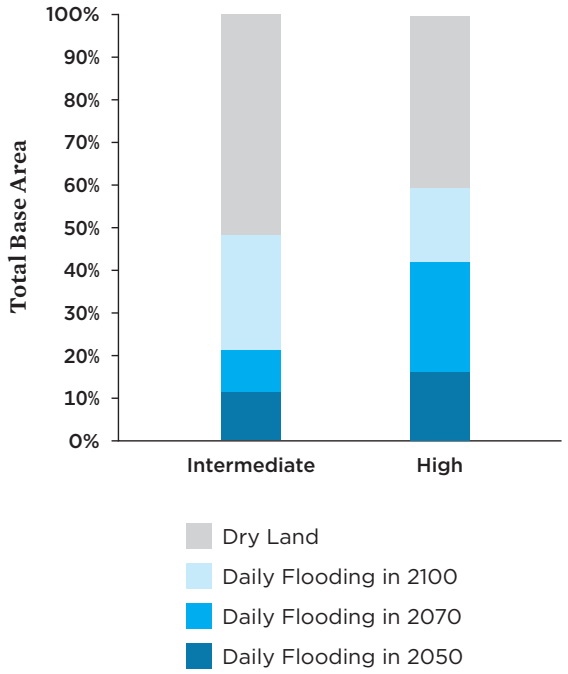
*Washington Navy Yard is located in southeastern Washington, DC, along the northern shore of the Anacostia River. Largely spared tidal flooding today, the Navy Yard could see 30 percent of its current land area flood daily by the end of the century, depending on the rate of sea level rise.*

increase (Parris et al. 2012).[1] We modeled tidal flooding, permanent inundation, and storm surge from hurricanes.[2] The results below outline potential future flooding to which JBAB and Washington Navy Yard could be exposed, assuming no new measures are taken to prevent or reduce flooding.[3] This analysis finds the following key results:

#### TIDAL FLOODING, PERMANENT INUNDATION, AND LAND LOSS

- **Areas currently unaffected by occasional tidal flooding could flood more often than daily.** Naval Support Facility (NSF) Anacostia, the northern half of JBAB, is currently affected by flooding during extra-high tides more than 40 times per year on average. By 2050, flood-prone areas could experience 450 to 600 floods per year, depending on the scenario.
- **Flooding during extreme high tides will become more extensive.** Extreme high tides do not typically flood the Washington Navy Yard today. But in the highest scenario, roughly 40 percent of Washington Navy Yard is inundated by the end of this century during the extra-high tides that affect the area more than 40 times per year on average.
- **Extensive land loss at NSF Anacostia is possible.** In the intermediate scenario, which projects four feet of sea level rise by the end of the century, roughly 50 percent of NSF Anacostia's land area—primarily developed, utilized land—floods daily, effectively becoming part of the tidal zone.

FIGURE 1. NSF Anacostia May Experience Major Land Loss




*As high tide reaches farther inland, extensive land loss is possible at NSF Anacostia. Losses may be substantial but smaller at Washington Navy Yard and insubstantial at Bolling Air Force Base (AFB). Affected land may include developed and undeveloped areas. NSF Anacostia is projected to see substantial loss of currently developed and utilized areas.*

#### STORM SURGE

- **Sea level rise exposes previously unaffected areas of JBAB and Washington Navy Yard to storm surge flooding.** In the intermediate scenario, the area of Washington Navy Yard exposed to flooding increases by 25 percent or more during Category 1 and 2 storms by 2100.
- **Sea level rise exposes JBAB and Washington Navy Yard to deeper, more severe flooding.** Over time, the area inundated during storm surges by seawater five feet or more deep increases.

## Base Information

#### JB ANACOSTIA-BOLLING

JBAB is located in the southeastern portion of Washington, DC, along the Potomac and Anacostia rivers. It is situated within an East Coast sea level rise hot spot, where natural subsidence, low-lying topography, and changing ocean circulation patterns contribute to above-average sea level rise (Sallenger, Doran, and Howd 2012).

JBAB comprises NSF Anacostia and Bolling AFB. The major tenant command on JBAB is the Defense Intelligence Agency, the DOD combat support agency that provides military intelligence information to combat and noncombat military missions (DIA n.d.). The US Naval Research Laboratory and the White House Communications Agency are also located at JBAB. Bolling AFB provides administrative support to the Air Force and is the home of the 11th Wing, "The Chief's Own" (The Military Zone n.d.).

#### WASHINGTON NAVY YARD

Washington Navy Yard is also located in southeastern Washington, DC, along the northern shore of the Anacostia River. Like JBAB, it lies within a hot spot of elevated rates of sea level rise.

Founded in 1799, the Navy Yard is the oldest US Navy shore facility (Global Security.org 2013). Originally a shipbuilding facility, the installation now provides administrative and ceremonial functions. Washington Navy Yard is also home to the Commander, Navy Infrastructure Command (CNIC), which manages coastal installations for the US Navy,

## JB Anacosta-Bolling

| | |
|---|---|
| **Branch:** | Navy and Air Force |
| **Established:** | 2010 |
| **NSF Anacostia:** | 1917 |
| **Bolling AFB:** | 1948 |
| **Size (Acres):** | 956 |
| **NSF Anacostia (Military):** | 1,898 |
| **NSF Anacostia (Civilians):** | 1,362 |
| **Bolling AFB (Military):** | 11,893 |
| **Bolling AFB (Civilians):** | 1,638 |
| **Defense Intelligence Agency:** | 16,500 |
| **Naval Research Lab (Military):** | 354 |
| **Naval Research Lab (Civilians):** | 4,578 |
| **Tenant Units:** | 48 |

SOURCE: DOD 2016; MILITARYLIFE 2016; MILITARY ZONE N.D.; DIA N.D.

## Washington Navy Yard

| | |
|---|---|
| **Branch:** | Navy |
| **Established:** | 1799 |
| **Size (Acres):** | 86 |
| **Military:** | 1,209 |
| **Commands:** | 5 |

SOURCE: : CNIC 2016; KARKLIS AND VOGEL 2013; MILITARYLIFE 2016.

and several other tenant commands, including the Naval Facilities Engineering Command and the Naval Inspector General (CNIC 2016). While the workforce does include Navy and Marine Corps personnel, the majority of employees are civilians, including Navy contractors, engineers, lawyers, and procurement officials (Karklis and Vogel 2013).

## Historic Exposure to Storm Surge and Flood Hazards

Category 1 storms are the most likely hurricane threat to the Washington, DC, area. Since 1851, there have been eight Category 1 storms and two Category 2 storms that have tracked within 150 miles of the District; no Category 3 or higher storms have been recorded (DOEE 2015).

In August 2011, Hurricane Irene (Category 1) produced a storm surge of one to 2.5 feet in the northern Chesapeake Bay region (NWS 2011). In September 2003, Hurricane Isabel (Category 2) produced moderate to major river flooding in the Potomac River Basin and caused record tidal flooding and damage to the Naval District along the Anacostia, including damage to marinas and the flooding of cars and buildings (NWS 2003).[4]

While less than 1 percent of the southern portion of JBAB currently floods during Category 1 storms, about 45 percent of the northern portion of NSF Anacostia floods during the same storms; the area lies so low that when it rains, water encroaches from both the river and inland.

JBAB has few remaining natural flood buffers as a result of land filling, construction of hard flood control structures along the rivers, and construction of buildings and paved areas (DON 2010). A 2.4-mile levee system along the Anacostia River provides some protection to JBAB from river flooding caused by large volumes of storm water (ASCE 2016). However, the levee is "decertified," as it does not provide risk reduction against the authorized maximum flood discharge level from the Potomac and Anacostia rivers (ASCE 2016). The base has three powerful sump pumps and a spillway designed to handle large storms (Oliphant 2016). JBAB and other DC facilities depend on the District's Blue Plains sewage treatment plant located just south of JBAB. While the management of Blue Plains is working to fortify the plant, it too is exposed to coastal flooding and storm surge.

## Future (Projected) Exposure to Storm Surge and Flood Hazards

### SEA LEVEL RISE

The intermediate scenario projects that the Washington, DC, area will experience four feet of sea level rise, and the highest scenario projects 6.4 feet of rise by 2100. This rise will affect the frequency and extent of tidal flooding and increase the risk of land loss.

## JB Anacostia-Bolling

### TIDAL FLOODING AND LAND LOSS

Routine flooding during high tides is a persistent issue in the Washington, DC, area. This flooding, which currently occurs an average of 43 times annually, can be disruptive to transportation and business. The central portion of NSF Anacostia, in the northern half of JBAB, experiences such flooding in its low-lying areas.

In the intermediate scenario, tidal flooding occurs roughly 450 times per year and in the highest scenario 600 times per

year by 2050. In the highest scenario, this flooding occurs, on average, twice daily with high tides. With such regular flooding, affected areas could become unusable within the next 35 years.

With the highest scenario, JB Anacostia-Bolling's flood-prone areas would be underwater not just at high tide, but for over 70 percent of the year by 2070. In locations such as NSF Anacostia, the difference between high and low tide is small enough that, with the projected increases in sea level, inundation in flood-prone areas will eventually exist even at low tide. During the last quarter of this century, flood events in this area will begin to span many high tide cycles. As a result, the number of individual flood events will decrease but the duration of flood conditions will increase until flooding is essentially constant and land that was once above the high tide mark is permanently inundated. In the highest scenario, roughly half of NSF Anacostia becomes part of the tidal zone, flooding daily.

### THE CHANGING THREAT OF HURRICANES

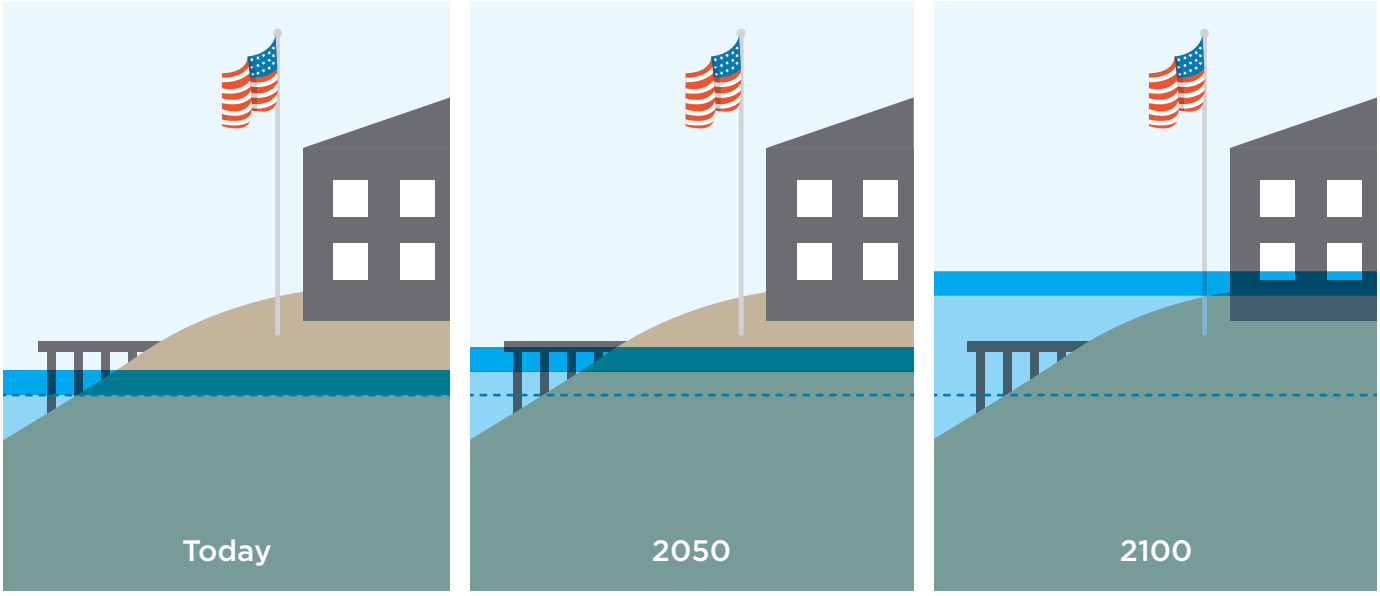
Category 1 hurricanes are the most likely type to affect this area.[5] Over time, sea level rise exposes a greater proportion of each base's area to inundation caused by a Category 1 storm. This trend is especially clear in the projections for the northern section of JBAB, the NSF Anacostia area, where the area exposed to storm surge flooding increases in the intermediate scenario to 65 percent and in the highest scenario to roughly 75 percent by 2100. In each of these scenarios, the area in

TABLE 1. Washington, DC, Area Bases: Projected Sea Level Rise (Feet) in Two Scenarios

| Year | Intermediate | Highest |
|---|---|---|
| 2050 | 1.2 | 1.8 |
| 2070 | 2.1 | 3.3 |
| 2100 | 4.0 | 6.4 |

*In the intermediate scenario, ice sheet loss increases gradually in the coming decades; in the highest scenario, more rapid loss of ice sheets occurs. The latter scenario is included in this analysis to help inform decisions involving an especially low tolerance for risk. Moreover, recent studies suggest that ice sheet loss is accelerating and that future dynamics and instability could contribute significantly to sea level rise this century DeConto and Pollard 2016; Trusel et al. 2015; Chen et al. 2013; Rignot et al. 2011). Values shown are local projections that include unique regional dynamics such as land subsidence (see www.ucsusa.org/MilitarySeasRising).*

FIGURE 2. How Sea Level Rise Causes Tidal Flooding and Land Loss




*As sea level rises, local flood conditions can happen more often, to a greater extent, and for longer time periods when extreme tides occur. And the daily high tide line can eventually begin to encompass new areas, shifting presently utilized land to the tidal zone. In this analysis, land inundated by at least one high tide each day is considered a loss. This is a conservative metric: in reality, far less frequent flooding would likely lead to land being considered unusable.*

TABLE 2. Flood-Prone Areas Could Be Underwater at All Times by 2100

| | Intermediate | | Highest | |
|---|---|---|---|---|
| Year | Events per Year | % of Year | Events per Year | % of Year |
| Current | 43 ± 13 | 1 | 43 ± 13 | 1 |
| 2050 | 456 ± 24 | 18 | 606 ± 15 | 34 |
| 2070 | 641 ± 11 | 42 | 559 ± 29 | 73 |
| 2100 | 257 ± 20 | 91 | 1 ± 0 | 100 |

*Sea level rise will lead to constant or near-constant flooding around JBAB and Washington Navy Yard. Shown here are flood events in low-lying areas projected by the intermediate and highest scenarios. Events per year are reported as the average over a five-year period with one standard deviation. Percent of year is reported simply as the average over a five-year period. As flood conditions span multiple high tide cycles, the number of distinct flood events drops but the duration of flooding increases until it is constant. Installations will be affected by this flooding depending on the presence of currently flood-prone land on-site.*

NSF Anacostia inundated by a Category 1 storm in 2100 will be greater than the area inundated by a Category 2 storm today.[6]

> ***With such regular flooding, affected areas could become unusable within the next 35 years.***

Sea level rise also changes the depth of flooding that the northern NSF Anacostia section of JBAB can expect with major storms. Whereas most of the inundation caused by a Category 1 storm today is five feet or less deep, a Category 1 storm in 2100 in the intermediate scenario causes more than 25 percent of NSF Anacostia to flood to a depth of five to 10 feet. However, even in 2100, Bolling AFB will be unaffected by flooding during a Category 1 storm.

For the mid-Atlantic region, a Category 4 storm in the highest scenario represents the worst case for future storm surge inundation. A Category 4 storm today exposes 30 percent of Bolling AFB and almost 90 percent of NSF Anacostia to flooding. In 2100 in the highest scenario, 75 percent of Bolling AFB and over 95 percent of NSF Anacostia flood during storm surge. At both sites, more than half of the flooded areas are under more than five feet of water.

## Washington Navy Yard

### TIDAL FLOODING AND LAND LOSS

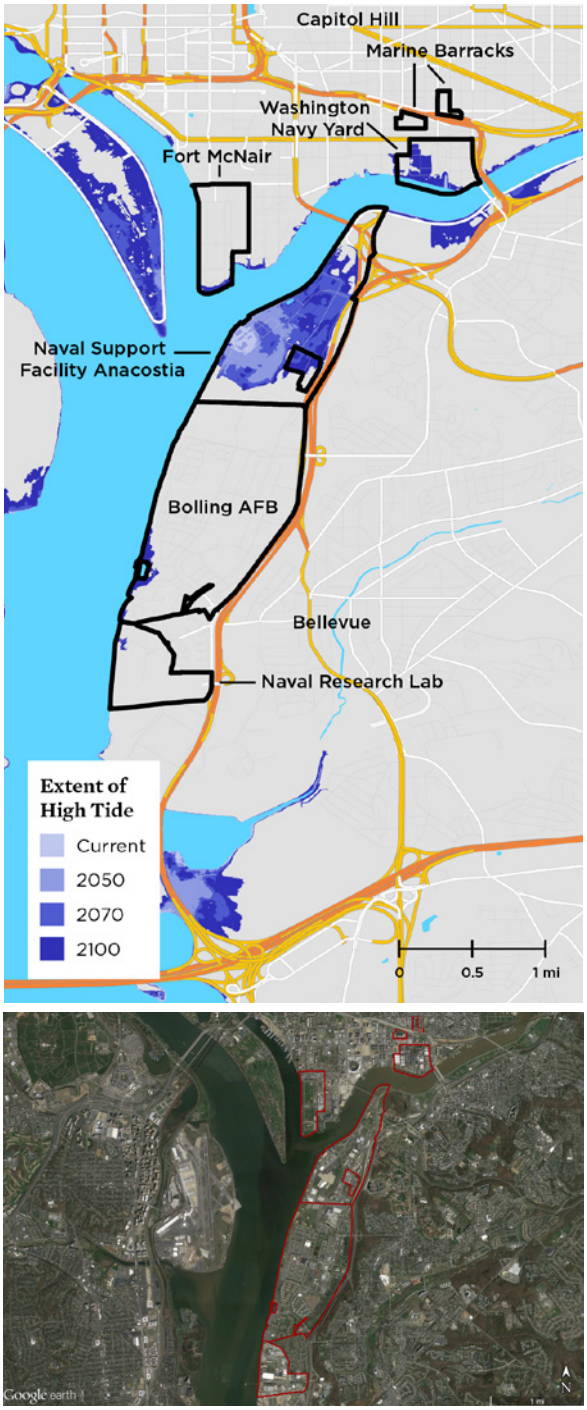
Washington Navy Yard is not directly affected by the routine high tide flooding that impacts the Washington, DC, area an average of about 40 times per year. As sea level rises, however, the base will experience increasingly frequent and extensive inundation during routine high tides. In the intermediate scenario, Washington Navy Yard experiences flooding of limited extent even in 2100. In the highest scenario, however, about 30 percent of the installation's land area becomes part of the tidal zone and an additional 10 percent experiences flooding during extra-high tides by the end of the century.

### THE CHANGING THREAT OF HURRICANES

Category 1 hurricanes are the most likely type to affect this area. Just above 10 percent of Washington Navy Yard is exposed to storm surge resulting from a Category 1 storm today. Most of that storm surge flooding is five to 10 feet deep. In the intermediate scenario, the extent of exposure increases by 5 percent by 2050. By 2100, 45 percent of the base is exposed to storm surge from a Category 1 storm, greater than the area exposed to flooding during a Category 2 storm today.

A Category 4 storm hitting in 2100 in the highest scenario is the worst-case scenario for the area. In this case, more than 75 percent of Washington Navy Yard is exposed to storm surge. About 65 percent of the base experiences flooding more than five feet deep, and flooding is deepest along the shore of the Anacostia River. Even in this worst-case scenario,

FIGURE 3. JBAB Is Expected to Lose Currently Utilized Land




*The projected reach of future daily high tides, shown in the top panel, encompasses currently utilized land; the Naval Support Facility Anacostia (home to the National Defense University and US Coast Guard headquarters) is particularly affected. The highest scenario is mapped here.*

SOURCE: GOOGLE EARTH.

the northeastern corner of Washington Navy Yard is unaffected by flooding.

## Mobilizing on the Front Lines of Sea Level Rise

A vital trait of our nation's military is its ability to adapt in response to external threats. Climate change and sea level rise have emerged as key threats of the 21st century, and our military is beginning to respond (Hall et al. 2016; USACE 2015; DOD 2014). JBAB recognizes it has a flood risk problem and inadequate protection and is working to mitigate these risks, including by prioritizing storm water management strategies to reduce flood hazards (NCPC 2014). For its part, the Washington Navy Yard is working with the Army Corps of Engineers on a vulnerability study (Underwood 2016).

> ***The gap between the military's current sea level rise preparedness and the threats outlined by this analysis is large and growing.***

But here and across coastal installations there is still far to go: the gap between the military's current sea level rise preparedness and the threats outlined by this analysis is large and growing. Low-lying federal land inundated by rising seas, daily high-tide flooding of more elevated land and infrastructure, and destructive storm surges—most of the installations analyzed, including JBAB and the Washington Navy Yard, face all of these risks.

This analysis provides snapshots of potential future exposure to flooding at JBAB and Washington Navy Yard. For the military to take additional action on the front line of sea level rise, however, it will need more detailed analysis and resources to implement solutions. Congress and the DOD should, for example, support the development and distribution of high-resolution hurricane and coastal flooding models; adequately fund data monitoring systems such as our nation's tide gauge network; allocate human, financial, and data resources to planning efforts and to detailed mapping that includes future conditions; support planning partnerships with surrounding communities; and allocate resources for preparedness projects, on- and off-site, many of which will stretch over decades.

Military bases and personnel protect the country from external threats. With rising seas, they find themselves on an unanticipated front line. Our defense leadership has a special responsibility to protect the sites that hundreds of thousands of Americans depend on for their livelihoods and millions depend on for national security.

### ENDNOTES

1 *The intermediate sea level rise scenario assumes ice sheet loss that increases over time, while the highest scenario assumes rapid loss of ice sheets. The latter scenario is particularly useful for decisions involving an especially low tolerance for risk. These results are a small subset of the full analysis. For more information, the technical appendix, and downloadable maps, see www.ucsusa.org/MilitarySeasRising.*

2 *UCS analyzed storm surge depth and exposure extent for each base using the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model, developed by the National Oceanic and Atmospheric Administration (NOAA), for storm events ranging in severity from Category 1 to Category 4, in addition to tidal floods. Both storm surge and flooding during extra-high tides can be significantly exacerbated by rainfall and wave action, neither of which was included in this study.*

3 *This analysis involved consultation with JBAB. However, here and at other installations, preventive measures may be planned or in place that are not reflected in the analysis; these could affect the degree of current and future flooding.*

5 *Nor'easters are more common in the region and known to generate damaging storm surge. As SLOSH models only hurricanes, we did not include lesser storms, such as nor'easters, in this analysis. Increases in surge extent and depth should be expected with these storms as well.*

6 *It is important to note that while the JBAB partial levee is technically decertified, it would provide some protection above that shown in the models.*

4 *The watershed that contributes flooding affecting JBAB and the Washington Navy Yard originates in Bladensburg, Maryland. This watershed area is highly urbanized and quickly generates large volumes of storm runoff resulting from rain. This modeling does not account for rainfall.*

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