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Brookings' Amy Liu weighs in on region's biggest hurdle

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Climate change is all too real for local developers and leaders – and they're working mightily to adapt

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COVER STORY

THAT SINKING FEELING

Sea levels are rising. Storms are surging.
Waterfront projects must adapt to survive.

BY DANIEL J. SERNOVITZ
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Dan Simons still gets anxious every time a big storm is brewing. By this spring, it will have been nine years since the Potomac River overran its banks and inundated Washington Harbour with more than 10 feet of surging water. Several tenants at the mixed-use development had found themselves suddenly displaced – Simons and his Farmers & Fishers among them, costing his Farmers Restaurant Group revenue it could ill afford to lose.

The flood waters eventually subsided. By November of the following year, in 2012, Farmers Restaurant Group opened a new concept, Farmers Fishers Bakers, at the waterfront destination. Was it tempting fate? Not the way Simons saw it. After all, the Georgetown spot had been his restaurant group's third-best performer, so he wasn't inclined to just walk away. And he figured MRP Realty, Washington Harbour's property manager and also its co-owner at the time, had learned an onerous-enough lesson from the flood – and its ensuing property damage and legal battles – to ensure there would never be a repeat of 2011.

But still ...

“When really heavy rains and rising waters are forecasted, I will admit I twitch a little bit,” he said.

“I really do trust MRP,” he added, “and I just don't see the same thing happening again. For me, it connects to the much larger topic – I want all business people to be seeing these situations through the reality of climate change. And I would like the political party of business to understand they need to be the political party of climate as well.”

Indeed, the intertwined nature of commerce and climate change has become ever more salient in recent years as storms of increasing frequency and severity have overwhelmed waterfront properties and caused flash flooding further inland in the D.C. region. Major floods have swept parts of the District at least four times in the past two decades, and 2018 was Washington's wettest on record. And throw in this past July's flash flood, when a record-setting 3.3 inches of rain fell within an hour's time at Reagan National Airport, taxing countless local governments and emergency response crews during the morning rush no less.

Even as a political debate rages over global warming and climate change, government officials and private property owners alike are racing to address a new reality: a forecast for rising sea levels and menacing floods that jeopardize crucial parts of the nation's capital. Consider it a bitter irony that the threat of rising flood waters is intensifying just as the District is finally embracing its waterfront

along the Anacostia and Potomac rivers after turning its back on those banks for so long. A surge of multimillion-dollar projects to build new homes, offices, hotels, arts venues, retail and restaurants have cropped up along local waterways, from The Yards by Nationals Park to the Robinson Terminal redevelopment in Old Town Alexandria.

“If we want to continue building more and more high-value real estate in these vulnerable areas, we need to take the steps to reduce the risk and also make sure that there's infrastructure to protect everybody against extreme weather events,” said Billy Grayson, who leads the Center for Sustainability and Economic Performance at the Urban Land Institute. He said he's seen a number of developers, especially in waterfront areas, going above and beyond what is required by law – “partly because they had to and partly because they saw the benefit.”

Many questions remain on just how much work must be done to contain surging waters, what it will cost and who will bear the financial burden. But one thing is becoming increasingly clear: It's high time for action.

“The bottom line is smart waterfront development is still a good investment,” said Jon Penndorf, senior project manager and sustainability leader in the D.C. office of architecture firm Perkins & Will. “But you have to design it understanding what the true risks are.”



Washington Harbour saw a surge of more than 10 feet of flood water in April 2011.

COURTESY WASHINGTON HARBOUR

A glass half full, or ready to overflow?

Grappling with the region's water woes won't be an easy lift. And a growing body of evidence suggests conditions are becoming more precarious with each passing year.

The average high tide of the Potomac and Anacostia rivers has increased by 11 inches in the past 90 years. For the next 60 years, the Army Corps of Engineers estimates sea levels will rise in D.C. by another 3 to 4 feet, according a report by the D.C. Department of Energy & Environment.

"Even since I've been in this job over the past five years, the role of water and flooding in the District has substantially been changed by a changed climate," said Tommy Wells, director of DOEE since 2015 and, before that, a D.C. councilman from Ward 6, an area that includes much of D.C.'s waterfront land.

"We're having to deal with water in a different way," Wells said. "Our main role is to do our best to provide the private sector and the public sector the best science and the best information we can get around prediction of water levels and prediction of flood events. The public sector and the private sector have to weigh that, and the public also has an interest in what's built, in terms of risks to the assets and risk to the humans that are in those assets."

In a bid to adapt to some of those changes, the agency at the end of 2016 released "Cli-



FILE PHOTO

"For me, it connects to the much larger topic – I want all business people to be seeing these situations through the reality of climate change."

DAN SIMONS, co-owner, Farmers Restaurant Group, which operates Farmers Fishers Bakers

mate Ready D.C.," a 20-page proposal that Penndorf also helped write and that identified a combination of storm surges and sea level rise as one of D.C.'s top three risk factors. The plan broke down action items by relevant government department.

There were short-term items, meant to be completed in one to three years, including identifying at-risk facilities to either upgrade or replace and creating alternate evacuation

routes around flood-prone roads and bridges. And then the long-term items, with time frames of 10 to 20 years, included bolstering the combined sewer and separate stormwater system capacity and flood-proofing the region's most important facilities.

A new clean energy law, passed in 2018, was an outgrowth of that report's recommendations, requiring property owners to cut their energy use or face fines by 2026. DOEE is also close to awarding a \$5.5 million contract to an engineering firm to model the city for flood risks to more accurately foresee problems and identify fixes.

While the District already imposes certain requirements on building on flood-prone areas, Wells acknowledged that some of the Climate Ready plan could arrive in the form of even more limits for developers. For instance, at DOEE's recommendation, the District's planning office filed an application in January with the zoning commission to propose changing the city's zoning code that governs development in flood-prone areas. That includes expanding the designation for those areas from being a 100-year flood plain – meaning their properties have a 1% probability of being inundated by water in any given year – to the higher standard of a 500-year flood plain. DOEE has also proposed restrict-

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COVER STORY



Vicki Johnson's 110-unit Peninsula 88 takes its name from the Buzzard Point peninsula.

TASHA DOOLEY FOR THE WASHINGTON BUSINESS JOURNAL

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ing development “in any areas of the District forecasted to be permanently inundated in the year 2100,” putting destinations like Poplar Point in Southeast D.C. in the crosshairs.

“We’ve had more construction in the past 10 years than at any time in our history, other than right after World War II. And we’re trying to guide it,” Wells said. “The city is the economic envy of cities across America because we’re continuing to run surpluses, and we came through the recession a lot stronger because of foreign investment in building. But it’s got to be tempered with commonsense restrictions.”

As one of several agencies with authority to review planned developments, DOEE has already had some of these battles over projects undergoing the District’s entitlement process. At RiverPoint, the redevelopment of the Coast Guard headquarters on Buzzard Point in Southwest D.C., DOEE sought additional protections, including setting aside the building’s lower 16 feet for nonresidential uses to help keep potential floodwaters in check. Ultimately, partners Akridge and Western Development opted to use that space for retail, including a restaurant by Baltimore chef Spike Gjerde and a 20,000-square-foot food hall.

Penndorf also calls for tighter restrictions on development. But he does not think that translates to no-build zones in parts of the city at risk of flooding.

“Just because there is a risk doesn’t mean you can’t build there. But you



JOANNE S. LAWTON / STAFF

“We are not merchant-builders. We are long-term holders of these assets. We want to do the things that are going to ensure their value is maintained in the future.”

MATT STEENHOEK, senior vice president at Hoffman & Associates, which co-developed The Wharf with Madison Marquette. The development partners said they went above and beyond requirements to help safeguard the project.

have to understand what the implications are,” he said. “I think the city is in the process of educating themselves and the developers about what the potential risks are and what the trade-offs are.”

When it’s time to go with the flow

It was in a conference room at Alexandria City Hall early this past November when the shock of reality set in.

The city had long ago built its water-

front below its adjacent river’s natural elevation and carried a history of flooding in Old Town, in particular. In 2014, city leaders had OK’d a waterfront small area plan containing an infrastructure-heavy set of flood mitigation steps such as a bulkhead to be built along the waterfront, a raised promenade from Canal Center Plaza to Jones Point Park, a pump system to redirect surplus water and permeable surfaces designed to better absorb

water rather than passing it along.

This past May, the city council voted to set aside \$50 million in Alexandria’s budget to speed up implementation of that plan.

But then, fast-forward six months to a Nov. 7 budget work session. And city leaders heard Tony Gammon, deputy director of the Alexandria Department of Project Implementation, say something akin to nails on a chalkboard: Cost escalations, market forces and more detailed engineering studies had swelled that estimated \$50 million cost to \$122 million.

And even then, he warned, the plan might not go far enough.

Several heads popped up from their printed materials to see if they heard Gannon right. A pregnant pause lasted upward of 10 seconds before anyone spoke up next. It was Alexandria Mayor Justin Wilson who finally broke that silence.

“Obviously, when we went through the waterfront planning process, the top priority of everyone was flood mitigation. That was everyone’s priority, regardless of what side you were on, on that issue,” Wilson said at the meeting. “But this is a ton of money.”

City officials are now returning to the proverbial drawing board to come up with an alternate plan, not just for flood mitigation anymore, but now for resiliency. Indeed, consider that the newest buzzword in the industry, essentially a fancy way of telling Mother Nature, “You do you. We’ll respond accordingly.”

“In the past, everybody thought about, ‘Let’s put up a bulkhead. Let’s

put in pump stations. Let's mitigate this flooding.' And now they're saying, 'Instead of mitigating it – because it's going to happen, Mother Nature's going to beat us – let's be resilient to it. Let's be able to withstand the flooding, recover from it quickly and move forward,'" Terry Suehr, Alexandria's director of project implementation, said at the meeting after Wilson's remarks. "So that's our plan, is to look at those sorts of things and examine if we can get a better cost-benefit ratio with some of those other ideas."

The city manager is slated to present Alexandria's budget Feb. 18, and he is expected to include updated information on the flood mitigation effort in that document, Wilson said in a recent interview. Among the possibilities is moving forward on the old plan through what's known as a progressive design-build contract. That means the city can emphasize certain priorities, such as cost or resiliency – potentially resulting in such measures as increasing permeable surface areas and installing underground cisterns – while de-emphasizing others. But Wilson said it's too soon to say what the city's next steps will be.

"There is definitely some climate resiliency piece to this if we're going to continue to utilize some of these properties going forward," he said in the interview. "We're going to have to deal with these issues."

Like in the District, Alexandria imposes additional requirements for developers building in flood-prone areas, but many of those standards were based on historical estimates that might become insufficient over time in the face of rising flood waters. Ultimately, Wilson said, there may come a point when the city may need to go further in curtailing development or imposing greater requirements, especially if flash flood events such as the one in July become more frequent or severe.

"If what happened on July 8 happens every other year, that's a much bigger conversation," Wilson said. "We're never going to size our storm-water system in Alexandria to withstand 4 inches of rain in an hour."

Resiliency is a notion other jurisdictions, locally and across the globe, are increasingly embracing. In 2017, the District was selected from more than 1,000 cities worldwide to join 100 Resilient Cities, an effort backed by the Rockefeller Foundation that counts the likes of Paris, New York, Bangkok and Buenos Aires among its members.

With support from that program, the District released a follow-on to its 2016 Climate Ready report in April. The new dispatch, "Resilient D.C.: A Strategy to Thrive in the Face of Change," identified four overarching goals and a raft of objectives and initiatives meant to strengthen the city's resilience, be it addressing rising sea levels or keep-

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ON THE WATERFRONT

In just the last few years, the Washington region has seen a buzz of development activity along its waterfronts with new mixed-use projects rising faster than, well, the actual sea levels. Here are some major waterfront developments that have redefined the region's coastlines – but also heightened concerns for potential flooding down the road.



COURTESY HOLLIDAY FENOGLIO FOWLER

WASHINGTON HARBOUR

- ▶ **Opened:** 1986
- ▶ **Size:** 925,000 square feet
- ▶ **Developer:** Washington Harbour Associates
- ▶ Opened more than three decades ago, Washington Harbour has become a part of the Georgetown landscape. The complex, designed by architect Arthur Cotton Moore, is primarily composed of office space with restaurants on the ground floor. Washington Harbour also has the largest outdoor ice rink in the District, at 11,800 square feet.



FILE PHOTO

NATIONAL HARBOR

- ▶ **Opened:** 2008
- ▶ **Size:** 350 acres
- ▶ **Developer:** Peterson Cos.
- ▶ In addition to a host of retail, National Harbor is home to the Gaylord National Resort and Convention Center, MGM National Harbor, Tanger Outlets and the Capital Wheel, a 160-foot-tall ferris wheel. National Harbor is now a census-designated part of Prince George's County.



COURTESY STUDIOS ARCHITECTURE

THE YARDS

- ▶ **Opened:** 2010
- ▶ **Size:** 42 acres
- ▶ **Developer:** Brookfield Properties
- ▶ The Yards is part of the Capitol Riverfront Business Improvement District that completed its first phase in 2014. It was designed around a 5.5-acre park and features several restaurants, a microbrewery, a pet hospital, a grocery store and the newly opened Thompson Hotel. The second phase is expected to be finished by 2030, and will add 6 acres of development to The Yards' footprint.



FILE PHOTO

THE WHARF

- ▶ **Opened:** 2017
- ▶ **Size:** 3.2 million square feet
- ▶ **Developer:** Hoffman & Associates, Madison Marquette
- ▶ The Wharf is a multiuse development in Southwest D.C. that includes retail, office space, apartments, hotels and a live music venue. The first phase of construction finished in 2017, while the second phase is expected to deliver in 2022. On the water, public piers and docks have been built.



COURTESY D.C. UNITED

AUDI FIELD, BUZZARD POINT

- ▶ **Opened:** 2018
- ▶ **Size:** Up to 20,000 seats
- ▶ **Developer:** D.C. United
- ▶ D.C. United unveiled its new soccer stadium at Buzzard Point in 2018. It opened with 15,000 square feet of largely as-yet-unleased retail space, but the surrounding area's appeal has since grown. D.C. United selected Hoffman & Associates in 2019 to develop a pair of sites at the foot of Audi Field, setting the stage for additional street-level activity adjacent to the stadium.



COURTESY SHALOM BARANES ASSOCIATES

ROBINSON LANDING

- ▶ **Opened:** Expected in 2020
- ▶ **Size:** 3 acres
- ▶ **Developer:** EYA
- ▶ Robinson Landing is another example of a former industrial site becoming ritzy. Located on Duke Street in Alexandria, the mixed-use development offers one- to three-bedroom condos, as well as townhouses, totaling 96 residences. It also offers a 5,000-square-foot fine dining establishment on site. Several condos have sold and more are expected to deliver this year.

COVER STORY

CONTINUED FROM PAGE 25

ing the power on during energy-draining heat waves, reducing greenhouse gas emissions and upgrading critical infrastructure. Some of those objectives include ensuring all new buildings are climate-ready by 2032, retrofitting or relocating at-risk buildings by 2050 and designing climate-ready neighborhoods.

Penndorf also points to the land that physically separates a development from the water as a key defender. That, he said, mimics the way nature has protected the East Coast of the United States, where multiple series of barrier islands take the brunt of potentially harmful weather patterns. “You mold the landscape and hardscape such that it is your first line of defense,” he said.



“Just because there is a risk doesn’t mean you can’t build there. But you have to understand what the implications are.”

JON PENNDORF, senior project manager and sustainability leader in the D.C. office of architecture firm Perkins & Will

How to bulk up on resources

Resilience is already a growing underlying notion behind much of what’s getting built along D.C.’s waterfront these days.

Take the Dockmaster Building at The Wharf. It’s a two-story glass building featuring 2,000 square feet of rentable event space. It’s also flood-friendly, said Matt Steenhoek, vice president of development at Hoffman & Associates, which co-developed the 3.2 million-square-foot project with Madison Marquette. The building’s lower level has vents designed to allow water to flow through if conditions warrant.

Those vents have yet to come into use, given that water hasn’t scaled the top 6 feet of the bulkhead protecting the space since The Wharf opened in 2017. But from its first stages of development, its team members wanted to learn from previous waterfront endeavors in D.C., Steenhoek said. So they “went to the smartest people in the room” – DOEE and the Federal Emergency Management Agency.

The advice they got?

“Take the mapped 100-year-flood

plain and add a foot and a half,” Steenhoek recalled. He said they followed that guidance and did “a little bit more everywhere that we could.”

Approximately half of The Wharf’s buildings have green roofs to catch rain and minimize internal temperatures. Some 300 trees were planted on the property, and the landscaping incorporates rain gardens to minimize runoff. The project also incorporated permeable pavement to act as a rudimentary filtration system for rain and stormwater, which then gets redirected to a system of cisterns capable of collecting up to 11 million gallons of annual rainwater and up to 3.2 inches of stormwater. It is filtered, ultraviolet-treated and pumped to the development’s apartment building cooling tower. There, it functions in place of energy-intensive drinking water.

Steenhoek said such measures make “great financial sense” for the company, though he declined to disclose how much more integrating those flood mitigation efforts added onto the cost of the \$2.5 billion project. For the developer, it’s a matter of protecting its investment.

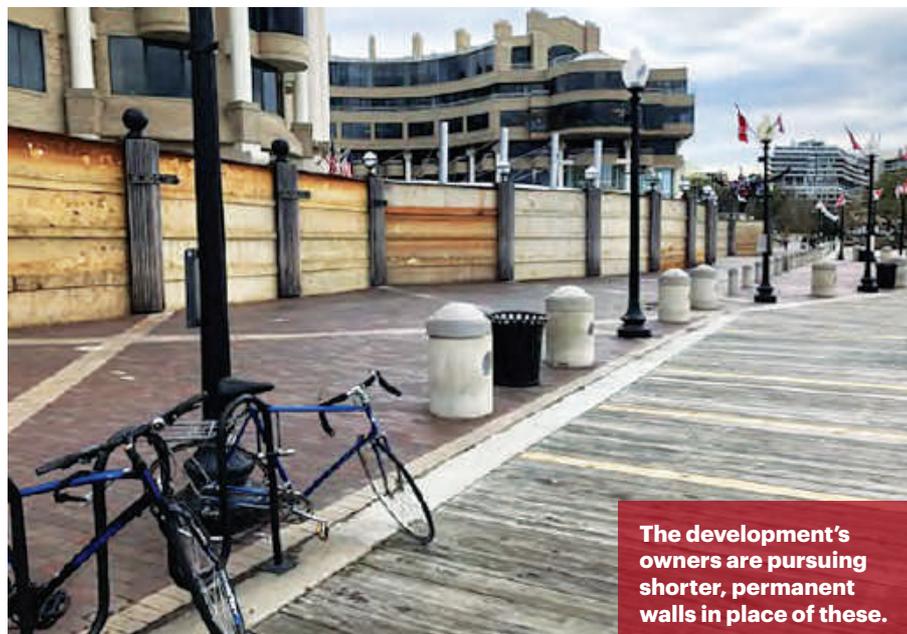
“We are not merchant-builders. We are long-term holders of these assets,” Steenhoek said. “We want to do the things that are going to ensure their value is maintained in the future.”

Areas like Buzzard Point, a strip of land in Southwest D.C. bounded by the Washington Channel and Anacostia River, have been a magnet for new development as well. One project drawn to that stretch is the 110-unit Peninsula 88 condominiums being developed by Capital City Real Estate just shy of the tip of the Buzzard Point peninsula.

Units in the eight-story project, designed by Eric Colbert & Associates LLC, are priced from the \$500,000s to \$1.8 million, with delivery planned for April. The building will feature prime waterfront views, a rooftop deck with grills and firepits, and underground parking – and a host of other necessary “amenities” to meet FEMA guidelines for a 500-year flood plain that Vicki Johnson, director of design, sales and marketing at Capital City, hopes will never need to be fully utilized.

Those include a retaining wall, deployable flood barriers, and monitoring and early warning systems, all of which tacked another roughly \$450,000 onto the cost of the overall project. The building’s mechanical and electrical systems were installed on floors above the height of a 500-year storm, as were the first of the building’s residential floors. On-site staff will monitor weather conditions with an extensive set of video and audio monitors.

“I think everyone has to be realistic,” Johnson said. “Things are going to happen, but I think being prepared and having a plan in place is really important. And, I think people realize



The development’s owners are pursuing shorter, permanent walls in place of these.

FILE PHOTO

that living on the water comes with that potential risk.”

RiverPoint, the former Coast Guard building at 2100 Second St. SW, was ironically designed to house spaces below the 100-year flood plain. It’s held up well over the years, said Tom Wilbur, executive vice president at Akridge. But by today’s standards, it would be built at greater elevations.

Wilbur said Akridge and Western Development are taking proper precautions to minimize the risk of flooding, monitor changing weather conditions and prepare ahead of time for potential emergency conditions.

“The fact is that you go down to Miami and you go up and down the

shore there, there’s tons of construction,” Wilbur said. “People love the water. There’s studies that say it makes people more calm, and there’s obviously the recreational aspect of it and the views.

“People that like that will understand that: If you’re going to be near water, there’s obviously the possibility that water could still come up,” he added.

At yet another waterfront project, The Yards, whose second phase is underway and expected to finish in 2030, Brookfield Properties is overseeing the Southeast D.C. project’s risk assessment and response. Steps included modulating the grades of



A shorter, but more permanent, wall is being proposed for Washington Harbour.

COURTESY PERKINS EASTMAN / GLOBAL HOLDINGS

internal streets and open space and setting ground-floor slabs above flood plain levels, “where practical,” said Abe Naparstek, Brookfield’s executive vice president for development. At The Yards, he said, one of the most sensitive points is the project’s underground parking, which is generally below grade. Those areas can be subject to flooding, which is why they include such increased protections as flood barriers. Naparstek declined to disclose how much more it cost to build the additional flood mitigation steps into the project.

“We’re very conscious of how high we’re building our buildings in the flood plain. It’s an issue that, at all of our properties across the country, we take very seriously,” he said. “We’re very comfortable with our efforts to design around potential rising water. We stay vigilant on it and look at where we are compared to industry standards.”

Lessons learned from the waterfront

The April 2011 flood hit Washington Harbour hard. Its courtyard and several restaurants were immersed in muddy brown water. Fire and rescue and EMS evacuated first-floor retail tenants and condo residents another floor above. Dozens of businesses were unable to reopen for days.

Soon after, 43 retail employees affected by the flooding sued then-owner MRP Realty for \$5 million. The plaintiffs included staffers of

Farmers & Fishers, Tony & Joe’s Seafood Place, Roche Salon, Sequoia, Starbucks, Cabanas Restaurant, Nick’s Riverside Grille and National River Tours. According to the suit, some businesses lost up to \$40,000 a day following the flood. The case was ultimately dismissed.

The development’s otherwise top-of-the-line floodgates would have prevented the flood, according to a spokesman for the D.C. Fire and Rescue Department – if they had been raised properly that day. Today, as Washington Harbour enjoys renewed foot traffic of locals and visitors alike, MRP ensures those 10-foot-tall flood walls are erected well ahead of potentially dramatic storms. The tricky part, however, is predicting which ones those are.

MRP raised the gates more than average during 2018’s record rainfall in the D.C. region. That has proven a costly affair, so representatives for the property’s current owner since 2018, Global Holdings Management Corp., hired Perkins Eastman that year to study the problem. Together, they have proposed building a shorter, but permanent, concrete knee or stair wall of up to 30 inches to help keep out floodwaters but minimize the costs and manpower of crews physically raising the taller gates every time stormclouds threaten. Those shorter walls are expected to handle about 65% of the neighborhood’s rain events annually.

“We started working on that problem right after the flood happened in 2011, and I’m actually really pleased that current ownership is advancing it, because it removes 90% of the time that you have to raise the gate,” said MRP Realty Managing Principal Bob Murphy. “It would definitely buy you time.”

Today, city leaders continue to watch Washington Harbour, subject to flooding from Rock Creek at times, as well as from the Potomac River and flash floods. Washington Harbour, designed by renowned architect Arthur Cotton Moore, opened in 1986.

“Was it wise to build that way there?” Wells asked. “Hopefully we’ll be able to use devices and man-made things to protect them. But that’s an example of risk that, when they built there, they moved the risk but they probably did not fully understand or embrace how rapidly the water level has risen.”

While Simons said the owners have improved Washington Harbour – he lauds the fountain that doubles as an ice rink in winter months, for instance – life inside those flood walls, when elevated, can be imposing.

“It looks a little like being inside a castle you would see on ‘Game of Thrones,’” he said.

Still, he added, it may not be ideal, but he knows all too well the situation could be far worse. ❧

– Laura Spitalniak
contributed to this report.

WHAT WE LEARNED FROM OTHER CITIES

Washington isn’t the only metro area to neighbor the waterfront. Other markets have experimented with, and implemented, various flood mitigation measures.



Flooding from Hurricane Harvey submerge homes in Houston in 2017.

COURTESY NEWSCOM

BOSTON

With 47 miles of waterfront, the city is taking a multitiered approach to combating the increasing threat of rising flood waters with the aid of an ambitious “Climate Ready Boston” plan that calls for a mix of regulatory changes, infrastructure upgrades and capital projects. Parts of the plan call for elevating the coastline in some areas, installing floodwalls, building districtwide berms and living shorelines in other sections. Mayor Marty Walsh has committed to set aside 10% of the city’s total \$2.78 billion capital improvement plan over the next five years toward fighting climate change.

In addition to those efforts, the city is working with property owners to help them protect and retrofit their sites from rising floodwaters and, in a bid to look ahead, drafting a set of guidelines to ensure developers fully account for the potential effects of climate change before moving forward with their planned projects.

“Projects that are going through large project review will have to fill out a checklist and explain to us how these projects are reacting to future risks,” said Rich McGuinness, deputy director of climate change and environmental planning for the Boston Planning & Development Agency. “We can’t tell people exactly what they must do. They just have to demonstrate to us through their own designs that they’re protected.”

Boston has a long and storied connection to its waterfront, going back to the 1700s and the Boston Tea Party. As in D.C., Bostonians aren’t about to turn their back now on the water in spite of increasing threats, McGuinness said. That’s why city planners are trying to strike a careful balance between protecting residents and property on one hand and, on the other, not cutting them off from the waterfront that many still cherish as a part of life in Boston.

“What we heard from all the neighborhoods we’ve engaged to date is that they don’t want to be walled off from the waterfront,” he said, adding he doesn’t believe the city would pursue no-build zones. “We’re not really thinking about retreat, because the city is already well built close to the water’s edge.”

HOUSTON

Hurricane Harvey, a 100-year-flood in 2017, dumped 9 trillion gallons of rain on Houston, with flooding extending far beyond what FEMA maps had predicted, and experts said Houston’s rapid addition of paved surfaces was in part to blame. Samuel Brody, a professor at Texas A&M University, calculated that, between 1996 and 2011, that region increased its impervious surface cover by 25%, largely in the form of pavement. With nowhere else for the water to go, the flooding was pushed further inland than anticipated, worsening the humanitarian and economic impact.

SAN FRANCISCO

A 3-mile-plus concrete seawall runs along the Embarcadero, a roadway bordering the city’s financial district that today requires repairs worth about \$5 billion. San Francisco Proposition A, approved by city voters at the end of 2018, will raise \$425 million toward repairs. The remaining gap has yet to be addressed.

According to the San Francisco Business Journal, a sister publication of the Washington Business Journal, some residential developments in the area have trucked in dirt in the past to raise the site level. While this has shown initial success, its longevity through severe weather events remains untested.

MIAMI

To be proactive, Miami has taken such steps as adjusting building codes to increase base flood level elevation, increasing the pumping capacity of management systems, and raising streets and sidewalks, according to a city Land Use and Development Committee memorandum. That committee also moved to compensate developers for additional costs by removing some building height restrictions — a tool that would be difficult to implement in the District as long as the Height Act remains in place.

“It’s an innovative way not to penalize developers by not taking away some of their square footage, by making them build their base flood elevation higher,” said Billy Grayson of the Urban Land Institute. “I’m not sure that would fly in D.C.”

COVER STORY

WHAT IS THE 100-YEAR FLOOD?

The term may seem a bit misleading, but theoretically, it means a flood has only a 1% chance of happening in any given year. In reality, floods of that scope have occurred more frequently in the D.C. area and elsewhere. Ellicott City in Howard County, Maryland, for example, was hit across a three-year span by two rain events categorized as 1,000-year storms, which normally carry an only 0.1% likelihood of occurring.

The Federal Emergency Management Agency maintains an online database of flood maps to serve as guidelines for what risks might arise for a particular property. D.C.-area properties have an overall 26% chance of flooding across a 30-year mortgage, according to Corey DeMuro, a congressional affairs representative for FEMA's Region III.

"However, we know that flooding can often happen outside the FEMA-delineated flood plain," DeMuro said in an email. "Especially in a dense urban environment like D.C., there can be multiple factors that contribute to flooding, such as rainfall, river flooding and the city's stormwater system."

SPEAKING OF STORMWATER

A major contributor to floods in the District is its aging infrastructure of sewer and stormwater pipes. D.C. Water is in the midst of a \$2.6 billion Clean Rivers program meant to increase the system's capacity for handling stormwater and reduce flooding in its growing neighborhoods.

D.C. Water estimates about 6.3 billion gallons of sewage has been captured and sent to the Blue Plains Advanced Water Treatment Plant in Southwest D.C. since part of the system known as the Anacostia River Tunnel opened in October 2018. It figures an additional 2,500 tons of trash that might have otherwise ended up in the river have instead been removed.

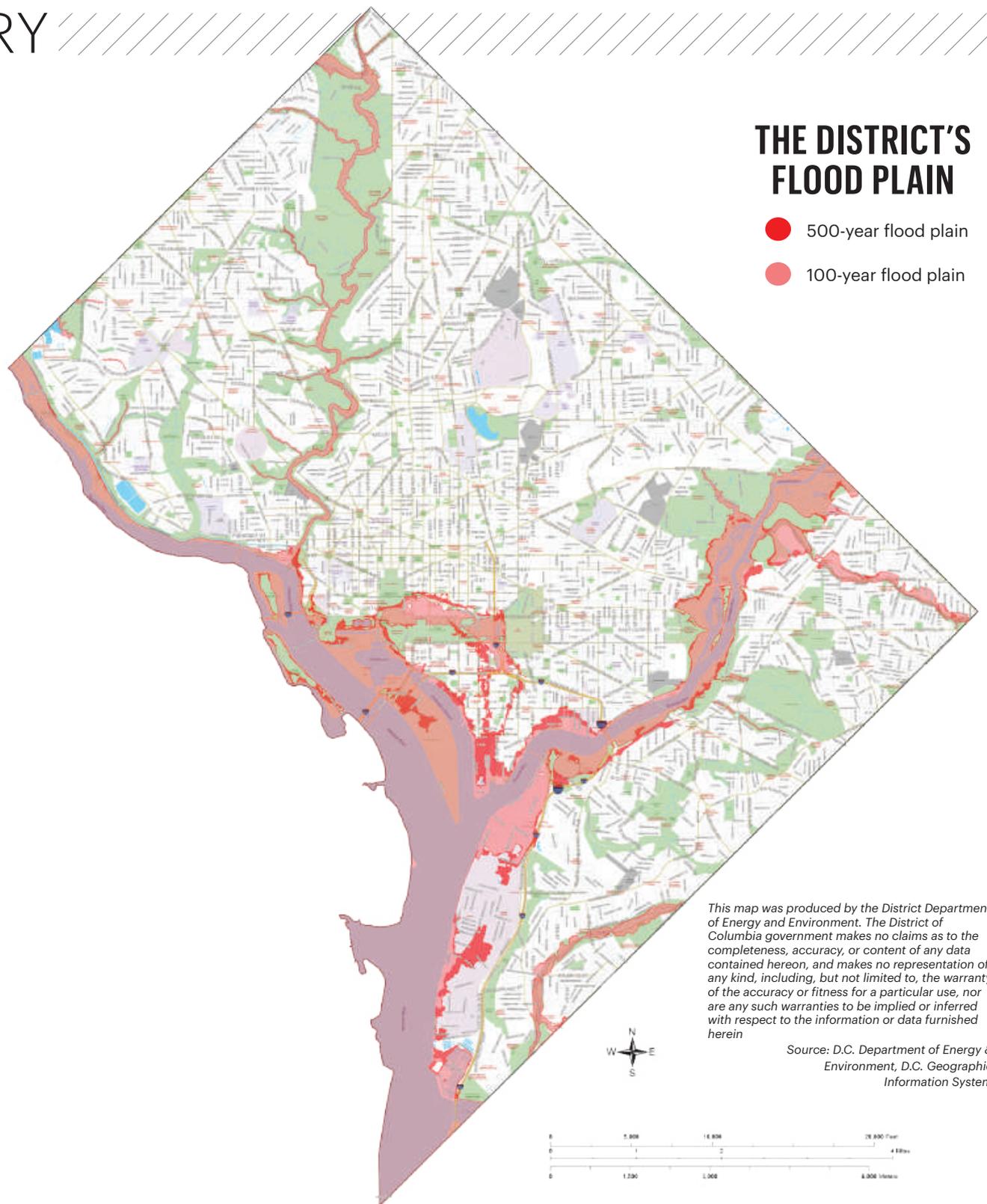
The authority is now in the midst of developing the system's final leg, known as the Northeast Boundary Tunnel. It is about halfway completed, while the broader project is slated for completion in 2023.

SO HOW BAD WILL IT BE?

Government officials in the D.C. region have kicked off several studies to better determine the actual flood risk and flood mitigation approaches. The District has also come up with its own map, one that includes FEMA's regulatory flood plains as well as flooding potential from storm surges and sea level rise (see top right). Areas most at risk include Buzzard Point, parts of the Navy Yard area and Joint Base Anacostia-Bolling.

The results of inaction could be severe, according to Climate Central, an independent group of scientists and university professors from the likes of Princeton and Stanford universities. The research group released a simulation in 2017 called "Surging Seas: Extreme Scenario 2100." In it, by that year, the District's Tidal Basin, World War II memorial and Constitution Gardens would be submerged, among other areas. Anacostia Park would become more swamp than recreation area.

Climate Central also calculated that approximately 1,400 people reside in 400 homes on the 1,350 acres of D.C. land that lies fewer than 6 feet above the high tide line. That's \$4.6 billion in property value. The group puts the likelihood of a 6-foot flood by 2100 at 100%.



THE DISTRICT'S FLOOD PLAIN

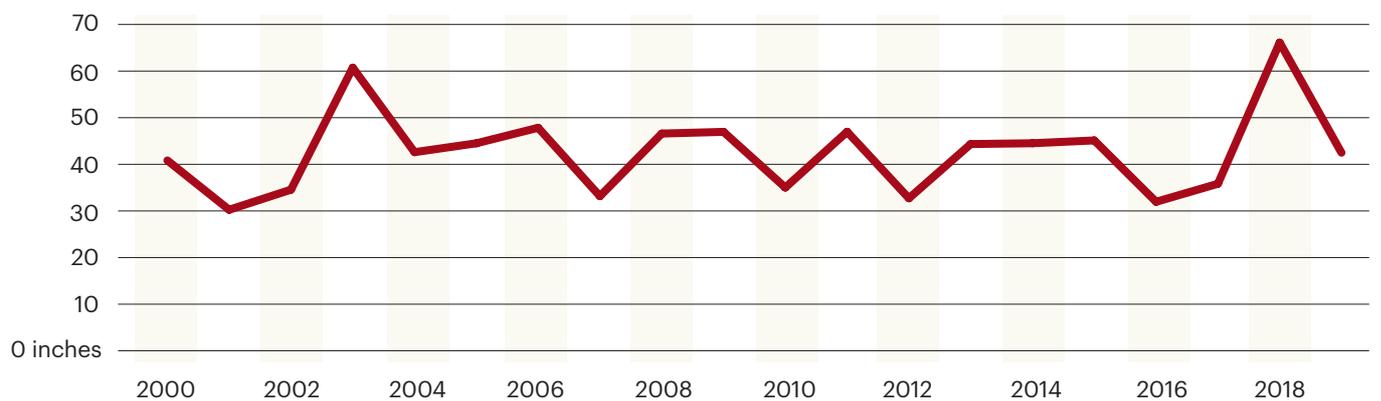
- 500-year flood plain
- 100-year flood plain

This map was produced by the District Department of Energy and Environment. The District of Columbia government makes no claims as to the completeness, accuracy, or content of any data contained herein, and makes no representation of any kind, including, but not limited to, the warranty of the accuracy or fitness for a particular use, nor are any such warranties to be implied or inferred with respect to the information or data furnished herein

Source: D.C. Department of Energy & Environment, D.C. Geographic Information System

► D.C.'S TOTAL RAINFALL

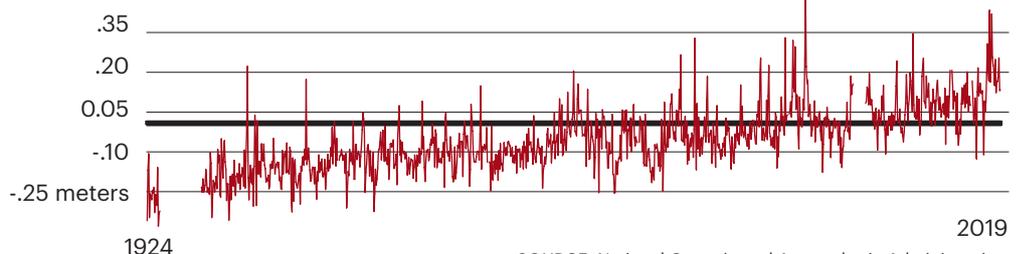
You may have thought 2019 was soggy. It did soar about the 30-year average — but it fell far below the record-breaking 2018, according to annual National Oceanic and Atmospheric Administration statistics on rainfall at Reagan National Airport.



► D.C.'S SEA LEVELS

A RISING TIDE

This plot shows the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures and ocean currents.



SOURCE: National Oceanic and Atmospheric Administration