

IN THE UNITED STATES COURT OF FEDERAL CLAIMS

IN RE UPSTREAM ADDICKS AND)	
BARKER (TEXAS) FLOOD-CONTROL)	Sub-Master Docket No. 17-cv-9001L
RESERVOIRS)	
)	Judge Charles F. Lettow
)	
_____)	Electronically filed August 20, 2019
THIS DOCUMENT RELATES TO:)	
)	
)	
ALL UPSTREAM CASES)	
_____)	

UNITED STATES’ POST-TRIAL MEMORANDUM

Hurricane Harvey was the greatest single rainfall event in United States history. The storm’s maximum rainfall over a four-day period had a return interval exceeding 5,000 years in most portions of Harris County. Over the Addicks and Barker Watersheds, where the Trial Properties are located, Hurricane Harvey had a return interval over a five-day period of approximately 850 years and 775 years, respectively. The historic rainfall caused widespread flooding throughout the greater Houston region.

The flooding in Houston would have been far worse if the United States had never constructed the Buffalo Bayou and Tributaries Project (“the Project”) west of downtown Houston in the 1940s. The Project, which includes the Addicks and Barker Dams and Reservoirs, protected downstream properties, including the City of Houston, during Hurricane Harvey and numerous earlier storms by temporarily detaining flood waters upstream of the dams. When the United States Army Corps of Engineers (“the Corps”) constructed the Project, it bought more than enough property upstream of the dams to accommodate the flood pools expected during even the worst storm then considered reasonably characteristic of the region.

Over the years, however, the reasonably-expected flood pool and the reasonably-expected worst storm changed.

Since the 1940s, and with full knowledge of the Project's existence and purpose, local governments have allowed extensive urbanization to occur immediately beyond the Project boundaries. The United States had no control over this development approval. As a result, many housing developments were constructed in areas at risk of flooding associated with the Project (termed "controlled inundation") during extreme storms, and those housing developments, in turn, increased runoff. In addition, unexpected changes in weather patterns, which brought larger and more extreme storms to the area, further increased the upstream properties' flood risks. Once those increased risks became clear, the Corps warned local governments, developers, and the public that the Project could not prevent flooding on private properties during the most extreme storms. Large storms generate flood pools that may, in extreme circumstances, exceed the boundaries of government-owned land ("GOL") upstream of the reservoirs. And large storms could require the Corps to release flood waters downstream, which could, in some situations, contribute to downstream flooding. Some storms might be so large that flooding on both upstream and downstream properties becomes unavoidable.

Hurricane Harvey was such a storm. It exceeded the rainfall of the largest storm considered reasonably characteristic of the basin when the Corps constructed the Project. It produced record flood pools behind the dams, which inundated some upstream properties for the first time and caused the Corps to release flood waters downstream of the reservoirs. The storm created a true zero-sum game situation—the Corps could not reduce flooding on upstream properties without increasing the risk of downstream flooding; and it could not reduce flooding on downstream properties without increasing the risk of upstream flooding.

Section I discusses the Factual Evidence related to the Corps' construction of the Project; the local governments' subsequent decisions to allow development immediately upstream of the GOL boundaries; the Corps' post-construction analyses of new weather data and hydrology, which showed an increased risk of upstream flooding; the years-long release of information to local governments, developers and the public about the risk of upstream flooding; and the United States' actions during and after Hurricane Harvey, including the granting of billions of dollars to assist individuals and communities impacted by flood waters.

Section II discusses the Expert Evidence, which addressed the size and rarity of Hurricane Harvey; the amount of upstream development after Project construction; a careful study of the storm under actual and hypothetical conditions; and the impact of the storm under those conditions.

Section III discusses the several reasons why the trial evidence supports dismissal of Plaintiffs' claims. First, Plaintiffs' claims fail because Plaintiffs did not prove facts that support Fifth Amendment takings claims, as opposed to tort claims.

Second, the evidence showed that the Corps' actions constituted an exercise of governmental power to prevent loss of life and far worse damage to private property that would have occurred if the Corps had not acted. That type of government action—an exercise of sovereign police power calculated to address an unavoidable public harm—does not amount to a taking of property compensable under the Fifth Amendment.

Third, the evidence showed that the Corps acted during an emergency in a way that prevented far worse flooding to downstream properties. The doctrine of necessity precludes liability in such circumstances.

Fourth, Plaintiffs failed to prove that they have a compensable property interest to be free of floodwaters generated during a hurricane.

Fifth, Plaintiffs' claims fail with respect to those Trial Properties that would have flooded in the absence of government action.

Sixth, Plaintiffs' claims fail under the multi-factor test established in *Arkansas Game and Fish Commission v. United States*. The evidence showed that the Trial Properties were developed decades after construction of the Project. Those properties have been subject to controlled inundation due to their proximity to the reservoirs since the late 1940s, well before Plaintiffs' acquisition. The trial evidence also showed that each property was capable of repair and any inundation lasted for a relatively short time period. Thus, if the Court reaches the merits of Plaintiffs' claims, it should reject those claims under *Arkansas Game and Fish Commission*.

Finally, Plaintiffs failed to establish a taking of any personal property and those claims should, therefore, be rejected.

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I. Factual Evidence

A. The Corps Built the Project at the Request of, and in Cooperation with, Local Interests to Reduce Downstream Flood Risks More than Seventy Years Ago

1. The Project Was Needed Because Houston is Extremely Flood-Prone

The City of Houston is the most flood prone city in the United States. Tr. at 2030:18-20 (Bedient). Houston and the surrounding counties are naturally prone to flooding for two main reasons. First, the area is remarkably flat, rising only about one foot per mile from the coast. Tr. at 613:17-24 (Lindner, describing the geography as “extremely flat”); Tr. at 2031:11-16 (Bedient, describing Harris County as “very flat”).¹ The flat terrain exacerbates flooding because high water moves in a sheet flow across the ground, over and through developed areas, as it slowly moves towards lower ground.

There are twenty-two watersheds in Harris County, each of which drains rainfall and stormwater runoff to a creek or waterway and, eventually, to Galveston Bay. DX-737 at FEMA078355 (HCFCD Federal Briefing, Spring 2018, showing watersheds); DX-682 at 2 (Harris County Watersheds map). Each watershed has “its own independent flooding problems.” DX-737 at FEMA078352 (HCFCD Federal Briefing, Spring 2018). Addicks Reservoir Watershed, Barker Reservoir Watershed, and Cypress Creek Watershed (during large storms) naturally drain into Buffalo Bayou, which, prior to Project construction, carried uncontrolled flows through the center of Houston. Before Project construction, high rainfall events resulted in uncontrolled flows that overtopped waterways and flooded properties on numerous occasions. *See, e.g.*, ECF No. 211, ¶ 81 (Joint Stipulations, stating there were six major floods that occurred

¹ Jeff Lindner has worked at the Harris County Flood Control District (“HCFCD”) since 2004 and served as the Director of Hydrology Operations for HCFCD since 2016. Tr. at 543:11 to 545:8 (Lindner). Mr. Lindner has a Bachelor’s Degree in Meteorology from Texas A&M. Tr. at 543:23 to 544:2 (Lindner).

in Buffalo Bayou between 1854 and 1935); JX-5 at USACE129507 (1940 Definite Project Report, same).

Second, Houston is close to the Gulf of Mexico, where hurricanes and tropical storms develop regularly. As Jeff Lindner explained, the proximity to the Gulf renders the region susceptible to “really big rainfall events” with “very large rainfall totals over a very large area” Tr. at 614:7-23 (Lindner). Sufficiently large storms with prolonged rainfall—not just hurricanes—can inundate structures in Harris and Fort Bend Counties, as occurred even in recent years, including 1994 and 2016. DX-682 at 4 (Lindner Presentation); Tr. at 2464:22 to 2465:4 (Fitzgerald, agreeing that the Houston-Galveston area receives not only “large amounts of rain but also high, intense amounts of rain,” which are a major contributing factor to flooding in Harris County).²

As a result of these natural conditions, Fort Bend and Harris Counties have always struggled with flooding. Tr. at 611:7-14 (Lindner); DX-684 (HCFCD website, Harris County’s Flooding History); DX-737 at FEMA078352 (HCFCD Federal Briefing, Spring 2018, stating “[n]ature also challenges us with flat terrain, clay soils that do not absorb water well, and an average annual rainfall of 48 inches”). Mr. Lindner described flooding as the region’s “natural disaster,” explaining that “we historically had flooding, and flooding and tropical storms and hurricanes [are] our natural hazard[s] here.” Tr. at 611:7 to 612:14 (Lindner); DX-684 at DEPO_0035111 (HCFCD website, “Flooding Is Our Natural Disaster”); DX-737 at FEMA078357 (HCFCD Federal Briefing, Spring 2018, stating “[t]ropical rain and flooding will

² Steven Fitzgerald is a registered professional engineer and was HCFCD’s Chief Engineer for 20 years. Tr. at 2385:7-14 (Fitzgerald). Mr. Fitzgerald has worked on nearly every flood event in Harris County since 1983. Tr. at 2424:12-17 (Fitzgerald). Between the early 1990s and 2018, he was HCFCD’s primary point of contact for coordinating with the Corps on the Project. Tr. at 2386:6 to 2387:4 (Fitzgerald).

always be the primary natural threats to Harris County and the Gulf Coast”). The region’s natural flood risk is unavoidable—complete elimination of flood damage is impossible in Harris County “because the terrain is relatively flat and our rainfall, particularly along the Gulf Coast, is very intense and can overwhelm the drainage systems pretty easily.” Tr. at 2390:3-8 (Fitzgerald). Consequently, “[e]verybody [in Harris County] has a flood risk. Some residents have a higher flood risk than others, but every single resident in this county has a risk.” Tr. at 613:10-16 (Lindner).

In 1929 and 1935, large storms caused devastating flooding in the region. ECF No. 211 ¶¶ 82-83 (Joint Stipulations). The 1935 Storm, which produced approximately 15 inches of rain in 72 hours, was particularly destructive. Tr. at 199:21-23 (Thomas);³ Tr. at 2018:11-12 (Bedient); ECF No. 211 ¶ 83 (Joint Stipulations). That storm, the then-largest to hit the Houston area, resulted in eight deaths and caused millions of dollars of damage. ECF No. 211 ¶ 83 (Joint Stipulations). Concern about future storms prompted local interests to request that the United States and the Texas Legislature take actions to reduce flood risks. DX-684 (HCFCD webpage—Harris County’s Flooding History); H.R. Rep. No. 75-456 at 8, ¶ 6 (1937). In 1937, the Texas Legislature created the HCFCD to develop flood reduction projects. DX-737 at

³ Robert Thomas has a Bachelor’s Degree in Maritime Systems Engineering and a Master’s Degree in Ocean Engineering. Tr. at 439:10-18 (Thomas). He began working full time at the Corps in 2010 as a Research Coastal Engineer at the Corps’ Engineering Research and Development Center. Tr. at 440:3-14 (Thomas). In 2013, Mr. Thomas became the Chief of the Galveston District’s Hydrology and Hydraulics Branch, Tr. at 440:24 to 441:2 (Thomas), and since October 2016, has served as the Chief of the Corps’ Engineering and Construction Division, in Galveston, Texas, Tr. at 54:4-8 (Thomas). In that role, Mr. Thomas oversees the District’s engineering design, construction, and technical analyses. Tr. at 443:6-10 (Thomas). Mr. Thomas is also the District’s Dam Safety Officer, which includes all water control and technical activities related to Addicks and Barker Dams. Tr. at 443:11-16 (Thomas).

FEMA078352 (HCFCD Federal Briefing, Spring 2018); Tr. at 599:1-7 (Lindner).⁴ Shortly after, the Corps began planning the Project—a massive public works project, with input from HCFCD and other local entities. In 1938, Congress authorized construction of the Addicks and Barker Dams and Reservoirs as part of the Project. Tr. at 2386:6-12, 2387:5-8 (Fitzgerald, explaining that one of HCFCD’s main purposes is to serve as the non-federal partner, or sponsor, for the Project); Tr. at 531:20 to 532:7 (Thomas, describing the role of HCFCD as the non-federal sponsor).⁵ HCFCD has served as the Project’s non-federal sponsor since its inception. Tr. at 531:20-25 (Thomas). As the non-federal sponsor, HCFCD regularly communicates with the Corps and other entities on Project operations. Tr. at 532:1-21 (Thomas).

HCFCD and local drainage districts have taken numerous additional steps to try to address flooding in this area, including establishing an “elaborate network of ditches and drainage ditches and creeks and bayous to help expedite the flow of that water to get out into the bay and the Gulf of Mexico.” Tr. at 613:24 to 614:6 (Lindner). HCFCD’s extensive drainage and flood control infrastructure includes “more than 1,500 channels totaling about 2,500 miles in length (about the distance from Los Angeles to New York) and more than 200 stormwater detention basins (9,189 acres) ranging in size (from 1 to 1,400+ acres).” DX-737 at FEMA078352 (HCFCD Federal Briefing, Spring 2018).

⁴ Thus, HCFCD’s mission is to “[p]rovide flood damage reduction projects that work, with appropriate regard for community and natural values.” DX-737 at FEMA078350-51 (HCFCD Federal Briefing, Spring 2018).

⁵ The Project was the Corps’ first project with which HCFCD was involved. Tr. at 2388:3-8 (Fitzgerald). HCFCD also serves as the non-federal sponsor for other federal flood risk reduction projects within Harris County. Tr. at 2388:9 to 2389:8, 2445:10-22 (Fitzgerald); DX-737 at FEMA078375 (HCFCD Federal Briefing, Spring 2018, listing projects).

2. Congress Authorized the Project to Reduce Houston’s Flood Risks

Congress authorized the Project, and the Corps constructed it, with the intent to reduce flood risks to the City of Houston, the ship channel and turning basin, and structures downstream of the dams’ outlet works. Tr. at 64:20-25, 91:10-13 (Thomas); Tr. at 1453:7-14 (Long); *see also* ECF No. 211 ¶¶ 79-80 (Joint Stipulations, discussing authorizing statutes).⁶

The original Project design contemplated construction of three reservoirs, a system of canals and levees, and channel rectification along Buffalo Bayou. JX-5 (1940 Definite Project Report, describing the Project’s various features); Tr. at 190:14-17 (Thomas). This included approximately 7.5 miles of channel rectification along Buffalo Bayou below the reservoirs, and construction of a south canal that would bypass Houston, with sufficient capacity to carry large reservoir releases. Tr. at 192:11-22 (Thomas). The original design also included construction of an upstream levee to prevent overflow from the Cypress Creek Watershed into the Addicks Reservoir. Tr. at 193:1-5 (Thomas).

3. At the Time of Construction, the Corps Purchased More than Enough Upstream Property to Accommodate the Flood Pools Likely to Be Created by the Worst Storm Reasonably Characteristic of the Region

i. Construction of the Dams

The Corps completed construction of Barker Dam and Reservoir in February 1945 and Addicks Dam and Reservoir in December 1948. JX-91 at USACE016054 (2009 Master Plan); ECF No. 211 ¶¶ 90, 95 (Joint Stipulations). As constructed, Addicks and Barker Dams are elongated “U-shaped” earthen embankments, approximately 13.6 miles and 11.5 miles long,

⁶ Richard Long is a Natural Resource Management Specialist with the Corps. Tr. at 1444:5-9 (Long). He has worked for the Corps for more than 40 years. Tr. at 1494:20-22, 1495:25 to 1496:8 (Long). Mr. Long is the District’s point of contact on natural resource management issues for the Project, and he acts as a liaison between the Corps’ Construction and Operations Office and the Corps’ Public Affairs Office. Tr. at 1495:3-13 (Long).

respectively, and rising approximately 48 and 36 feet above the stream bed at their highest points, respectively. The reservoirs lie north and west of the confluence of Buffalo Bayou and South Mayde Creek, near the western edge of the Houston city limits. The majority of Addicks and Barker Reservoirs fall within Harris County, but a small portion of Barker Reservoir crosses into Fort Bend County.

The Corps planned to build the Project in stages over time, but several components were never constructed. JX-5 at USACE129504 (1940 Definite Project Report). As Mr. Thomas and Dr. Bedient explained, the decision not to construct certain project elements resulted from increased urbanization on adjacent properties and a lack of available funding, likely stemming from the United States' expenditures associated with its entry into World War II. Tr. at 473:8-18 (Thomas); Tr. at 2012:7-13 (Bedient).

Because all Project components were not constructed, runoff can still move from the Cypress Creek Watershed into the Addicks Watershed during extreme rain events. Tr. at 1539:3-11 (Long). That water flows into Addicks Reservoir and can increase the size of the resultant flood pool. The Corps estimates that Addicks Reservoir receives approximately one-third of its total volume from the Cypress Creek Basin during major flood events. JX-110 at USACE016322 (2012 Water Control Manual).⁷

Since its construction, the Project has protected downstream properties spectacularly well, by retaining upstream flood runoff and releasing flood waters downstream at a slower rate

⁷ Water moved from the Cypress Creek Watershed into the Addicks Watershed, and then into the Addicks Reservoir, during the 2016 Tax Day Flood and during Hurricane Harvey. Tr. at 79:17-20 (Thomas). Dr. Nairn calculated that more than 30 percent of the Addicks Reservoir inflows during Hurricane Harvey were overflows from the Cypress Creek Watershed. Tr. at 2724:8-21 (Nairn). Dr. Bedient testified that if the Cypress Creek levee had been built, it could have lessened the flooding upstream of Addicks reservoir. Tr. at 2011:23 to 2012:1 (Bedient).

than would otherwise occur. Tr. at 445:21-23 (Thomas); JX-91 at USACE016051 (2009 Master Plan).

ii. Land Acquisition

At the time of design and construction, the 1935 Storm was the worst flood to hit the watersheds in recorded history. Tr. at 453:20-23 (Thomas). The Corps used the calculated flood pool that would have been generated by that storm, plus three vertical feet of freeboard to account for uncertainty, as the basis for land acquisition for the planned reservoirs. Tr. at 202:10-15 (Thomas, explaining that freeboard is a vertical allowance above pool level to allow for uncertainties); Tr. at 857:21 to 858:17 (Johnson-Muic);⁸ JX-4 (1942 Letter Recommending Purchase of Land Consistent with 1940 Definite Project Report); JX-5 at USACE129508 (1940 Definite Project Report, explaining that the Corps based its land purchase by reference to the “most intense storm to visit the basin during the period of record”—the 1935 Storm). Because the land in this area is so flat, a freeboard of three vertical feet corresponds to much more land measured horizontally. Tr. at 456:18-25 (Thomas, explaining that three vertical feet may correspond to 3,000 or 15,000 horizontal feet).

The Corps’ use of the worst storm in the region as the basis for establishing the government’s land acquisition boundaries—that is, as the “land acquisition flood”—was consistent with the Corps’ approach in the 1940s. Tr. at 453:24 to 454:4 (Thomas); Tr. at 2016:21 to 2017:2 (Bedient). Current and past Corps regulations require that land acquisition decisions take into account the land type upstream of reservoirs—“for example, if it’s all

⁸ Ms. Paula Johnson-Muic is the Chief of Real Estate for the Corps’ Southwestern Division. Tr. at 822:13-18 (Johnson-Muic). She has served as Chief of Real Estate for approximately 10 years, and has worked for the Corps for almost 29 years. Tr. at 854:11-22 (Johnson-Muic). Ms. Johnson-Muic holds a Bachelor’s Degree from Penn State and Juris Doctorate Degree from the Dickinson School of Law. Tr. at 855:3-5 (Johnson-Muic).

farmland, you might have a lower land acquisition flood. If it's all [developed], then you would have a higher land acquisition flood.” Tr. at 454:14-21 (Thomas). Prior to construction, upstream properties were almost entirely undeveloped and rural. JX-91 at USACE016054 (2009 Master Plan, discussing undeveloped, rural nature of the properties upstream of the reservoirs before construction of the reservoirs); PX-1597 at USACE755519-21 (Meeting Slides for Addicks and Barker Reservoirs Overview Meeting, showing aerial photographs from 1948); Tr. at 455:8-19 (Thomas, explaining that, in the 1940s, the upstream properties were almost exclusively used for ranching and rice farming); Tr. at 2086:3-9 (Bedient). The Corps set the GOL boundary, in part, on the rural nature of land upstream of the proposed dams in the 1940s. Tr. at 200:17-25 (Thomas). Dr. Bedient testified that, even as late as 2014, the Corps had the same internal real estate acquisition guidance that existed in the 1940s—to buy approximately three vertical feet above the worst storm of record in the region. Tr. at 2015:24 to 2016:3 (Bedient).

By 1945, when it became clear that the proposed Cypress Creek levee would not be built, the Corps acquired additional lands upstream of Addicks Reservoir to accommodate the anticipated overflow from Cypress Creek. Tr. at 474:11 to 475:7 (Thomas, explaining that the Corps purchased an additional three to four vertical feet).

4. After Construction of the Dams, the Corps Owned More than Enough Property to Accommodate the Flood Pool Likely to be Created by the Worst Storm Reasonably Characteristic of the Region

i. Standard Project Flood

Although the term was not used in the 1940s when the Corps conceived and built the Project, the Corps now uses the term “Standard Project Storm” to define the “worst storm that you reasonably expect to occur during the life of the project.” Tr. at 465:2-4 (Thomas, discussing PX-707, the Mar. 1, 1965 Engineering Manual 1110-2-1411, defining the term). The

flood pool expected from the Standard Project Storm is termed the Standard Project Flood (“SPF”). Tr. at 467:13-15 (Thomas, discussing PX-707, the Mar. 1, 1965 Engineering Manual 1110-2-1411, defining the term); Tr. at 97:11-14 (Thomas, explaining that the SPF is a “hypothetical flood that [the Corps uses] to describe a flood that might be the worst flood [one] could see that’s reasonably characteristic of the [basin]”). The Corps uses the SPF, in some instances, to set real estate acquisition lines. Tr. at 97:20-23 (Thomas).

The Corps did not use the term SPF in the 1940s, Tr. at 467:20-23 (Thomas), but the 1935 Storm was “[w]ithin a foot or so” of the SPF as calculated in the Corps’ 1955 Regulation Manual. Tr. at 468:12-15 (Thomas). During the design phase, the Corps anticipated that storms of similar intensity to the 1935 Storm would likely occur several times during the lives of the dams. JX-5 at USACE129527 (1940 Definite Project Report).

The Corps was also aware of a much larger 1899 storm, called the Hearne Storm, which had impacted a different part of Texas, but determined that storm represented the upper limit of possible storms and was not reasonably characteristic of storms likely to occur in the region of the two reservoirs. Tr. at 1029:7-20 (Thomas). As Mr. Thomas explained, to set the land acquisition line, the Corps looks for “a storm that’s large, but not the worst ever, because if [the Corps] designed for the worst ever, they wouldn’t be able to afford all the projects. . . .” Tr. at 1060:22-25 (Thomas). Thus, the Corps determined in the 1940s that the Hearne Storm did not qualify as a Standard Project Storm. Tr. at 1030:10-13 (Thomas); Tr. at 1060:1 to 1061:3 (Thomas, explaining that the Corps’ use of the 1935 Storm was a reasonable determination when the Corps designed and constructed the Project).

ii. Spillway Design Flood

Because of the acute consequences of a dam failure, Corps engineers design dams to withstand hypothetical storms much larger than the SPF. Though not in use in the 1940s, modern engineers now use a hypothetical storm known as the “Spillway Design Storm” to design a dam’s spillway and guard against dam failure. Tr. at 125:25 to 126:1, 468:20-23 (Thomas). Engineers call the flood pool expected from the Spillway Design Storm the “Spillway Design Flood,” often shortened to “SDF.”

At Addicks and Barker Reservoirs, engineers currently base the SDF on the “Probable Maximum Flood,” the flooding expected to occur during the “Probable Maximum Precipitation” (“PMP”), the worst rainfall that engineers believe could be generated in the region. Tr. at 175:19-22, 468:20 to 469:3 (Thomas); PX-51 at USACE013571 (1984 General Design Mem., explaining that the PMP is the “theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year”). In this context, the word “probable” is a term of art—it does not imply a likelihood of occurrence, but rather a belief that it is probably the worst, most extreme storm event that could occur. Tr. at 338:12 to 339:5 (Thomas, explaining that “probable” in this context does not have the common meaning that “this is probably going to happen”); Tr. at 500:3-10 (Thomas, explaining that the word “probable” is a term of art in engineering circles, and it means that it is “probably not capable of being exceeded”); Tr. at 975:2-4 (Thomas, explaining that the PMF’s likelihood of occurrence “[e]ssentially . . . means it’s our theoretical maximum limit for a flood. . . .”). Thus, the PMP “is just a hypothetical number that climatologists and meteorologists have [estimated to represent] physically how much rain the atmosphere can physically produce in a certain area.” Tr. at 628:12-20 (Lindner).

The Corps did not use the term SDF in the 1940s. Tr. at 469:12-14 (Thomas). The Corps instead used a “Design Storm,” which it based on the Hearne Storm, a storm that was much larger than the 1935 Storm. JX-5 at USACE129526 (1940 Definite Project Report, comparing anticipated pool levels resulting from the 1935 Storm and the Design Storm). In the 1940s, as today, the Corps typically designed dams to survive water levels higher than the levels that would result during the worst storm of record within the watershed to try to guard against a catastrophic dam failure. Tr. at 470:12-16 (Thomas).

During the Project design phase, the Corps noted that “the occurrence of [the Design Storm] in the basin cannot be expected to occur more than once in the lives of these structures,” meaning that “it could happen, but they don’t think something worse would happen.” Tr. at 471:9-16 (Thomas, discussing JX-5 at USACE129527). While physically possible, the Corps stated in the 1940s that the likelihood of a Hearne-like storm occurring in the Buffalo Bayou basin was “very remote.” JX-5 at USACE129510 (1940 Definite Project Report). As discussed below, the SPF and SDF calculations for the reservoirs have changed over time. The current SDF has a probability of occurring approximately once in 179,000 years for Addicks Reservoir and once in 135,000 years for Barker Reservoir. DX-255 at USACE065070, USACE065074 (May 2013 Dam Safety Modification Engineering Appendix).

iii. After Construction of the Dam, the GOL Elevation Exceeded the SPF Elevation

Immediately prior to construction, the existing data showed that the Corps intended to buy enough land upstream of the dams to accommodate the flood pool anticipated in the event of the SPF, the worst storm one could reasonably expect to occur in the watershed:⁹

⁹ Elevation is measured against a zero-elevation reference point known as a “vertical datum.” The vertical datums used by surveyors have changed over time and are often adjusted to account

Reservoir	1935 Storm (effectively the SPF) (ft.)	Acquisition (ft.)	Design Storm (effectively the SDF) (ft.)
Addicks	101.4	104.4	108.3
Barker	95.3	98.3	101.7

JX-5 at USACE129526 (1940 Definite Project Report). By 1955, after completing construction of the dams, the Corps still owned more than sufficient land upstream of the reservoirs to accommodate the SPF flood pool:

Reservoir	Standard Project Flood (ft.)	Acquisition (ft.)	Maximum Design Water Surface Elevation (effectively the SDF) (ft.)
Addicks	104.0	108	113.8
Barker	96.7	98.3	104.8

DX-25 at USACE284671 (Aug. 1955 Reservoir Regulation Manual); Tr. at 483:6 to 484:2 (Thomas, testifying that, in 1955, the Corps owned more than enough land upstream of the reservoirs to accommodate the flood pool resulting from the most severe storm considered reasonably characteristic of the region); Tr. at 2029:3-8 (Bedient, testifying that before 1977, the boundaries of the GOL exceeded the SPF boundaries).

iv. After Gating of the Dams' Conduits, the GOL Elevation Exceeded the SPF Elevation

The original Project design included five outlets on each dam, one of which was to be gated for emergency purposes. Tr. at 197:20 to 198:6 (Thomas). As downstream development continued, the Corps added gates to further reduce flooding risks to downstream properties. Tr. at 451:17-23 (Thomas). By the early 1950s, the Corps had gated three of the five conduits at

for local conditions. Historic elevation data discussed here are as reported in the Project documents and are not comparable among different vertical datums.

each reservoir, Tr. at 208:4-14 (Thomas), and the Corps gated the remaining conduits by 1962. Tr. at 208:4-14, 452:13-15 (Thomas).¹⁰

After installation of gates on all the conduits, the Corps still owned more than enough land upstream of the two reservoirs to accommodate the pool expected to be generated by the SPF:

Reservoir	Standard Project Flood (ft.)	Acquisition (ft.)	Spillway Design Flood (ft.)
Addicks	104.8	108	114.6
Barker	97.7	98.3	106.4

JX-16 at USACE011634 (Apr. 1962 Reservoir Regulation Manual); Tr. at 2029:3-8 (Bedient, testifying that before 1977, the boundaries of the GOL exceeded the SPF boundaries).

B. Fort Bend County and Harris County Approved Development Upstream of the Reservoirs, Within the Potential Pool Area

After Project construction, Fort Bend and Harris Counties allowed developers to build homes and businesses upstream of the reservoirs, within the potential flood pool area: “Homes were allowed to be developed and sold in this flood pool area with the knowledge of federal, state, and local governments.” Tr. at 2089:16-19 (Bedient, discussing DX-883 at 24 (Aug. 2018 SSPEED Center Report: Houston a Year After Harvey: Where We Are and Where We Need to Be)). The upstream development was approved by Harris and Fort Bend Counties, not the United States. Tr. at 2089:20 to 2090:3 (Bedient); Tr. at 2456:10-24 (Fitzgerald, explaining that the upstream development occurred within the county and therefore was presumably done with Harris County’s knowledge and approval); PX-1812 at USACEII00993349 (Draft Q&A’s for

¹⁰ Mr. Ickert, whose work is discussed further below, showed that the percentage of undeveloped land in Buffalo Bayou downstream of the Project went from 91 percent in the 1940s to 47 percent in the 1960s. DX-600 at Table 4 (Ickert Expert Report). That percentage dropped to 8 percent by 2014. *Id.*

Addicks and Barker Reservoirs, Answer 10, noting that private development outside of the Corps' boundary is governed by local land use regulations, which the Corps does not control).¹¹

C. The Corps Authorized Outgrants to Reduce Some Natural Flooding on Upstream Properties

In order to facilitate upstream development, some developers sought the Corps' permission to extend channel improvements into the reservoirs. JX-52 at USACE15144 (1995 Reconnaissance Report). Beginning in approximately 1981, the Corps granted several of these requests. JX-52 at USACE015144 (1995 Reconnaissance Report); Tr. at 382:24 to 383:5 (Thomas). As a result, several improved upstream tributaries now extend into the reservoirs, and facilitate movement of water off of upstream private properties. Tr. at 383:9-20 (Thomas); Tr. at 2090:20-23 (Bedient, explaining that the effect of those channels was to allow water to move into the reservoirs); Tr. at 692:15 to 693:6 (Vogler, testifying that drainage channels improvements allowed developers to increase runoff rates, reduce the floodplain and "to potentially develop more property or sell more homes").¹²

The Corps' approval took the form of "outgrants"—real estate transactions allowing a third party's use of federal lands. Tr. at 863:19-22 (Johnson-Muic). In some cases, these

¹¹ See also DX-139 (Cinco Ranch Equestrian Village Section 3 subdivision plat, showing approval by the Houston Planning Commission, the Harris County Engineer, HCFCD, and final approval by the Harris County Commissioners Court); DX-557 (Canyon Gate Cinco Ranch Section 7 subdivision plat, showing approval by the Houston Planning Commission, the Fort Bend County Engineer and final approval by the Fort Bend County Commissioners Court); DX-137 at FB0000492-493 (Fort Bend County records, showing review of subdivision plan and final approval by County Commissioners); DX-122 at FB0000611 (Fort Bend County records from 1992-1993, showing review of Kelliwood Courts subdivision plan noting that "this subdivision is subject to controlled inundation from Barker Reservoir"); Tr. at 712:25 to 713:3 (Vogler, testifying that Fort Bend County Commissioner's Court is the final approving authority for a subdivision plat).

¹² Mark Vogler has served as the Fort Bend County Drainage District Manager and Chief Engineer since 2005, Tr. at 671:21 to 672:4 (Vogler), and worked at Fort Bend County since the early 1980s, Tr. at 683:10-16 (Vogler).

outgrants were the only possible means of draining water from upstream lands. Tr. at 868:17-23 (Johnson-Muic). The Corps granted approximately 29 outgrants, Tr. at 864:8-10 (Johnson-Muic), including the following:

Project	Date Approved	Effect of Project	Nearby Trial Property
Tributary 52.9 to Buffalo Bayou	1976. DX-50 (Recorded easement granted to HCFCD for Channel Improvements at Barker Dam).	DX-130 at USACE309659 (FONSI, stating that draining into the reservoir was the only viable alternative to remove stormwater efficiently from the proposed development); DX-130 at USACE309646 (FONSI, explaining that the drainage ditch was “necessary to prevent flooding”).	Soares. DX-801 (Barker Map Depicting Certain Drainage Easements).
Mason Creek Diversion Channel	1983. DX-84 (Recorded easement granted to Harris County for Channel Improvements at Barker Dam).	JX-28 at USACE522967-2969 (Proposal for Improvements to Mason Creek by HCFCD, explaining that the purpose of the diversion channel was to reduce flooding upstream of the Reservoir and that the diversion channel was needed because severe flooding occurred upstream from Barker Reservoir in August of 1981).	Popovici. DX-801 (Barker Map Depicting Certain Drainage Easements).
Willow Fork Diversion Channel	1986. DX-94 (Recorded easement granted to Willow Fork Drainage District for Willow Fork Diversion Channel).	DX-94 at FB0025601 (Recorded easement, stating that without the outgrant, “frequent flooding would render these upstream lands undevelopable”); JX-33 at USACE750430 (1984 EA, explaining that the Willow Fork Diversion and Channel Improvements were needed because the “topography of much of the land in this area is nearly level, and as a result, land areas adjacent to, and upstream of the Barker Reservoir, are subjected to frequent flooding events”).	Micu. DX-801 (Barker Map Depicting Certain Drainage Easements).
Willow Fork of Buffalo Bayou	1986. DX-95 (Recorded easement granted to Fort Bend County Drainage District for Channel Improvements to Willow Fork of Buffalo Bayou).	DX-95 at FB0025621 (Recorded easement, stating that without the outgrant, “frequent flooding would render these upstream lands undevelopable”); JX-33 at USACE750430 (1984 EA, explaining that the Willow Fork Diversion and Channel Improvements were needed because the “topography of much of the land in this area is nearly level, and as a result, land areas adjacent to, and upstream of the Barker Reservoir, are subjected to frequent flooding events”).	Banker and Giron. DX-801 (Barker Map Depicting Certain Drainage Easements).

Project	Date Approved	Effect of Project	Nearby Trial Property
Bear Creek Subdivision Drainage	1973. DX-45 (Recorded easement granted to HCFCD for drainage ditch at Addicks Dam).	DX-64 at USACE610242 (1979 letter, explaining that because the existing drainage ditch was not properly functioning, homes had flooded or were at risk of flooding).	Stewart, Turney, and Sidhu. DX-800 (Addicks Map Depicting Certain Drainage Easements).
Horsepen/Langham Creek Diversion Channel	1986. DX-91 (Recorded easement granted to Harris County for channel improvements at Addicks Dam).	JX-35 at USACE313239 (Correspondence, explaining that Harris County proposed the project after major flooding occurred in August 1981 that flooded property outside of the reservoirs, including several homes in Bear Creek Village subdivision).	Burnham. DX-800 (Addicks Map Depicting Certain Drainage Easements).
Bear Creek Diversion Channel	2000. DX-153 (Recorded easement granted to HCFCD for Bypass Channel at Addicks Dam).	DX-152 at USACE794686 (FONSI for Bear Creek Bypass Channel, explaining that the proposed drainage improvements would address continual out-of-banks flooding of populated areas around Bear Creek outside the boundaries of the GOL); DX-149 at USACE325228 (Environmental Assessment for Bear Creek Bypass Channel, explaining that the only feasible and economic option to reduce flooding was construction of a bypass channel on government lands).	West Houston Airport Company (“WHAC”) property. DX-800 (Addicks Map Depicting Certain Drainage Easements).

D. Rapid Urbanization and Updated Methodology and Data in the Corps' 1977 Hydrology Report Revealed Vastly Increased Flood Risks

Increased urbanization and a better understanding of the region's hydrology caused the Corps to become aware in the 1970s that a real possibility existed of a large storm creating flood pools at the reservoirs that could extend into the new developments upstream of the GOL boundaries. PX-37 at USACE667927 (May 1973 Mem., stating that "maximum impoundment in subject reservoirs will cause flooding of substantial amounts of private lands adjoining the fee-owned Government lands"); PX-38 at USACE233706 (July 1974 Inspection Report, noting that "[d]evelopment of the area will eventually place the Government in the position of having to flood the area within the reservoir with the accompanying damages in order to protect downstream improvements in the event of a severe future storm"). In October 1974, an internal memorandum recommended that the Corps prepare a study "detailing the problems and recommending solutions" to the upstream flooding issue. PX-39 at USACE233664 (Oct. 1974 Mem.).

In August 1977, the Corps completed an extensive Hydrology Report to evaluate the safety and functional reliability of the two dams, in light of the increased urbanization and updated hydrologic criteria. JX-23 at USACE318522 (Aug. 1977 Hydrology Report). The report represented a sea change—it raised immediate concerns about dam safety and contained a dramatically increased estimate of inflows associated with the expected SPF and SDF. Tr. at 497:15-21 (Thomas).

The 1977 Hydrology Report developed a new PMP—approximately 43 or 44 inches of rain. Tr. at 254:25 to 255:2, 499:11-13 (Thomas). It also used updated methodologies to calculate inflows associated with the SPF and SDF. The new inflow analyses set forth in the

1977 Hydrology Report indicated, for the first time, that the pools associated with the SPF, as recalculated based on updated information, would likely exceed the GOL boundaries:

Reservoir	New SPF Calculation (50 percent of the PMP rainfall) (ft.)	Acquisition (ft.)	New SDF Calculation (one-half of PMP, followed five days later by PMP) (ft.)
Addicks	107.5	103	115
Barker	99	95	108

JX-118 at USACE019883-85 (2014 Emergency Action Plan); Tr. at 210:20 to 211:6 (Thomas).¹³

The 1977 Hydrology Report raised two concerns. First, the new analysis revealed a serious safety issue—the dams could not safely retain or convey downstream the rainfall and runoff associated with the newly-determined SDF. Tr. at 257:21 to 258:1 (Thomas); PX-51 at USACE013568 (1984 General Design Mem., stating “present dams are potential safety hazards in light of present day engineering standards, and thus, do not meet Corps . . . criteria for dam safety”). Second, the report showed a more likely possibility of flooding on upstream properties than had been understood at the time the Corps constructed the Project. Tr. at 258:2-6 (Thomas). The Corps entered into a renewed period of analysis to evaluate the safety concern to downstream properties and the related flooding concern to upstream properties. Tr. at 507:4 to 508:5 (Thomas).

¹³ The new approach calculated the inflows associated with a new SPF based on 50 percent of the SDF, or approximately 22 inches of rain over a three-day period. Tr. at 255:7-22, 499:13-15 (Thomas). To determine the SDF, the Corps routes the Standard Project Storm through the watershed and then assumes the Probable Maximum Precipitation falls on the watershed five days later. Tr. at 499:11-21 (Thomas).

E. The Corps Alerted the Public of the Increased Flood Risks and Acted to Alleviate the Imminent Dam Safety Risk in the 1980s

1. The Corps' 1980-Era NEPA Documents Informed the Public About the Possibility of Upstream Flooding

After issuing the 1977 Hydrology Report, the Corps considered various options to address the two concerns, including degrading the ends of the dams to reduce the maximum flood pools. PX-45 at USACE327041 (May 1980 Mem.); PX-44 at USACE570695 (Aug. 1980 Mem., discussing Plan I, which involved degrading portions of the ends of the dams). But that plan presented its own concerns—lowering the height of the ends of the dams was anticipated to reduce the risk of upstream flooding, but it would have increased the risk of downstream flooding. Tr. at 508:14 to 509:2, 964:1-9 (Thomas).

In contrast to the more distant possibility of upstream flooding, the dam safety issues raised immediate and grave concerns about potential downstream loss of life and property damage. A dam failure would result in a massive quantity of impounded water flowing down Buffalo Bayou through the City of Houston, and cause devastating flooding on downstream properties. Tr. at 89:22 to 90:2 (Thomas); Tr. at 2088:8-12 (Bedient).¹⁴ By August 1980, some individuals within the Corps recommended adopting Plan I (degrading the ends of the dams) as “an interim measure” to reduce the likelihood of a catastrophic dam failure. PX-44 at USACE570695 (Aug. 1980 Mem.); JX-26 at USACE530470 (Sept. 1980 Mem.).

¹⁴ In later years, the Corps underscored the dam safety concern when, in 2009, it classified Addicks and Barker dams as Dam Safety Action Classification 1 (“DSAC-1”), the highest risk category for dams. Tr. at 89:11-20 (Thomas); DX-883 at 23 (Aug. 2018 SSPEED Center Report: Houston a Year After Harvey: Where We Are and Where We Need to Be, noting that a DSAC 1 rating means “the dam is almost certain to fail under normal operations within a time frame from immediately to within a few years without intervention or the combination of life or economic consequences with probability of failure is extremely high”); JX-118 (2014 Emergency Action Plan at USACE019768, stating that DSAC-1 refers to “high hazard dams due to the probable loss of life and impacts on economic, environmental, and lifeline interests in the event of failure”).

In a September 5, 1980 memorandum, Brigadier General Robinson recommended that the Corps move forward with immediate actions to fix the unsafe dam structures to avoid a possible dam failure and prepare more detailed studies to evaluate the possibility of acquiring additional real estate upstream of the dams. JX-26 at USACE530471 (Sept. 1980 Mem.). Within a few days, however, the Corps decided it had to focus on the critical structural issues, and deferred further consideration of purchase of real estate upstream of the reservoirs. PX-48 (Sept. 1980 telephone record); Tr. at 305:16-17 (Thomas, stating that “they’re deferring the decision to a later date”).

In November 1981, the Corps publicly released a Draft Environmental Assessment (“Draft EA”) as part of a public process under the National Environmental Policy Act (“NEPA”). PX-87 (Nov. 1981 Draft EA); Tr. at 511:4-15 (Thomas, explaining that the Corps released the Draft EA to the public as a “key component of the NEPA process”); PX-105 at USACE681851, USACE681860-61 (Mar. 1986 Environmental Assessment discussing public release of the Draft EA—the “public document to inform the public of the proposed selected plan”—and discussing public comments from various members of the public). In addition to discussing Plan I, the Draft EA explicitly discussed the possibility of upstream flooding during large storm events: “Although the existing reservoir embankments are sufficient to contain the SPF, should this storm occur, flooding would extend beyond the Government owned land upstream of the embankments.” PX-87 at USACE012909 (Nov. 1981 Draft EA).¹⁵

Later documents confirm the Corps’ public release of the Draft EA:

In late 1981 steps were initiated to inform the public of the Corps of Engineers plan to implement an interim solution for the dams and the possible alternatives for a

¹⁵ The Draft EA stated that, in the 1940s, the possibility of upstream flooding was considered a “limited problem, because the land’s primary use at that time was for agricultural purposes and any damages which might occur would be infrequent and relatively minor.” PX-87 at USACE012909 (Nov. 1981 Draft EA).

permanent solution. This course of action was the subject of a news release by the Galveston District Engineer on 19 November 1981. This news release accompanied by background information received wide publicity throughout the Houston Metropolitan area and its surroundings.

PX-51 at USACE013574 (1984 General Design Mem.); Tr. at 515:11-20 (Thomas, explaining that other Corps documents describe the public release).

In the 1980s, Houston area newspapers discussed the Corps' consideration of various plans, and some articles included graphics showing the possibility of flooding on upstream properties under certain storm conditions. Tr. at 520:11-20, 522:19-25 (Thomas, discussing newspaper articles from the early 1980s showing flooding upstream of the reservoirs beyond GOL); DX-71 (Houston Chronicle article discussing the Corps' consideration of Plan I, with graphic showing flooding beyond the reservoirs upstream of the GOL during "an extreme storm such as the one which struck in the Alvin area in 1979").¹⁶

2. The Corps' 1980-Era Modifications Did Not Impact the Size of the Flood Pool that the Dams Could Retain

Plan I resulted in a great deal of public opposition: "[A] segment of the public who objected to Plan I did not appear to be convinced that the threat of a statistical infrequent storm such as the SDF warranted acceptance of the attendant disadvantages of Plan I." PX-51 at USACE013574-75 (1984 General Design Mem.). The opposition convinced the Corps to develop and adopt a new alternative (known as Plan IV(b)), which involved two primary actions to prevent dam failure: raising the main embankments and adding roller-compacted concrete on the dams' auxiliary spillways. PX-51 (1984 General Design Mem.); Tr. at 335:10-13 (Thomas).

¹⁶ Given the labeling—which references areas "[t]o be lowered"—the graphic shows the upstream flooding that would occur under then-present conditions. DX-71 (Houston Chronicle article); Tr. at 1062:6-8 (Thomas). The flood pool resulting from Plan I, if implemented, would have been smaller because the dam would have held less water. Tr. at 1062:3-15 (Thomas).

The Corps completed the work in the late 1980s and early 1990s. Tr. at 527:6-11 (Thomas); Tr. at 1504:21 to 1505:4 (Long). The modifications did not affect the size of the flood pools the reservoirs could retain in a severe storm, but they provided additional protection against dam failure in such an event. Tr. at 490:15 to 491:6 (Thomas); Tr. at 1505:5-8 (Long); PX-2284 at FB0000633 (1989 Arbuckle Mem., noting that the Corps had “recently completed the Dam Safety Project which included raising part of the dam and constructing concrete lined overflow spillways along the depressed segments near the ends of the dam. This did not increase the effective storage of the dam”). As Mr. Thomas explained, the raising of the main embankments did not impact the size of the flood pool held by the dams during Hurricane Harvey because “the water didn’t get high enough to reach its previous peak or current crest.” Tr. at 996:9-16 (Thomas). And the Corps ensured that the concrete reinforcement did not increase the elevation of the spillways. Tr. at 526:25 to 527:5, 997:17-18 (Thomas, explaining “they were very careful at the time not to change the ends of the dam, the elevation, and so long as those didn’t fail very early in the event, the engineers at the time determined that the pool levels would be the same whether they armored them or not”); Site Visit Tr. at 29:11 to 30:4 (Ciliske). Thus, the modifications were irrelevant during Hurricane Harvey—the flood pools were identical to what they would have been if the Corps had never made those modifications. Tr. at 490:15 to 491:6 (Thomas).¹⁷

The Corps is currently engaged in a large construction project to replace and improve both dams’ outlet structures, and expects to complete that work in 2020. Tr. at 975:19-24

¹⁷ In addition, the dam modifications did not increase the amount of water impounded during Hurricane Harvey because the “pool levels didn’t reach an elevation where they would engage those roller-compacted spillways in a way that could have caused them to fail.” Tr. at 527:12-20 (Thomas).

(Thomas). Although replacing the outlet structures will further reduce the risk of dam failure, it will not change the possibility of flooding on upstream or downstream properties or result in a change to the SDF or SPF calculations. Tr. at 976:3-17 (Thomas).

F. Information About the Risk of Flooding Was Publicly Available and Upstream Plaintiffs Knew or Should Have Known of the Potential for Upstream Flooding Decades Ago

For the last several decades, the Corps has informed the public about the possibility of upstream flooding during large storms in several different forums. Before discussing some of this evidence, we pause to note Plaintiffs' erroneous assertions that "the Government did its best to ensure none of the upstream landowners knew of their danger" and that the Corps engaged in a "misinformation campaign" regarding flooding risks. Pls.' Post-Trial Br. at 23, 122. Those propositions are false and contradicted by the trial exhibits and testimony highlighted below.¹⁸

1. Publicly Available Maps Have Long Shown the Possibility of Upstream Flooding

Several publicly available maps have long identified the Addicks and Barker Reservoirs and included information about the elevation of the maximum flood pool or the possibility of flooding on upstream properties.

¹⁸ In support of the supposed "misinformation campaign," Plaintiffs point to two sources—a draft Q&A document dated September 28, 2017, and a page of Mr. Long's trial transcript. The Corps' draft Q&A document accurately states that "[t]here are no homes built inside the reservoir. All private residences are outside of the Corps boundary and are governed by local land use regulations which we do not control." Pls.' Post-Trial Br. at 122-23 (quoting PX-1812 at USACEII00993349). That draft document, prepared after the Hurricane Harvey flood waters had receded, is completely accurate because there are, in fact, no homes inside the reservoir. Plaintiffs next state that Mr. Long "admitted [that] this is misleading." Pls.' Post-Trial Br. at 123. But Plaintiffs' statement is false—Mr. Long admitted no such thing. The word "misleading" appears in the transcript, but the suggestion that the Corps' draft document was misleading was made by Plaintiffs' counsel, not Mr. Long, and Mr. Long did not concur with Plaintiffs' counsel's characterization. Tr. at 1472:15-19 (Long).

i. Key Maps

Key Maps of Harris County graphically depict Addicks and Barker Reservoirs and include information that would allow a reader to understand the elevation of maximum flood pools at each reservoir. For example, the 2002 version of the Houston-Harris County Atlas Key Map identifies the “Addicks Reservoir Flood Control Pool” at “Elevation 114.0 feet” and the “Barker Reservoir Flood Control Pool” at “Elevation 107 feet.” DX-795 at 4, 5, 7 (2001 Key Map). Key Maps are so ubiquitous in the Houston area that real estate listings include a Key Map page reference. JX-76 at Giron_000005 (Oct. 2005 Listing for Giron property); PX-Burnham-09 (Dec. 2014 Multiple Listing Service listing for Burnham property).

ii. FIRM Maps

The Federal Emergency Management Agency (“FEMA”) prepares Flood Insurance Rate Maps (“FIRMs”) to show areas expected to flood during 100-year and 500-year storms. Tr. at 1904:12-21 (Bedient, noting that FIRMs are based on data generated by a Corps hydrologic modeling program). Areas expected to flood during 100-year storms, or storms with a one percent annual chance of occurrence, are termed “Special Flood Hazard Areas,” and denoted as Zone AE on FIRM maps. Tr. at 2353:13-24 (Nakagaki).¹⁹ Areas expected to flood during 500-year storms, or storms with a 0.2 percent annual chance of occurrence, are denoted as Zone X (shaded) or Zone B on FIRM maps. Tr. at 2354:3-10, Tr. at 2355:2-9 (Nakagaki).

FIRMs designate areas outside the Special Flood Hazard Area and Zones X (shaded) and Zone B as Zone X (unshaded). Tr. at 2381:4-7 (Nakagaki). A Zone X (unshaded) designation

¹⁹ As a program specialist in FEMA’s Engineering and Modeling Division, Michael Nakagaki helps FEMA employees to deliver flood hazard maps to communities. Tr. at 2350:13 to 2351:2, 2374:19 to 2375:1 (Nakagaki). Mr. Nakagaki received a Master’s Degree in Geoscience from Virginia Tech. Tr. at 2351:3-5 (Nakagaki).

does not mean that the property will never flood; it merely means that the property should flood only in a storm larger than a 500-year storm. Tr. at 2355:10-19 (Nakagaki).

FIRM maps generated at the time of Plaintiffs' acquisition, and currently, show the following for each Trial Property:

Trial Property	Flood Zone When Acquired	Current Flood Zone
Banker	X (shaded) (Likely to flood in 500-year storm) DX-806 at FEMA081008	X (shaded) (Likely to flood in 500-year storm) DX-806 at FEMA081010
Burnham	AE (Likely to flood in 100-year storm) DX-807 at FEMA081044	AE (Likely to flood in 100-year storm) DX-807 at FEMA081044
Giron	X (shaded) (Likely to flood in 500-year storm) JX-283 at FEMA080996	X (shaded) (Likely to flood in 500-year storm) JX-283 at FEMA080998
Holland	X (unshaded) (Likely to flood in greater than 500-year storm) JX-284 at FEMA081026	X (shaded) (Likely to flood in 500-year storm) JX-284 at FEMA081028
Lakes on Eldridge	X (unshaded) (Likely to flood in greater than 500-year storm) JX-285 at FEMA081066	X (unshaded) (Likely to flood in greater than 500-year storm) JX-285 at FEMA081068
Micu	X (shaded) (Likely to flood in 500-year storm) JX-286 at FEMA081001	X (shaded) (Likely to flood in 500-year storm) JX-286 at FEMA081004
Popovici	X (unshaded) (Likely to flood in greater than 500-year storm) JX-287 at FEMA081020	X (unshaded) (Likely to flood in greater than 500-year storm) JX-287 at FEMA081022
Sidhu	X (unshaded) (Likely to flood in greater than 500-year storm) JX-288 at FEMA081038	X (unshaded) (Likely to flood in greater than 500-year storm) JX-288 at FEMA081040

Trial Property	Flood Zone When Acquired	Current Flood Zone
Soares	X (shaded) (Likely to flood in 500-year storm) JX-289 at FEMA081014 ²⁰	X (unshaded) (Likely to flood in greater than 500-year storm) JX-289 at FEMA081016
Stewart	C (Likely to flood in greater than 500-year storm) DX-815 at FEMA081085	X (unshaded) (Likely to flood in greater than 500-year storm) DX-815 at FEMA081087
WHAC	C (Likely to flood in greater than 500-year storm) DX-817 at FEMA081079	X (unshaded) (Likely to flood in greater than 500-year storm) DX-817 at FEMA081081
Turney	C (Likely to flood in greater than 500-year storm) DX-816 at FEMA081048	X (unshaded) (Likely to flood in greater than 500-year storm) DX-816 at FEMA081050
Wind	X (unshaded) (Likely to flood in greater than 500-year storm) DX-818 at FEMA081060	X (unshaded) (Likely to flood in greater than 500-year storm) DX-818 at FEMA081062

iii. USGS Quad Maps

The United States Geological Survey (“USGS”) has produced topographic maps of the United States, known as “quadrangle maps” or “quads,” for 140 years. Tr. at 2267:6-19, 2271:21 to 2272:5.²¹ Prior to 2010, the public could access these maps at USGS offices, universities, public libraries, and some county offices. Tr. at 2285:25 to 2286:7 (Hansmann). Currently, the

²⁰ The transcript states that Mr. Nakagaki stated that the Soares property was in an “X (unshaded)” zone at the time of acquisition. Tr. at 2368:3-24 (Nakagaki). Assuming that is not a transcription error, it is a misstatement, since the property was located in an “X (shaded)” zone in 2001, as shown in the relevant FEMA map. JX-289 at FEMA081014.

²¹ Les Hansmann is the United States Geological Survey Section Chief for the Cartographic Products Section in Rolla, Missouri. Tr. at 2265:22 to Tr. at 2266:8 (Hansmann). Mr. Hansmann has worked at the USGS for 31 years in various capacities related to production of the USGS topographic maps. Tr. at 2265:24 to 2266:5, 2266:9-21 (Hansmann). Mr. Hansmann is familiar with the USGS topographic maps around the Addicks and Barker Reservoirs. Tr. at 2269:8-10 (Hansmann).

public may download these maps online. Tr. at 2285:21-24 (Hansmann). The maps depict roads, including interstates, U.S. highways, states routes and some local routes, and include enough detail that a person can approximate the location of individual properties. Tr. at 2274:17 to 2275:2 (Hansmann).

Since 1970 or 1971, the quad maps have depicted the areas upstream of the Addicks and Barker Dams, including the location of each Trial Property, as subject to controlled inundation. Tr. at 2283:10-24 (Hansmann); JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties); JX-276 (1970 USGS Topographic Map, showing Lakes on Eldridge (“LOE”) and Wind properties); JX-271 (1970 USGS Topographic Map, showing Soares, Banker and Micu properties); JX-280 (1971 USGS Topographic Map, showing Giron property). Project notes indicate that the line for areas subject to inundation would be drawn at 114 feet at Addicks Reservoir and 107 feet at Barker Reservoir. Tr. at 2284:1 to 2285:18 (Hansmann, discussing DX-42 (Mar. 1971 Project Notes)).²²

The public and local governments have used USGS topographic maps for decades. In 1989, for example, a potential home buyer in a Kelliwood subdivision upstream of Barker Reservoir asked for more information after recognizing that a USGS topographic map depicted the area up to elevation 107 feet as subject to controlled inundation. PX-2284 (1989 Arbuckle Mem.). Fort Bend County responded that it knew about the flooding potential, and had used the USGS topographic maps to inform its drainage analyses. *Id.*; Tr. at 751:8-16 (Vogler).

²² Prior to 2010, USGS topographic maps outlined areas subject to inundation with a blue line, and a corresponding elevation value. Tr. at 2279:12-17 (Hansmann). Beginning in 2010, USGS began using somewhat different symbology on its new electronic maps, including a slightly lighter color of blue to depict the areas subject to controlled inundation. Tr. at 2279:21 to 2280:2 (Hansmann).

Similarly, in 1999, when a firm representing more than 1,500 homes and families upstream of the reservoirs asked for details about the possibility of upstream flooding, the Corps responded, in part, by pointing to USGS topographic maps showing the approximate areas subject to controlled inundation. DX-933 at USACE464798 (USACE letter); Tr. at 1512:8-20, 1514:6-16, 1519:11-20 (Long).

2. In the 1980s and 1990s, the Corps Conducted Public Discussions, Which Discussed the Upstream Flood Risks

In the mid-1980s, the Corps began to perform public outreach efforts regarding the Project. Tr. at 1498:20-25, 1503:11-14 (Long). Richard Long directed this public outreach to upstream and downstream communities, businesses, and governmental entities that had an interest in the Project, and made numerous briefings every year, including dozens of presentations to upstream community members. Tr. at 1499:1 to 1500:20, 1501:7-11 (Long). Mr. Long has also discussed the Project with members of the press on dozens of occasions. Tr. at 1502:18-24 (Long).²³

At these meetings, Mr. Long generally covered the Project's purpose, history, operations, and operational limitations. Tr. at 1499:22 to 1500:10 (Long). He also explained the Project's storage capacity and told attendees that, during severe storms, flood pools could exceed the upstream limits of the GOL. Tr. at 1501:12-19 (Long). Due to the potential for upstream flooding, Mr. Long consistently encouraged attendees to acquire flood insurance. Tr. at 1501:12 to 1502:17 (Long). The Corps' general message to the upstream community stayed the same over time, but was updated to reflect the more frequent pools, new pools of record, and updates in the survey data the Corps used for the pools. Tr. at 1511:16-22 (Long).

²³ The upstream outreach included community associations, business associations, and governmental entities. Tr. at 1500:21 to 1501:1 (Long).

3. In the 1980s and 1990s, the Corps Discussed the Possibility of Upstream Flood Risks with Developers

In the 1980s and 1990s, Mr. Long continued discussing the possibility of upstream flooding with potential developers. In 1989, for example, Stan Hubbard of Kickerillo, a developer of the Kelliwood subdivisions in Fort Bend County, sought information about the limits of Barker Reservoir's allowable flood pools following an inquiry from a potential home buyer who "noted a 107 contour on a USGS quad map as indicating 'areas of controlled inundation.'" PX-2284 at FB0000632 (1989 Arbuckle Mem.); Tr. at 725:7-20 (Vogler, identifying Kickerillo as a developer of the Kelliwood subdivisions upstream of the reservoirs). Mr. Long shared a fact sheet with Mr. Hubbard's engineer, Randal Arbuckle, noting the possibility of upstream flooding beyond the limits of the GOL during large storm events. PX-2284 at FB0000633 (1989 Arbuckle Mem.); Tr. at 1506:8-14 (Long). Mr. Long explained that he shared the fact sheet in order to ensure that upstream developers understood the Project limitations and the size of pools that the dams could impound. Tr. at 1507:5-10 (Long).

In the 1980s and 1990s, in order to ensure local entities understood Project operations and the possibility of upstream flooding, the Corps made public presentations with partner agencies including HCFCD, Fort Bend County's Office of Emergency Operations, and other public agencies with an interest in the Project. Tr. at 1502:3-10 (Long).

4. In the early 1990s, Fort Bend County Understood the Possibility of Upstream Flooding and Began Including Warning Language in Upstream Subdivision Plats

In the late 1980s, Fort Bend County had an interest in the Project because new residential development behind Barker Reservoir required the county to work on drainage plans in the area. Tr. at 1503:20 to 1504:3 (Long). Corps employees discussed the possibility of upstream flooding with Fort Bend County employees and, at least by the early 1990s, the topic generated a

great deal of internal discussions and meetings within the county. Tr. at 679:16 to 680:1 (Vogler).²⁴

The county was aware upstream properties could flood in large storms and understood the maximum pool that Barker Reservoir could produce. Tr. at 719:3 to 722:21 (Vogler). Despite knowing these specifications, the county tied its drainage criteria for new developments to the 100-year floodplain, not the maximum spillway elevation. Tr. at 719:3 to 722:21 (Vogler). Developers were also aware of the risk associated with the reservoir's flood pool, but argued that the building requirements for properties located outside the 100-year floodplain should be the same, and that the County should not impose stricter building requirements for properties adjacent to the reservoir but outside the 100-year floodplain for the reservoir. Tr. at 679:16 to 681:1 (Vogler).²⁵

²⁴ Several documents reflect Fort Bend County's knowledge of the potential for upstream flooding, including a 1992 Review Form for the Kelliwood Courts, Section 1 subdivision, which stated, "Please notice that this subdivision is subject to controlled inundation for Barker Reservoir." DX-122 at FB0000611 (July 1992 Review Form, County of Fort Bend Engineering Department).

²⁵ An engineering firm for the Cinco Ranch development analyzed the need for the Willow Fork Diversion and Channel Improvements in 1984. JX-33 at USACE750430 (EA Willow Fork Diversion and Channel Improvements); Tr. at 877:8 to 879:9 (Johnson-Muic). That assessment explained that the "topography of much of the land in this area is nearly level, and as a result, land areas adjacent to, and upstream of the Barker Reservoir, are subjected to frequent flooding events." Tr. at 879:4-7 (Johnson-Muic); JX-33 at USACE750430 (EA Willow Fork Diversion and Channel Improvements). The flooding events from the area were reported in existing literature. Tr. at 870:7-9 (Johnson-Muic); JX-33 at USACE750430 (EA Willow Fork Diversion and Channel Improvements).

The engineering firm explained that 2410 acres of the Cinco Ranch properties were within the 100-year floodplain, including the Barker Reservoir flood pool. JX-33 at USACE750430 (EA Willow Fork Diversion and Channel Improvements); Tr. at 878:10-25 (Johnson-Muic). The assessment also describes the area around Willow Fork as wetlands, some of which are subject to seasonal flooding. JX-33 at USACE750448 (EA Willow Fork Diversion and Channel Improvements). A map of the proposed improvements by an engineer shows the Cinco Ranch development boundary adjacent to the Barker Reservoir, including that parts of the Cinco Ranch Development were at less than the 100-year flood elevation. DX-86 (Map of Cinco Ranch Development and Proposed Channel Improvements in Relation to Reservoir).

Somewhere between 1990 and 1992, the county began requiring the addition of warning language on plats to inform potential purchasers about the possibility of upstream flooding resulting from Barker Reservoir operations. Tr. at 736:9-14, 679:16 to 681:1 (Vogler). The developers and their engineers were aware of the flood risk from the reservoir pool, but were opposed to including language on the subdivision plats. Tr. at 737:7-15 (Vogler). The county decided to require the language on the plats to inform potential home buyers since the developers were already aware of the issue. Tr. at 736:20 to 737:15 (Vogler). Subdivision plats are recorded as 24-inch tall and 36-inch wide documents, Tr. at 730:4-11 (Vogler), and notations on the originals that are recorded in Fort Bend County records are legible, Tr. at 730:9-11 (Vogler).²⁶ Some of the plats were introduced into evidence to demonstrate the warning language:

²⁶ The County's subdivision regulations require plats to be submitted at this size. <https://www.fortbendcountytexas.gov/government/departments-e-n/engineering/regulations-3864> (Fort Bend County Engineering Regulations); <https://www.fortbendcountytexas.gov/home/showdocument?id=1329> (Regulation of Subdivisions, Section 3.2 Submitting Requirements).

Trial Property	Plat Language	Exhibit Number
Soares	“This subdivision is adjacent to Barker Reservoir and is subject to extended controlled inundation under the management of the U.S. Army Corps of Engineers.”	DX-139
Micu	“This subdivision is adjacent to the Barker Reservoir, and for events greater than the 100-year event, could be subject to controlled inundation under the management of the U.S. Army Corps of Engineers.”	DX-557
Giron	“This subdivision is located adjacent to Barker Reservoir and is subject to extended controlled inundation under the management of the U.S. Army Corps of Engineers.”	DX-146
Banker	“This subdivision is adjacent to Barker Reservoir, which is subject to controlled inundation under the management of the U.S. Army Corps of Engineers.” ²⁷	DX-177

Mr. Long recalled that, in the late 1980s and early 1990s, he discussed the possibility of upstream flooding with Charles Crocker, an Assistant County Engineer with Fort Bend County. Tr. at 1509:3-10 (Long). In early 1992, Mr. Long transmitted a spreadsheet to Crocker, which showed, among other things, that the maximum flood pools behind the reservoirs would exceed the GOL boundaries and potentially inundate more than 4,000 acres upstream of the reservoirs. Tr. at 1510:2-16 (Long); Tr. 775:7-19 (Vogler); JX-45 at FB0006378 (July 1992 letter). Mr. Crocker understood those lands were “located in one of the fastest growing areas shared by Fort Bend and Harris Counties, the Cinco Ranch and Kelliwood Developments,” and he shared the letter with several county officials. JX-45 at FB0006378-80 (July 1992 letter).

In response to Mr. Crocker’s letter, the Fort Bend County Drainage District retained Larry Dunbar, one of Plaintiffs’ attorneys, to investigate the potential for upstream flooding. JX-49 (Mar. 1993 letter). In his transmittal letter, Fort Bend County Drainage District Manager

²⁷ Despite the slight variation in the plat note language, the intent of the note on the plat was the same as the other notes. Tr. at 775:1-6 (Vogler).

Daniel Gerken noted that the Fort Bend Drainage District required “a note on plats that gives notice to buyers that these areas are subject to controlled inundation from the reservoir.” JX-49 at FB0006372 (Mar. 1993 letter). Mr. Dunbar’s report references contemporaneous correspondence discussing the possibility that reservoir operations would inundate upstream properties. JX-49 at FB0006373-77 (Mar. 1993 letter); JX-47 (Nov. 1992 letter). Thus, developers in this area were well-aware of the risk of upstream inundation at least by the early 1990s. Tr. at 679:16-22, 736:20 to 737:15 (Vogler, explaining that developers and the engineers already knew about the possibility of upstream flooding: “[I]n the early ‘90s, when we were discussing this issue to try to come up with a conclusion, they were against putting this note on the plat.”).

5. For Years Before Hurricane Harvey, HCFCD Understood and Warned the Public About Flooding Risks

Harris County was also aware of the increased risk of upstream flooding decades before Hurricane Harvey. Steve Fitzgerald described a March 1992 storm that created record pool levels in both Addicks and Barker as a “wake-up call” for the community about the risk of flooding upstream from rising reservoir pools. Tr. at 2397:5 to 2400:18 (Fitzgerald). The increased awareness of upstream flood risk is reflected in several studies undertaken by HCFCD following the March 1992 flooding. JX-54 at USACE686046 (Katy Freeway Corridor Flood Control Study, HCFCD May 1996); JX-60 at USACE795732 (HCFCD Feasibility Study for Improvements to the Addicks and Barker Reservoirs, Mar. 2000, identifying growing concerns of “residents, business owners, and government representatives” regarding the potential for upstream flooding dating back to the winter of 1991 and spring of 1992).

Over the years, HCFCD, like Fort Bend County, has educated the public about flood risk through public meetings. Tr. at 612:15 to 613:9 (Lindner). HCFCD’s public outreach efforts

have included discussions with the public about the potential for flooding from Project operation. Tr. at 595:16-23 (Lindner); DX-695 (HCFCD webpage).

Well before Hurricane Harvey struck, HCFCD informed the public that everyone in Harris County should purchase flood insurance because everyone has some flood risk. Tr. at 595:16-25, 615:6-18 (Lindner); Tr. at 2390:14 to 2391:10 (Fitzgerald, stating that HCFCD advises all citizens “to buy flood insurance because every home is susceptible to flooding in Harris County.”); DX-695 (HCFCD webpage). HCFCD also informs residents that “[a] major flood still occurs somewhere in Harris County about every two years” and that “[d]espite tremendous flood damage reduction projects that have indeed reduced the risk of flooding, more flood insurance funds have been paid here than in any other National Flood Insurance Program-participating community.” DX-684 at DEPO_0035111 (HCFCD website).²⁸

6. The National Flood Insurance Program Statistics Demonstrate Knowledge of Flood Risks in Harris and Fort Bend Counties

The United States established the National Flood Insurance Program (“NFIP”) as a federally-backed flood insurance program in 1968. Tr. at 2318:21 to 2319:1 (Asche).²⁹ The NFIP was designed to reduce the risks and costs borne by taxpayers, individuals, and communities by offering subsidized flood insurance to people and businesses living in participating communities. Tr. at 2319:11-16 (Asche). Participating communities must adopt

²⁸ Among other approaches, HCFCD provides information for the public about the County’s flooding history and risks on its website. Tr. at 611:7-23 (Lindner). The website includes a “Flood Education Mapping Tool,” which allows residents to enter particular addresses to learn whether a property lies in or near a mapped floodway or floodplain. Tr. at 617:5-24 (Lindner); DX-695 at US0000375 (HCFCD webpage); <https://www.hcfcd.org/interactive-mapping-tools/harris-county-flood-education-mapping-tool/>.

²⁹ Dr. Elizabeth Asche works at FEMA as the Chief of the Insurance Analytics and Policy Branch within the Federal Insurance Directorate. Tr. 2316:6-13 (Asche). Dr. Asche holds a Bachelor’s in Environmental Engineering from the Massachusetts Institute of Technology, and a Master’s in Economics and a PhD in Economics from the University of California at Santa Barbara. Tr. 2318:8-14 (Asche).

and enforce minimum floodplain management ordinances, which are intended to reduce risks and costs of flooding. Tr. at 2319:17-20 (Asche).

The proportion of properties covered by flood insurance policies is called the “flood insurance market penetration rate.” Tr. at 2321:1-13 (Asche). The relevant residential market penetration rates, as discussed by Dr. Asche, are:

Date		Harris County	Fort Bend County	Nation
August 31, 2017	All Properties	21%	19%	3%
	Properties in 100-year flood plain	46%	26%	30%
February 28, 2019	All Properties	28%	34%	4%
	Properties in 100-year flood plain	46%	29%	28%

Before Hurricane Harvey hit, while the national residential market penetration rate was only approximately three percent, the rate in Harris County was seven times higher and the rate in Fort Bend County was more than six times higher. Tr. at 2325:7-17 (Asche). These data show that people in Harris and Fort Bend Counties hold flood insurance at high rates, almost certainly because they know those counties are prone to flooding.³⁰

Three of the Trial Plaintiffs carried flood insurance at the time of Hurricane Harvey, and several had purchased flood insurance in the past:

³⁰ HCFCD’s efforts to educate the public about flood risk and flood insurance have led to an increase in the number of flood insurance policies in Harris County. HCFCD’s 2018 Federal Briefing includes NFIP statistics showing that, in Harris County, the number of flood insurance policies under the NFIP increased from 179,440 policies in 2001 to 274,239 policies in 2017. DX-737 at FEMA078365 (HCFCD 2018 Federal Briefing). From 1978 through 2016, over \$3 billion in claims have been paid out under NFIP flood insurance policies (as measured in 2017 dollars) in Harris County. *Id.*

Trial Plaintiff	Purchased Flood Insurance at Acquisition	Carried Flood Insurance When Hurricane Harvey Struck	Citation
LOE	No	Yes	Tr. at 1416:14 to 1418:9 (Strebel)
Popovici	Yes	Yes	Tr. at 1226:15-17 (Popovici); JX-240 at POPOVICI-000366
Wind	Yes	Yes	Tr. at 1643:3-7 (Wind)
Burnham	Was required to, but did not	Was required to, but did not	DX-628 at 081532
Banker	Yes	No	Tr. at 1706:5-13 (Banker)
Giron	Yes	No	Tr. at 1654:19-24 (Giron)
Soares	Yes	No	Tr. at 1076:3-14 (Soares)
Turney	Yes	No, because he believed it was Ms. Ramirez's responsibility after he entered into a sale contract on the property	Tr. at 2139:15 to 2140:6 (Turney)
WHAC	Yes, for 33 years	No	Tr. at 2123:16-24 (W. Lesikar)

7. The March 1992 Flood Pools Demonstrated the Possibility of Flooding on Upstream Properties

In late 1991 and early 1992, a series of storms resulted in then-record flood pools at both reservoirs. Tr. at 2399:11-13 (Fitzgerald); Tr. at 363:20-23, 528:1-8 (Thomas). The storms caused Barker Reservoir to fill to approximately 93.60 feet, or eighty percent of the capacity of the government-owned land, and raised public concern about possible upstream flooding: “As the extent of the flooding became known through the media there was a public concern not only for the flooding that occurred but also for the areas that almost flooded. This included the privately owned land inside the reservoirs at an elevation just beyond that owned entirely, or in fee, by the Government.” JX-52 at USACE015195, USACE015138 (1995 Reconnaissance

Report, explaining further that the 1992 storm “produced concern in a segment of the public, the local sponsor, the Galveston District, and the Southwestern Division,” by revealing “the extent of the flooding problem. . .”).

The record pool levels caused road closures, including State Highway 6, a “very heavily traveled” road that runs north-south through Addicks Reservoir. Tr. at 2399:14-24 (Fitzgerald); DX-795 (2001 Key Map). The closure of Highway 6 is a well-publicized event, because it requires upstream community members to find alternate routes. Tr. at 2412:5-24 (Fitzgerald). As a result of the 1992 flood pools, Highway 6 was closed for six to ten days, which “affected 37,000 vehicles per day.” JX-54 at USACE686055 (May 1996 HCFCD Katy Freeway Corridor Flood Control Study). The record pool levels and resulting road closures received significant media attention because of the large number of residents impacted by the disrupted traffic. Tr. at 2399:14 to 2340:18 (Fitzgerald). As noted above, Mr. Fitzgerald described the 1992 flood pools as a “wake-up call” for the community because it underscored that “the reservoirs could fill not just from a single large event but from a series of smaller events over time.” Tr. at 2399:25 to 2400:18 (Fitzgerald).

After the flood, the Corps released a 1992 Special Report to publicly reemphasize the “order of magnitude of the anticipated flooding damages which could occur off of Government property assuming different flood events.” JX-44 at USACE015073 (May 1992 Special Report on Flooding). The report explicitly told the public that large storms could cause damage to upstream private properties, noting that:

- if the SPF occurred, approximately 2,800 structures (valued at \$400 million) would flood, resulting in an estimated \$100 million in damages;
- if the PMF occurred, approximately 4,000 structures (valued at \$725 million) would flood, resulting in an estimated \$245 million in damage; and
- if the reservoirs filled completely, flood pools extending to the natural ends of the dams would cause an estimated \$475 million in damages.

JX-44 at USACE015081 (May 1992 Special Report on Flooding); JX-52 at USACE015186 (1995 Reconnaissance Report, App'x D).

The 1992 Special Report discussed several potential alternative measures to address the possibility of upstream flooding, JX-44 at USACE015082-88 (May 1992 Special Report on Flooding), and recommended that the Corps prepare a reconnaissance study, pursuant to Section 216 of the Flood Control Act, to reinvestigate those alternatives. JX-44 at USACE015088-89 (May 1992 Special Report on Flooding). At that time, Corps policy required the preparation of a reconnaissance report to evaluate whether a more detailed and costly analysis was economically justified. Tr. at 531:4-11 (Thomas).

8. In 1995, the Corps Issued a Reconnaissance Report, Which Publicly Discussed the Possibility of Upstream Flooding

On June 29, 1994, the Corps publicly released an announcement about its re-evaluation, explicitly noting in its public announcement that “[t]here is a potential that flooding from rare events could occur upstream from the reservoir lands as a result” of urban development and prolonged impoundments behind the dams. DX-896 at USACE315093 (June 1994 Public Announcement); Tr. at 957:15 to 958:4 (Plaintiffs’ counsel, stipulating that the Corps actually issued the Public Announcement on June 29, 1994).³¹

The Corps developed its report in coordination with HCFCD and other local entities. DX-895 (Attendee list for June 16, 1994 Coordination Meeting Regarding Addicks and Barker

³¹ The Court admitted two letters to the Corps, which provide further proof that the Corps made the public announcement. DX-896 at USACE315092 (July 1994 letter from Harris County regarding Corps’ reevaluation analysis); DX-896 at USACE315095 (July 1994 letter from Kerry Gilbert to Corps regarding Corps’ reevaluation of the dams). The Court declined to admit other, similar documents. Counsel for the United States made a proffer that additional documents would have provided further proof that the Corps made the public announcement and that it was received by the public. Tr. at 957:11-19 (Counsel for the United States stating that, if permitted by the Court, he would have offered into evidence additional letters identified as JX-50 at USACE315083, -84, -90, -91).

Reservoirs Section 216 Study); Tr. at 939:17 to 940:2 (Plaintiffs' counsel agreeing a coordination meeting was held in June 1994 in contemplation of the Reconnaissance Report).

In 1995, the Corps publicly released its Reconnaissance Report and transmitted public notice of its publication "to all interested parties including the Congressional Delegation." JX-52 at USACE015109 (1995 Reconnaissance Report); Tr. at 958:20 to 959:4 (Thomas, stating that the Corps typically provided public notification of reconnaissance reports). The Corps attached the 1992 Special Report as an exhibit to the 1995 Reconnaissance Report. JX-52 at USACE015159 (1995 Reconnaissance Report); Tr. at 371:8-17, 961:4-9 (Thomas).

Like the 1992 Special Report, the 1995 Reconnaissance Report explicitly noted a "potential threat of property damage upstream of the reservoir lands":

The dams and reservoir lands acquired for upstream temporary reservoir storage are now surrounded by residential and commercial urban development. Densely populated housing developments essentially fill the fringe areas between the [GOL] and the maximum pool elevation adjacent to Addicks Reservoir. Much of the fringe areas of Barker Reservoir are bordered by similar developments and the rest are rapidly developing.

JX-52 at USACE15136, USACE15154 (1995 Reconnaissance Report, same information included in Oct. 29, 1993 Information and Status Report). The report noted that recent storm events "indicate a potential for future flooding problems." *Id.* Based on then-available information, the 1995 Reconnaissance Report estimated that Addicks Reservoir had adequate GOL to accommodate a flood pool likely to be generated by a storm with a recurrence interval of 250 years and that Barker Reservoir had adequate GOL to accommodate a flood pool associated with a storm with a recurrence interval of seventy years. *See id.* at USACE15137.

The 1995 Reconnaissance Report evaluated various alternatives to address the possibility of upstream flooding, but concluded that none were economically justified. *See id.* at

USACE15136-37, USACE15148 (recommending termination of the study due to “insufficient economic benefits to justify project modification”).

One of the alternatives that could not be economically justified was additional upstream land acquisition, due in large part to the fact that the possibility of extensive upstream flooding was extraordinarily low. Tr. at 972:8-14 (Thomas); Tr. 849:20-23 (Johnson-Muic). Indeed, the Corps’ 2013 evaluation indicated the PMF at Addicks Reservoir had a 178,000-year recurrence interval, and the PMF at Barker Reservoir had a 135,000-year recurrence interval. DX-255 at USACE065070-074 (May 2013 Dam Safety Modification Engineering Appendix); Tr. at 974:2 to 975:18 (Thomas).³²

9. As Early as 1996, HCFCD Released Public Reports Noting the Possibility of Upstream Flooding

HCFCD understood that an extreme storm could produce flood pools large enough to impact upstream properties, and, in May 1996, released a public study that explicitly acknowledged that possibility: “The maximum flood pool levels of the Addicks and Barker reservoirs extend far beyond the limits of the government-owned land.” JX-54 at USACE686046 (May 1996 HCFCD Katy Freeway Corridor Flood Control Study).³³ The study explained that a flood pool from a large storm could flood “6,000 structures and more than 8,000 acres within the reservoir fringe areas between the limits of the [GOL] and the extent of the

³² The Corps also considered adopting a flood warning and evacuation plan. JX-52 at USACE015137 (1995 Reconnaissance Report). However, as Mr. Thomas explained, the Corps did not adopt that alternative because “state and local governments have the authority for evacuations for those projects.” Tr. at 962:23-25 (Thomas).

³³ The Katy Freeway is the portion of Interstate 10 that runs east-west along the south side of Addicks Reservoir and north of Barker Reservoir. JX-54 (May 1996 HCFCD Katy Freeway Corridor Flood Control Study); Tr. at 2402:6-7 (Fitzgerald).

Addicks and Barker maximum flood pools.” *Id.*; Tr. at 2402:20 to 2403:14 (Fitzgerald).³⁴ HCFCD’s 1996 study also acknowledged that this problem could become worse based on projected growth in the areas upstream of the reservoirs, noting that “[w]hile 6,000 [structures at risk] is a large number, projected growth rates for West Harris County could easily increase the number of structures in the fringe to 25,000 or more.” JX-54 at USACE686046 (May 1996 HCFCD Katy Freeway Corridor Flood Control Study).

Local media discussed HCFCD’s 1996 report, including a 2001 newspaper article in the Houston Chronicle, which explicitly noted the possibility of upstream flooding: “As one example [of possible future flooding], a 1996 study showed that if the Addicks and Barker reservoirs ever filled to their spillways, more than 6,000 houses and other buildings would be inside the reservoirs.” DX-886 at PDF 1 (Houston Chronicle, “Allison’s Victims, Six Months Later”). Dr. Bedient, Plaintiffs’ expert witness, is quoted in the same 2001 newspaper article: “The take-home message is Houston is very flood-prone, and we all need to learn to deal with the flood menace rather than think we can somehow fix it” *Id.*

HCFCD issued subsequent public reports that also addressed the issue of potential flooding on upstream properties. In March 2000, for example, HCFCD prepared a Feasibility Study, which studied potential flooding on upstream properties. JX-60 at USACE795732 (Mar. 2000 HCFCD Feasibility Study). That report noted the 1992 flood pool had “prompted the concerns of the residents, business owners, and government representatives to be expressed regarding the level of protection that the reservoirs provide to the property upstream of the

³⁴ The “fringe area” is the area between the government owned land and the boundary of the maximum flood pool. Tr. at 2456:2-6 (Fitzgerald).

dams.” JX-60 at USACE795732 (Mar. 2000 HCFCD Feasibility Study); Tr. at 2405:2-19 (Fitzgerald).

10. ABECT Members Discussed the Possibility of Upstream Flooding in the Mid-2000s

In approximately 2007, the Corps established the Addicks and Barker Emergency Coordination Team (“ABECT”) to coordinate better with local agencies about reservoir operations. Tr. at 1000:6-11 (Thomas); Tr. at 2406:3-13 (Fitzgerald); Tr. at 2407:1-9 (Fitzgerald); DX-737 at FEMA078453 (HCFCD Federal Briefing, Spring 2018). ABECT includes representatives from the Corps, the National Weather Service, USGS, HCFCD, Harris County Office of Emergency Management, Fort Bend County Office of Emergency Management, City of Houston Office of Emergency Management, and the Texas Department of Public Safety. Tr. at 1000:14-18 (Thomas); Tr. at 1497:9-18 (Long); DX-737 at FEMA078453 (HCFCD Federal Briefing, Spring 2018).

ABECT members discussed the possibility of upstream flooding on multiple occasions. Among other activities, for example, ABECT conducted several tabletop exercises to coordinate response actions during hypothetical flooding events, including flooding on upstream properties. Tr. at 1485:3-6 (Long); Tr. at 598:14-21 (Lindner); DX-206 at USACE467221 (Sept. 2009 After Action Report for Multi-Agency Table Top Exercise, noting that “it is only a matter of time before the reservoirs flood off” GOL). ABECT has also identified “trigger points with elevations” so that the county and other participants would know when the first streets and homes would flood from a rising reservoir pool above the reservoirs. DX-194 at USACE727385-86 (Mar. 2009 ABECT Agenda and spreadsheet).

In early 2008, ABECT members created an Action/Response Plan to help direct communication and actions during large storm events. Tr. at 2407:10 to 2408:20 (Fitzgerald,

discussing JX-88 (Feb. 2008 email discussing Addicks/Barker Emergency Response Plan)). The plan lists key flood pool elevations and related consequences, together with anticipated responses for each local, state and federal government agency. JX-88 (Feb. 2008 email discussing Addicks/Barker Emergency Response Plan); DX-194 (Mar. 2009 ABECT Agenda and spreadsheet). The Action/Response Plan states that, when the flood pool begins to flood streets, the Corps should notify HCFCD, Harris County and the City of Houston, and HCFCD will then issue a major flood warning, indicating the potential for house flooding. DX-194 at USACE727392-94 (Mar. 2009 ABECT Agenda and spreadsheet).

11. In 2009, the Corps Continued Efforts to Inform the Public About the Possibility of Upstream Flooding

In 2009, the Corps continued developing presentations to inform the public about the possibility of upstream flooding. In June 2009, for example, the Corps prepared slides for several public meetings, which show upstream flooding during large storm events. PX-1597 at USACE755528-39, USACE755542-53 (June 2009 Meeting Slides for Addicks and Barker Reservoirs Overview Meeting); DX-196 at USACEII01821272 (June 2009 Meeting Slides for Addicks Reservoir Information Meeting); DX-198 at USACEII01394792 (June 2009 Meeting Slides for Barker Reservoir Information Meeting).

12. In 2010 and Later, the Corps Discussed the Possibility of Upstream Flooding in Public Meetings

In early 2010, the Corps embarked on additional public efforts to inform the public about the possibility of upstream flooding. JX-94 (Feb. 2010 Addicks and Barker Upstream Meeting Summary Report). On February 12, 2010, the Corps issued a News Release, to inform the public that the Corps was engaged in a Project update to address public safety issues and “flooding issues upstream of Addicks and Barker” Reservoirs. JX-94 at USACE594487 (Feb. 2010 Addicks and Barker Upstream Meeting Summary Report). The Corps set out signs at busy

intersections and advertised upcoming meetings in local newspapers. Tr. at 1017:14 to 1018:13 (Thomas, discussing JX-94 at USACE594474-85 (Feb. 2010 Addicks and Barker Upstream Meeting Summary Report)). The Corps also transmitted invitation letters to approximately 1,600 landowners and homeowner associations who owned property adjacent to the reservoirs. Tr. at 1018:9-13 (Thomas, discussing JX-94 (Feb. 2010 Addicks and Barker Upstream Meeting Summary Report)). At the public meetings, the Corps showed slides that demonstrated that large storms could cause upstream flooding. JX-94 at USACE594433-35 (Feb. 2010 Addicks and Barker Upstream Meeting Summary Report).

Mr. Long continued to provide public outreach after the 2010 public meetings, repeatedly informing meeting participants of the possibility of upstream flooding. Tr. at 1558:4-19 (Long); DX-238 at USACE597768 (Aug. 2011 Corps' Presentation to the Katy Sunrise Rotary Club); DX-304 at USACEII00656860 (June 2017 Corps' Presentation to the Eagles Trace Retirement Community); Tr. at 1560:3-24 (Long).

13. The 2016 Tax Day Flood was the Most Recent Reminder of the Risk of Upstream Flooding

In April 2016, a large storm, known as the 2016 Tax Day Storm, struck the Houston area. This intense storm produced ten to fifteen inches of rainfall over much of northwest Harris County over approximately twelve hours. DX-295 at DEPO_0053691 (HCFCD Tax Day 2016 Report). According to the Corps' analysis, the storm amounted to a 180-year and 110-year event in the Addicks and Barker Watersheds, respectively. JX-134 at USACE869255 (2016 Annual Water Control Report). The 2016 Tax Day flood was "strictly a riverine flood. . . ." Tr. at 1987:17-18 (Bedient).

The storm created new record flood pools in the two reservoirs, which slightly exceeded the GOL for the first time in Project history. Tr. at 166:6-10 (Thomas); JX-128 at

USACE207227 (May 2016 Report of Performance, explaining that the flood pools extended to 102.65 feet and 95.2 feet at Addicks and Barker Reservoirs, respectively). These record pool levels resulted in the complete closure of Highway 6, North Eldridge Parkway, and Clay Road, which pass through the reservoirs. Tr. at 574:22 to 577:1 (Lindner); DX-295 at DEPO_0053699 (HCFCD Tax Day 2016 Report). Highway 6 was impassable for four weeks following the Tax Day storm. DX-295 at DEPO_0053699 (HCFCD Tax Day 2016 Report). Although the flood pools extended past the GOL boundary line, and resulted in some street flooding in residential subdivisions adjacent to the reservoirs, they did not inundate any structures. Tr. at 978:17-22, 995:7-9 (Thomas); Tr. at 625:17 to 626:14 (Lindner); JX-126 (HCFCD Press Release, Apr. 21, 2016).³⁵

G. Hurricane Harvey Was Unprecedented and Flooding Was Unavoidable

1. Hurricane Harvey Was an Extraordinarily Rare and Powerful Storm Event

Hurricane Harvey was an unprecedented rainfall event. PX-1812 at USACEII00993350 (Draft Q&A's for Addicks and Barker Reservoirs, Answer 11); Tr. at 2030:7-10 (Bedient, testifying that Hurricane Harvey was an historic event for all of Harris County); DX-883 at 9 (Aug. 2018 SSPEED Center Report: Houston a Year After Harvey: Where We Are and Where We Need to Be). The storm made landfall on August 25, 2017, near Rockport, Texas, as a

³⁵ House flooding did occur upstream of the reservoirs during the storm, but not due to the Project. DX-295 at DEPO_0053699 (HCFCD Tax Day 2016 Report, stating “[h]ouse flooding occurred on all the tributaries adjacent to the reservoir due to these high flows and overwhelmed internal drainage systems prior to the reservoir levels rising”). The President issued a Disaster Declaration for the 2016 Tax Day storm, thereby making disaster assistance available from FEMA for affected areas. Tr. at 2963:11 to 2965:10 (Glasschroeder); 2976:18 to 2977:6 (Glasschroeder). The Burnham property flooded with approximately three feet of water during that storm and she applied for and received approximately \$9,970 in disaster assistance from FEMA in connection with that flooding. Tr. at 1764:11 to 1765:8, Tr. at 1815:22-1819:9 (Burnham); DX-629R at FEMA081531 (FEMA records for Burnham, Tax Day 2016). The Turney property also flooded during the Tax Day storm. Tr. at 2142:1-12 (Turney).

Category 4 hurricane. ECF No. 211 ¶ 107 (Joint Stipulations). Over the next five days, Hurricane Harvey dropped an average of more than 43 inches of rain over a 2,000 square mile area, shattering the United States' record for that time period. DX-737 at FEMA078357 (HCFCD Federal Briefing, Spring 2018); Tr. at 641:10 to 642:12 (Lindner, describing Hurricane Harvey as “unprecedented”); Tr. at 2030:11-13 (Bedient, testifying that Hurricane Harvey was far and away a record-setting event over a five-day period).³⁶

Hurricane Harvey was the largest storm in the recorded history of the United States. Tr. at 2030:14-17 (Bedient); DX-883 at 9 (Aug. 2018 SSPEED Center Report: Houston a Year After Harvey: Where We Are and Where We Need to Be). Every watershed in Harris County experienced some flooding, and homes in every major watershed in the county flooded. Tr. at 2447:15 to 2448:7 (Fitzgerald); Tr. at 636:21-24 (Lindner). Mr. Fitzgerald explained that of the approximately 1 million homes in Harris County, approximately 154,000 homes flooded during the storm. Tr. at 2451:19 to 2452:2 (Fitzgerald).

Within Harris County, Hurricane Harvey dropped an average of 33.7 inches, nearly seventy percent of the County's yearly rainfall, over a four-day period. DX-682 at PDF 5 (Lindner Presentation).³⁷ For the areas upstream and downstream of the Addicks and Barker Reservoirs, HCFCD determined that the peak four-day rainfall from Hurricane Harvey was a

³⁶ Approximately 1 trillion gallons of water fell in Harris County during the four-day storm. DX-682 at PDF 5 (Lindner presentation slides). That equates, approximately, to the amount of water needed to run the Niagara Falls for 15 days or to fill the Astrodome 3,200 times. *Id.* DX-737 at FEMA078357 (HCFCD 2018 Federal Briefing).

³⁷ In 1955, shortly after construction, the Addicks, Barker, and Buffalo Bayou Watersheds experienced a mean annual precipitation of approximately 45 inches. DX-25 at USACE284640 (Aug. 1955 Reservoir Regulation Manual). The 2012 Water Control Manual reported that the average annual rainfall in Addicks and Barker Watersheds was approximately 43 inches. Using these metrics, approximately 80 percent of the mean annual rainfall fell during Hurricane Harvey. Tr. at 481:12-18 (Thomas).

5,000-year to 20,000-year storm event. DX-737 at FEMA078359 (HCFCD Federal Briefing, Spring 2018, Four Day Peak Rainfall Frequency).

During the storm, approximately 450,000 acre-feet of water flowed into the reservoirs.

Tr. at 2702:15-24 (Nairn). This cumulative inflow was unprecedented:

- The 1935 flood, which the Corps treated as the SPF, for example, would have resulted in approximately 175,000 acre-feet of inflow.
- The SPF calculated in 1962 would have resulted in an inflow of approximately 171,000 acre-feet into the reservoirs.
- The 100-year flood would have resulted in an inflow of approximately 177,000 acre-feet into the reservoirs.
- The SPF calculated in 1977 would have resulted in an inflow of approximately 319,000 acre-feet into the reservoirs.
- The 2016 Tax Day Storm had a cumulative inflow of approximately 208,000 acre-feet.

Tr. at 2703:22 to 2704:25 (Nairn).

The inflow from Hurricane Harvey was so large that it caused water to move around the northern end of Addicks Dam, an event that had never occurred before in the history of the Project. DX-683 at DEPO_0035106 (HCFCD website).³⁸ Although water went around the northern end of Addicks Dam, water did not pass over the auxiliary spillways of either dam. Tr. at 138:20-23 (Thomas).

2. The Corps' Reservoir Operations During Hurricane Harvey Complied with its Water Control Manual

i. The Corps Followed the 2012 Water Control Manual

During the storm, the Corps followed the 2012 Water Control Manual, a document that provides explicit guidelines on how to operate the reservoirs. Tr. at 59:2 to 61:3, 175:6

³⁸ Trial evidence demonstrated that, as the flood pool increased, water flowed around the end of the northeastern spillway of Addicks Dam—both between the end of the dam and the building adjacent to the dam, and north of the building near Tanner Road. Tr. at 1533:16 to 1534:7 (Long). The flow of the water in the Tanner Road area (approximately 2,000 cfs) was larger than the flow of water going around the end of the dam between the end of the dam and the building (approximately 500 cfs). Tr. at 1534:8-21, 1567:20 to 1568:1 (Long); Tr. at 134:1-25 (Thomas).

(Thomas); Tr. at 1449:3-8 (Long); JX-110 at USACE016305 (2012 Water Control Manual); ECF No. 211 ¶ 109 (Joint Stipulations). The 2012 Water Control Manual is a public document. Tr. at 981:17-18 (Thomas). Consistent with the purpose of the Project, the manual explains the “general plan for reservoir regulation will be to operate the reservoirs in a manner that will utilize to the maximum extent possible, the available storage to prevent the occurrence of damaging stages on Buffalo Bayou within the limits placed by the constraints on project operations.” JX-110 at USACE016338 (2012 Water Control Manual). Like many other Corps documents, the manual explicitly discusses the possibility of upstream flooding: “Acquisition of real estate was based on the original design. Presently, pool levels in excess of [GOL] will damage residential developments adjacent to [GOLs].” JX-110 at USACE016335 (2012 Water Control Manual).

When Hurricane Harvey made landfall, Addicks and Barker Reservoirs were empty. Tr. at 160:21-25 (Thomas); JX-146 at DEPO_0050290 (CWMS Forecast, Aug. 25, 2017, stating “[t]he Addicks and Barker Reservoirs are fully empty”). At the beginning of the storm, the Corps closed the dam gates, as the Water Control Manual directs. Tr. at 1446:10-15 (Long); DX-340 at DEPO_0048827 (CWMS Forecast, Aug. 26, 2017, reporting that the reservoir gates “were closed last night”); DX-649 (Corps Timeline).

On August 25, 2017, Colonel Zetterstrom declared a general emergency, which covered dam safety emergencies. Tr. at 118:25 to 119:2, 979:18 to 980:2 (Thomas). The Corps followed the instructions for Emergency Levels 1 and 2, as required in the Corps’ Emergency Action Plan, but, because Colonel Zetterstrom had already declared an emergency, the Corps did not announce additional emergency levels during the storm. Tr. at 119:4-17 (Thomas); Tr. at 981:7-10 (Thomas, explaining “there wasn’t a need to make another formal declaration of

emergency”); PX-25 at USACE016691 (Report of Performance, Oct. 13, 2017, noting that Stage 2 Extended Watch alert was activated on Aug. 27, 2017).

The 2012 Water Control Manual, like earlier versions of the manual, includes a provision for “Induced Surcharge Flood Control Regulation,” that is, controlled releases intended to optimize the available storage in the reservoirs and protect the integrity of the dams. JX-110 at USACE016339 (2012 Water Control Manual); Tr. at 987:9-13 (Thomas). To determine whether to make induced surcharge releases, the manual directs Corps engineers to examine flood pool levels and the rates of rise of those pools—if the flood pools reach 101 feet and 94.9 feet in Addicks and Barker Reservoirs, respectively, and if the pools continue to rise at a high enough rate, the Corps will make induced surcharge releases. Tr. at 983:7-16 (Thomas).

The Corps initiated releases shortly after midnight on August 28 at both reservoirs. DX-384 at COH-DOJ0008867 (CWMS Forecast, Aug. 28, 2017); DX-649 (Corps Timeline). Due to the heavy rainfall and record inflows, the reservoir levels continued to rise even after the releases began. DX-396 at DEPO_0048862 (CWMS Forecast, Aug. 29, 2017); DX-649 (Corps Timeline); Tr. at 991:5-19 (Thomas). On August 30, 2017, the flood pool peaked at approximately 109.1 feet and 101.59 feet at Addicks and Barker Reservoirs, respectively. JX-143 at DEPO_0039649 (Table, noting the corresponding peak storage of 217,800 AF at Addicks Reservoir); JX-144 at DEPO_0039691 (Table, noting the corresponding peak storage at Barker Reservoir of 171,500 AF); ECF No. 211 ¶¶ 110-15 (Joint Stipulations).

Once the emergency ended and the flood pools dropped to safer levels, the Corps began reducing releases. Because the Corps could not immediately stop all releases without stressing the outlet structures and potentially causing sloughing on the dam embankments and the banks of the Buffalo Bayou, it developed a drawdown plan to minimize damage while fulfilling the intent

of the Water Control Manual. Tr. at 992:4 to 993:16 (Thomas).³⁹ On September 3, the Corps approved and initiated its drawdown plan and, on September 16, it resumed normal operations. DX-649 (Corps Timeline).

ii. Hurricane Harvey Presented a Zero-Sum Game Situation

When Hurricane Harvey struck, no option existed to allow the Corps to minimize flooding on upstream properties without simultaneously causing more flooding on downstream properties. Tr. at 965:22 to 966:1 (Thomas). If the Corps had simply left the gates open during Hurricane Harvey, for example, downstream properties would have flooded more than they actually did during the storm. Tr. at 965:6-14 (Thomas). And if the Corps had breached the dam during the storm, downstream properties would have flooded far more than they actually did. Tr. at 965:15-21 (Thomas). Before closing the gates at the outlet structures, the Corps considered other options to try to minimize upstream flooding, including placing sandbags at various locations or modifying outflows from the dams. PX-1658 (Aug. 2017 email). The sandbag options would not have worked for several reasons. PX-1658 at USACE805927 (Aug. 2017 email). Releasing more water faster might have reduced flooding on upstream properties, but, as Mr. Thomas explained, “[i]f we do this, we may flood downstream and violate the water control manual.” PX-1658 at USACE805927 (Aug. 2017 email).

The Corps also had no way to eliminate flooding on downstream properties without simultaneously causing additional flooding on upstream properties and increasing the risk of dam failure. Holding more water in the reservoirs for a longer period of time might have reduced

³⁹ The Corps had ample reason to worry about the stability of the outlet conduits. In 2015, the Corps began construction of a long-term fix by awarding a \$72 million contract to overhaul the reservoirs’ outlet structures. When Hurricane Harvey hit, the conduit structures were active work areas.

flooding on some downstream properties, but it would have exacerbated flooding depths and durations on upstream properties.

As Mr. Thomas explained, Hurricane Harvey presented a zero-sum game—“it was either flood more downstream and less upstream, or flood more upstream and less downstream. . . .” Tr. at 1058:9-12 (Thomas). Dr. Bedient agreed—“in a storm this size,” someone’s property was going to flood precisely because this was a zero-sum game situation. Tr. at 2096:7-22 (Bedient). The evidence on this point is undisputed—the Corps had no other option to prevent flooding on private properties during Hurricane Harvey. Tr. at 1058:15-18 (Thomas).⁴⁰

3. The Corps Coordinated with ABECT Members During Hurricane Harvey

The Corps activated ABECT in anticipation of the storm, on or about August 23. Tr. at 2426:2-18 (Fitzgerald). During the storm, ABECT members held conference calls approximately twice a day and continually exchanged information, including weather forecasts and operational plans. Tr. at 2427:11 to 2428:16 (Fitzgerald); DX-683 at DEPO_0035106 (HCFCD website, stating that HCFCD “is in daily communication with the Corps on the level of stormwater in the reservoirs, and on the release rates from the reservoirs into Buffalo Bayou.”).

Michael Kauffman, a civil engineer with the Corps’ Hydrology and Hydraulics Department in Galveston, prepared and distributed the Corps’ Water Management System (“CWMS”) forecasts throughout the storm. Tr. at 2430:5-18, 2462:10-16 (Fitzgerald). The

⁴⁰ Mr. Long was correct when he told members of the public that “the opening of the gates is good for you”—the surcharge releases did reduce upstream flooding, even though that same government action contributed additional water into Buffalo Bayou, which overflowed its banks and flooded downstream properties. PX-2176 (Excerpts of live broadcast of Richard Long public statements); Tr. at 1473:3-7 (Long).

CWMS reports explained the then-current expected rainfall amounts and the Corps' then-current operational plans at the reservoirs.⁴¹

The Corps' notifications provided information federal, state and local organizations needed to make informed decisions about issuing any necessary warnings to the public, consistent with the Corps' Emergency Action Plan, ABECT's action and response plans, and the local governments' legal authorities. DX-194 (ABECT action/response chart); Tr. at 2407:10 to 2407:9 (Fitzgerald); JX 118 at USACE19777-78 (Emergency Action Plan, stating “[w]arning and evacuation planning are the responsibilities of local authorities who have the statutory obligation.”); JX 118 at USACE019817-818 (Emergency Identification/Response Matrix); Tr. at 962:13-25 (Thomas, testifying that “the state and local governments have the authority for evacuations”); Tr. at 1498:13-15 (Long).⁴²

4. The Corps' Actions Prevented Significant Damages to Downstream Properties

The Project performed as expected with no significant problems. PX-25 at USACE016689 (Oct. 2017 Mem., stating that “[t]he embankment, outlet structures, and emergency spillways functioned as intended”). However, a risk of dam failure certainly existed during this unprecedented storm. Tr. at 119:24 to 120:1 (Thomas). When the storm struck, Addicks and Barker Dams were “the highest risk dams in the Corp of Engineers' inventory”—there was a known risk associated with running the outlet works, there were known risks

⁴¹ DX-427 (CWMS Report, dated Aug. 31, 2017); DX-415 (CWMS Report, dated Aug. 30, 2017); DX-396 (CWMS Report, dated Aug. 29, 2017); DX-384 (CWMS Report, dated Aug. 28, 2017); DX-360 (CWMS Report, dated Aug. 27, 2017); DX-340 (CWMS Report, dated Aug. 26, 2017); JX-146 (CWMS Report, dated Aug. 25, 2017).

⁴² Mr. Fitzgerald explained that, although people often want to evacuate when their house might flood, experience has shown that it is often safer for people to stay in their homes. Tr. at 2463:12 to 2464:21 (Fitzgerald). As an example, he explained that during Tropical Storm Allison, twenty-two people died as a result of evacuations, but no one died in their homes. Tr. at 2463:12 to 2464:21 (Fitzgerald).

associated with the embankments in some locations, there were risks associated with the emergency spillways, and Hurricane Harvey caused new pools of record in both reservoirs— “[s]o there was a lot of risk.” Tr. at 987:21 to 988:4 (Thomas).

After the storm, the Corps estimated the damages prevented to properties below the reservoirs as a result of the Project’s existence and operation—that is, it estimated the damages that would have occurred if the Corps had not constructed the Project. Tr. at 161:20-23 (Thomas, discussing JX-228 (2017 Annual Water Control Report)). Mr. Thomas, who was familiar with the modeling effort and had discussed the approach used with the individuals who conducted the modeling, explained that the model did not attempt to depict upstream flooding in the absence of the reservoirs. Tr. at 162:11-16, 163:15 to 164:3 (Thomas). The Corps’ model showed that the existence and operation of the Project during Hurricane Harvey prevented more than \$6.96 billion of losses to properties downstream of the reservoirs. Tr. at 164:24 to 165:5 (Thomas, discussing JX-228 at USACE869495 (2017 Annual Water Control Report)). Given the extensive downstream urbanization, the Project almost certainly saved far more than the eight lives lost during the 1935 Storm.

H. The United States Undertook Extensive Efforts to Assist Individuals and Communities After Hurricane Harvey

During and after the storm, the United States took extensive steps to assist individuals and communities impacted by Hurricane Harvey. We discuss some of those efforts below.

1. U.S. Department of Housing and Urban Development’s Community Development Block Grant Program Allocated Billions of Dollars to Assist Harris and Fort Bend Counties

The United States Department of Housing and Urban Development (“HUD”) provides federal funding to state and local governments for a wide range of community and housing activities, including for disaster recovery assistance, through its Community Development Block

Grant Program (“CDBG”). Tr. at 2987:25 to 2988:21 (Gimont).⁴³ The program intends to promote long-term recovery from major declared disasters, such as restoration of housing and infrastructure and for economic revitalization, and in some instances, mitigation. Tr. at 2989:18 to 2990:2 (Gimont).

Before HUD can distribute CDBG Disaster Recovery funding to a grantee, HUD must collect information about the region’s unmet needs and Congress must make an appropriation. Tr. at 2990:3 to 2991:3 (Gimont). Once an appropriation is made, HUD allocates funds for the unmet needs related to qualifying events and areas and issues a Federal Register notice, which establishes funding requirements. Tr. at 2990:23 to 2991:11 (Gimont).

In response to Hurricane Harvey, HUD allocated to the State of Texas more than \$5.7 billion dollars through the CDBG program. DX-845 (Summary of HUD CDBG allocations to Texas from 2015-2017). HUD considered Harris and Fort Bend Counties some of the “most impacted and distressed” areas, Tr. at 2998:3-23 (Gimont), and Texas allocated approximately \$1.2 billion dollars each to Harris County and the City of Houston. Tr. at 3001:3-7 (Gimont). Those local jurisdictions oversee the allocation of those amounts, and, as of the date of trial, they were only just beginning to spend those monies. Tr. at 2998:24 to 2999:2 (Gimont).

Before Texas can distribute funding, it must prepare an action plan and obtain HUD approval of that plan. Tr. at 2991:12-20, 3016:14-18 (Gimont). At the time of the trial, HUD had approved Texas’ action plan for CDBG funding in relation to Hurricane Harvey. Tr. at 2999:11 to 3000:15 (Gimont); DX-845 (Summary of HUD CDBG allocations to Texas). Texas’

⁴³ Mr. Gimont is the Deputy Assistant Secretary for Grant Programs in the Office of Community Planning and Development with HUD. Tr. at 2986:11-17 (Gimont). Among other duties, Mr. Gimont oversees the Office of Block Grant Assistance, which is responsible for CDBG program. Tr. at 2986:21 to 2987:5 (Gimont). Mr. Gimont has worked at HUD for 32 years. Tr. at 2987:6-10 (Gimont).

action plan indicates that Fort Bend County homeowners may receive reimbursement of funds they spent to rehabilitate or reconstruct their home. Tr. at 3001:13-22 (Gimont); DX-845 at PDF 1 (Summary of HUD CDBG allocations to Texas). Harris County will use the \$1.2 billion in CDBG funds on housing programs like homeowner assistance, residential buyout, and single-family new construction. Tr. at 3003:18 to 3004:5 (Gimont); DX-845 at PDF 4 (Summary of HUD CDBG allocations to Texas).

HUD also plans to allocate to the State of Texas and the City of Houston a portion of at least \$12 billion dollars for mitigation activities like infrastructure investments and activities outlined in FEMA hazard mitigation plans. Tr. at 3007:16 to 3008:14 (Gimont). The State of Texas should receive approximately \$4.3 billion dollars and the City of Houston should receive approximately \$61.8 million dollars for these purposes. Tr. at 3009:16-22 (Gimont); DX-845 at PDF 3 (Summary of HUD CDBG allocations to Texas).⁴⁴

2. FEMA Provided Financial and Direct Assistance to Many Trial Plaintiffs

FEMA provides various forms of assistance when disasters strikes, including natural disasters like hurricanes. Tr. at 2963:11 to 2964:21 (Glasschroeder). Under FEMA's Individual

⁴⁴ HUD has allocated billions of dollars in CDBG funding to the State of Texas on other occasions. Tr. at 2992:10-13 (Gimont); DX-845 (Summary Texas Action Plan for CDBG Funding). For example, HUD allocated Texas more than \$238 million in CDBG funding for flooding in 2016, and noted that Harris and Fort Bend Counties were some of the "most impacted and distressed" areas. DX-846 (Summary of HUD CDBG allocations to Texas from 2015-2017); Tr. at 2998:3-23 (Gimont). As of the date of trial, Harris County was beginning to spend that money. Tr. at 3005:15-18 (Gimont).

HUD also allocated Texas more than \$74 million in CDBG funding in response to flooding in 2015, again considering Harris County one of the "most impacted and distressed" areas. DX-846 (Summary of HUD CDBG allocations to Texas from 2015-2017); Tr. at 2998:3-23 (Gimont). HUD also allocated the City of Houston more than \$87 million in CDBG funding in 2015. DX-846 (Summary of HUD CDBG allocations to Texas from 2015-2017). Both the State of Texas and City of Houston are in the process of allocating those funds. Tr. at 3006:21-25 (Gimont). These earlier floods further show the flood prone character of the region.

and Household Assistance Program, direct and financial assistance is made available when a disaster occurs, the state requests assistance because the disaster is beyond the capability of the local and state government to respond, and the President issues a disaster declaration. Tr. at 2964:22 to 2965:10 (Glasschroeder). Such a request was made in connection with Hurricane Harvey and the President issued a Disaster Declaration (No. 4332) that covered an area that included Harris and Fort Bend Counties. Tr. 2965:11-17, 2976:18 to 2977:10 (Glasschroeder).

FEMA has provided significant federal monies and other support to individuals impacted by Hurricane Harvey in Harris and Fort Bend Counties. Tr. 2965:14-19 (Glasschroeder).⁴⁵ This funding, which includes Financial and Direct Assistance, aims to help applicants with damages to their primary residence. Tr. 2965:1-5 (Glasschroeder); DX-560 (FEMA Individual and Households Program Fact Sheet).

FEMA provided several types of Financial Assistance after Hurricane Harvey, including Housing Assistance and Other Needs Assistance. Applicants who receive Financial Assistance from FEMA are not required to pay those funds back. Tr. 2984:15-18 (Glasschroeder). FEMA's Housing Assistance includes funding for rent, lodging, and repair costs. Housing Assistance recipients can receive up to \$33,300 per applicant, including fair market rent payments for up to 18 months. Tr. at 2968:6-10 (Glasschroeder). FEMA's Other Needs Assistance covers needs such as essential personal property and post-disaster supplies. Tr. 2965:20-23, 2966:4-25 (Glasschroeder). Other Needs Assistance recipients can receive up to \$33,300 per applicant. Tr. at 2968:3-10 (Glasschroeder).

⁴⁵ Ms. Glasschroeder has worked at FEMA for the past 26 years, and she is currently an Individual Assistance Liaison for the Program Management Section. Tr. 2963:11-18 (Glasschroeder). Ms. Glasschroeder ensures that FEMA follows its Individual and Household Program policies and procedures, and assists the public in understanding FEMA's practices. Tr. 2963:24 to 2964:6 (Glasschroeder).

FEMA has provided the Trial Plaintiffs the following financial assistance to date:

Trial Property	FEMA Financial Assistance Provided
Burnham	\$28,557.65
Giron	\$25,409.11
Stewart	\$19,301.90
Wind	\$2,381.99
Micu	\$30,656.46
Banker	\$23,922.89
Soares	\$13,092.35
Holland	\$9,959.67
Turney (Ramirez) ⁴⁶	\$49,172.71

DX-866 (Summary of FEMA Individual Assistance Awards). The Burnham, Giron, Micu, Banker, Soares, and Holland Plaintiffs received Direct Assistance through the transitional sheltering assistance hotel program. Tr. at 2974:16-22 (Glasschroeder). Ms. Ramirez, who was living in the Turney property and in the process of purchasing that property at the time of Hurricane Harvey, also received such assistance. In addition, the Giron Plaintiffs received the use of a FEMA travel trailer on the property. Tr. at 2974:23-24 (Glasschroeder).

II. Expert Evidence

A. William Kappel Showed Hurricane Harvey Was an Extraordinarily Rare and Large Storm

William Kappel, President of Applied Weather Associates, testified as an expert in meteorology. Tr. at 1155:3-5 (Kappel). Mr. Kappel provided the only expert analysis quantifying the rarity and magnitude of the rainfall during Hurricane Harvey. Tr. at 1131:1-7 (Kappel).

Mr. Kappel focused his analysis on the Addicks, Barker, and Buffalo Bayou Watersheds. DX-601 (Kappel Expert Report). He based his analysis on an enormous data set collected during

⁴⁶ As discussed below, FEMA paid this amount to Margie Ramirez, who purchased this property in 2010. Mem. § III(F)(6).

the storm—more than 1,300 hourly rain gage observation stations, daily and supplemental rain gage station data, and calibrated radar data. DX-601 at 62 (Kappel Expert Report). His extensive analysis produced an extraordinarily detailed mapping product, where each pixel in his model domain shows location- and time-specific rainfall amounts. DX-601 at 105 (Kappel Expert Report). Mr. Kappel’s analysis is the only trial evidence showing the pattern of rain that fell in the relevant watersheds during the storm.⁴⁷

Mr. Kappel showed that, over a five-day period, the basin of interest (as used in Dr. Nairn’s analysis) experienced an average of 32.9 inches of rain, with a range of 18.5 inches to 50.0 inches at individual pixels. DX-601 at 190 (Kappel Expert Report). During the same time period, the average rainfall amounts in Addicks, Barker and Buffalo Watersheds totaled:

- 31.3 inches in Addicks Watershed;
- 31.1 inches in Barker Watershed; and
- 34.4 inches in Buffalo Bayou Watershed.

DX-601 at 199, 205, 211 (Kappel Expert Report).⁴⁸

Mr. Kappel also determined the annual exceedance probability (“AEP”)—that is, the probability of an event occurring in any given year—of the rainfall that fell during Hurricane Harvey. DX-601 at 57 (Kappel Expert Report). Over a five-day period, the rainfall in the basin of interest used by Dr. Nairn constituted an average of a 770-year storm, with a maximum value

⁴⁷ HCFCD prepared a post-storm report on Hurricane Harvey that includes information about rainfall amounts in Harris County based on data from HCFCD’s gage network. JX-229 (HCFCD Immediate Report-Final, Hurricane Harvey-Storm and Flood Information); Tr. at 555:10 to 556:22 (Lindner). HCFCD based its report on a smaller dataset of rainfall gage data, without consideration of radar data. JX-229 (HCFCD Immediate Report-Final, Hurricane Harvey-Storm and Flood Information). In addition, HCFCD did not assess rainfall by watershed.

⁴⁸ By comparison, the HCFCD report estimated the return frequency for the four-day peak rainfall in the areas upstream and downstream of the reservoirs within Harris County as between 5,000 years and 20,000 years. JX-229 at DEPO_0054404 (HCFCD Immediate Report-Final, Hurricane Harvey-Storm and Flood Information); DX-737 at FEMA078359 (HCFCD Federal Briefing, Spring 2018).

of 4,190 years, and a minimum of 75 years. DX-601 at 195 (Kappel Expert Report). During the same time period, the average AEPs in Addicks, Barker and Buffalo Bayou Watersheds were:

- 774-year storm within Addicks Watershed;
- 846-year storm within Barker Watershed; and
- 905-year storm within Buffalo Bayou Watershed.

DX-601 at 202, 208, 214 (Kappel Expert Report).

To understand the size of Hurricane Harvey, Mr. Kappel also compared the Hurricane Harvey rainfall totals with the rainfall generated during Tropical Storm Allison in June of 2001 and the 2016 Tax Day Storm:

- Tropical Storm Allison averaged 13.0 inches across the domain during a 120-hour period, less than half the rain that fell in that period during Hurricane Harvey, and constituted only a 56-year storm.
- The 2016 Tax Day Storm averaged only 8.7 inches over the domain during a 24-hour period. Hurricane Harvey produced nearly twice that amount in a 24-hour period over the domain, with an average of 16.9 inches.

DX-601 at 36 (Kappel Expert Report).

B. Andrew Ickert Showed the Significant Development Upstream of the Reservoirs After Project Construction

Andrew Ickert, a registered professional civil engineer, with a concentration in hydrology, hydraulics, and floodplain management, testified as an expert in hydrology. Tr. at 3047:6-15, 3082:6-7 (Ickert). Mr. Ickert conducted a detailed analysis of the land use changes within the relevant watersheds from the 1940s until the present. Tr. at 3056:4-8 (Ickert). His expert analyses were the only investigation of this issue presented at trial.

In order to classify and quantify different land use types over time, Mr. Ickert and his team closely examined numerous historic aerial images of the relevant area. Tr. at 3088:21 to 3089:7 (Ickert). His analysis showed that, before the Corps constructed the Project in the 1940s, the areas upstream of the Addicks and Barker Reservoirs were primarily undeveloped prairie lands. Tr. at 3084:1-7 (Ickert, discussing DX-600 at Fig. 2 (Ickert Expert Report)). After Project

construction, the areas upstream and downstream of the reservoirs underwent significant development. Tr. at 3093:2-11 (Ickert, discussing DX-600 at Table 4 (Ickert Expert Report)); Tr. at 3095:11 to 3096:4 (Ickert, discussing significant increase in development after 1990s). When the Corps constructed the Project in the 1940s, the Addicks and Barker Watersheds were approximately ninety-eight percent undeveloped. DX-600 at Table 4 (Ickert Expert Report). By the 1990s, those watersheds were approximately eighty to eighty-three percent undeveloped. *Id.* By 2014, they were approximately fifty-eight to fifty-nine percent undeveloped. *Id.*⁴⁹

In a developed watershed, the amount of impervious surface increases, so less water is absorbed into the soil and runoff increases. Tr. at 3097:2-25 (Ickert); Tr. at 2031:2-10 (Bedient, explaining that development impacts flooding because, rather than falling on porous ground, rain hits more impervious surfaces); DX-600 at 4 ¶ 10 (Ickert Expert Report, “Thus, as the impervious area increases, the volume of runoff will increase as well.”). This higher volume of water runoff resulting from increased urbanization leads, in turn, to increased reservoir inflows. Tr. at 3104:13 to 3105:1 (Ickert).

As the runoff moves across a watershed, it follows the natural meander and the natural topography across the surface, which imposes friction on the water. Tr. at 3099:13-21 (Ickert). Various features associated with development, such as grading, stormwater systems, and paving, reduce the friction and cause that runoff to move more quickly than in an undeveloped watershed. Tr. at 3099:22 to 3100:7 (Ickert). This quicker watershed response leads to higher peak flows downstream. Tr. at 3100:23-24 (Ickert).

⁴⁹ Mr. Ickert included the land in the reservoirs themselves in his calculations. Had he excluded that property (which was not available for development anyway), the percentage changes would have been even more dramatic. Tr. at 3093:23 to 3094:13 (Ickert).

When an area is relatively undeveloped, once the runoff makes its way into a natural waterway (e.g., a creek, a bayou, or river system), it follows the natural bends and meanders of that system. Tr. at 3101:10-14 (Ickert). During high flow events in an undeveloped or unchannelized watershed, the water will oftentimes spill out of banks, where it will interact with brush and other vegetation, which will slow down the water in a process called “attenuation.” Tr. at 3101:14-21 (Ickert). Thus, when a natural, undeveloped water body is channelized, and the water is contained within a channel, there is less attenuation and therefore less water in the overbank area, which results in higher peak flows. Tr. at 3102:5-10 (Ickert).

Thus, the post-1940 urbanization upstream of the reservoirs changed the natural hydrologic responses, particularly with respect to runoff volume, peak flow, and timing of flow. Tr. at 3056:9-13 (Ickert). More upstream development resulted in more water, moving faster, to the reservoirs—the volume of runoff increased, the peak flows increased, and the rate of water movement increased. Tr. at 3084:17-24, 3097:2-11 (Ickert). This point is not in dispute—Dr. Bedient agreed that more urbanization can increase runoff. Tr. at 2086:14-16 (Bedient). He agreed that increased runoff will increase the volume of water and the speed of water entering the reservoir, as compared to an undeveloped upstream area. Tr. at 2086:17-22 (Bedient). Thus, Dr. Bedient explained that rampant development has increased Houston’s natural flood proneness. Tr. at 2031:2-10 (Bedient).

Mr. Ickert also discussed the undisputed fact that ten of the eleven highest pool elevations in the nearly seventy-five year history of Addicks and Barker dams have occurred within the last twenty-five years, during which period of time the upstream areas underwent significant urbanization. Tr. at 3085:10-14 (Ickert); DX-600 at Fig. 12 (Ickert Expert Report). There likely is a causal link between land use development and higher peak pool elevations. Tr. at 3075:18-

21, 3107:14-21 (Ickert); Tr. at 3122:21-25 (Ickert, testifying that higher pool levels are partly attributable to changed land use in the watersheds); Tr. at 3123:10-16 (Ickert, testifying that there is a link between land use and higher pool elevations).

C. Dr. Nairn Prepared a Comprehensive Hydrologic Analysis of Hurricane Harvey and the Project

Dr. Robert Nairn is a registered Professional Engineer with more than thirty years of experience working on large and complex river projects that involve numerical modeling. Tr. at 2626:4-6 (Nairn). The Court qualified Dr. Nairn as an expert in coastal and riverine engineering, with a specialty in numerical modeling across actual and hypothetical conditions. Tr. at 2697:8-11 (Nairn).

Dr. Nairn has a Bachelor's of Science degree in Civil Engineering from Queens University, a Master's Degree in Coastal Engineering from Queens University, and a Doctorate in Coastal Processes in Civil Engineering from the Imperial College of Science, Technology and Medicine. Tr. at 2626:13-19 (Nairn); DX-608 at App. B (Nairn CV). He has published approximately 120 papers in journals and conference proceedings, many of which involve discussions of numerical modeling techniques. Tr. at 2633:3-13 (Nairn). He has lectured in the field of coastal and riverine engineering, and has testified as an expert witness on several occasions, including in the United States Court of Federal Claims. Tr. at 2633:14 to 2636:3 (Nairn).

1. Dr. Nairn Followed the Standard Approach to Develop, Calibrate and Validate a Comprehensive Model

Dr. Nairn was the only witness who prepared numerical modeling for purposes of this case. Tr. at 2639:1-3 (Nairn). As he explained, a numerical model is a set of algorithms that allow engineers to understand and describe physical processes, including the movement of water over time and space. Tr. at 2628:22 to 2629:3 (Nairn). Use of a numerical model is the

accepted, standard practice for evaluating complex river and coastal environments, and the only way to evaluate hypothetical scenarios. Tr. at 2639:5-19 (Nairn); Tr. at 2036:14-20 (Bedient, who did not prepare any modeling, agreeing that numerical models are typically used to evaluate what would have happened to properties in hypothetical conditions).

Dr. Nairn prepared a comprehensive expert report explaining his methodology, analyses, and conclusion. DX-608 (Nairn Expert Report). As that report describes, and as he explained at trial, Dr. Nairn applied the standard and accepted process to select a numerical model (the TELEMAC model), based on a variety of relevant model features and the narrow time constraints imposed by the Court's pre-trial schedule. Tr. at 2643:1-15 (Nairn); DX-608 at 50-54 (Nairn Expert Report). The TELEMAC model solves various mathematical equations at different grid points, based on well-accepted principles of conservation of mass and momentum. Tr. at 2650:2-11 (Nairn); DX-608 at 52-53 (Nairn Expert Report).⁵⁰

Dr. Nairn explained the TELEMAC model inputs at length, including the use of the spatially and temporally varying rainfall and wind dataset generated by Applied Weather Associates, Tr. at 2650:22 to 2651:10 (Nairn), a flexible mesh, Tr. at 2644:14-23 (Nairn),⁵¹ and the best-available data for topography, hydrologic losses and roughness coefficients. DX-608 at 54-66 (Nairn Expert Report).⁵²

⁵⁰ Dr. Nairn considered using the Corps' HEC-RAS model. Dr. Bedient testified that the Corps' 2D HEC-RAS model, like other two-dimensional numerical models, solves the same, or similar, partial differential equations that Dr. Nairn's model uses. Tr. at 2039:11 to 2040:5 (Bedient). In addition, Dr. Bedient believed that the Corps' 2D HEC-RAS model has only been accurate for the last year or so. Tr. at 2039:11-14 (Bedient).

⁵¹ Dr. Nairn used a very large mesh, which included approximately 2.9 million triangular elements. Tr. at 2714:19-22 (Nairn).

⁵² For model elevation data, Dr. Nairn primarily used the 2008 LiDAR, Tr. at 2647:1-5 (Nairn), because the more current 2018 LiDAR data was released after he completed his report, Tr. at 2719:20-23 (Nairn). Dr. Nairn looked at the 2018 LiDAR data after its release and determined that none of the changes affected his results at the Trial Properties. Tr. at 2720:1-9 (Nairn).

To improve model accuracy, Dr. Nairn undertook an extensive model calibration effort, following standard protocol. Tr. at 2657:23 to 2661:15 (Nairn); DX-608 at 67-84 (Nairn Expert Report).⁵³ He also performed standard model validations by comparing his modeling results to independent data sets, including high water marks and NOAA aerial images. Tr. at 2662:18 to 2664:24 (Nairn); DX-608 at 84-91 (Nairn Expert Report).⁵⁴ His analyses followed the standard approach in the field and produced highly confident results. Tr. at 2668:1-8 (Nairn). Most importantly, Dr. Nairn's analysis estimated total flows into the reservoirs within plus or minus one percent of the inflows. Tr. at 2681:9-23 (Nairn). A one percent error in total inflow corresponds to an error of approximately 0.15 feet in pool elevation. Tr. at 2681:22-23 (Nairn).⁵⁵

Dr. Nairn undertook an extensive effort to ascertain error rates, including an assessment of the root mean square estimate, which showed that the model was reliable and fit for purpose. Tr. at 2725:2-16 (Nairn); DX-608 at 83-84 (Nairn Expert Report). Dr. Nairn also considered the Nash-Sutcliffe efficiency factor ("NSE"), which showed that his model estimated five of the rain

Consistent with best practices in the field, Dr. Nairn used national databases to describe hydrologic losses. Tr. at 2647:21 to 2648:10 (Nairn). And Dr. Nairn used a standard approach to determining appropriate roughness coefficient variables (known as Manning's n roughness). Tr. at 2652:12 to 2654:11 (Nairn).

⁵³ Dr. Nairn explained that he first developed a matrix of possible Manning n and hydrologic loss coefficients. Tr. at 2658:18-22 (Nairn). Dr. Nairn then ran each combination through his model, and ascertained the closest fit to measured gage data. Tr. at 2658:18-22 (Nairn). After completing his initial calibration, Dr. Nairn conducted a more detailed model calibration, during which he compared particular gage data to his modeled results. Tr. at 2660:22 to 2661:4 (Nairn).

⁵⁴ The high water marks are the least dependable data set available for model validation purposes. Tr. at 2688:7-12 (Nairn). As Dr. Nairn explained, the high water marks were collected in the days and weeks following the storm, but, in some cases, not measured until many months after the storm. Tr. at 2730:11-21 (Nairn). Many of the high-water marks were below peak pool levels, which means they did not accurately record peak pool levels. Tr. at 2731:11-14 (Nairn).

⁵⁵ The inflow data was one of the most complete data sets available because USGS published measured pool elevations every 15 minutes. Tr. at 2701:15-22 (Nairn).

gages as “very good,” one as “good” and the remainder as “satisfactory.” Tr. at 2726:6-16 (Nairn).

Dr. Bedient calculated a different NSE rating for Dr. Nairn’s modeling analysis, but he used a flawed approach. Tr. at 2090:24 to 2091:1 (Bedient). Although Dr. Nairn’s model covered a much longer focus period, Dr. Bedient based his NSE calculation on a 3.5-day period. Tr. at 2091:13-17 (Bedient). However, the paper Dr. Bedient relied upon to support his NSE calculation specifically states that the NSE is appropriate for continuous long-term simulations for a monthly time step. Tr. at 2094:5-10 (Bedient). Thus, Dr. Bedient’s attempt to calculate the NSE for a shorter time frame than the entire focus period conflicts with the very paper he relied upon. The same paper states that for single-event modeling efforts (such as the one Dr. Nairn undertook), the objective should focus on peak flow. Tr. at 2094:11-16 (Bedient); Tr. at 2728:1-15 (Nairn). Dr. Bedient failed to undertake such an analysis, but Dr. Nairn testified that focusing on peak depths results in an “excellent” rating for all gages except Upper Buffalo Bayou, which Dr. Nairn explained, produced erroneous data during the storm. Tr. at 2728:1-15 (Nairn).

Buffalo Bayou is the largest tributary flowing into Barker Reservoir. Tr. at 2745:18-22 (Nairn). If the Upper Buffalo Bayou gage was working properly, one would expect to see a peak shortly after a large peak was measured on a different gage upstream of the same creek, and on other gages in the same area, consistent with a large amount of rainfall at that time. Tr. at 2746:5 to 2747:3 (Nairn). As Dr. Nairn explained, the lack of a peak suggests an error at the Upper Buffalo Bayou gage. Tr. at 2746:17-22 (Nairn). Furthermore, the field notes for the Upper Buffalo Bayou gage noted the existence of vegetation around the crest stage pipe after the storm, which can interfere with gage readings. PX-155 (USGS Field Notes).

Dr. Bedient also based his critique on what he perceived to be differences between measured gage data and model output. But Dr. Bedient agreed that several of the gages experienced problems during Hurricane Harvey and measured erroneous data. Tr. at 2057:17-21 (Bedient). Thus, the data collected at the gages at Bear Creek, Langham Creek, and Willow Fork Creek include clear and obvious measuring errors. Tr. at 2057:24 to 2061:5 (Bedient, discussing PX-526 at 122, 123, 127, 129 (Bedient Expert Report)). Dr. Bedient explained that erroneous data often occurs in large storms due to gage failures or the existence of debris. Tr. at 2058:20 to 2059:3 (Bedient). Most critically, however, he did not know that the Upper Buffalo Bayou gage collected inaccurate information, likely because he never looked at the field notes for that gage. Tr. at 2062:4-25 (Bedient). Thus, Dr. Bedient erroneously based his critique on uncorrected data for this gage, before USGS changed the data on its website. Tr. at 2744:13-18 (Nairn). His reliance on those data to critique Dr. Nairn's analysis cannot be sustained.

Finally, Dr. Nairn explained that if he had additional time to prepare his expert analysis, he would have conducted additional calibration and used more recent data, such as the 2018 LiDAR. Tr. at 2774:3-11 (Nairn). With additional time, Dr. Nairn could have also investigated the storm drain issues more closely and incorporated those drains in the model itself. Tr. at 2774:14-16 (Nairn). Dr. Nairn also stated that, with additional time, he could have quantified the impact of the changing urbanization upstream of the dams. Tr. at 2774:21-24 (Nairn). The aggressive pre-trial schedule rendered these additional analyses impracticable.

2. If the Corps Had Not Built the Project, the Burnham, Micu and Giron Properties Would Have Flooded and the Downstream Properties Would Have Flooded Far More

For the "no-project run," Dr. Nairn used the same computer model, but removed the dams and any diversion channels on GOL, in order to represent the area as if the Corps had never constructed the Project. Tr. at 2759:3-17 (Nairn); DX-608 at 128-58 (Nairn Expert Report). Dr.

Nairn's analysis showed that three properties would have flooded in the "no-project run"—the properties owned by Burnham, Micu and Giron. Tr. at 2760:16 to 2761:1 (Nairn); DX-608 at 129 (Nairn Expert Report).

Bear Creek Village, where the Burnham property is located, is set in an area that can be lower than the water level within nearby Langham Creek. Tr. at 2709:7 to 2710:9 (Nairn). Water from Langham Creek typically flows onto GOL via the Langham Creek-Horsepen diversion channel, but during large storms, water in Langham Creek can reverse flow through existing storm sewer networks and flood the Bear Creek Village area. Tr. at 2709:7-15 (Nairn). Dr. Nairn explained that the removal of the Langham Creek-Horsepen diversion channel on GOL land, as required in the no-project run, even further reduces the capacity of those channels, which creates a backwater effect and causes additional flooding on the Burnham property. Tr. at 2762:21 to 2763:23 (Nairn).⁵⁶ Dr. Nairn testified that the confidence level in this analysis is high—within 0.32 feet. Tr. at 2764:2-15 (Nairn).⁵⁷

Plaintiffs state that Dr. Nairn's model "over-predicted the data regarding the Barker reservoir by more than a foot." Pls.' Post-Trial Br. at 71, 82. Dr. Nairn acknowledged that over-prediction, but clarified that it occurred only at Barker and only in the Actual Hurricane Harvey run. Tr. at 2681:24 to 2682:4 (Nairn). The hypothetical analyses, as discussed above, had

⁵⁶ This is consistent with purpose of the Langham Creek-Horsepen diversion channel, which, as discussed previously, was built on reservoir lands to reduce flooding of the upstream developments, including homes in Bear Creek Village. Mem. § I(C). As occurred in August 1981, without the diversion channel, upstream developments will flood. *See id.*

⁵⁷ In addition, as discussed above, Dr. Nairn did not include stormwater drains in his analysis because that analysis was difficult and the trial schedule did not provide sufficient time to address those complications. Tr. at 2707:4-12 (Nairn). One effect of not including stormwater drains is that the model may miss timing of certain early peaks. Tr. at 2708:8-12, 2740:3-7 (Nairn, describing that absence of consideration of the stormwater drains results in a delayed inflow of water into the receiving channels, which causes the model to miss an early peak).

significantly smaller error rates. And Dr. Nairn's model estimated the peak pool at Addicks to within 0.2 feet. Tr. at 2734:11-12 (Nairn).

Dr. Nairn testified the removal of the upstream diversion channels had little effect on the Micu and Giron properties, but that both would have flooded in the "no-project run" due to flooding that would have otherwise occurred irrespective of the flood pool impounded by the Project. Tr. at 2765:10 and 2768:20 (Nairn).⁵⁸ Dr. Nairn testified that his model's prediction in this area and at this point in time (i.e., before the reservoir pool impacted the area) was within 0.36 feet. Tr. at 2769:19 to 2770:12 (Nairn).

Removal of the Project would have reduced upstream flooding, but it would have completely eliminated the extraordinary benefits the Project provides to downstream properties. Dr. Nairn explained that if the Corps had never built the Project, the downstream properties would have flooded by nine to fifteen feet of water, rather than the zero to five feet of water that actually flooded those properties. Tr. at 2773:12-16 (Nairn); DX-608 at App. C, Table C-1 (Nairn Expert Report, Summary of Results for Downstream Trial Properties). Dr. Nairn also explained that more than 100,000 more properties would have flooded if the Corps had never constructed the Project. Tr. at 2773:16-23 (Nairn); Tr. at 2034:16-25 (Bedient, agreeing that if the reservoirs had not existed during Hurricane Harvey, downstream properties would have experienced more damage than they actually experienced). The Project also almost certainly

⁵⁸ That the areas around Micu and Giron would flood regardless of the reservoirs and improved channels is not surprising. The Willow Fork channel improvements and diversion channel, discussed previously, were built on reservoir lands to better drain upstream properties that were subject to "frequent flooding." Mem. § I(C). As Fort Bend County acknowledged in the 1980s, without drainage improvements into the reservoir, that "frequent flooding" of the upstream lands would render them "undevelopable."

saved lives—if the reservoirs had not existed, there would have been a much higher risk of loss of life in downstream areas. Tr. at 2035:6-9 (Bedient).

3. If the Corps Had Not Closed the Gates, the Burnham, Sidhu, Turney, Micu and Giron Properties Would Still Have Flooded and the Downstream Properties Would Have Flooded Far More

For the “gates-open run,” Dr. Nairn used the same computer model but assumed the Corps never closed the dam outlet gates. Tr. at 2770:21 to 2771:1 (Nairn); DX-608 at 161-162 (Nairn Expert Report). Dr. Nairn testified that in the “gates-open run,” five Trial Properties would have flooded—Burnham, Sidhu, Turney, Micu and Giron. Tr. at 2771:10-15 (Nairn); DX-608 at 162 (Nairn Expert Report). These properties would still have flooded in a “gates-open run” because the combined capacity of the gates (approximately 16,000 cfs) is much smaller than the maximum Hurricane Harvey inflows into the reservoirs (at least 160,000 cfs). Tr. at 2771:16-21 (Nairn); DX-608 at 22 (Nairn Expert Report). Dr. Nairn testified that the error rate for the “gates-open run” was approximately 0.35 feet. Tr. at 2771:24 to 2772:12 (Nairn).

Although keeping the gates open would have reduced upstream flooding, it would have increased flooding on downstream properties. Dr. Nairn explained that if the Corps had left the gates open during Hurricane Harvey, the downstream Trial Properties would have flooded an additional 1.5 to three feet. Tr. at 2772:18-24 (Nairn); DX-608 at App. C, Table C-1 (Nairn Expert Report, Summary of Results for Downstream Trial Properties). Dr. Bedient did not separately analyze the issue, but he agreed that if the Corps had kept the gates open during the storm, downstream properties would have flooded more than they actually flooded. Tr. at 2096:1-6 (Bedient).

4. If the Corps Had Never Opened the Gates, All the Upstream Trial Properties Would Have Flooded Far More

If the Corps had attempted to maximize benefits to downstream properties, it might have considered closing the dam gates during the entire storm. For the “gates-closed run,” Dr. Nairn used the same computer model, but assumed the Corps never made any induced surcharge releases. Tr. at 2755:2-4 (Nairn); DX-608 at 159-160 (Nairn Expert Report). Dr. Nairn testified that in the “gates-closed run,” all of the Trial Properties would have flooded at a much higher depth for a longer period of time, as compared to the actual Hurricane Harvey scenario. Tr. at 2756:9-17 (Nairn); DX-608 at 160 (Nairn Expert Report). Although he did not separately analyze the question, Dr. Bedient agreed that if the Corps had kept the gates closed during the storm, flooding on the upstream Trial Properties would have been worse. Tr. at 2095:15-25 (Bedient). Thus, maximizing the flood benefits to downstream properties would have increased flooding on upstream properties. Dr. Nairn explained that the error rate for the “gates-closed run” depended on the accuracy of the inflows, which was extremely good—within 0.9 percent at Addicks Reservoir (0.13 feet) and 1.3 percent at Barker Reservoir (0.12 feet). Tr. at 2757:3-8 (Nairn).

Of course, if the Corps had kept the gates closed during the storm, more water would have flowed around the north end of Addicks Dam, which could have increased flooding on other downstream properties.

5. Dr. Nairn’s Analysis Confirms that Hurricane Harvey Was So Large that Flooding Somewhere—on Upstream Properties and Downstream Properties—Was Unavoidable

Consistent with the testimony from Mr. Thomas and Dr. Bedient, Dr. Nairn’s analysis showed that Hurricane Harvey was a zero-sum game—the storm was so large, and dropped so much rain, that flooding on private properties was unavoidable. Dr. Nairn estimated flood

depths at each Trial Property during the period of interest in actual conditions during Hurricane Harvey, if the dam gates had remained closed, if the dam gates had remained open, and if the Corps had never constructed the dams. Tr. at 2666:12-14 (Nairn). Those analyses showed that Hurricane Harvey's rainfall exceeded the Project's hydraulic design conditions, as defined by the SPF. Tr. at 2775:6-8 (Nairn). Although the Corps made induced surcharge releases, the Project effectively reduced peak flows and flood elevations downstream of the dams. Tr. at 2775:10-14 (Nairn). In short, his calculations confirmed that flooding was unavoidable both upstream and downstream of the dams due to the magnitude of Hurricane Harvey. Tr. at 2775:16-17 (Nairn).

6. Dr. Bedient's Evaluations Are Flawed

Plaintiffs offered no numerical modeling at trial, and the opaque approach taken by Dr. Bedient suffers from numerous flaws. Dr. Bedient explained he took three approaches in this case. First, he looked at the one-hour duration rainfall gage data. Tr. at 1921:1-5 (Bedient). But that analysis has little meaning. Several of the gages Dr. Bedient used are miles away from any Trial Property, and, therefore, do not measure inflow into the waterway between the gage and the Trial Properties. Tr. at 2046:23-25 (Bedient). That omission is important because, as Dr. Bedient conceded, additional runoff entered the channel from adjacent drainage areas (particularly if the area is highly developed) as the waterway proceeded towards the reservoirs. Tr. at 2053:11 to 2054:22 (Bedient). Thus, any conclusions related to those rainfall gages have little value in assessing conditions at the Trial Properties. Additionally, Dr. Bedient admitted that his analysis ignored any cumulative rainfall impacts. Tr. at 2056:7-11 (Bedient). The evaluation, therefore, simply looks at the rainfall at locations miles away from any Trial Property at a particular moment in time, not during the multi-day rainfall event itself.

Second, Dr. Bedient looked at rainfall data at the Addicks and Barker Dams during 6- to 12-hour increments of time. Tr. at 2063:6-9 (Bedient). Unlike the one-hour rainfall data he viewed, these data were not the maximum measurements, but simply discrete 6- and 12-hour periods occurring at set times during the day. Tr. at 2063:6 to 2065:15 (Bedient). These data are also inconsequential because they ignore any cumulative effects; they simply measure rainfall at discrete time periods.

Third, Dr. Bedient attempted to estimate riverine flooding at each Trial Property. Tr. at 1923:13-22 (Bedient). For this evaluation, Dr. Bedient considered the 100-year and 500-year flood elevations at certain upstream gages. Tr. at 1925:8-14 (Bedient). He then looked at the peak elevations at these gages during Hurricane Harvey, which, he stated, were somewhere between the 100-year and 500-year peak elevations. Tr. at 1925:17-22 (Bedient). He then attempted to apply a linear extrapolation to estimate water levels near the Trial Properties using FEMA profile maps. Tr. at 1926:10-16 (Bedient). This approach ignores pluvial flooding, which was significant during Hurricane Harvey. Tr. at 2828:11 to 2830:16 (Nairn, discussing the difference in magnitude between reservoir inflows and total flows through tributaries).

When attempting to estimate the flood depth on the Trial Properties, Dr. Bedient lowered the surveyed elevation at each property by 0.3 feet because, he believed, the surveyed elevation data used a different benchmark than the gage elevation data. Tr. at 1917:20-24 (Bedient); Pls.' Post-Trial Br. at 43 (discussing the adjustment). For reasons that remain unclear, however, when he looked at data from the exact same gages to evaluate why the properties flooded, he did not make a 0.3-foot adjustment to the same surveyed elevation data. Tr. at 2045:12-14 (Bedient, discussing PX-526 at 54 (Bedient Expert Report)). His opinion should be rejected for this reason alone.

At trial, as he did during his deposition, Dr. Bedient explained his approach in the context of the Micu property—he determined the 100-year elevation at the nearest gage (102.56 feet); he determined the same gage reading during Hurricane Harvey (102.77 feet); he subtracted those numbers (0.2 feet); and he added that to his estimate of the 100-year FEMA profile at the Micu property (97.2 feet). Tr. at 2070:1-9, 2073:17 to 2074:17 (Bedient). Dr. Bedient explained he took the same approach with respect to all of the Trial Properties. Tr. at 2074:18-20 (Bedient); Tr. at 1973:2-6 (Bedient, agreeing that, at his deposition, he explained the analysis he undertook for the Micu property, but that all of the property analyses were done in exactly the same way).

At trial, government counsel walked through the exact same methodology Dr. Bedient used for the Micu property with the Burnham property, and demonstrated that Dr. Bedient's approach showed approximately two feet of riverine flooding on the Burnham property (i.e., flooding unrelated to the operation of the Project). Tr. at 2075:17-20 (Bedient). However, Dr. Bedient explained, for the first time, that he undertook a different approach for the Burnham property, and possibly some other properties, and used data apparently generated during the 2016 Tax Day flood because, he felt, "it was a better indicator." Tr. at 1981:15-21 (Bedient). Over the United States' objection, the Court allowed Dr. Bedient to testify about a new expert analysis, PX-2296, which Plaintiffs provided to the United States the last business day before trial started.⁵⁹ The new analysis contains no narrative discussion and includes a new Table 15-1, which revises several of Dr. Bedient's numbers. Plaintiffs' Post-Trial Brief does not attempt to explain the new approach, beyond stating that it apparently uses a "linear extrapolation." Pls.'

⁵⁹ The parties exchanged their expert reports on November 5, 2018. Tr. at 1971:23-25 (Bedient). The United States deposed Dr. Bedient on December 18, 2018. Tr. at 1972:4-6 (Bedient). Five months after his deposition, Dr. Bedient provided his new analysis, PX-2296, to his attorneys, and Plaintiffs' counsel provided it to the United States for the first time on May 13, 2019, the last business day before trial started. Tr. at 1973:11-13 (Bedient).

Post-Trial Br. at 46. Nor do Plaintiffs explain why the 2016 Tax Day flood data were unavailable in November 2018, when the parties exchanged expert reports.

Dr. Bedient's analysis is impossible to decipher and the Court should, therefore, reject his opinion. The new report's numbers for the Burnham property, for example, show the "Harvey Floodplain Elevation" as 105.4' (104.5'**) PX-2296 at PDF 3 (Bedient New Report). At trial, Dr. Bedient claimed that the number in parentheses was an "adjusted value[] using the Tax Day profile." Tr. at 1984:5-6 (Bedient). Dr. Bedient's original expert analysis showed the "Harvey Floodplain Elevation" for that property as 104.5 feet. PX-526 at 54 (Bedient Expert Report). But at trial, Dr. Bedient stated that his "earlier number was 105.4." Tr. at 2079:15 (Bedient). Dr. Bedient then explained that the "[n]ew correct number with the Langham Slope is 104.5. 104.5." Tr. at 2080:1-2 (Bedient). Thus, Dr. Bedient explained the number in his original expert report (104.5 feet) was actually the correct number. Tr. at 2080:15-17 (Bedient). Dr. Bedient then reversed course and stated that the current use of the new data results in 105.4 feet. Tr. at 2081:6-8 (Bedient). Dr. Bedient, therefore, changed his analysis the day before trial started and provided it to the United States in a form that is impossible to understand. The Court should reject his analysis.

D. David Hooper Showed that Damage to Several Upstream Properties Was Unavoidable

David Hooper was the only expert who testified at trial about the types of repairs needed to remediate the Trial Properties after Hurricane Harvey and the types of repairs that would have been needed in some of the hypothetical conditions assessed by Dr. Nairn.⁶⁰ Mr. Hooper has

⁶⁰ Mr. Hooper earned a Bachelor's of Science degree in microbiology from the University of Pittsburgh, and a Master's Degree in Microbiology from Clemson University. Tr. at 2875:8-12 (Hooper). Mr. Hooper is a licensed Texas mold assessment consultant, Tr. at 2875:13-18 (Hooper), and has worked as a microbiologist for Madsen Kneppers & Associates, a construction consulting firm, for five years. Tr. at 2873:15 to 2874:2 (Hooper).

extensive experience in this field and has prepared more than 1,000 similar scopes of work in the past, including properties damaged by Hurricane Harvey and other storms. Tr. at 2876:11-20, 2879:10-19 (Hooper). The Court accepted Mr. Hooper as an expert in preparing scopes of work for properties damaged by flooding. Tr. at 2901:5-7 (Hooper).

Mr. Hooper used the standard method for preparing scopes of work: he investigated each property's background information; applied industry standard guidelines to determine the likely damage; and developed detailed lists of work needed to repair the structure using like-kind materials. Tr. at 2880:15 to 2881:23 (Hooper). He also considered possible mold growth, but noted that any mold damage on the Trial Properties was capable of remediation. Tr. at 2878:13-19 (Hooper).

Mr. Hooper's expert reports include a discussion of his comprehensive analyses and his conclusions, which include bulleted scopes of work organized by room. DX-602 to DX-606 (Hooper Expert Reports); Tr. at 2898:23 to 2899:1 (Hooper). He also prepared tables to summarize and compare his conclusions. DX-855 to DX-857 (Hooper Expert Report Summary Tables); Tr. at 2903:10-12 (Hooper).

1. Burnham Property

For the Burnham property, Mr. Hooper determined that for the Actual Scenario, No Project Scenario, and Open Gates Scenario, "[t]he overwhelming amount[] of work is the same between all three scopes," because a four-foot flood cut is required in each scenario. Tr. at 2909:19-23 (Hooper). Some minor, additional repairs would be required under the Actual Harvey scenario for items located between the four- and eight-foot wall line, such as drywall and a thermostat. Tr. at 2909:19 to 2910:1 (Hooper). Mr. Hooper found mold remediation was

likely in the Actual Harvey and Gates Open Scenarios. DX-855 at 1 (Hooper Expert Report Summary Tables for Burnham Property).

2. Giron Property

For the Giron property, Mr. Hooper determined that for the Actual Scenario, No Project Scenario, and Open Gates Scenario, the scopes of work “are almost exactly the same,” because a four-foot flood cut would be required under each scenario. Tr. at 2912:20 to 2913:13 (Hooper). Mr. Hooper noted that mold remediation likely would be needed in the Actual Scenario. Tr. at 2913:11-13 (Hooper); DX-856 at 1 (Hooper Expert Report Summary Tables for Giron Property).⁶¹

3. Micu Property

For the Micu property, Mr. Hooper determined that for the Actual Scenario, the No Project Scenario, and Open Gates Scenario, at least a four-foot flood cut is required. Tr. at 2918:1-5 (Hooper). This results in very few differences among the scenarios. Mr. Hooper determined that mold remediation would be likely under all but the No Project Scenario. DX-854 at 1 (Hooper Expert Report Summary Tables for Micu Property).⁶²

4. Sidhu Property

For the Sidhu property, Mr. Hooper determined that under the Actual Scenario and Open Gates Scenario the scopes of work “are very similar,” and each require a four-foot flood cut minus a few minor differences related to electrical receptacles and faceplates at the 1-foot level.

⁶¹ Mr. Giron testified that a mold assessor came to his property after Hurricane Harvey and did not find mold damage. Tr. at 1690:15-25 (Giron).

⁶² An inspection of the Micu property in March 2018 determined that the property was free from mold damage. DX-520 (Micu property mold assessor’s certificate).

Tr. at 2921:2-11 (Hooper). Mr. Hooper also found that mold remediation would be likely in the Actual Scenario. DX-853 at 1 (Hooper Expert Report Summary Tables for Sidhu Property).⁶³

5. Turney Property

For the Turney property, Mr. Hooper determined that under the Actual Scenario and the Open Gates Scenario the “scopes of work are the same.” Tr. at 2925:16-18 (Hooper). Under either scenario Mr. Hooper found that mold remediation would be likely. DX-857 at 1 (Hooper Expert Report Summary Tables for Turney Property).

III. Legal Argument

“[N]o magic formula enables a court to judge, in every case, whether a given government interference with property is a taking” because of “the nearly infinite variety of ways in which government actions or regulations can affect property interests[.]” *Ark. Game & Fish Comm’n v. United States*, 568 U.S. 23, 31 (2012). And although “government-induced flooding temporary in duration gains no automatic exemption from Takings Clause inspection,” a taking caused by temporary flooding is the exception, and not the rule. *See id.* at 37-38 (explaining that the “modest” decision “augurs no deluge of takings liability”). The Court should reject Plaintiffs’ claims for a number of independent reasons.

A. Plaintiffs’ Claims Fail Because Plaintiffs Did Not Prove Facts that Support Fifth Amendment Claims, As Opposed to Tort Claims

The Court of Federal Claims lacks jurisdiction over tort claims. 28 U.S.C. § 1491(a)(1). When a plaintiff alleges a Fifth Amendment taking of real property, as opposed to a tort, the Court must determine first, “whether the effects [plaintiff] experienced were the predictable result of the government’s action,” and second, “whether the government’s actions were sufficiently substantial to justify a takings remedy.” *Ridge Line, Inc. v. United States*, 346 F.3d

⁶³ Mr. Sidhu did not testify about any mold damage at his property.

1346, 1355 (Fed. Cir. 2003). Plaintiffs bear the burden of proving “that treatment under takings law, as opposed to tort law, is appropriate under the circumstances.” *Id.* at 1355; *see also* 28 U.S.C. § 1491(a)(1) (2018). The Court should reject Plaintiffs’ claims because they failed to meet their burden of proof with respect to both requirements.

1. The Claimed Losses Were Not the Direct, Natural or Probable Result at the Time the Corps Constructed the Project

A takings plaintiff must prove that the claimed damages are “directly attributable to government action,” because no liability exists when the government action is a secondary or contributory factor. *Bartz v. United States*, 633 F.2d 571, 593 (Ct. Cl. 1980) (per curiam). Thus, a claimant bears the burden of showing that his injury is the “direct, natural, or probable result of an authorized activity and not the incidental or consequential injury inflicted by the action.” *Ridge Line*, 346 F.3d at 1355 (quoting *Columbia Basin Orchard v. United States*, 132 F. Supp. 707, 709 (Ct. Cl. 1955)). The government action in 2017 was not a deviation from some earlier action—it simply put into action long-standing operations related to reservoirs built in the 1940s. The relevant government action, then, should not divorce the construction of the Project from its operation, and the focus for purposes of this analysis should be at the time the Corps constructed the dams in the 1940s. *See John Horstmann Co. v. United States*, 257 U.S. 138, 146 (1921) (“[I]t would border on the extreme to say that the government intended a taking by that which no human knowledge could even predict.”); *Ark. Game & Fish Comm’n v. United States*, 736 F.3d 1364, 1373 (Fed. Cir. 2013) (considering impact of series of approved deviations by looking at knowledge at the time of the deviations).

In evaluating this factor, the Court must consider “the degree to which the invasion is intended or is the foreseeable result of authorized government action.” *Ark. Game & Fish Comm’n*, 568 U.S. at 39. Making the showing requires more than simply showing some remote

possibility of the complained of injury. The agency’s knowledge at the time of action that a particular result is a *possible* result does not mean it is a *direct, natural or probable* result; therefore, an agency’s recognition of the possibility of a result from an action does not meet this element. *Moden v. United States*, 404 F.3d 1335, 1345 (Fed. Cir. 2005). Even an intentional act that increases the risk of a detrimental result “does not equate to making the detrimental result direct, natural, or probable.” *Cary v. United States*, 552 F.3d 1373, 1378 (Fed. Cir. 2009).

In the 1940s, the Corps constructed the Project and acquired enough land upstream of the reservoirs to accommodate flood pools larger than the pools that would have been created by the worst storm to ever hit the watersheds. Mem. § I(A)(3)(ii).⁶⁴ At that time, and for the next several decades, the Corps owned more than enough property upstream of the reservoirs to accommodate the flood pool reasonably expected to occur during the life of the project. Mem. §§ I(A)(3)-(4). That situation did not change until the 1970s, when increased urbanization, better understanding of weather phenomena and improved engineering techniques prompted a sea change in the Corps’ thinking. Mem. § I(D). But that information came to light in the 1970s—specifically when the Corps published the 1977 Hydrology Report.⁶⁵ It was not known, and could not have been known, earlier, including at the time that matters for this analysis—when the Corps constructed the project in the 1940s. And, in fact, the SPF calculated in 1977 was based on a far smaller inflow than that generated by Hurricane Harvey. As Dr. Nairn explained, the total inflow associated with the SPF calculated in 1977 was 319,000 acre-feet. Tr. at 2704:5-7

⁶⁴ Internal citations to this Post-Trial Memorandum are denoted as “Mem. § [SECTION].”

⁶⁵ This point is not in dispute. Dr. Bedient admitted that the first time that the elevation of the pool created by the SPF was understood to exceed the elevation of the GOL was after 1977. Tr. at 2029:3-8 (Bedient).

(Nairn). The total inflow associated with Hurricane Harvey was more than forty percent larger—450,000 acre-feet. Tr. at 2702:15-24 (Nairn).

Certainly the Corps did not foresee Hurricane Harvey or the resulting damage when it constructed the Project in the 1940s. Even Dr. Bedient confessed that, in the 1940s, the Corps “would be hard-pressed” to have foreseen that a storm like Hurricane Harvey would hit the Addicks and Barker Watersheds. Tr. at 2029:20 to 2030:6 (Bedient). And there is no evidence that the Corps foresaw, or could have foreseen, in the 1940s that the local governments would allow such significant development upstream of the reservoirs.⁶⁶ As Mr. Ickert described, when the Corps constructed the Project, the upstream watersheds were approximately ninety-eight percent undeveloped. Mem. § II(B). By 2014, several years before Hurricane Harvey struck, less than sixty percent of the same watersheds remained undeveloped. *See id.* Thus, the claimed losses were not the direct, natural or probable result at the time the Corps constructed the Project, and Plaintiffs’ claims must fail.

To find otherwise would hold the Corps responsible for unforeseen urbanization and the fact that larger storms occur in the upstream watersheds in the modern era, as compared to the 1940s. As Dr. Bedient explained, storms in the upstream watersheds in the 1940s were smaller than storms that have impacted that area recently. Tr. at 2026:22 to 2027:18 (Bedient, agreeing that “they were smaller storms back when these reservoirs were designed”). In the decades since construction, the likelihood of larger storms hitting the area near the reservoirs has increased. Tr. at 2027:19-22 (Bedient). But it was impossible for the Corps, in the 1940s, to expect that the

⁶⁶ There is also no evidence that the Corps foresaw, or could have foreseen, that the local governments would allow such significant development along Buffalo Bayou downstream of the reservoirs. As discussed above, that downstream development led to the addition of gates on all of the dam outlets by 1962.

weather would change in that way. Tr. at 2028:8-13 (Bedient). The Corps did not foresee, and could not have foreseen, these changes in weather phenomena when it constructed the Project.⁶⁷

In addition, the inundation of Plaintiffs' properties during this rare and record-setting rainfall event is, at most, a consequential result of Project construction and operation, not a "direct, natural, or probable" result of the government's actions. Congress authorized the Project, and the Corps constructed it and operates it, as a flood-risk reduction project. The direct, natural, or probable result of the government action is to reduce the risk of catastrophic downstream flooding, not to intentionally flood upstream properties, all of which were built decades after Project construction. That such flooding occurred in connection with Hurricane Harvey was merely a consequential result of operating the Project in the face of a storm of unprecedented magnitude.

In support of their position, Plaintiffs make two arguments. First, Plaintiffs argue that the "Government has *always known* that each reservoir would store significantly more stormwater runoff than the [GOL] could contain." Pls.' Post-Trial Br. at 9 (emphasis added). In support, Plaintiffs rely on post-construction analyses, all of which were prepared decades after Project construction. *See, e.g., id.* at 17 (citing the 1981 Draft EA); *id.* at 17 n.61 (citing a 1984 Mem.); *id.* at 31-33 (listing documents after Project construction); *id.* at 112-13 (citing, as "clear evidence of foreseeability" computer mapping prepared decades after construction (PX-268), PowerPoint presentations prepared in 2009 (PX-1597), surveying efforts undertaken in "2003-2004," and the supposed "establish[ment] in the 1980s" of a new "Taking Line"). But these

⁶⁷ Similarly, there is no evidence that the Corps could have foreseen the significant upstream urbanization that occurred after Project construction.

post-construction analyses cannot show foreseeability at the time of Project construction—they are, therefore, irrelevant to the inquiry at hand.

Although irrelevant to any issue before the Court, we note that Plaintiffs’ argument also depends on a misreading of certain post-construction documents. In their discussion of a 1984 memorandum, for example, Plaintiffs emphasize that the newly-calculated PMF (which, as discussed above, was based on a 1977 Hydrology Report) “on an empty pool is considered a probable occurrence. . . .” Pls.’ Post-Trial Br. at 17; *id.* at 19 (asserting that the PMF “was actually probable to occur”). But the trial evidence showed that the word “probable” in the hydrologic context is a term of art that cannot be divorced from the accompanying word “maximum”—in this context, “probable” does not imply a likelihood of occurrence, but rather a belief that the PMP is probably the worst, most extreme storm event that could occur. Mem. § I(A)(4).

To support their foreseeability argument, Plaintiffs also rely on the 1940 Definite Project Report. *See* Pls.’ Post-Trial Br. at 31 n.107 (citing JX-5 (1940 Definite Project Report)). But, as discussed above, when the Corps constructed the Project, it bought more than enough property upstream of the reservoirs to accommodate the flood pools that were expected to be generated during the worst storm that is reasonably characteristic of the basin. Mem. § I(A)(3)(ii).⁶⁸ For decades after construction—until the 1970s—the Corps believed it owned more than enough property to accommodate such flood pools. It was only after preparation of the 1977 Hydrology Report—after decades more hydrologic information; after decades more engineering

⁶⁸ The Corps was aware of and considered the 1899 Hearne storm in its design of the Project, but the Corps and the local interests (represented by HCFCD) ultimately concluded and agreed that “the probability of the occurrence on the Buffalo Bayou basin of a storm as severe as the June-July 1899 Hearne storm was very remote. . . .” JX-5 at USACE129510 (1940 Definite Project Report).

development; after decades more upstream development—that the situation changed and it became clear that a higher risk of upstream and downstream flooding existed.

Plaintiffs cite the 1981 Draft EA for the proposition that the “inadequacy of [GOL] upstream of the reservoir embankments to contain water from the SPF was recognized in the original design of the reservoirs.” Pls.’ Post-Trial Br. at 31 (quoting PX-87 at 4 (Draft EA)). Plaintiffs correctly cite that document, but they ignore the undisputed trial testimony of Mr. Thomas, who explained that statement (made in a draft document nearly forty years after Project construction) is wrong—it does not “match what you see in the 1955 or 1962 regulation manuals.” Tr. at 514:7-8 (Thomas). It is undisputed that those manuals show that the Corps owned more than sufficient property upstream of the reservoirs to accommodate the flood pools likely to be generated by the SPF. Mem. § I(A)(4) (discussing DX-25 (Aug. 1955 Reservoir Regulation Manual) and JX-16 (Apr. 1962 Reservoir Regulation Manual)). In addition, Dr. Bedient admitted that the boundaries of the GOL was understood to contain the SPF until after 1977, decades after Project construction. Tr. at 2029:3-8 (Bedient).

Second, Plaintiffs argue the Corps’ “failure to acquire—in fee—all land up to the top of the flood control pool . . . violated its standing land acquisition policy.” Pls.’ Post-Trial Br. at 9. In support, Plaintiffs repeatedly point to Corps guidelines authored decades after Project construction, rather than the guidelines in place when the Corps constructed the Project. *See id.* at 10 n.34 (citing 1969 and 1991 engineering regulations); *id.* at 11 (citing 1991 engineering regulation); *id.* at 13 (same); *id.* at 16 (citing 1978 engineering technical letter). Plaintiffs’ reliance on post-construction engineering guidelines is flawed for three reasons. First, by definition, the post-construction guidelines did not exist at the time of Project construction. Those documents are, therefore, irrelevant to the issue before the Court related to foreseeability.

Second, Plaintiffs' position is wrong because newly adopted engineering guidelines do not apply retroactively to existing projects. Tr. at 863:5-15 (Johnson-Muic). The Corps' real estate acquisitions in the 1940s complied with the policies in place at the time of Project construction. Tr. at 453:24 to 454:4 (Thomas); Tr. at 2016:21 to 2017:2 (Bedient); Tr. at 862:6-9 (Johnson-Muic, testifying that she found no exceptions of the Corps' real estate policy for reservoir real estate acquisition policies). As discussed above, the Corps based the GOL boundary in the 1940s on the largest storm reasonably characteristic of the region and the rural, undeveloped character of the upstream properties. Tr. at 200:17-25 (Thomas). Dr. Bedient, Plaintiffs' expert, agreed that the Corps' approach was consistent with its standards as they existed in the 1940s regarding land acquisition. Tr. at 2016:25 to 2017:2 (Bedient).

Unless an exception is made, the Corps bases real estate acquisitions on policies in place at the time of acquisition. Tr. at 861:20-23 (Johnson-Muic). Thus, when a new real estate policy goes into place, it is not generally applied to an existing project. Tr. at 862:25 to 863:4 (Johnson-Muic). As Ms. Johnson-Muic explained, Corps policies change often, and those policies typically do not state that they are retroactive to existing projects. Tr. at 863:5-15 (Johnson-Muic). The Corps applies new policies to new projects, but it does not apply new policies retroactively to existing projects. Tr. at 863:5-15 (Johnson-Muic).⁶⁹

⁶⁹ Plaintiffs erroneously assert at page 113 of their Post-Trial Brief that the Corps "established in the 1980s" a new "Taking Line" above the reservoirs. They base this assertion on notes taken during a July 1980 meeting, which simply discuss possible land acquisition should the Corps eventually move forward with proposed plans (which it did not). PX-46 at USACE474371 (July 1980 Disposition Form). Those meeting notes did not "establish[]" a new "Taking Line" as Plaintiffs assert. Establishment of taking lines requires formal approvals, as occurred in the early 1940s. JX-9 (Feb. 1942 Mem., concurring in recommendation of approval of taking line for Barker Reservoir); JX-10 (Mar. 1942 Mem., approving taking line for Barker Reservoir).

Third, acceptance of Plaintiffs' position would mean that the Corps' land acquisition actions violated internal guidelines. But "[a] takings claim cannot be found on the theory that the United States has taken unlawful action." *Moody v. United States*, No. 2018-2227, slip. op. at 11 (Fed. Cir. July 24, 2019). "[C]omplaints about the wrongfulness of the [government action] are therefore not properly presented in the context of [a] takings claim." *Rith Energy, Inc. v. United States*, 270 F.3d 1347, 1352 (Fed. Cir. 2001). Thus, "a claim premised on a regulatory violation does not state a claim for a taking." *Lion Raisins, Inc. v. United States*, 416 F.3d 1356, 1369 (Fed. Cir. 2005); *see also Moody v. United States*, No. 2018-2227 (Fed. Cir. July 24, 2019) (affirming dismissal of plaintiffs' Fifth Amendment claim based on "the theory that the [federal agency's] actions were contrary to law. . . .").

2. One-Time Flooding During this Historic Storm Was Not Substantial and Frequent Enough to Rise to the Level of a Taking

To state a takings claim, Plaintiffs must also show that the "government's interference with any property rights of [plaintiff] was substantial and frequent enough to rise to the level of a taking." *Ridge Line*, 346 F.3d at 1357. "Isolated invasions, such as one or two floodings . . . do not make a taking . . . , but repeated invasions of the same type have often been held to result in an involuntary servitude." *Id.* (quoting *Eyherabide v. United States*, 345 F.2d 565, 569 (Ct. Cl. 1965); *see also Ark. Game & Fish Comm'n*, 568 U.S. at 29 ("[W]hile a single act may not be enough, a continuance of them in sufficient number and for a sufficient time may prove [a taking]." (quoting *Portsmouth Harbor Land & Hotel Co. v. United States*, 260 U.S. 327, 329-30 (1922))); *Fromme v. United States*, 412 F.2d 1192, 1197 (Ct. Cl. 1969) (per curiam) (no taking where flooding of land could "reasonably be expected to recur . . . once in every 15 years, on the average"); *N. Ctys. Hydro-Elec. Co. v. United States*, 151 F. Supp. 322, 323 (Ct. Cl. 1957) ("Two floodings, one ten years after the pool behind the dam was completely full, and the other

nineteen years after, do not constitute a taking.” (citations omitted)); *B. Amusement Co. v. United States*, 180 F. Supp. 386, 389 (Ct. Cl. 1960) (one flood not sufficient to constitute a taking); *Nat’l By-Products, Inc. v. United States*, 405 F.2d 1256, 1273-75 (Ct. Cl. 1969) (two floods not sufficient to constitute a taking). Hurricane Harvey caused record flood pools and, for the first time, some property owners experienced flooding inside their homes as a result of those rising pools. Plaintiffs’ claims fail because one-time flooding associated with a single, extraordinarily large storm, unprecedented in both the historical record and the Project’s seventy-year history, does not constitute a compensable taking under the Fifth Amendment.

Moreover, for the government’s actions to constitute a taking, “an invasion must appropriate a benefit to the government at the expense of the property owner, or at least preempt the owner’s right to enjoy his property for an extended period of time, rather than merely inflict an injury that reduces its value.” *Ridge Line*, 346 F.3d at 1356 (citations omitted). But here, the alleged invasion did neither. The United States gained no benefit from the flooding that occurred. And the flooding did not preempt Plaintiffs’ right to enjoy their properties for an extended period of time. Flooding was instead the unfortunate and unavoidable consequence of an unprecedented natural event. The widespread effects of Hurricane Harvey damaged twelve of Plaintiffs’ homes (and thousands of other homes in the Houston area), caused Plaintiffs to vacate their properties for a relatively short period of time and, for some, resulted in expenditure of money on repairs. But the “mere[] inflict[ion of] an injury that reduces [a property’s] value” does not establish a Fifth Amendment taking. *Id.*

B. Plaintiffs’ Claims Fail Because the Corps’ Actions Were an Exercise of Governmental Power to Prevent Loss of Life and Mitigate Unavoidable Damages to Private Properties

The Supreme Court has long held that all property rights are subject to a “fair exercise” of the police power. *Chi. & Alton R.R. v. Tranbarger*, 238 U.S. 67, 77 (1915). Even the

destruction or seizure of property is not generally viewed as a compensable taking so long as the government is acting to protect public health or safety. *See, e.g., Mugler v. Kansas*, 123 U.S. 623 (1887).⁷⁰ Particularly in an emergency, where the government action is part of an effort to reduce or mitigate unavoidable harms to the public, no viable taking claim exists. *See Miller v. Schoene*, 276 U.S. 272, 279-80 (1928) (state-ordered destruction of cedar trees to prevent spread of disease to nearby apple trees held not to be a taking); *Bowditch v. City of Boston*, 101 U.S. 16, 18-19 (1879) (government not liable for a taking where firefighters destroyed a home to arrest the spread of fire in the protection of other private properties). That principle applies here and precludes recovery.

In *Miller v. Schoene*, the state had to decide how to address an unavoidable harm to private property—it could either destroy plaintiff’s red cedar trees that contained an infectious fungus that could spread to nearby apple orchards, or do nothing and risk damaging the larger local apple industry. 276 U.S. at 278-79. When the state opted to destroy the individual farmer’s trees, the Supreme Court held that no violation of the Fifth Amendment occurred—when the government is forced to make a choice between the preservation of one kind of property or another, it does not act unconstitutionally in doing so. *Id.* at 279 (holding that when government is “forced to such a choice” between the preservation of two types of property, “the state does not exceed its constitutional powers by deciding upon the destruction of one class of property in order to save another. . .”).

⁷⁰ Texas law, like federal law, recognizes that when a government action is part of an effort to reduce or mitigate unavoidable harms to the public, no viable takings claim exists. Under Texas law, “[t]he protection of the public against floods by levees and storage reservoirs by the state and its agencies is of ancient origin, universal in its extent, and a practice of modern times.” *Motl v. Boyd*, 286 S.W. 458, 470 (Tex. 1926). As a result, the Texas Supreme Court recognizes that government actions taken to protect against floods are “authorized under the police power inherent in the state as a government” *Id.*

The “public use” requirement of the Takings Clause is “coterminous with the scope of a sovereign’s police powers.” *Brewer v. State*, 341 P.3d 1107, 1112 (Alaska 2014) (citing *Haw. Housing Auth. v. Midkiff*, 467 U.S. 229, 240 (1984)). “When private property is damaged [as a result of] the exercise of police power, [that] damage is not a taking for public use[] because the property has not been altered or turned over for public benefit.” *Bachmann v. United States*, 134 Fed. Cl. 694, 696 (2017). The Fifth Amendment does not invariably require compensation for government-caused damages to property.

The same principle applies here. The factual and expert evidence showed that this was a zero-sum game situation—no matter what the Corps did in regard to the opening and closing of the reservoirs’ gates, homes upstream and downstream would have flooded. If the gates had remained closed, the homes upstream would have flooded more and the homes downstream less. If the gates had remained open, the homes upstream would have flooded less but the flooding would have been exacerbated on downstream properties. Mem. §§ I(G), II(C)(3).

Moreover, the facts showed that the Corps’ actions during the storm were made in an emergency situation, in an effort to protect lives and prevent catastrophic damage to hundreds of thousands of properties. Mem. § I(G). Plaintiffs concede that the authorized purpose of the Project “is to reduce potential flood damage along the downstream reach of Buffalo Bayou.” Pls.’ Post-Trial Br. at 3 (quoting PX-59 at USACE464077 (Oct. 2009 Draft Operational Assessment); *see also* ECF No. 211 ¶ 86 (Joint Stipulations, same). The historic amount of rainfall resulted in widespread flooding. Harris County estimates that 140,000 to 160,000 homes and businesses flooded during the storm, and that flood waters caused \$80 million in damages to the drainage infrastructure that it maintains. *See* DX-737 at FEMA078353, -57 (HCFCD Federal

Briefing, Spring 2018); DX-682 at 7 (Map showing location of Hurricane Harvey structure flooding in Harris County).

In the face of this significant and catastrophic storm, the Corps operated the Project in accordance with the Water Control Manual. Mem. § I(G). It closed the gates in anticipation of the storm to protect downstream properties, and, when the rains continued unabated and the pools reached historic levels, the Corps made surcharge releases for the first time in Project history. *See id.* These actions, taken during the largest storm in United States history, fall squarely within the police powers doctrine.

To maximize protection of the downstream properties, the Corps might have ignored dam safety issues (and the Water Control Manual) and kept the gates on both dams closed throughout Hurricane Harvey. But if the Corps had taken that action, all of the upstream Trial Properties would have flooded more and for a longer period than they actually flooded during the storm. Mem. § II(C)(4). If the Corps had kept the gates open during the storm, at least five of the Trial Properties (Burnham, Sidhu, Turney, Micu and Giron) would have still experienced some flooding, and all of the downstream trial properties would have flooded more and for a longer period of time than they actually did. Mem. § II(C)(3).

Although the Corps could not prevent flooding of all private property, the Corps' operation of the Project protected the integrity of the dams and avoided the risk of far more significant loss of life and property damage downstream of the dams. The Corps' analysis after the storm demonstrated that the federal actions—the construction and operation of the Project during Hurricane Harvey—prevented an extraordinary \$6.96 billion in losses to downstream properties that would have otherwise occurred. Tr. at 164:24 to 165:5 (Thomas, discussing JX-228 at USACE869495 (2017 Annual Water Control Report)). The federal actions were an

exercise of the government’s police powers and cannot support a claim for compensation under the Fifth Amendment.⁷¹

Plaintiffs complain that the existence and operation of the Project favors the downstream properties, “without regard to the impact” on upstream properties. Pls.’ Post-Trial Br. at 4. But that complaint ignores the fact that the exercise of police power precludes recovery under the Fifth Amendment even when the government’s choice shows “preferment of [one group’s] interest over the property interest of the individual, to the extent even of its destruction [and is, in fact] one of the distinguishing characteristics of every exercise of the police power which affects property.” *Miller*, 276 U.S. at 279-80.

Therefore, Plaintiffs’ claims fail because the United States exercised its sovereign police power to mitigate an unavoidable public harm—catastrophic flooding, and untold property damage and loss of life, during the worst storm to ever hit the United States in recorded history.

C. Plaintiffs’ Claims Fail Under the Necessity Doctrine

The United States Supreme Court has observed that “common law ha[s] long recognized that in times of imminent peril—such as when fire threatened a whole community—the sovereign could, with immunity, destroy the property of a few that the property of the many and the lives of many more could be saved.” *TrinCo Inv. Co. v. United States (TrinCo II)*, 722 F.3d 1375, 1377 (2013) (citing *United States v. Caltex*, 344 U.S. 149, 154 (1952)). This principle, referred to as the doctrine of necessity, “absolv[es] the State of liability for the destruction of real

⁷¹ Since its construction, the Project has accomplished its purposes spectacularly well, by retaining upstream flood runoff and releasing flood waters downstream at a slower rate than would otherwise occur. Tr. at 445:21-23 (Thomas); JX-91 at USACE016051 (2009 Master Plan). In addition to the damages prevented during Hurricane Harvey, the Corps calculated that the existence and operation of the Project prevented more than \$5.6 billion in damages in fiscal year 2016, and prevented cumulative damages of approximately \$16.6 billion through fiscal year 2016. JX-134 at USACE869251 (2016 Annual Water Control Report).

and personal property, in cases of actual necessity, to prevent or forestall grave threats to the lives and property of others.” *Id.* (citing *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1029 n.16 (1992)) (ellipses and quotation marks omitted). As Nichols’ *Law of Eminent Domain* explains: “In the case of fire, flood, pestilence or other great public calamity, when immediate action is necessary to save human life or to avert an overwhelming destruction of property, any individual may lawfully enter another’s land and destroy his property, real, or personal, providing he acts with reasonable judgment.” *Steele v. City of Houston*, 603 S.W.2d 786, 792 n.2 (1980) (citing Philip Nichols, et al., *THE LAW OF EMINENT DOMAIN* § 1.43 (rev. 3d ed. 1979); *see also* *RESTATEMENT (SECOND) OF TORTS* § 196 (1965)). The doctrine of necessity can absolve the government of a duty to compensate a party for the taking or destruction of property. *TrinCo II*, 722 F.3d at 1378.

The doctrine of necessity emerged at common law, where “everyone had the right to destroy real and personal property, in cases of actual necessity . . . and there was no responsibility on the part of such destroyer, and no remedy for the owner.” *Bowditch*, 101 U.S. at 18. As applied to a Fifth Amendment takings claim, the necessity defense has three components: “[it] requires both an actual emergency and an imminent danger met by a response that is actually necessary.” *TrinCo II*, 722 F.3d at 1380.

The doctrine of necessity applies here for the same reasons discussed in relation to the police power doctrine. Hurricane Harvey presented an emergency situation when it struck the Texas coast. The Corps acted reasonably and in the only way it could to reduce flooding and the loss of life to downstream properties—it closed the gates at the Project and began to retain water behind the dams. The effect of that action was to lessen downstream flooding and reduce the risk of loss of life. Thus, under the necessity doctrine, the floodwaters that collected behind the

gated reservoirs and temporarily backed onto Plaintiffs' properties cannot serve as the basis for a Fifth Amendment claim against the United States.

D. Plaintiffs' Claims Fail Because They Lack a Compensable Property Interest to be Free of Floodwaters Generated During a Hurricane

Plaintiffs' claims fail, too, because they lack a compensable property right to be free of flooding during a hurricane. Plaintiffs have the burden of establishing that they possess a property right alleged to have been taken. *See Wyatt v. United States*, 271 F.3d 1090, 1097 (Fed. Cir. 2001); *Conti v. United States*, 291 F.3d 1334, 1341-42 (Fed. Cir. 2002). Only those expectancies that are "fortified by law" are compensable property rights. *Broughton Lumber Co. v. United States*, 30 Fed. Cl. 239, 243 (1994) (citing *United States v. Willow River Co.*, 324 U.S. 499, 502 (1945)); *see also Webb's Fabulous Pharms., Inc. v. Beckwith*, 449 U.S. 155, 161 (1980) ("[A] mere unilateral expectation or an abstract need is not a property interest entitled to protection."). Property interests arise from "existing rules and understandings and background principles derived from an independent source, such as state, federal, or common law. . . ." *Air Pegasus of D.C., Inc. v. United States*, 424 F.3d 1206, 1213 (Fed. Cir. 2005) (internal quotation marks omitted).

Under Texas law, property rights are limited by "appropriate government action under its police power (such as addressing nuisances)" and "pre-existing limitations in the rights of real property owners that have existed 'since time immemorial'" *Severance v. Patterson*, 370 S.W.3d 705, 710 (Tex. 2012) (citations omitted). The right of the government to mitigate against floodwaters is such a limitation under Texas law.

The Texas Supreme Court observed in 1926 that "severe and destructive floods are characteristic of the streams of this state." *Motl v. Boyd*, 286 S.W. 458, 469 (Tex. 1926). Recognizing the "great destruction" caused by floodwaters as such waters flow through the

streams of Texas into the Gulf of Mexico, the Texas Supreme Court further stated: “We think flood waters are to be treated as a common enemy, the control and suppression of which is a public right and duty.” *Id.* at 470-71 (citations omitted); *see also id.* at 471 (referencing “the well-known . . . fact that flood waters are injurious to the general public”). The right of the state to mitigate against flood waters is well established in Texas law. *See id.* at 470 (discussing an “inherent” police power to take steps to ameliorate “overflow conditions” by improving drainage, building levees and constructing storage reservoirs).

The government’s efforts to control flood waters and mitigate against flooding and flood damages thus serve as a pre-existing limit on Texas property rights under the police power. *See id.* at 470-71 (government’s power and authority to control floods is considered an “ancient right[] of the police power”). On this point, Texas authorities that recognize no liability for flooding prompted by extreme precipitation or rainfall demonstrate that the ownership of private property does not include a right under Texas law to keep property free from government-released floodwaters during and after a hurricane. *See Benavides v. Gonzalez*, 396 S.W.2d 512, 514 (Tex. Civ. App. 1965) (finding that “[u]nprecedented rainfall or Act of God is uniformly recognized” as a defense for allegedly unlawful diversions of water); *Sabine River Auth. of Texas v. Hughes*, 92 S.W.3d 640, 642 (Tex. App. 2002) (government’s release of water from reservoir following storm was not taking where government never released more water than was entering the reservoir from rainfall); *Wickham v. San Jacinto River Auth.*, 979 S.W.2d 876, 880-81 (Tex. App. 1998) (affirming ruling that flooding of downstream properties following government’s release of water from a reservoir during rainfall event exceeding the 100-year frequency was not a taking) (citing *DuPuy v. City of Waco*, 396 S.W.2d 103, 108-09 (Tex. 1965)).

Texas law has long recognized that property rights must yield to government action to protect public safety. In cases of floods or other great public calamity, “when immediate action is necessary to save human life or to avert an overwhelming destruction of property,” the government may lawfully enter another’s land and destroy his property without incurring takings liability. *Steele*, 603 S.W.2d at 792 n.2 (court considering challenge to city’s burning of home to catch criminals hiding inside explained, *inter alia*, that government action to destroy private property could be justified by great public necessity). In 1934, the Texas Supreme Court explained that government actions, such as those to provide for safety of the general public, “do not constitute a taking of property under the right of eminent domain.” *Lombardo v. City of Dallas*, 73 S.W.2d 475, 478 (Tex. 1934) (case discussing relation of property rights and police power in context of challenge to state zoning statutes and city zoning ordinance). In 1921, the Texas Supreme Court explained that private property rights must yield to government action necessary to protect public safety; this grant of authority from the people to their government agents is broad and comprehensive. *See Spann v. City of Dallas*, 235 S.W. 513, 515 (Tex. 1921) (explaining the rationale of city zoning ordinances as an appropriate government action under the police power). In 1879, the Texas Supreme Court explained that a plaintiff had no common law claim against the city after his house was destroyed to prevent the spread of a fire to other houses. *See Keller v. City of Corpus Christi*, 50 Tex. 614, 629 (1879).

Here, the government was acting to control flooding in the face of extraordinary rainfall from Hurricane Harvey, which constitutes an Act of God under Texas law. *See Harris County Flood Control District v. Kerr*, 499 S.W.3d 793, 807 & n.59 & 809 (Tex. 2016) (describing the storms at issue in the case—“Tropical Storm Francis in 1998, Tropical Storm Allison in 2001, and another unnamed storm in 2002”—as Acts of God that partially contributed to flooding in an

inverse condemnation case). *Cf. Landgraf v. Nat'l Res. Conservation Serv.*, No. 6:18-CV-0061, 2019 WL 1540643, at *2 (S.D. Tex. Apr. 9, 2019) (describing storm surge from Hurricane Harvey as an Act of God in tort claim); *Jefferson v. Haza Foods*, No. 3:17-CV-00359, 2018 WL 5268756, at *4 (S.D. Tex. Oct. 5, 2018), *report and recommendation adopted*, No. 3:17-CV-00359, 2018 WL 5264243 (S.D. Tex. Oct. 23, 2018) (describing unprecedented nature of Hurricane Harvey to Houston area in deciding equitable tolling question, and finding that “if Hurricane Harvey and [plaintiff’s] resulting displacement do not constitute extraordinary circumstances, then nothing does.”). The fact that Hurricane Harvey was an Act of God is relevant because Texas courts have found no Fifth Amendment taking when the government is acting in the face of a natural disaster, or Act of God, like Hurricane Harvey. *See Waller v. Sabine River Auth. of Texas*, No. 9:18-cv-00040, 2018 WL 6378510, at *5 (Tex. App. Dec. 6, 2018) (distinguishing takings claims from those in *Arkansas Game and Fish Commission*, in part, because “the facts in this case involve areas around and downstream of the Project which experienced flooding due to a historic weather event.”).

The Trial Properties were developed and bought by Plaintiffs years, or decades, after Project construction, when the land was already subject to the remote possibility of inundation from the dams’ existence and operations during extreme weather events. Plaintiffs have no right to be free from invasions from the existence or operation of the Project, whose construction and operations pre-dated the acquisition of their properties. *See Thomas v. Bunch*, 41 S.W.2d 359, 362-63 (Tex. Civ. App. 1931) (holding that a landowner erecting a dam to protect land acquired a vested right to maintain dam as originally constructed), *aff’d*, 49 S.W.2d 421 (Tex. 1932); *see also City of Dallas v. Winans*, 262 S.W.2d 256, 258 (Tex. App. 1953) (finding no liability where municipality’s operation had not changed, and noting that “if a cause of action ever existed, it

was in favor of some remote predecessor in title, not appellee”); *Meuth v. City of Seguin*, No. 4:16-cv-00183, 2017 WL 603646, at *3 (Tex. App. Feb. 15, 2017) (finding no liability where municipality continued to operate drainage culvert that was built prior to plaintiff’s acquisition of property).

Section 702c of the Flood Control Act of 1928 provides an additional background principle of federal law, which supports the conclusion that landowners in the vicinity of a federal project constructed and operated to reduce flood risk lack a right to compensation for damages caused by floodwaters not fully controlled by the Project.

E. Plaintiffs’ Claims Fail With Respect to the Trial Properties that Would Have Flooded Even in the Absence of Government Action

“It is well established that a takings plaintiff bears the burden of proof to establish that government action caused the injury.” *St. Bernard Parish Gov’t v. United States*, 887 F.3d 1354, 1362 (Fed. Cir. 2018), *cert. denied*, No. 18-359, 2019 WL 113112 (S. Ct. Jan. 7, 2019).

“Causation requires a showing of ‘what would have occurred’ if the government had not acted.” *Id.* (quoting *United States v. Archer*, 241 U.S. 119, 132 (1916)). Plaintiffs, therefore, must prove that the damage to their properties would not have occurred in the absence of the government’s action.

The government actions to be considered in the causation analysis are “the entirety of government actions that address the relevant risk[,]” *i.e.*, flood risk. *St. Bernard Parish*, 887 F.3d at 1364. The causation test cannot focus simply on whatever federal action Plaintiffs choose to identify in their complaint—“the causation analysis must consider both risk-increasing *and risk-decreasing government actions over a period of time* to determine whether the totality of the government’s actions caused the injury.” *Id.* at 1365 (emphasis added). Thus, “[w]hen government action mitigates the type of adverse impact that is alleged to be a taking, it must be

considered in the causation analysis, regardless of whether it was formally related to the government project that contributed to the harm.” *Id.* at 1367. The diversion channels and channel improvements the United States allowed to be built on the Project property were built to reduce flood risks to upstream properties, as evidenced in the recorded instruments granted by the United States, and supporting documentation. Mem. § I(C). Plaintiffs, therefore, must prove that the damage to their properties would not have occurred in the absence of the Project, including the dams, as well as the diversion channels and channel improvements the United States allowed on Project property.

As discussed above, Dr. Nairn conducted the only computer modeling for purposes of this case. His analysis showed that the Burnham, Micu, and Giron properties would have flooded to various depths even if the Corps had never built the Project. Mem. § II(C)(2). In addition, Plaintiffs failed to consider the flooding that would have occurred if the Corps not approved the upstream channel diversion and channel improvement projects. Plaintiffs’ failure to address these actions is erroneous, given the Federal Circuit’s direction that the “causation analysis must consider the impact of the entirety of government actions that address the relevant risk.” *St. Bernard Parish*, 887 F.3d at 1363.

Although the depths and durations of flooding in those scenarios were less than the flooding that actually occurred, Mr. Hooper showed that the damage in those scenarios was nearly the same as the actual damage those properties experienced during the storm. Since the damage to these properties was approximately the same with and without the Project, the Corps’ actions did not effect a taking of those properties. To hold otherwise “would be to say that the Fifth Amendment requires the Government to pay a landowner for damages which may result from conjectural major floods, even though the same floods and the same damages would occur

had the Government undertaken no work of any kind.” *United States v. Sponenbarger*, 308 U.S. 256, 265 (1939). The Supreme Court has been clear that such a holding “would far exceed even the ‘extremest’ conception of a ‘taking’ by flooding within the meaning of that Amendment.”

Id. (internal quotations in original, citations omitted).

F. Plaintiffs’ Claims Fail Under the Multi-Factor Test Established in *Arkansas Game and Fish Commission*

The Supreme Court has held that “not every act of government-induced flooding constitutes a taking.” *Ark. Game & Fish Comm’n*, 736 F.3d at 1370; *see also Ridge Line*, 346 F.3d at 1355 (not every “invasion” of private property resulting from government activity amounts to an appropriation). Although “government-induced flooding of limited duration may be compensable,” in some circumstances, the Court must “weigh carefully the relevant factors and circumstances in each case.” *Ark. Game & Fish Comm’n*, 568 U.S. at 34, 36. “Flooding cases, like other takings cases, should be assessed with reference to the particular circumstances of each case” *Id.* at 37 (internal quotations and citations omitted).

Plaintiffs argue that the Court should ignore *Arkansas Game and Fish Commission* and base its decision solely on earlier case law. Pls.’ Post-Trial Br. at 106 (urging the Court not to undertake the multi-factor analysis). That is an invitation to commit legal error, as decisions from the Supreme Court are binding on this Court.

In Sections III(G)(1)-(5), we highlight the relevant trial evidence that applies to all of the Trial Properties generally. In Section III(G)(6), we discuss the property-specific evidence with respect to each Trial Property.

1. The Character of Plaintiffs' Land—Plaintiffs' Properties Are Located Within an Area Subject to Controlled Inundation, With a Propensity to Flood

The “character of the land at issue” is relevant to the takings inquiry. *Ark. Game & Fish Comm'n*, 568 U.S. at 39. The Trial Properties are located in the most flood-prone city in the United States, in locations that are, themselves, naturally prone to flooding due to their flat terrain and proximity to the Gulf of Mexico. Mem. § I(A). Fort Bend and Harris Counties have always struggled with flooding, particularly since development began in earnest after Project construction. *Id.*

The Trial Properties have long been subject to the risk of flooding, including possible inundation associated with the pools impounded by the Project. The Corps completed the Project approximately seventy years ago, years or decades before the properties were developed. At the time of Project construction, the upstream properties were almost entirely vacant and used for ranching and rice farming. Mem. § I(A)(3).

Plaintiffs admit this point, but argue the “Corps affirmatively acted to aid the alteration of the ‘character of the land’ from rice fields to residential subdivisions within the footprint of the reservoirs.” Pls.’ Post-Trial Br. at 114. Plaintiffs are wrong. The trial evidence showed that the Corps had no ability to control or manage upstream (or downstream) development—those decisions are in the hands of local governments, like Harris and Fort Bend Counties, not the United States. Mem. § I(B). The trial evidence also showed that Fort Bend and Harris Counties have known, in precise detail, of the risk of controlled inundation on upstream properties for decades—as the non-federal sponsor, HCFCD would have known of the possibility of upstream flooding during extreme storms, as discussed in the Project design documents, and the Corps reiterated the possibility of upstream flooding to local governments in the 1980s and 1990s. Mem. § I(E). Given the properties’ natural tendency to flood, the counties have long encouraged

residents to purchase flood insurance and prepare for possible flooding. *See id.* Since at least the early 1990s, Fort Bend County has required inclusion of warning language in public plats to warn potential purchasers about the possibility of Project-related flooding. *See id.* The United States should not be held liable for the development decisions made by third party entities, particularly for decisions made decades after Project construction.

Without the upstream outgrants, many of the Trial Properties would be subjected to constant flooding from other sources. Mem. § I(C). The Corps' approval of outgrants—which reduced natural flooding on at least some of the Trial Properties—demonstrates why the Corps should not be liable in this case, not the opposite as Plaintiffs suggest.

In sum, the character of the Trial Properties, since their initial construction, has always been properties susceptible to flooding during extreme weather events. The Trial Properties have always been subject to flood risk and the flooding that occurred during Hurricane Harvey did not change that characteristic. This factor, therefore, weighs against finding a compensable taking.

2. Severity—The Repairable Damage to the Trial Properties is Not the Type of Severe Impact that Can Support a Fifth Amendment Claim

i. The Trial Properties Experienced Repairable Damage

“Severity of the interference figures in the [liability] calculus as well.” *Ark. Game & Fish Comm’n*, 568 U.S. at 39 (citations omitted). This factor favors a finding of no liability because repairable damage resulting from temporary flooding during a single flood event is not the type of severe impact that can support a claim for compensation under the Fifth Amendment.

At the time of trial, each Trial Property was either fully repaired or capable of being fully repaired. That type of repairable, temporary harm from water damage in a flood-prone area is manifestly different from the type of injury that can support a Fifth Amendment claim. In *Arkansas Game and Fish Commission*, for example, the plaintiff argued that the “cumulative

impact of this flooding over a six-year period . . . resulted in the destruction of timber in the Management Area *and a substantial change in the character of the terrain*, which necessitated costly reclamation measures.” *Id.* at 29 (emphasis added). The flooding allegedly “altered the character of the Management Area,” rendering “natural regeneration of the forests improbable in the absence of reclamation efforts.” *Id.* at 30. Plaintiffs’ properties here suffered no such permanent injury or modification of the character of their land and this factor, therefore, weighs against a finding of a compensable taking. These landowners experienced no lasting infringement on their property rights and they find themselves in the same position as thousands of other Texans in nearby areas whose homes flooded during Hurricane Harvey.

In addition, two Trial Plaintiffs recovered significant flood insurance and nine Trial Plaintiffs received FEMA grants or other federal benefits. Mem. § I(H). Those benefits offset Plaintiffs’ out-of-pocket repair and temporary housing expenses, and lessened the harm resulting from this storm. In addition, the evidence showed that additional federal grant monies will soon become available and could further lessen any remaining harm. *See id.*

Finally, three of the properties—Burnham, Micu and Giron—would have flooded to various depths if the Corps had not built the Project. Mem. § II(C)(2). And five of the properties—Burnham, Sidhu, Turney, Micu and Giron—would have flooded even if the Corps had not closed the gates. Mem. § II(C)(3). Most of the repairs required under those scenarios are the same as the actual repairs, meaning that the damage attributable to the government action was relatively minor. Mem. § II(D).

ii. The Testimony of Randall Bell and Matthew Deal

In support of their argument regarding the severity of the interference, Plaintiffs rely on the testimony of Randall Bell and Matthew Deal. Neither witness attempted to quantify the severity of the impact from flooding for any of the Trial Properties, and their limited and

qualified reports demonstrate that damages from flood waters from a single flood event can be repaired and that a single flood event did not change the character or use of these properties.

Matthew Deal is a real estate appraiser, but he did not appraise any of the Trial Properties or offer an opinion about the market value of any property either before or after Hurricane Harvey.⁷² Tr. at 2195:23 to 2196:13 (Deal). Although Mr. Deal collected some raw sales data, he did not adjust any of those sales and, as a result, did not offer an opinion that quantifies the severity of the impact from flooding. Tr. at 2196:7-13, 2198:5-7, 2207:13 to 2208:1 (Deal). Mr. Deal's collection of raw sales data shows that flood-damaged homes can be repaired to their pre-flood condition, or improved with updated finishes and major renovations that result in an "essentially new home." Tr. at 2221:7-19, 2223:13-2224:4 (Deal).

Mr. Deal's sales data also show that repaired and renovated properties can recover their pre-flood value. Specifically, the raw, unadjusted sales included in his report indicate that properties that have been repaired or renovated after flooding sold for more than similar properties that were sold in "wet" or "guttled" condition.⁷³ Tr. at 2221:20 to 2222:2, 2224:14-20 (Deal). Mr. Deal's raw sales data also show that homes that were repaired or renovated

⁷² Mr. Deal considered certain residential properties (Banker, Burnham, Giron, Stewart and Turney), but did not prepare any study of the WHAC property. Tr. at 2228:8-18, 2229:1-5, 2229:15-19 (Deal).

⁷³ Mr. Deal used "wet" to describe a home that is sold in its "as-is" condition after flooding, with flood-damaged walls and floors still in place and without any remediation, Tr. at 2220:17 to 2221:1 (Deal), and "guttled" to indicate that wet walls and flooring have been removed, but no repairs have been done, Tr. at 2225:9-18 (Deal). Deal used "renovated" to mean that the property has been returned to habitable condition and people can live there, but he found that there is a wide range of conditions in the category of "renovated" properties. Tr. at 2221:2-15 (Deal).

following flooding sold at prices that were close to or, in some cases, above the pre-flood prices for similar properties.⁷⁴ PX-2205 at 3-12 (Deal Report).

Dr. Bell also attempted to consider the “severity” issue. Tr. at 1336:10-15 (Bell). However, he was not provided with a definition of that term, he did not identify a definition or standard by which severity is measured in applicable professional standards such as the Uniform Standards of Professional Appraisal Practice, and he did not define the term in his report. Tr. at 1345:19 to 1346:8, 1348:15 to 1349:5 (Bell). In addition, he did not attempt to quantify any flood-related impacts on any Trial Property.⁷⁵ Tr. at 1336:7-9 (Bell); Tr. at 1366:25 to 1367:2 (Bell, testifying he reached no opinion as to cost to repair). Dr. Bell’s opinions regarding severity of the impact from flooding are, therefore, decidedly qualitative, not quantitative. PX-660 at 4 (Bell Report, stating that “the focus of my analysis was . . . not the specific quantification of any lost value”).⁷⁶

Dr. Bell included a listing of sales that he identified as “Preliminary Case Studies” and labeled as “DRAFT. Work in progress. Subject to change.” PX-660 at 14 (Bell Report). Not

⁷⁴ For example, the three renovated homes listed in Deal’s “Comparable Transactions After the Flood” table for the Burnham property were sold for \$160,000, \$165,000 and \$185,000. PX-2205 at p. 6. Those sale prices are near or above the price at which Ms. Burnham purchased her home in December 2014. Tr. at 1754:11 to 1754:8 (Burnham); ECF No. 211, ¶ 13 (Joint Stipulations). Similarly, in the sales tables for the Stewart property, the average price per square foot of the two renovated homes on Mr. Deal’s “after” table is \$84.79, which is higher than both the average (\$81.17) and median (\$83.25) price per square foot for the sales listed by Mr. Deal in the “before” table. PX-2205 at PDF 9-10.

⁷⁵ Dr. Bell’s report relates only to the properties of the following Plaintiffs: Popovici, Micu, Soares, Sidhu, Wind, LOE, and Holland. PX-660 at 17-20.

⁷⁶ The Court declined to allow Dr. Galloway to testify as an expert witness on flood proneness because the Court found that Dr. Galloway’s opinions based his analysis on subjective beliefs. Tr. at 2579:13 to 2582:3, 2545:2-9 (Court). Mr. Deal and Dr. Bell’s opinions on “severity” suffered from the same type of methodology. Their opinions on the severity of the interference from flooding are decidedly subjective and simply summarize the testimony of the Plaintiffs in the form of expert testimony on the question of severity of the impact.

surprisingly, those sales data show that homes sold in an “unrepaired condition” after flooding sold at prices below their “pre-flood value.” *Id.* The sales data show that when flood damage is repaired prior to a sale, the property can sell at a price that is similar to its “pre-flood value.” *Id.* Although his preliminary study does not include sufficient factual detail or analysis to address variations in pre- and post-flood prices, the data he provides do support the conclusion that flood damage to a residential property from a single-flood event such as Hurricane Harvey can be repaired, and that such flooding does not change the character of the land or the post-flood use of such properties as residential properties.⁷⁷

The testimony provided by Mr. Deal and Dr. Bell, therefore, show that the flood-related impacts to the Trial Properties were temporary and repairable. In addition, although these witnesses did not quantify the flood damages for any property, certain of those Plaintiffs who applied for disaster assistance through FEMA after the storm received various forms of grant assistance, including rental assistance and home repair assistance. DX-866 (Summary of FEMA Individual Assistance Awards to Harvey Upstream Plaintiffs). The disaster assistance provided

⁷⁷ Dr. Bell’s report also includes a discussion of “risk” as an issue that may affect the market value of a property after a flood event. He identifies several techniques that may be used to measure whether there is a diminution in value due to flooding, separate from the repairable flood damage, but he does not apply those techniques here to the specific properties at issue and does not offer an opinion as to whether any of the Plaintiffs’ properties have suffered a permanent diminution in market value due to the flooding, which varied for the properties he inspected from flooding in the yard only (Popovici) to inches or feet of flood water. PX-660 at 15-20 (Bell Report); Tr. at 1365:6-17, 1366:16-20 (Bell). In addition, Dr. Bell was not asked to and has not made any determination as to whether the existence of a risk factor has been diminishing since Harvey occurred. Tr. at 1366:8-15 (Bell).

Dr. Bell also provides an equation for measuring “loss of use for the single-family test properties,” but he does not apply that equation or quantify the loss of use as part of his limited opinion. PX-660 at 16. His qualitative assessment of severity based on loss of use does not consider individual assistance awards made by FEMA to Plaintiffs for rental assistance. DX-866 (Summary of FEMA Individual Assistance Awards to Harvey Upstream Plaintiffs).

by the United States through FEMA relates specifically to Hurricane Harvey flooding and must be factored into any assessment of the severity.

3. Reasonable Investment-Backed Expectations—Plaintiffs Lacked a Reasonable Investment-Backed Expectation that their Properties Would Never Flood

A landowner’s “reasonable investment-backed expectations’ regarding the land’s use” is a relevant factor. *Ark. Game & Fish Comm’n*, 568 U.S. at 39 (citation omitted). An objective standard applies. *See Chancellor Manor v. United States*, 331 F.3d 891, 907 (Fed. Cir. 2003). The “burden is on the owners to establish a reasonable investment-backed expectation in the property at the time it made the investment.” *Cienega Gardens v. United States*, 503 F.3d 1266, 1288 (Fed. Cir. 2007) (citing *Forest Props., Inc. v. United States*, 177 F.3d 1360, 1367 (Fed. Cir. 1999)).

Plaintiffs did not meet their burden of proof because they lacked an objectively reasonable expectation that their properties would not flood in a Hurricane Harvey-like event. As discussed above, Harris and Fort Bend Counties have a long history of flooding during large storms, particularly in the modern era. Mem. § I(A). Public documents discussing the possibility of upstream flooding during large storms has existed since at least the 1980s. Mem. § I(E). As a result, Harris and Fort Bend Counties (and the Corps) have, for decades, notified the public of flood risks and encouraged individuals to purchase flood insurance. Mem. § I(F). Many residents have done so—at a far higher rate than the national average—demonstrating that the possibility of upstream flooding has long been knowable in this region. Mem. § I(F)(6).

Plaintiffs first ask the Court to ignore this prong, on the ground that “the factor should not be applied here because this action involves an actual physical taking.” Pls.’ Post-Trial Br. at 116. Plaintiffs’ argument asks the Court to commit legal error because the factor is specifically identified by the Supreme Court as a relevant factor.

Plaintiffs next argue that the Court should look at the Plaintiffs' subjective knowledge. *See id.* at 117. That argument, too, is wrong because investment-backed expectations involve an objective, not subjective, standard. *Chancellor Manor*, 331 F.3d at 907.

Plaintiffs' final argument—that the Corps intentionally kept the public “in the dark,” Pls.' Post-Trial Br. at 117-18—is also wrong, and contradicted by documents spanning literally decades of time, as discussed above. Mem. §§ I(E), (F).

4. Duration—A One Time Flooding Event During a Historically Large Storm Cannot Support a Fifth Amendment Claim

The shorter the period of alleged invasion, the less likely a taking exists. *See Ark. Game & Fish Comm'n*, 568 U.S. at 38 (“When regulation or temporary physical invasion by government interferes with private property, our decisions recognize, time is indeed a factor in determining the existence *vel non* of a compensable taking.” (citations omitted)). Plaintiffs base their claims on one flood event, which occurred during a single, historically large storm. This is not a case of repeated flooding, and Plaintiffs presented no evidence that flooding would occur again anytime soon. This factor, therefore, favors a finding of no liability generally and for the property-specific reasons discussed below.⁷⁸

In regard to this factor, Plaintiffs argue that case law “confirms that the flooding of private property behind a dam constitutes a taking—a virtually self-evident proposition.” Pls.’

⁷⁸ The duration of flooding here is far less than the duration at issue in other flooding cases. On remand in *Arkansas Game and Fish*, for example, the Federal Circuit found the “period of flooding imposed a severe burden on [plaintiff’s] property” because the repeated incidents of flooding over a six-year period so profoundly changed the property that plaintiff “could no longer use those regions for their intended purposes, *i.e.*, providing habitat for wildlife and timber for harvest.” *Ark. Game & Fish Comm’n*, 736 F.3d at 1370 (internal quotation marks and citation omitted). *See also Laughlin v. United States*, 22 Cl. Ct. 85, 111 (1990) (flooding deprived plaintiff of property for a five-year period), *aff’d*, 975 F.2d 869 (Fed. Cir. 1992); *Cooper v. United States*, 11 Cl. Ct. 471, *rev’d on other grounds*, 827 F.2d 762 (Fed. Cir. 1987) (inevitably recurring flooding during spring, summer, and winter months for multi-year period).

Post-Trial Br. at 28, 123.⁷⁹ But the cases upon which Plaintiffs rely do not support their position. In *Pumpelly v. Green Bay Co.*, the Supreme Court held that when property “is actually invaded by superinduced additions of water . . . so as to effectively destroy or impair its usefulness, it is a taking within the meaning of the Constitution. . . .” 80 U.S. 166, 181 (1872). But the evidence showed that none of the Trial Properties were invaded by flood waters long enough to “effectively destroy or impair [their] usefulness.” *Id.* Every Trial Property was repaired (or capable of repair), and all were being used (or capable of being used) for the exact same use as before Hurricane Harvey struck.

At pages 29 and 123 of their Post-Trial Brief, Plaintiffs cite *United States v. Cress* for the proposition that there is “no difference of kind, but only of degree, between a permanent condition of continual overflow by backwater and a permanent liability to intermittent but inevitably recurring overflows. . . .” 243 U.S. 316, 328 (1917); *Stockton v. United States*, 214 Ct. Cl. 506, 515 (1977). But that proposition is irrelevant here. The Project has impacted upstream properties exactly once in the last seventy years—during the largest rain event in the recorded history of the United States. Plaintiffs presented no evidence that future flooding is “intermittent but inevitably recurring,” and, on these facts, predicting what will happen in the future requires pure guesswork—as Dr. Bedient stated, upstream flooding might not occur for another 22,000 years. Tr. at 2032:9-13 (Bedient, conceding that he did not conduct any study to estimate when flooding on upstream properties might ever occur again).

⁷⁹ Plaintiffs also repeatedly cite briefs filed in other cases, in an apparent effort to convince the Court that the United States has conceded the issues in other matters. See Pls.’ Post-Trial Br. at 2, 39 (citing United States’ briefs filed in *Arkansas Game and Fish Commission* and *St. Bernard Parish Government*). But the references cited in those briefs refer to permanent flooding scenarios, not temporary flooding situations like the one presented here.

Finally, at page 29 of their Post-Trial Brief, Plaintiffs rely on *United States v. Dickinson*, a case holding merely that “[w]hen [the state] takes property by flooding, it takes the land which it *permanently floods* as well as that which inevitably washes away as a result of that flooding.” 331 U.S. 745, 750 (1947). But that case, too, is irrelevant, as Plaintiffs presented no evidence that any Trial Property experienced permanent flooding.

In addition, with respect to several Trial Properties, Plaintiffs emphasize the length of time before some Plaintiffs completed repairs, rather than the length of time flood waters inundated the interior of the homes. *See, e.g.*, Pls.’ Post-Trial Br. at 61 (alleging the Bankers completed seven months of repairs); *id.* at 80 (alleging that Ms. Micu completed repairs a year after the storm). That analysis is wrong because it focuses on a repair period dependent on individual circumstances over which the United States has no control. Even assuming the Corps caused water to flood the interior of certain homes, Hurricane Harvey flood waters unassociated with the Project disrupted utility services, road passage, and a multitude of other public and private activities. *See, e.g.*, Tr. at 2014:7-12 (Bedient, explaining that Hurricane Harvey rainfall caused several other projects to exceed design capacities, which flooded nearby private properties). Repairs may be delayed while construction workers remediate properties flooded for reasons unrelated to the Corps’ operation of the Project. Individual landowners may make their own decisions about the speed and type of repairs to make based on factors outside the control of the United States. If the Corps placed water on certain properties, it is the time frame associated with that action—the length of time the water inundates the properties—that is relevant to the liability inquiry.

5. Nature of the Government’s Action

In evaluating all of the facts relevant to liability, the Court should also consider the nature of the government’s action. First, the occupation of properties by floodwaters was temporary,

unplanned, and occurred under exigent circumstances. *Ark. Game & Fish Comm'n*, 568 U.S. at 38-39 (citing *National Bd. of YMCA v. United States*, 395 U.S. 85 (1969), for the proposition that temporary, unplanned occupations under exigent circumstances are not a taking). The flooding on the Trial Properties was temporary. The manner in which the storm hit the Houston area and the Corps operated the Project during the storm make clear the flooding on some private property was unavoidable. Mem. § I(G). And exigent circumstances existed—Hurricane Harvey was a catastrophic storm, unlike that which had ever hit the United States. Mem. § II(A). Thus, the facts surrounding the occupation of the Trial Properties by floodwaters are simply not the type that make up a taking.

Second, the facts in this case showed that no viable option existed to allow the Corps to minimize flooding on the upstream Trial Properties without simultaneously increasing flooding on downstream properties. Mem. §§ I(G)(2)(ii), II(C). Even if the Corps had not closed the gates, the Burnham, Sidhu, Turney, Micu and Giron properties would have flooded during Hurricane Harvey. Mem. § II(C)(3). The damage resulting during that gates-open hypothetical would have been similar to the actual damage those Trial Properties experienced during the storm. Mem. § II(D). But the downstream properties would have experienced far worse flooding—further proof that flooding was unavoidable during this massive storm. Mem. § II(C)(3).

The facts also proved the converse—the Corps had no way to minimize flooding on downstream properties without simultaneously increasing flooding on upstream Trial Properties. If the Corps had kept the gates closed during the storm, each of the Trial Properties would have experienced deeper and longer flooding. Mem. § II(C)(4). Unlike other cases upon which

Plaintiffs rely, the undisputed facts here show this was a zero-sum game situation. Should the Court evaluate a multi-factor analysis, this fact should support a finding of no liability.

Third, consideration of the Corps' actions more generally also supports a finding of no liability. As discussed elsewhere in this memorandum, Plaintiffs spend much of their brief complaining that the Corps should have bought additional upstream lands once the possibility of upstream flooding became known. *See, e.g.*, Pls.' Post-Trial Br. at 9, 10, 11, 13, 16, 30-31. But this argument ignores the undisputed fact that, when the Corps buys land for a reservoir, it prohibits any development on that property. Tr. at 860:10-12 (Johnson-Muic); Tr. at 509:21 to 510:4 (Thomas, explaining that if the Corps had acquired any real estate upstream of the reservoirs, the Corps' policy would have prevented anyone from building structures on that property); Tr. at 1033:21 to 1034:4 (Thomas, explaining that if the Corps owns a flowage easement, one cannot maintain any personal property or construct any buildings there). Therefore, if the Corps had purchased more upstream land beyond the reservoirs where the Trial Properties are currently located, those homes could not have been built on that land, and Plaintiffs would never have had the opportunity to reside on those properties. Tr. at 860:13-17 (Johnson-Muic).

6. Trial Property-Specific Information

In addition to the evidence described in Sections III(G)(1) to (5), which applies to all of the Trial Properties, more property-specific evidence supports a finding of no liability.

i. Banker Property

The Banker Plaintiffs bought the property located at 4614 Kelliwood Manor Lane in July 2007, approximately 62 years after the Corps constructed Barker Reservoir. Tr. at 1700:12-15 (Banker); JX-82 at DEPO_0008519 (2007 Deed of Trust); ECF No. 211, ¶ 8 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before the Bankers' acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Barker Reservoir. In 2007, as today, publicly-available FEMA FIRM maps indicated that this property was likely to flood during a 500-year storm or larger. DX-806 at FEMA081008 (FEMA FIRM Map).⁸⁰ Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-271 (1970 USGS Topographic Map, showing Soares, Banker and Micu properties). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that if the Corps had not constructed Barker Reservoir and allowed development of a channel improvement on the Willow Fork of Buffalo Bayou, "frequent flooding would render these upstream lands undevelopable." DX-95 at FB0025621 (Recorded easement for Channel Improvements to Willow Fork of Buffalo Bayou). Given the close proximity of this property to that channel, it is likely that the Banker property could not have been developed without those government actions. DX-801 (Barker Map Depicting Certain Drainage Easements).

For more than 60 years before acquisition, the Banker property has backed up to the GOL at Barker Reservoir—it is "literally the first home after the reservoir." Tr. at 1699:17-20 (Banker); JX-254 at DEPO_0008516 (Google Map of Banker Property). Since the Bankers' acquisition in 2007, the property has been immediately adjacent to Barker Reservoir and, therefore, has been susceptible to flooding due to flood pools retained in the reservoir.

⁸⁰ The property is located at the edge of the 500-year flood hazard zone, near the 100-year flood hazard zone. DX-806 at FEMA081008 (FEMA FIRM Map).

Reasonable Investment-Backed Expectations

The Bankers had no reasonable investment-backed expectations at the time of their acquisition that the property would not flood during Hurricane Harvey, approximately an 850-year storm in the Barker Watershed. DX-601 at 208 (Kappel Expert Report). At the time of their acquisition, publicly-available FIRM maps and USGS quad maps showed that this property was likely to flood during 500-year storms or larger and that the property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

Furthermore, Mr. Banker testified he has lived in West Houston for more than 30 years and grew up near the Barker Reservoir. Tr. at 1728:8-22 (Banker). He understood that Barker Reservoir's purpose is to retain water, and he described the reservoir as a "rain catcher." Tr. at 1729:18 to 1730:2 (Banker). Mr. Banker's familiarity with the Project means he would have been familiar with the pool of record generated in 1992, which demonstrated the possibility of flooding on upstream properties during large storms.

In addition, when the Bankers bought the house in 2007, they received several closing documents, including a legal description of the property and a reference to the subdivision plat for the property. Tr. at 1725:9-23 (Banker); JX-82 at DEPO_0008534 (2007 Deed of Trust). That plat informed prospective buyers, including the Bankers, that the subdivision in which the property is located is "adjacent to Barker Reservoir which is subject to controlled inundation under the management of the U.S. Army Corps of Engineers." DX-177 at 1 (Plat of Kelliwood

Park Subdivision, Note 31).⁸¹ The large open areas of land adjacent to the Banker property on the plat map are also clearly marked as “George Bush Park (Barker Reservoir).” *Id.*

The Bankers bought flood insurance when they purchased the house, but, after holding the policy for nine years, decided to drop it “to help pay for [a vacation] home.” Tr. at 1706:5-13 (Banker). The fact that they originally bought flood insurance shows there existed a reasonable expectation of flooding at the time of acquisition.

Finally, the Bankers purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately twenty-six years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately twenty years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately fifteen years after Fort Bend County began to add warnings to public plats in the early 1990s;
- thirteen years after the Corps publicly made its 1994 announcement, stating that there was a potential for upstream flooding during large storm events;
- twelve years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- eleven years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Banker property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

⁸¹ When they refinanced the house in 2010 and 2016, the Bankers received copies of the same or similar documents, which also referenced the subdivision plat. Tr. at 1726:3 to 1727:24 (Banker).

Plaintiffs claim approximately one foot of water entered the Banker's home. PX-526 at 46 (Bedient Expert Report). Flood waters did not impact the second floor of the house, Tr. at 1730:14-24 (Banker), and the repair involved removal of four feet of drywall throughout the first floor, Tr. at 1714:23-25 (Banker). The Bankers fully remediated the damage—they repaired, and now live in, the house as they did before the storm. Tr. at 1717:16-18 (Banker).

To date, FEMA has provided the Bankers nearly \$24,000 in financial assistance, which they are not required to repay. DX-866 (Summary of FEMA Individual Assistance Awards); Tr. at 1731:14-19 (Banker). The Bankers also received Direct Assistance through the transitional sheltering assistance hotel program. Tr. at 2974:16-22 (Glasschroeder). Even if the FEMA assistance did not fully cover their expenses, that federal money reduces the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Banker property was short-lived. Flood waters stayed inside the house for approximately four days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). The Bankers evacuated the house the morning of August 28, 2017. Tr. at 1710:1-21 (Banker). When they returned on September 4, 2017, Tr. at 1712:16-20 (Banker), the water inside the house had already receded. Tr. at 1713:3-4, 1730:7-13 (Banker).

In summary, the liability factors favor a finding of no liability, and the Court should reject the Bankers' claim on the merits.

ii. Burnham Property

Plaintiff Burnham bought the property located at 15626 Four Season Drive in December 2014, approximately 66 years after the Corps constructed Addicks Reservoir. Tr. at 1754:11-8 (Burnham); ECF No. 211, ¶ 13 (Joint Stipulation); JX-121 (Burnham deed).

Character of the Property

The character of the property is a residential home, which, for many decades before Ms. Burnham's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir. The property is located near Langham Creek, one of the major drainage channels flowing into Addicks Reservoir. Tr. 1810:2 to 1811:14 (Burnham); DX-804 (photo of Langham Creek looking toward Bear Creek Village). As Dr. Nairn explained, Bear Creek Village, where the Burnham property is located, is set in an area that can be lower than the water level within Langham Creek. Tr. at 2709:7 to 2710:9 (Nairn). During large storms, water in Langham Creek can reverse flow through existing storm sewer networks and flood the Bear Creek Village area. Tr. at 2709:7-15 (Nairn).

The evidence showed that several properties in the Bear Creek Village subdivision flooded during a major flood in August 1981. JX-35 at USACE313239 (Correspondence). That natural flooding was partially alleviated by the existence of Addicks Reservoir and the Corps' willingness to allow improvements to the Horsepen and Langham Creek Diversion Channel to facilitate movement of water off private properties into the reservoir. But for those government acts, that flooding would have remained unchecked.

In 2014, as today, publicly-available FEMA FIRM maps informed the public that the Burnham property will flood during 100-year storms or larger. DX-807 at FEMA081044 (FEMA FIRM Map). Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

Less than two years after she purchased her home in Bear Creek Village, Ms. Burnham's home naturally flooded with approximately three feet of water during the 2016 Tax Day Storm. Tr. at 1764:11 to 1765:8, 1815:13-21 (Burnham). That flooding had nothing to do with the flood pool at Addicks Reservoir—the house flooded because the property is located in a 100-year floodplain and floods naturally during large storm events.⁸² Further, as described below, the home also flooded before Mr. Burnham's date of acquisition.

For more than 66 years before acquisition, the Burnham property has been near the GOL at Addicks Reservoir—the neighborhood in which it is located (Villages of Bear Creek) abuts the reservoir close to the Burnham property boundary—and, therefore, has always been susceptible to flooding due to flood pools retained in the reservoir. DX-827 (area map).

Reasonable Investment-Backed Expectations

Ms. Burnham had no reasonable investment-backed expectations at the time of her acquisition in 2014 that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). At the time of Ms. Burnham's acquisition, publicly-available FIRM maps and USGS quad maps showed that this property would flood during 100-year storms or larger, and that the property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

⁸² Ms. Burnham did not have flood insurance at the time of the Tax Day 2016 flooding. Tr. at 1765:9-10 (Burnham). However, she applied for, and received, approximately \$9,970 in disaster assistance from FEMA after the 2016 Tax Day Storm. Tr. at 1815:22 to 1819:9 (Burnham); DX-628R at FEMA081531 (FEMA Application). This amount included \$7,390 for home repairs. Tr. at 1816:5 to 1819:9 (Burnham); DX-628R at FEMA081531 (FEMA Application).

The house on this property flooded before Ms. Burnham's acquisition, a fact that Ms. Burnham knew before she completed her purchase. Tr. at 1759:3-20, 1813:18-22 (Burnham). The seller's disclosure notice, provided to her at closing, stated: "In April 2009 we received 10-12 inches of rain in 3-4 hr. House flooded. Drywall removed up to 4 ft—all repairs made immediately." JX-119 at DEPO_0014337 (Seller's Disclosure Notice). Prior to the sale, the seller also disclosed to Ms. Burnham that the property was located in the 100-year floodplain, and that the seller held a flood insurance policy on the property. Tr. 1814:3-23 (Burnham); JX-119 at DEPO_0014336 (Seller's Disclosure Notice). Thus, at the time of acquisition, Ms. Burnham knew, or should have known, that the property had flooded, and would flood again, during large storms.

After the home flooded during the 2016 Tax Day Storm, FEMA gave Ms. Burnham almost \$10,000, and informed her that if she accepted the money, she must "obtain and maintain flood insurance. . . . Failure to obtain flood insurance may affect your eligibility for future disaster assistance." DX-628R at 81532 (FEMA Application). Burnham accepted the free money. Tr. at 1767:10-13, 1816:5 to 1819:9 (Burnham). But she neglected to obtain any flood insurance before Hurricane Harvey struck approximately 16 months later.

At trial, Ms. Burnham testified that she could not afford the premium, which she stated might cost between \$4,000 and \$4,500, based on an "oral estimate." Tr. at 1765:11-19, 1819:21 to 1820:1 (Burnham). When Ms. Burnham eventually purchased flood insurance, after Hurricane Harvey, however, the actual premium was only \$750. Tr. at 1820:6-10 (Burnham).

Plaintiffs state that "[a]s Dr. Bell predicted, the fact that the home had flooded during the Tax Day flood made the flood insurance too expensive for Ms. Burnham to get full coverage for her home and made the process take much longer." Pls.' Post-Trial Br. at 64 (citing Tr. at

1765:9-19 (Burnham)). The transcript reference does not support the latter part of Plaintiffs' assertion. And the former part of the assertion is demonstratively false, as Ms. Burnham actually purchased flood insurance after Hurricane Harvey for a price she could afford. Thus, rather than support Dr. Bell's opinion, Ms. Burnham's testimony shows why the Court should reject his opinion—he reached his opinion based on a flawed consideration of claimed market-wide trends, not facts specific to any particular landowner.

Finally, Ms. Burnham purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately thirty-three years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately twenty-nine years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately twenty-two years after Fort Bend County began to add warnings to public plats in the early 1990s;
- twenty years after the Corps publicly made its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- nineteen years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding;
- eighteen years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding;
- five years after the Corps conducted additional public meetings to inform the public about the possibility of upstream flooding in 2009; and
- four years after the Corps publicly advertised, and held, public meetings to discuss flooding issues upstream of the reservoirs in 2010.

Mem. § I(F).

Severity

The impact of the flood waters on the Burnham property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately four feet of water entered Ms. Burnham's home. PX-526 at 46

(Bedient Expert Report).⁸³ As discussed above, the Burnham property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm, and the resultant flood damage would have been similar to the actual damage that occurred. Mem. § II(D)(1). Thus, the severity of the damage that could be attributed to any Corps action here was minimal.

Even if one ignores the hypothetical conditions, the impact was not legally severe. On February 5, 2018, Ms. Burnham sold the property for \$80,000 to Giering Investments. Tr. at 1763:21-24, 1781:3-21, 1823:5-25 (Burnham); ECF No. 211, ¶ 17 (Joint Stipulations); Burnham Ex. 20 (Burnham contract for sale of home). Ms. Burnham sold her home in an “as-is” condition and “under duress.” Tr. at 1823:11-13 (Burnham). At the time of the sale, Ms. Burnham had torn out the flood-damaged walls and removed what was wet, but had not made other repairs. Tr. at 1823:14-19 (Burnham). At trial, Ms. Burnham testified that she understands that Giering Investments repaired the home and resold it in a fully repaired condition. Tr. at 1825:7-20 (Burnham). Ms. Burnham testified that she believes that Giering Investments took advantage of her. Tr. at 1824:16-18 (Burnham).

After Hurricane Harvey, Ms. Burnham applied to FEMA for disaster assistance and received \$28,557 in financial assistance. DX-866 (Summary of FEMA Individual Assistance Awards). Ms. Burnham also received free transitional sheltering assistance from FEMA after her home was flooded (a room at the Wyndham hotel). Tr. at 1822:23 to 1823:4 (Burnham). Even if FEMA assistance did not fully cover Ms. Burnham’s expenses, that federal money reduces the degree of severity resulting from this natural disaster.

⁸³ Ms. Burnham estimated approximately 5 feet of flood water entered her house, but she was not in the home during the storm. Tr. at 1773:21-24 (Burnham).

Duration

The duration of flooding on the Burnham property was short-lived. Flood waters stayed inside the house for less than seven days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). Ms. Burnham left the property on August 25, 2017, Tr. at 1771:17-22 (Burnham), and returned approximately two weeks later, on September 8, 2017. Tr. at 1773:25 to 1774:5 (Burnham). The duration is shorter still when one considers that the Burnham property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm.

In summary, the liability factors favor a finding of no liability, and the Court should reject Ms. Burnham's claim on the merits.

iii. Giron Property

Plaintiff Giron bought the property located at 4310 Cassidy Park Lane in October 2005, approximately 60 years after the Corps constructed Barker Reservoir. Tr. at 1647:20-25 (Giron); ECF No. 211, ¶ 22 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before Mr. Giron's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Barker Reservoir. In 2005, as today, publicly-available FEMA FIRM maps informed the public that the Giron property will flood during a 500-year storm or larger. JX-283 at FEMA080996 (FEMA FIRM Map).⁸⁴ Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-280 (1971 USGS Topographic Map,

⁸⁴ The property is located at the edge of the 500-year flood hazard zone, near the 100-year flood hazard zone. JX-283 at FEMA080996 (FEMA Map).

showing Giron property). Further, during a 2015 flood, the street in front of the Giron house, and a portion of the Giron driveway, flooded. Tr. at 1693:13 to 1694:9 (Giron). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that if the Corps had not constructed Barker Reservoir and allowed development of a drainage channel improvement on Willow Fork of Buffalo Bayou, “frequent flooding would render these upstream lands undevelopable.” DX-95 at FB0025621 (Recorded easement for Channel Improvements to Willow Fork of Buffalo Bayou); JX-33 at USACE750430 (Environmental Assessment for improvements describing land around Willow Fork channel as subject to frequent flooding events, which were reported in existing literature); JX-33 at USACE750448 (Environmental Assessment for improvements classifying areas adjacent to Willow Fork channel to be wetlands that flooded regularly). Given that the Giron property is adjacent to the improved Willow Fork channel, it is likely that the property could not have been developed without those government actions that improved drainage. DX-801 (Barker Map Depicting Certain Drainage Easements).

For approximately 60 years before acquisition, the Giron property has been located just outside the GOL at Barker Reservoir. At the time of acquisition in 2005, the property was immediately adjacent to Willow Fork channel just before it flows into Barker Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since acquisition.

Reasonable Investment-Backed Expectations

Mr. Giron had no reasonable investment-backed expectations at the time of his acquisition that the property would not flood during Hurricane Harvey, approximately an 850-

year storm in the Barker Watershed. DX-601 at 208 (Kappel Expert Report). At the time of acquisition, publicly-available FIRM maps and USGS quad maps showed that this property was likely to flood during 500-year storms or larger and that the property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

When he bought the house in 2005, Mr. Giron received several closing documents, including a legal description of the property and a reference to the subdivision plat for the property. Tr. at 1687:7 to 1689:9 (Giron); Giron 1 at Giron_000048 (Giron Deed of Trust); Giron 7 at Giron_000029 (Chicago Title Insurance Company Survey); JX-78 at Giron_000068-000069 (Giron Settlement Statement); JX-79 at FB026169 (Giron Warranty Deed). That plat informed prospective buyers, including Mr. Giron, that the subdivision in which the property is located is “adjacent to Barker Reservoir and is subject to extended controlled inundation under the management of the U.S. Army Corps of Engineers.” DX-146 (Subdivision Plat: Giron Property).

The plat also shows that the property is adjacent to the improved Willow Fork channel, which—as discussed above—was improved to help reduce frequent flooding. *Id.* Mr. Giron knew he was located next to this channel—he described a gate at his home that led directly to the channel, and that he and his wife regularly walked along it. Tr. 1692:23 to 1693:12 (Giron). Moreover, as the Court saw on the site visit stop at the Willow Fork Diversion Channel, which was “representative of the large improved localized drainage channels that come into the reservoir,” such a large channel for draining water is obvious. Site Visit Tr. at 54:8-11 (Ciliske).

Such massive drainage infrastructure, particularly in such close proximity to a property, would lead a reasonable person to believe they may flood in a large storm.

Mr. Giron bought flood insurance after he purchased the property, but allowed that policy to lapse after several years. Tr. at 1654:19-24 (Giron). The fact that he bought insurance shows he knew, or should have known, that the property might flood during large storms.

Finally, Mr. Giron purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately twenty-four years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately twenty years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately thirteen years after Fort Bend County began to add warnings to public plats in the early 1990s;
- eleven years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- ten years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- nine years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Giron property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately three-and-a-half inches of water entered the Giron home. PX-526

at 46 (Bedient Expert Report).⁸⁵ As discussed above, the Giron property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm, and the resultant flood damage would have been similar to the actual damage that occurred. Mem. § II(D)(2).

Thus, the severity of the damage that could be attributed to any Corps action here was minimal.

Even if one ignores the hypothetical conditions, the impact was not legally severe.

Although the house can be remediated, as of the date of trial, Mr. Giron had not yet completed repairs. After the storm, a mold inspector determined there was some evidence of mold, but no remediation was needed. Tr. at 1690:15-25 (Giron).

To date, FEMA has provided Mr. Giron more than \$25,000 in financial assistance, which he is not required to repay. DX-866 (Summary of FEMA Individual Assistance Awards); Tr. at 1691:5-14 (Giron). Mr. Giron also received Direct Assistance through the transitional sheltering assistance hotel program. Tr. at 2974:16-22 (Glasschroeder). In addition, FEMA provided a trailer to Mr. Giron in January 2018, which he was allowed to keep for free for thirteen months. Tr. at 1682:9-12 (Giron); ECF No. 228-1 ¶¶ 6-9 (Decl. of Glasschroeder). Even if the FEMA assistance did not fully cover his expenses, that federal money and direct aid reduces the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Giron property was short-lived. Flood waters stayed inside the house for less than five days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). The duration is shorter still when

⁸⁵ Mr. Giron estimated his house flooded with “about 5 inches” of water, Tr. at 1675:2-6 (Giron), but he was in Austin during the storm, and did not return to the home until September 3, 2017. Tr. at 1663:16 to 1664:2 (Giron).

one considers that the Giron property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm.

In summary, the liability factors favor a finding of no liability, and the Court should reject Mr. Giron's claim on the merits.

iv. Holland Property

Plaintiff Holland had a rental agreement, but no ownership interest in, the property located at 1923 Wingleaf Drive. Tr. at 1830:3-5 (Holland). Mr. Holland rented the property from 2002 until he vacated the property during Hurricane Harvey in 2017. Tr. at 1830:8-13 (Holland).

Character of the Property

Because Mr. Holland did not own the real property, his ownership interest is in the nature of a lease agreement. Any claimed damage to the real property is irrelevant to his claim because he never had any ownership interest in that real estate. Mr. Holland testified that after the storm, he and his landlord agreed he could "walk away" from the property. Tr. at 1844:25 to 1845:4 (Holland). Thus, there is no evidence that Mr. Holland paid any additional rent after the storm. Because Mr. Holland decided to "walk away" from the property and end the rental agreement, he can also make no claim for lost rent.

If the character of the real property mattered to Mr. Holland's claim, which it does not, that property was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir. Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). Publicly-available FEMA FIRM maps in 2002 informed the public that the Holland property would flood during a greater than 500-year storm,

which Hurricane Harvey was.⁸⁶ JX-284 at FEMA081023 (FEMA Map). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

Mr. Holland began renting this property in 2002, approximately 54 years after the Corps constructed Addicks Reservoir. Thus, for 54 years before Mr. Holland began renting, this property has been adjacent to the Project and been susceptible to flooding due to retention of flood pools impounded in the reservoir.

Reasonable Investment-Backed Expectations

Mr. Holland had no reasonable investment-backed expectation at the beginning of his rental agreement that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). When Mr. Holland began renting this property, publicly-available USGS quad maps showed that the property is subject to flooding from controlled inundation from Project operations, and publicly available FIRM maps showed the property would flood in greater than 500-year storms, which Hurricane Harvey was. The only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

Mr. Holland began renting this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately twenty-one years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;

⁸⁶ The property was also located just a few blocks from both the 500- and 100-year flood hazard zones. JX-284 at FEMA081023 (FEMA Map).

- approximately seventeen years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately ten years after Fort Bend County began to add warnings to public plats in the early 1990s;
- eight years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- seven years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- six years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Holland rental agreement was not legally severe because Mr. Holland decided to “walk away” from the property after the storm. Tr. at 1844:25 to 1845:4 (Holland). To the extent the flooding of the real property mattered, which it does not, that flooding that occurred was short-lived, and there is no evidence that the resultant damage was not fully capable of being remediated. Plaintiffs claim approximately 1.5 feet of water entered the rental property. PX-526 at 46 (Bedient Expert Report). Because Mr. Holland decided to “walk away” from the property after the storm, he did not repair any of the damage.

To date, FEMA has provided Mr. Holland nearly \$10,000 in financial assistance, which he is not required to repay. DX-866 (Summary of FEMA Individual Assistance Awards). Mr. Holland also received Direct Assistance through the transitional sheltering assistance hotel program. Tr. at 2974:16-22 (Glasschroeder). That assistance, which FEMA intended to assist with rent, damaged personal property, and lodging, reduces the degree of severity resulting from this natural disaster.

Duration

As discussed above, there is no evidence that Mr. Holland paid any rent for this property after the storm, and therefore lost no rent due to any flooding. To the extent the property interest

is considered the real estate itself, the duration of flooding was short-lived. Flood waters stayed inside the house for approximately three-and-a-half days, an extraordinarily short period of time compared to the duration of his rental agreement. DX-608 at 164 (Nairn Expert Report).

In summary, the liability factors favor a finding of no liability, and the Court should reject Mr. Holland's claim on the merits.

v. Lakes on Eldridge

Plaintiff LOE acquired the clubhouse property in December 1995, approximately 47 years after the Corps constructed Addicks Reservoir. JX-291 (LOE Deed).

Character of the Property

The character of the property is a clubhouse, which, for many decades before LOE's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir.

Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-276 (1970 USGS Topographic Map, showing LOE and Wind properties). Publicly-available FEMA FIRM maps in 1995 informed the public that the LOE property would flood during a greater than 500-year storm, which Hurricane Harvey was.⁸⁷ JX-285 at FEMA081023 (FEMA Map). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

⁸⁷ The property is also located within several blocks to both the 500- and 100-year flood hazard zones. JX-285 at FEMA081066 (FEMA Map).

For more than 47 years before LOE's acquisition, the property has been just upstream of the Addicks Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since LOE's acquisition.

Reasonable Investment-Backed Expectations

LOE had no reasonable investment-backed expectations at the time of its acquisition that the property would not flood during Hurricane Harvey, approximately a 775- year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). At the time of LOE's acquisition, publicly-available USGS quad maps showed that this property was subject to flooding from controlled inundation from Project operations, and publicly available FIRM maps showed the property would flood in greater than 500-year storms, which Hurricane Harvey was. The only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

LOE carried flood insurance on its property, including at the time of Hurricane Harvey, and, at the time of trial, had received approximately \$650,000 in insurance proceeds. Tr. at 1416:14 to 1418:9 (Strebel). The fact that LOE bought insurance shows it knew, or should have known, that the property might flood during large storms.

Finally, LOE acquired this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately fourteen years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately ten years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately three years after Fort Bend County began to add warnings to public plats in the early 1990s;

- a year after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events; and
- the same year the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the LOE property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated. Ms. Strebel, who testified on behalf of LOE, testified that approximately four inches of water entered the clubhouse. Site Visit Tr. at 38:5-8 (Strebel). As demonstrated during the site visit, LOE fully repaired all the damage resulting from the storm.

At the time of trial, LOE had received approximately \$650,000 from its insurance carrier. Tr. at 1416:14 to 1418:9 (Strebel). Even if that amount did not fully cover LOE's expenses, those monies reduce the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the LOE property was short-lived. Flood waters stayed inside the clubhouse for less than a day-and-a-half, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report).

In summary, the liability factors favor a finding of no liability, and the Court should reject LOE's claim on the merits.

vi. Micu Property

Plaintiff Micu bought the property located at 6411 Canyon Park Drive in February 2012, approximately 67 years after the Corps constructed Barker Reservoir. Tr. at 1321:18-21 (Micu); ECF No. 211, ¶ 35 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before Ms. Micu's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Barker Reservoir. In 2012, publicly-available FEMA FIRM maps indicated that this property was likely to flood during a 500-year storm or larger. DX-806 at FEMA081007 (FEMA FIRM Map). Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-271 (1970 USGS Topographic Map, showing Soares, Banker and Micu properties). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that if the Corps had not constructed Barker Reservoir, and allowed development of a channel improvement on Willow Fork Diversion Channel, "frequent flooding would render these upstream lands undevelopable." DX-94 at FB0025601 (Recorded easement for Willow Fork Diversion Channel). Given the close proximity of this property to that improvement, it is likely that the property could not have been developed without those government actions. DX-801 (Barker Map Depicting Certain Drainage Easements).

Finally, for more than 67 years before acquisition, the Micu property has been near the GOL at Barker Reservoir. At the time of acquisition in 2012, the property was close to Barker Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since acquisition.

Reasonable Investment-Backed Expectations

Ms. Micu had no reasonable investment-backed expectations at the time of her acquisition that the property would not flood during Hurricane Harvey, approximately an 850-

year storm in the Barker Watershed. DX-601 at 208 (Kappel Expert Report). At the time of acquisition, publicly-available FIRM maps and USGS quad maps showed that this property was likely to flood during 500-year storms or larger and that the property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

When she bought the house in 2012, Ms. Micu received several closing documents. JX-109 (Micu property closing documents). Many of those documents reference a plat to the property, and many were signed by Ms. Micu. JX-109 (Micu property closing documents). Those documents also notified Ms. Micu that the property is subject to deed restrictions contained in multiple places, including the plat to the property. Tr. at 1312:14 to 1313:19 (Micu); JX-109 at MICU-000096-97 (Micu property closing documents). The referenced plat states that the subdivision is “adjacent to the Barker Reservoir and for events greater than the hundred-year flood event, could be subject to extended controlled inundation under the management of the Army Corps of Engineers.” DX-557 (Plat of Cinco Ranch Canyon Gate).⁸⁸

Finally, Ms. Micu purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;

⁸⁸ On September 2, 2018, Ms. Micu, in response to a question about whether she knew her home was located in the Barker Reservoir, posted on Facebook: “I remember my escrow officer mentioning it at closing, and I need to check my closing documents to verify.” Tr. 1305:15 to 1306:7 (Micu); Tr. 1316:9-13 (Micu); Micu-10 at 23 (Social Media Production). At trial, however, Ms. Micu claimed, “I don’t and I didn’t remember the specifics of the conversation with the escrow officer.” Tr. 1306:9-15 (Micu). Whether mentioned by the escrow officer or not, it is undisputed that the closing documents signed by Ms. Micu referenced the plat in multiple places.

- approximately thirty-one years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately twenty-seven years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately twenty years after Fort Bend County began to add warnings to public plats in the early 1990s;
- eighteen years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- seventeen years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding;
- sixteen years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding;
- three years after the Corps conducted additional public meetings to inform the public about the possibility of upstream flooding in 2009; and
- two years after the Corps publicly advertised, and held, public meetings to discuss flooding issues upstream of the reservoirs in 2010.

Mem. § I(F).

Severity

The impact of the flood waters on the Micu property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately two feet of water entered the home. PX-526 at 46 (Bedient Expert Report); Tr. at 1300:21-23 (Micu). The water stayed inside the home for approximately six days. DX-608 at 164 (Nairn Expert Report).⁸⁹ As discussed above, the Micu property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm, and the resultant flood damage would have been similar to the actual damage that occurred.

Mem. § II(D)(3). Thus, the severity of the damage that could be attributed to any Corps action here was minimal.

⁸⁹ Ms. Micu testified she believed water remained inside the home for about ten days. Tr. at 1300:21 to 1301:1 (Micu). However, Ms. Micu was in Dallas when the storm struck, and she did not return to the area until September 5, 2017. Tr. at 1296:22-25 (Micu).

Even if one ignores the hypothetical conditions, the impact was not legally severe. As demonstrated during the site visit, Ms. Micu fully repaired all the damage resulting from the storm. Several months after Hurricane Harvey, in March 2018, Ms. Micu received a certificate stating that a mold assessor determined that the property did not contain any evidence of mold damage. Tr. at 1320:15-23 (Micu); DX-520 (Micu property Mold assessor's certificate).

After the storm, Ms. Micu applied to FEMA for disaster assistance and received \$30,656 in financial assistance. DX-866 (Summary of FEMA Individual Assistance Awards). Ms. Micu also received Direct Assistance through the transitional sheltering assistance hotel program. Tr. 2974:16-22 (Glasschroeder). Even if that FEMA assistance did not fully cover her expenses, that federal money reduces the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Micu property was short-lived. Flood waters stayed inside the house for approximately six days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). Ms. Micu evacuated the house before the storm struck, and returned around September 5, 2017. Tr. 1296:22-25 (Micu). The duration is shorter still when one considers that the Micu property would have flooded if the Corps had not built the Project or not closed the dam gates during the storm.

In summary, the liability factors favor a finding of no liability, and the Court should reject Ms. Micu's claim on the merits.

vii. Popovici Property

Plaintiff Popovici bought the property located at 19927 Parsons Green Court in June 2003, approximately 58 years after the Corps constructed Barker Reservoir. Tr. at 1217:24 to 1218:4 (Popovici); ECF No. 211, ¶ 41 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before Ms. Popovici's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Barker Reservoir.

The Popovici property is located near the Mason Creek Diversion Channel. DX-801 (Barker Map Depicting Certain Drainage Easements). The evidence showed that several properties in that area flooded during a major flood in August 1981. JX-28 at USACE522967-2969 (Proposal for Improvements to Mason Creek by Harris County Flood Control District). That natural flooding was partially alleviated by the existence of Barker Reservoir and the Corps' willingness to allow improvement to the Mason Creek Diversion Channel to facilitate movement of water off private properties into the reservoir. But for those government acts, that flooding would have remained unchecked.

Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). Publicly-available FEMA FIRM maps in 2003 informed the public that the Popovici property would flood during a greater than 500-year storm, which Hurricane Harvey was.⁹⁰ JX-287 at FEMA081019 (FEMA Map). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

⁹⁰ The property was also located within a few blocks of both the 500- and 100-year flood hazard zones. JX-287 at FEMA081019 (FEMA Map).

For approximately 58 years before acquisition, the Popovici property has been near the GOL at Barker Reservoir, and the property was subject to controlled inundation from flood pools detained at the facility since then. DX-827 (area map).

Reasonable Investment-Backed Expectations

Ms. Popovici had no reasonable investment-backed expectations at the time of her acquisition that the property would not flood during a massive storm like Hurricane Harvey. She purchased flood insurance on this property at the time of acquisition, and maintained that insurance at the time of Hurricane Harvey. Tr. at 1226:15-17 (Popovici); JX-240 at POPOVICI000366 (Popovici Flood Insurance). Ms. Popovici did not file a claim under her flood insurance policy after Hurricane Harvey because the house did not flood during the storm. Tr. at 1252:12-15 (Popovici). The fact that Ms. Popovici maintained flood insurance shows she knew, or should have known, that the property might flood during large storms. At the time of acquisition, publicly-available USGS quad maps showed that this property was subject to flooding from controlled inundation from Project operations, and publicly available FIRM maps showed the property would flood in greater than 500-year storms, which Hurricane Harvey was.

Finally, Ms. Popovici purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately twenty-two years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately eighteen years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately eleven years after Fort Bend County began to add warnings to public plats in the early 1990s;
- ten years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;

- eight years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- seven years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Popovici property was not legally severe because the flood waters never entered the home and there was no damage to the property. Tr. at 1242:13-18 (Popovici). In addition, Ms. Popovici did not evacuate during the storm, and she was able to drive in and out of the neighborhood at least by September 1, 2017. Tr. at 1231:7-21, 1242:7-12 (Popovici).

Although Ms. Popovici carried flood insurance on this property, she did not file a claim under that policy for damages related to flooding from Hurricane Harvey—because there were no such damages. Tr. at 1252:12-15 (Popovici).

Duration

Because the interior of the home never flooded and Ms. Popovici was not excluded from her home, the relevant duration of impact is zero. Plaintiffs concede that no water entered the home, but complain about the existence of flood water on the lawn. Ms. Popovici testified that, by August 27, 2017, flood waters unassociated with the flood pool retained by the Project rose over the curb and flooded half of her lawn. Tr. at 1232:13-17 (Popovici). She claims that water receded to the street by August 28, 2017. Tr. at 1233:12-22 (Popovici). Ms. Popovici testified further that, on August 29, 2017, the water rose again, until it came within four inches of entering the house. Tr. at 1239:3-5 (Popovici). By September 1, 2017, the water had receded so that it covered approximately two-thirds of her lawn. Tr. at 1241:16-24 (Popovici). Thus, the second instance of high water—allegedly attributed to Project operations—lasted from August

29 to approximately September 1. Even if water on the lawn counts under this prong, which it should not, that is an extraordinarily short period of time, particularly compared to the entire duration of ownership.

In summary, the liability factors favor a finding of no liability, and the Court should reject Ms. Popovici's claim on the merits.

viii. Sidhu Property

Mr. Sidhu bought the two condominiums, known as Units 603 and 604, at 16111 Aspen Glen Drive in March 2005, approximately 57 years after the Corps constructed Addicks Reservoir. Tr. at 1733:16-25 (Sidhu); ECF No. 211, ¶ 47 (Joint Stipulations).

Character of the Property

The character of the property is a residential condominium, which, for many decades before Mr. Sidhu's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir. Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). In 2005, publicly-available FEMA FIRM maps informed the public that the Sidhu property would flood during a greater than 500-year storm, which Hurricane Harvey was.⁹¹ JX-288 at FEMA081038 (FEMA Map). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

⁹¹ The property was also located within several blocks of both the 500- and 100-year flood hazard zones. JX-288 at FEMA081038 (FEMA Map).

The evidence showed that the Corps' decision to grant an easement to facilitate drainage at the Bear Creek Subdivision Drainage helped alleviate some pre-existing flooding in that area. DX-64 at USACE610242 (1979 letter, explaining that because the existing drainage ditch was not properly functioning, homes had flooded or were at risk of flooding). Because the Sidhu property is located near that infrastructure, it is likely that the property benefited from that drainage structure. DX-800 (Addicks Map Depicting Certain Drainage Easements).

For approximately 57 years before acquisition, the Sidhu property has been just outside the GOL at Addicks Reservoir. At the time of acquisition in 2005, the property was already close to Addicks Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since Mr. Sidhu's acquisition.

Reasonable Investment-Backed Expectations

Mr. Sidhu had no reasonable investment-backed expectations at the time of his acquisition that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). At the time of Mr. Sidhu's acquisition, publicly-available USGS quad maps showed that this property is subject to flooding from controlled inundation from Project operations, and publicly available FIRM maps showed the property would flood in greater than 500-year storms, which Hurricane Harvey was. The maps show that, at the time of Mr. Sidhu's acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

Finally, Mr. Sidhu purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;

- approximately twenty-four years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately twenty years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately thirteen years after Fort Bend County began to add warnings to public plats in the early 1990s;
- eleven years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- ten years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- nine years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Sidhu property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated. Unit 604, a second-floor condominium located above Unit 603, did not flood during Hurricane Harvey. Tr. at 1743:1-8 (Sidhu). That unit, therefore, experienced no damage during the storm, and required no repairs. Tr. at 1748:5-7 (Sidhu). The renter in Unit 604 remained in that condominium during Hurricane Harvey and stayed through the summer of 2018. Tr. at 1748:19-24 (Sidhu). Thus, Mr. Sidhu continued to receive rental income on Unit 604.

Unit 603, which is on the first floor, flooded by approximately 2.4 feet of water. PX-526 at 46 (Bedient Expert Report). Mr. Sidhu eventually made repairs to that unit and by the summer of 2018 found a new renter for the unit. Tr. at 1748:11-18 (Sidhu). As discussed above, Unit 603 would have flooded even if the Corps had not closed the dam gates during the storm, and the resultant flood damage would have been similar to the actual damage that occurred. Mem. § II(D)(4). Thus, the severity of the damage that could be attributed to any Corps action here was minimal.

Duration

Because the interior of Unit 604 never flooded and neither Mr. Sidhu nor his renter were excluded from that property, the relevant duration of impact is zero for that unit.

The duration of flooding in Unit 603 was short-lived. Flood waters stayed inside the house for approximately four-and-a-half days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). The duration is shorter still when one considers that Unit 603 would have flooded if the Corps had not closed the dam gates during the storm.

In summary, the liability factors favor a finding of no liability, and the Court should reject Mr. Sidhu's claim on the merits.

ix. Soares Property

Plaintiff Soares and his wife bought the property located at 20526 Indian Grove Lane in 2001, approximately fifty-six years after the Corps constructed Barker Reservoir. ECF No. 211, ¶ 54 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before the Soares' acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Barker Reservoir. In 2001, at the time of acquisition, publicly-available FEMA FIRM maps indicated that this property was likely to flood during a 500-year storm or larger. JX-289 at FEMA081014 (FEMA FIRM Map). Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-271 (1970 USGS Topographic Map, showing Soares, Banker and Micu properties). The Key Map of the area where the Soares property is located shows the proximity of the Soares property to Barker Reservoir and that Key

Map included the notation on the adjacent reservoir stating “Barker Reservoir Flood Control Pool Elevation 107.” DX-795 at p. 486 (Key Map). That listed flood control pool elevation is approximately six feet higher than the surveyed elevation of the finished first floor of the home on the Soares property. Stipulation of Fact ¶ 55, ECF No. 211. The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that if the Corps had not constructed Barker Reservoir, and allowed development of a channel improvement on Tributary 52.9 to Buffalo Bayou, flooding of nearby properties was inevitable. DX-130 at USACE309659 (Environmental Assessment for a Kelliwood Subdivision, explaining that draining into the reservoir was the only viable alternative to remove stormwater efficiently from the proposed development); DX-130 at USACE309646 (FONSI for a Kelliwood Subdivision, explaining that the drainage ditch was “necessary to prevent flooding”). Given the close proximity of this property to that channel improvement, it is likely that the property could not have been developed without those government actions. DX-801 (Barker Map Depicting Certain Drainage Easements).

Finally, for approximately 56 years before acquisition, the Soares property has been near the GOL at Barker Reservoir. At the time of acquisition in 2001, the property was close to Barker Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since the Soares’ acquisition.

Reasonable Investment-Backed Expectations

The Soares had no reasonable investment-backed expectations at the time of their acquisition that the property would not flood during Hurricane Harvey, approximately an 850-year storm in the Barker Watershed. DX-601 at 208 (Kappel Expert Report). At the time of acquisition, publicly-available FIRM maps and USGS quad maps showed that this property was

likely to flood during 500-year storms or larger and that the property is subject to flooding from controlled inundation from Project operations. The Key Maps published at the time of his purchase also showed that the flood control pool elevation of Barker Reservoir was higher than the elevation of the first floor of the newly-constructed house he purchased in 2001. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

The Soares property is located in the Cinco Ranch Equestrian Village, Section 3 subdivision. This residential subdivision was approved by the Houston Planning Commission on October 18, 1999, by the County Engineer of Harris County on November 11, 1999, and the Commissioner's Court of Harris County on November 30, 1999. DX-139 at HARRIS0000779 (Cinco Ranch Equestrian Vill., Sec. 3 subdivision plat); Tr. at 763:21 to 764:13 (Vogler). Following that approval, the subdivision plat for the Cinco Ranch Equestrian Village, section 3 subdivision was recorded in the Harris County records on December 1, 1999. DX-139 at HARRIS0000779. The Harris County approvals of this subdivision occurred years after the County was aware of the flood risk to properties located in the "fringe area" between the GOL and the maximum flood pool for the reservoirs. JX-54 at USACE686051 (HCFCD Katy Freeway Corridor Flood Control Study).

When the Soares bought the house in 2001, they received recorded documents, including the legal description of the property and a reference to the subdivision plat for the property. JX-263 (Soares deed); Tr. at 1097:21 to 1099:5 (Soares). The plat provides notice to prospective buyers, including the Soares, that the subdivision in which their property is located is "adjacent to Barker Reservoir and is subject to extended controlled inundation under the management of

the U.S. Army Corps of Engineers.” DX-139 at HARRIS0000781, note 21 (Cinco Ranch Equestrian Vill., Sec. 3 Subdivision plat).

The Soares purchased flood insurance after they purchased the property, but did not renew the policy thereafter. Tr. at 1076:3-14 (Soares). The fact that they originally bought insurance shows there existed a reasonable expectation of flooding at the time of acquisition.

Finally, the Soares purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately twenty years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms;
- approximately sixteen years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s;
- approximately nine years after Fort Bend County began to add warnings to public plats in the early 1990s;
- seven years after the Corps publicly released its 1994 announcement stating that there was a potential for upstream flooding during large storm events;
- six years after the Corps published the 1995 Reconnaissance Report, which publicly discussed the possibility of upstream flooding; and
- five years after HCFCD released its 1996 public report, which noted the possibility of upstream flooding.

Mem. § I(F).

Severity

The impact of the flood waters on the Soares property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately eight-and-a-half inches of water entered the home. PX-526 at 46 (Bedient Expert Report). The Soares repaired the flood damage by removing the wet sheet rock and flooring. Tr. at 68:13-23 (Soares). Because the flood waters only impacted the first floor, Mr. Soares and his family lived on the second floor until they completed repairs. Tr. at 1093:11-

20 (Soares). The Soares completely repaired the house and they continue to live there today. Tr. at 68:4 to 69:20 (Soares).

To date, FEMA has provided Mr. Soares more than \$13,000 in financial assistance, which he is not required to repay. DX-866 (Summary of FEMA Individual Assistance Awards); Tr. at 1099:6-12 and Tr. at 1102:17-20 (Soares). Mr. Soares also received Direct Assistance through the transitional sheltering assistance hotel program. Tr. at 2974:16-22 (Glasschroeder). Mr. Soares was also referred to the IRS for tax assistance, and took a tax deduction related to Hurricane Harvey for uninsured disaster-caused losses. Tr. at 1104:14 to 1105:20 (Soares). Even if that assistance did not fully cover Mr. Soares' expenses, that federal money reduces the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Soares property was short-lived. Flood waters stayed inside the house for approximately three-and-a-half days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). Mr. Soares was vacationing in New York City when the storm struck, and returned to the property on August 31, 2017. Tr. at 1081:11 to 1084:9 (Soares).

In summary, the liability factors favor a finding of no liability, and the Court should reject the Soares claim on the merits.

x. Stewart Property

Plaintiff Mitchell Stewart bought the property located at 4719 Eagle Trail Drive in June 1983, approximately 35 years after the Corps constructed Addicks Reservoir. Tr. at 1700:12-15 (Banker); JX-82 at DEPO_0008519 (2007 Deed of Trust); ECF No. 211, ¶ 60 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before Mr. Stewart's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir.

Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that the Corps' decision to grant an easement to facilitate drainage at the Bear Creek Subdivision Drainage helped alleviate some pre-existing flooding in that area. DX-64 at USACE610242 (1979 letter, explaining that because the existing drainage ditch was not properly functioning, homes had flooded or were at risk of flooding). Because the Stewart property is located near that infrastructure, it is likely that the property benefited from that drainage structure. DX-800 (Addicks Map Depicting Certain Drainage Easements).

For more than 35 years before acquisition, the Stewart property has been just outside the GOL at Addicks Reservoir. Thus, at the time of acquisition in 1983, the property was already close to Addicks Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since acquisition.

Reasonable Investment-Backed Expectations

Mr. Stewart had no reasonable investment-backed expectations at the time of his acquisition that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Barker Watershed. DX-601 at 202 (Kappel Expert Report). At the time of

acquisition, publicly-available USGS quad maps showed that this property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

Finally, Mr. Stewart purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property; and
- approximately two years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms.

Mem. § I(F).

Severity

The impact of the flood waters on the Stewart property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately six inches of water entered the Stewart home. PX-526 at 46 (Bedient Expert Report). The water stayed inside the home for just over a day. DX-608 at 164 (Nairn Expert Report).

As demonstrated during the site visit, Mr. Stewart fully repaired all the damage resulting from the storm. Tr. at 1613:17-20 (Stewart).

After the storm, Mr. Stewart applied to FEMA for disaster assistance and received \$19,300 in financial assistance. DX-866 (Summary of FEMA Individual Assistance Awards). Even if that amount did not fully cover Mr. Stewart's expenses, that federal money reduces the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Stewart property was short-lived. Flood waters stayed inside the house for just over one day, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report).

In summary, the liability factors favor a finding of no liability, and the Court should reject Mr. Stewart's claim on the merits.

xi. Turney Property

Plaintiff Turney purchased the property located at 15910 Red Willow Drive in November 1975, approximately 27 years after the Corps constructed Addicks Reservoir. Tr. at 2127:18-23 (Turney); ECF No. 211, ¶ 66 (Joint Stipulations).

In 2010, Mr. Turney purchased and moved to another home in Houston that is not at issue in this case. Tr. at 2137:11-23 (Turney). At the same time, he entered into a contract to sell the subject property on Red Willow Drive to his stepdaughter, Margie Ramirez, and Ms. Ramirez moved into that property. Tr. at 2129:17 to 2130:3, 2137:24 to 2138:5 (Turney). Mr. Turney carried flood insurance on the property from 1982 to 2010, but after Ms. Ramirez took possession of the property in 2010, she became responsible for maintaining flood and homeowners' insurance. Tr. at 2139:15 to 2142:21 (Turney).

Mr. Turney testified that the sales price was \$50,000, and Ms. Ramirez paid him \$20,000 as a down payment, with subsequent monthly payments of \$500. Tr. at 2138:6-14 (Turney). Mr. Turney stated that, because Ms. Ramirez was delinquent on some payments, he was still owed approximately \$26,000 for the property when Hurricane Harvey struck. Tr. at 2138:15-22 (Turney). After the home flooded during the 2016 Tax Day Storm with approximately two feet of water (and was repaired) and then flooded again during Hurricane Harvey, Ms. Ramirez paid \$10,000 to Mr. Turney to complete the sales contract. Tr. at 2138:25 to 2139:5 (Turney). Thus,

when the property flooded, Mr. Turney was due \$26,000, and after the floodwaters receded, he accepted just \$10,000 to complete the sales contract.⁹²

Character of the Property

The character of the property is a residential home, which, for many decades before acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir. Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties).

The evidence showed that the Corps' decision to grant an easement to facilitate drainage at the Bear Creek Subdivision Drainage helped alleviate some pre-existing flooding in that area. DX-64 at USACE610242 (1979 letter, explaining that because the existing drainage ditch was not properly functioning, homes had flooded or were at risk of flooding). Because the Turney property is located near that infrastructure, it is likely that the property benefited from that drainage structure. DX-800 (Addicks Map Depicting Certain Drainage Easements).

The Turney property is close to Langham Creek, which Mr. Turney testified he has seen overflowing its banks on several occasions, including during Tropical Storm Allison and

⁹² On June 15, 2018, Ms. Ramirez filed a separate Fifth Amendment claim as to the property at 15910 Red Willow Drive, which is part of the upstream subdocket. Compl. in Case No. 1:18-cv-00854 (June 15, 2018). Ms. Ramirez, who is represented by the same counsel as Mr. Turney, identifies her property interest in the subject property as "lease/rent." *Id.* at ECF No. 1-1, Claim No. 100. The filing of claims by both Mr. Turney and Ms. Ramirez as to the same property raises a question as to who is the proper plaintiff with respect to this claim. Plaintiffs have the burden of proof on this issue but, at trial, did not introduce exhibits that address this issue, and only called Mr. Turney to testify. If the Court holds the United States liable with respect to this property, only one plaintiff—either Ms. Ramirez or Mr. Turney—is entitled to any just compensation. On the trial record before the Court, Mr. Turney has not met his burden of proving that he is entitled to any just compensation, to the exclusion of Ms. Ramirez.

possibly during the Tax Day flood. Tr. at 2145:8 to 2148:10 (Turney). During Tropical Storm Allison, approximately two inches of flood water entered the home. Tr. at 2147:5-10 (Turney). During the 2016 Tax Day flood, approximately two feet of flood waters inundated the home. Tr. at 2142:1-12 (Turney). As Mr. Turney explained at trial, the subdivision in which the property is located (Bear Creek), and particularly on Red Willow Drive, experiences poor water drainage and the whole subdivision “just seemed to back up very easily on heavy rainwater days.” Tr. at 2151:8-15 (Turney). These pre-Hurricane Harvey floods had nothing to do with flood pools impounded by the Project—the floods occurred because this property naturally floods during large storms.

For approximately 27 years before acquisition, the Turney property has been near the GOL at Addicks Reservoir. At the time of acquisition in 1975, the property was already close to Addicks Reservoir and, therefore, has been susceptible to flooding due to retention of flood pools impounded in the reservoir since acquisition.

Reasonable Investment-Backed Expectations

Mr. Turney had no reasonable investment-backed expectations at the time of his acquisition that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). At the time of acquisition, publicly-available USGS quad maps showed that this property is subject to flooding from controlled inundation from Project operations. The maps show that, at the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

Mr. Turney continuously maintained flood insurance on his property from 1982 until 2010, when he sold the property to Ms. Ramirez. Tr. at 2139:15 to 2140:2 (Turney). Mr. Turney

testified it was Ms. Ramirez's responsibility to maintain homeowner's insurance on the Red Willow Drive property after 2010. Tr. at 2140:3-6 (Turney). Ms. Ramirez apparently forgot to renew the flood insurance on the property prior to Hurricane Harvey, even though the property flooded to a depth of approximately two feet during the 2016 Tax Day storm. Tr. at 2141:19 to 2142:18 (Turney). The subject property also flooded with approximately two inches of water during Tropical Storm Allison in 2001. Tr. at 2147:5-19 (Turney). Mr. Turney explained at trial that he was bothered that Ms. Ramirez forgot to renew her flood insurance policy because he knew the property was exposed to potential water damage. Tr. at 2143:5-10 (Turney). The fact that Mr. Turney bought flood insurance, and maintained coverage for decades, shows there existed a reasonable expectation of flooding at the time of acquisition.

Severity

The impact of the flood waters on the Turney interest in the subject property was not legally severe because Mr. Turney entered into a contract to sell the property to Ms. Ramirez in 2010 and completed that sale after the storm. In addition, the flooding that occurred on the real property was short-lived, and the resultant damage was capable of being fully remediated. During the 2016 Tax Day Storm, the home flooded with approximately two feet of water and was repaired. During Hurricane Harvey, Plaintiffs claim approximately 4.9 feet of water entered the home. PX-526 at 46 (Bedient Expert Report). After the storm, Ms. Ramirez and her family completely repaired the property and Ms. Ramirez moved back into it. Tr. at 2143:11-23 (Turney). After the storm, Ms. Ramirez completed the purchase of the property, meaning the flooding event did not impact completion of Mr. Turney's sales contract.⁹³ In addition, as

⁹³ Mr. Turney accepted \$10,000 from Ms. Ramirez to complete the sale. He described the full sales price as "more of a gift to her" than a market value sale. Tr. at 2129:20 to 2130:3 (Turney). As noted above, the home flooded twice after Ms. Ramirez agreed to purchase the property—

discussed above, the Turney property would have flooded if the Corps had not closed the dam gates during the storm, and the resultant flood damage would have been similar to the actual damage that occurred. Mem. § II(D)(5).

Even if one ignores the hypothetical condition, the impact was not legally severe. Ms. Ramirez, who was occupying the subject property at the time Hurricane Harvey hit, applied to FEMA for disaster assistance related to the flooding of her home. To date, FEMA has provided Ms. Ramirez more than \$49,100 in financial assistance related to the flooding at the property, which she is not required to repay. DX-866 (Summary of FEMA Individual Assistance Awards). This amount included \$33,000 in home repair assistance, which is assistance made available “[t]o help repair an owners-occupied primary residence. . . .” DX-560 at 1 (FEMA Fact Sheet); DX-866 (Summary of FEMA Individual Assistance Awards). Ms. Ramirez also received Direct Assistance through the transitional sheltering assistance hotel program related to the flooding at the property. Tr. 2974:16-22 (Glasschroeder). That federal money, and other assistance, reduces the degree of severity resulting from this natural disaster.

Duration

As discussed above, the flooding did not impact the sales contract, as Mr. Turney completed the sale of the property to Ms. Ramirez after the storm. In addition, the duration of flooding on the real property was short-lived. Flood waters stayed inside the house for nearly eight days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). The duration is shorter still when one considers that the Turney property would have flooded if the Corps had not closed the dam gates during the storm.

during the 2016 Tax Day Storm and during Hurricane Harvey. The adjustment to the total purchase price occurred after these two flood events.

In summary, the liability factors favor a finding of no liability, and the Court should reject Mr. Turney's claim on the merits.

xii. Wind Property

The Wind Plaintiffs bought the property located at 5306 Sunbright Court in August 1990, approximately 42 years after the Corps constructed Addicks Reservoir. ECF No. 211, ¶ 74 (Joint Stipulations).

Character of the Property

The character of the property is a residential home, which, for many decades before the Winds' acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir. Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-276 (1970 USGS Topographic Map, showing LOE and Wind properties). In 1990, publicly-available FEMA FIRM maps informed the public that the Wind property would flood during a greater than 500-year storm, which Hurricane Harvey was.⁹⁴ DX-818 at FEMA081060 (FEMA Map). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

For more than 42 years before acquisition, the Wind property has been near the GOL at Addicks Reservoir and has been susceptible to flooding due to retention of flood pools impounded in the reservoir since the Winds' acquisition.

Reasonable Investment-Backed Expectations

The Winds had no reasonable investment-backed expectations at the time of their acquisition that the property would not flood during Hurricane Harvey, approximately a 775-year

⁹⁴ The property was also located within a few blocks of the 500 year flood hazard zone. DX-818 at FEMA081060 (FEMA Map).

storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report). At the time of acquisition, publicly-available USGS quad maps showed that this property is subject to flooding from controlled inundation from Project operations, and publicly available FIRM maps showed the property would flood in greater than 500-year storms, which Hurricane Harvey was. At the time of acquisition, the only reasonable expectation was that this property would flood during a large storm like Hurricane Harvey.

The Winds carried flood insurance on the property at Sunbright Court at the time of Hurricane Harvey. Tr. at 1643:3-7 (Wind). The fact that they bought insurance, and maintained it for decades, shows they knew, or should have known, that the property might flood during large storms.

Finally, the Winds purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms:

- decades after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Barker Reservoir could extend beyond the GOL and onto this property;
- approximately nine years after the Corps publicly released its Draft EA in November 1981, which explicitly discussed the possibility of upstream flooding during large storms; and
- approximately five years after the Corps held public meetings to discuss the risk of upstream flooding in the mid-1980s.

Mem. § I(F).

Severity

The impact of the flood waters on the Wind property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated.

Plaintiffs claim approximately 1.2 inches of water entered the Wind home. PX-526 at 46 (Bedient Expert Report). The water stayed inside the home less than a day. DX-608 at 164 (Nairn Expert Report).

As demonstrated during the site visit, the Winds fully repaired all the damage resulting from the storm. These repairs took approximately eleven months, and the Winds returned to live in their home. Tr. at 1636:25 to 1637:7 (Wind).

After the storm, the Winds filed an insurance claim and recovered \$350,000 for flood damage to their home. Tr. at 1643:13-23 (Wind). The Winds also had an insurance policy on a 2007 Lexus at the time of Hurricane Harvey. Tr. at 1644:2-5 (Wind). They filed a claim under that policy for damage to the car from Hurricane Harvey flood waters and received approximately \$21,000. Tr. at 1644: 6-13 (Wind). Even if those amounts did not fully cover their expenses, those monies reduce the degree of severity resulting from this natural disaster.

Duration

The duration of flooding on the Wind property was short-lived. Flood waters stayed inside the house for less than one day, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report).

In summary, the liability factors favor a finding of no liability, and the Court should reject the Winds' claim on the merits.

xiii. WHAC Property

The claim raised by Plaintiff WHAC is a tract of land, improved as a terminal building and located at 18000 Groschke Road. ECF No. 211, ¶ 76 (Joint Stipulations). Woody Lesikar Aircraft Sales and Services, Inc., acquired that property by warranty deed in November 1980, approximately 32 years after the Corps constructed Addicks Reservoir. WHAC-47 (General Warranty Deed); Tr. at 2109:5-19 (W. Lesikar). The United States understands Woody Lesikar Aircraft Sales and Services, Inc., formally changed its name to WHAC in 1993.

Character of the Property

The character of the property is an airport terminal, which, for many decades before WHAC's acquisition, was subject to natural flooding during large storms and controlled inundation due to flood pools impounded at Addicks Reservoir.

Since at least the early 1970s, publicly-available USGS quad maps have depicted this property as subject to controlled inundation due to reservoir operations. JX-266 (1970 USGS Topographic Map, showing Burnham, Stewart, Sidhu, Turney, WHAC, Holland, and Popovici properties). The character of the property, therefore, is a property that is subject to flooding during large storms, like Hurricane Harvey.

The evidence showed that if the Corps had not constructed Addicks Reservoir, and allowed development of the Bear Creek Diversion Channel, flooding of nearby properties was inevitable. DX-152 at USACE794686 (FONSI for Bear Creek Bypass Channel, explaining that the proposed drainage improvements would address continual out-of-banks flooding of populated areas around Bear Creek outside the boundaries of the GOL); DX-149 at USACE325228 (Environmental Assessment for Bear Creek Bypass Channel, explaining that the only feasible and economic option to reduce flooding was construction of a bypass channel on government lands). Because the WHAC property is located near that infrastructure, it is likely that the property benefited from that drainage structure. DX-800 (Addicks Map Depicting Certain Drainage Easements).

For more than 32 years before acquisition, the WHAC property has physically abutted the GOL at Addicks Reservoir. DX-843 (aerial photograph showing WHAC property). At the time of acquisition in 1980, then, the property was already close to Addicks Reservoir and, therefore,

has been susceptible to flooding due to retention of flood pools impounded in the reservoir since WHAC's acquisition.

Reasonable Investment-Backed Expectations

WHAC had no reasonable investment-backed expectations at the time of its acquisition that the property would not flood during Hurricane Harvey, approximately a 775-year storm in the Addicks Watershed. DX-601 at 202 (Kappel Expert Report).

WHAC had flood insurance for 33 years but decided to drop its coverage shortly before Hurricane Harvey to try to save some money. Tr. at 2123:16-24 (W. Lesikar). The fact that WHAC originally bought insurance, and maintained it for more than three decades, shows there existed a reasonable expectation of flooding at the time of acquisition.

Finally, WHAC purchased this property years after release of public information, which demonstrated the possibility of upstream flooding during large storms, including years after publication of public maps, such as Key Maps, FIRM maps, and USGS quad maps, showing the flood pool at Addicks Reservoir could extend beyond the GOL and onto this property. Mem. § I(F).

Severity

The impact of the flood waters on the WHAC property was not legally severe because the flooding was short-lived and the resultant damage was capable of being fully remediated. Plaintiffs claim approximately 7.6 inches of water entered the terminal. Tr. at 1866:18 to 1867:2 (Lesikar Martin). The upstairs portion of the terminal was not flooded. Tr. at 1889:1-9 (Lesikar Martin). Those areas, which include executive offices, conference rooms, a large meeting room and flight school and a flight school classroom, were useable and actually used the entire time. Tr. at 1889:1-9 (Lesikar Martin).

Clean-up activities in the terminal began on September 1, 2017, and, as demonstrated during the site visit, the flood damage to the terminal building was fully remediated. Tr. at 1878:4 to 1879:6 (Lesikar Martin).

Airport operations were only temporarily inconvenienced due to the storm, and the flooding in the terminal apparently did not cause a cessation in operations. As Ms. Lesikar Martin explained, if aircraft could fly into the airport, the airport would put fuel in the aircraft. Tr. at 1876:4-13 (Lesikar Martin).

Duration

The duration of flooding on the WHAC property was short-lived. Flood waters stayed inside the terminal for slightly more than two days, an extraordinarily short period of time compared to the duration of ownership. DX-608 at 164 (Nairn Expert Report). As of Friday September 1, the floodwaters had receded from the terminal building but were still in the area of the building. Tr. at 1886:7-13 (Lesikar Martin). Ms. Lesikar Martin explained that clean-up activities in the terminal began mid-day on September 1, 2017, almost immediately after flood waters receded. Tr. at 1878:4 to 1879:6 (Lesikar Martin). As of September 5, the runways were free of any floodwaters, and on or about September 7, the floodwaters were no longer on the airport property as a whole. Tr. at 1886:17-24 (Lesikar Martin).

In summary, the liability factors favor a finding of no liability, and the Court should reject WHAC's claim on the merits.

G. Plaintiffs Failed to Establish a Taking of Any Personal Property

Plaintiffs' principal claims are that the design, construction and operation of the Addicks and Barker Dams effected a taking of real property. Plaintiffs' Post-Trial Brief claims that the United States effected a taking of personal property, but speaks in such generalities that it is

impossible to ascertain what items Plaintiffs believe the United States inversely acquired. *See, e.g.,* Pls.’ Post-Trial Br. at 53 (alleging, without proof, “destruction of literally tons of personal property and effects”); *id.* at 107 (referencing “countless personal possessions”). Plaintiffs made no effort to identify these items and the United States, therefore, has no way of knowing what it allegedly took.

Plaintiffs’ generalized claims about personal property also fail because they seek consequential damages, which are not compensable under the Fifth Amendment. *Yuba Natural Res. v. United States*, 904 F.2d 1577, 1581 (Fed. Cir. 1990) (“It is a well settled principle of Fifth Amendment taking law . . . that the measure of just compensation is the fair value of what was taken, and not the consequential damages the owner suffers as a result of the taking.”) (citations omitted).⁹⁵ Property can be damaged by the government without effecting a taking. *Air Pegasus*, 424 F.3d at 1216; *Jackson v. United States*, 230 U.S. 1, 8-9 (annual flooding of real property from government levees was sustained by lower court as a proper takings claim while personal property damages from the same flooding—including destruction of cotton, mules, corn, and sheep—were dismissed as beyond jurisdiction of court). The rationale for the rule is that “the sovereign need only pay for what it actually takes rather than for all that the owner has lost.” *R. J. Widen Co. v. United States*, 357 F.2d 988, 994 (Ct. Cl. 1966) (personal property at issue in the case was not directly appropriated or destroyed by the government; the injury was an indirect consequence of action to take other property); *Klein v. United States*, 375 F.2d 825, 828 (Ct. Cl. 1967) (finding that injuries related to taking of land, including inventory, equipment, loss

⁹⁵ To the extent that Plaintiffs’ claims can be construed as seeking lost profits, such damages are also not recoverable under the Fifth Amendment under the same legal principles.

of good will and profits, and expenses incurred in readjusting operations were non-compensable).

The United States did not intend to take any personal property, and any damage to personal property was, at most, “an unintended incident of the [alleged] taking of the land,” which cannot support a takings claim. *Mitchell v. United States*, 267 U.S. 341, 345 (1925). Plaintiffs failed to prove a taking of personal property, and those claims should be rejected.

IV. Conclusion

For the reasons discussed above, neither the law nor the facts support using the Fifth Amendment to recompense Plaintiffs for their losses during Hurricane Harvey. The Court should reject Plaintiffs’ claims for the reasons discussed above and enter judgment in favor of the United States.

Dated: August 20, 2019

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