UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF LOUISIANA

IN RE KATRINA CANAL BREACHES CONSOLIDATED LITIGATION — **CIVIL ACTION**

NO. 05-4182

PERTAINS TO: — **SECTION "K"(2)**
***Armstrong*, C.A. No. 10-866**

FINDINGS OF FACT AND CONCLUSIONS OF LAW

The last of the Katrina floodwall breach cases came to trial in this Court on September 12, 2012, and continued through September 28, 2012. Plaintiffs Kenneth and Jeannine Armstrong, Fred Holmes, the Succession of Ethel Coats, Alvin Livers, and Clifford Washington ("Plaintiffs") allege that the negligent remediation of the East Bank Industrial Area ("EBIA") performed by United States and the Washington Group International, Inc. ("WGI") resulted in the North and South Breaches of the EBIA floodwall. [1] That floodwall ran along the east bank of the Inner Harbor Navigational Canal ("IHNC") providing protection to the Lower Ninth Ward and parts of Chalmette. On the morning of August 29, 2005, when Hurricane Katrina ("Katrina") came on shore, these breaches resulted in the inundation and destruction of the Lower Ninth Ward and parts of Chalmette. Plaintiffs were all victims of this flooding.

Jurisdiction over this action is exercised pursuant to 28 U.S.C. § 1331 (federal question jurisdiction), 28 U.S.C. § 1346(b) (Defendant United States); 28 U.S.C. § 2671, *et seq.* (Federal Tort Claims Act); and 28 U.S.C. § 1332(d)(2) as amended by the Class Action Fairness Act of 2005, Pub. L. 109-2; 28 U.S.C. § 1367. After considering all testimony and evidence presented at trial and the deposition testimony that the Court reviewed prior to the trial, the Court is

[1] See DX DM-0015 Silva Tula Demonstrative at 11.

prepared to rule as follows. To the extent a finding of fact constitutes a conclusion of law, the Court adopts it as such. To the extent a conclusion of law constitutes a finding of fact, the Court adopts it as such.

A. FACTUAL BACKGROUND

1. THE IHNC AND THE EBIA

The IHNC, also referred to as the "Industrial Canal" was built in conjunction with a lock in 1923 to provide a means of marine navigation between the Mississippi River and Lake Pontchartrain. It runs generally in a north-south direction. The most southern point of the canal feeds into the Mississippi River and its most northern point feeds into Lake Pontchartrain. During World War II, the Gulf Intracoastal Waterway ("GIWW") was rerouted through the IHNC with the Federal Government leasing the lock and a 2.1-mile reach of the canal. At that time, the United States assumed its operation and maintenance and eventually purchased the lock in 1986.

The River and Harbor Act of 1956 authorized the Mississippi River-Gulf Outlet ("MRGO"), a navigation channel which was completed in the mid-1960's and which runs from the Gulf of Mexico to the GIWW (Reach 2) in a north-south direction. The MRGO then turns westward (Reach 1) where it then is co-extensive with the GIWW. The MRGO/GIWW then forms a "T" intersection with the IHNC just above the Florida Avenue Bridge. At the time of Katrina, the MRGO provided a hydrological connection between the IHNC and Gulf of Mexico. The portion of the IHNC that is relevant for purposes of this litigation is that which runs

between the Florida Avenue Bridge at the north and the Claiborne Avenue Bridge to the south. This portion of the IHNC transects the Ninth Ward of New Orleans.

The IHNC lock is located immediately south of the North Claiborne Avenue Bridge. Because of the lock's presence, there is no hydrological link between the IHNC and the Mississippi River. The East Bank of the IHNC acts as the western border for the Lower Ninth Ward and is protected by a floodwall constructed by the United States Army Corps of Engineers as part of the Lake Pontchartrain and Vicinity Hurricane Protection Plan ("LPV"). The LPV was a program designed to construct a series of control structures, concrete floodwalls and levees intended to protect the Greater New Orleans area from flooding. The LPV was passed by Congress on October 27, 1965 as the Flood Control Act of 1965, 29 Stat. 1073, 1077 (42 U.S.C.A. §1962d-5).

2. THE EBIA FLOODWALL

When the IHNC was first constructed, earthen levees were built to protect the Upper and Lower Ninth ward neighborhoods from storm surge. The focus of this trial was on the improvements made as part of the LPV to the East Bank Industrial Area Floodwall ("EBIA Floodwall"). That floodwall runs parallel to Jourdan Avenue extending from the Florida Avenue Bridge (the northern boundary) to the North Claiborne Avenue Bridge (the southern boundary) and the lock system to the south. As part of the LPV construction process, the Corps undertook geotechnical evaluations and analyses with the aim of building an I-Wall which would remain stable in the event a hypothetical 13-foot storm surge would be propagated into the IHNC. This

storm surge was projected as part of the "Standard Project Hurricane" that formed the basis for all levees and floodwalls designed and constructed by the Corps pursuant to the LPV.

In 1965, the top of the earthen IHNC levee was increased to an elevation of +9 ft and 19.5 foot long sheet piles driven through the levee and foundation soils to an elevation of -8 NGVD, embedding the sheet pile in a layer of fat clays above soft organic clays. Using current datum NAVD88, this resulted in a bottom elevation of -10.5. (Expert Report of Timothy Stark at 14) From 1969 to 1970, the Corps shaped and sculpted the levee to provide a wider crown. Then, a concrete flood wall crown (8 ft high and 2 ft wide) was constructed to cover the existing sheet piles that had been installed in 1965 to create the EBIA Floodwall that is at issue herein. (JX-01672, March 12, 2012,Expert Report of Francisco Silva-Tulla ("Silva") at 0021). No erosion protection on the landside of the floodwall was authorized, designed or constructed to protect the landside of the levee in the event that storm surge waters overtopped the floodwall. (Trial Transcript ("TT") of Silva at 3697).

At the most northern point along the floodwall, a small portion of the wall was replaced in 1982. This new I-wall was constructed with longer sheetpile which was approximately 13 feet longer–34.5 feet in length and its tip penetration was at least 15 feet deeper (approximately -25 feet below NAVD88). It ran for about 30 feet in a north-south direction (that is as the EBIA floodwall was originally constructed. Then, it made a right angle to the west or toward the IHNC. These two attributes–longer length of sheet pile and right angle–acted as a restraint to hold that part of the wall from moving landward when the storm surge occurred. (TT of William Marr ("Marr") at 1847).

In addition, there was a structural anomaly at the North Breach. The only mechanisms by which the old and new portions of the floodwall were connected were by a joint and a field weld; the original 1969 I-Wall with 19.5 foot sheet piles was connected directly to the 1982 I-Wall with 34.5 foot sheet piles with no transition. (TT of Silva 3759-60). The connection between these two sheet piles of different lengths was an "undesirable design feature" that made structural failure, caused by increased stress concentrations at the connection point, more likely during a storm surge event. (*Id.*; TT of Marr 1847-48). The failure to use a "step connection" resulted in a stress concentration when the Katrina storm surge occurred. In addition, the joint and field weld at the connection was very crude and had a very, very low resistance to tearing when stress was applied. (TT of Silva at 3767).

While the levee was built to +13.5 feet, because of the compressible soils underneath the levee, settlement and ground subsidence occurred. The effect was that parts of the EBIA Floodwall were one to two feet below the original construction top of the wall height, and indeed the lowest points coincided with the South Breach and North Breach locations. (TT of Marr at 1862; see JX-1864, Marr Report, Fig. 3-1, at -0034[2]). By 1999, the lowest top of floodwall elevation was +11.3 NAVD88 and included the section of the floodwall that failed at the North Breach. The second lowest top-of-floodwall elevation was +12.1 feet and included the section of the floodwall that failed at the South Breach. ((JX-01672, Silva Expert Report 12 March 2012 at -0022).

[2]The Court has used the Bates Stamp numbering of all of the exhibits cited. It is for this reason that each such number is preceded by a hyphen.

3. IHNC SUBSURFACE GEOLOGY

The subsurface geology of the land from the IHNC to the landside of the EBIA floodwall requires explanation as well. As noted, in order for the Corps to determine what was necessary to insure the floodwall's stability, it had to have an understanding of the soil in which the sheetpile would be driven. The EBIA area is nestled between the remnants of two major distributaries, the Bayou Sauvage system and the Mississippi River system which means that during the 4000 years of this area's geological formation, the EBIA area would have been subject to swamp conditions in the area as it developed. (TT of Marr at 1757).

In 1966, in preparation for the construction of the new floodwall, the Corps prepared a Generalized Soil and Geologic Profile (See JX-04, Design Memorandum No. 3 for the LPV, at -0193). Using the Unified Soil Classification System (USCS), the Corp produced a cross-section representation of the soil underneath EBIA floodwall. *Id.* In doing so, various soil borings which were used to create this cross section were identified. The South Breach occurred between Borings 4 and 5; the North Breach occurred in between Borings 7 and 8.

From this profile, as well as a number of subsequent investigations, it is clear that the soil underneath the EBIA floodwall is composed of various types of clays. The bottom tip of the sheetpile is for the most part imbedded in what is referred to as "fat clay" (CH) with the next strata below categorized as "clay with organic matter" (CHO) below. Beneath that there is a small lens of "sandy silt" (ML) which stretches from Boring 1 slightly past Boring 4 (the South Breach area). This lens is very narrow at the site of the South Breach and is located somewhere below 22 feet NAVD88. It is even more narrow between Borings 4 and 5. Below that strata is again more fat clay reaching down to approximately 42 feet NAVD88 and deeper. (TT Marr at

1763-64). Boring 8 (the North Breach area) is quite similar, without any sandy silt lens; however, it was noted in cross-examination that there are some incidents of "SIS" which indicates that there are some layers of shell present in those borings.

Thus, for geotechnical engineering purposes, the Corps properly treated this soil as having the permeability, strength, and compressibility characteristics of clay. The Corps prior to the construction of the 1966 floodwall performed two types of geotechnical analysis–stability and seepage. (See JX-004, Design Memorandum 3 at -0114). As to seepage, the Corps stated in its Design Memorandum 3, "Based on the soil conditions along this part of the project and the short duration of hurricane floods, hazardous seepage or hydrostatic uplift on the protected side is not anticipated." (*Id.*) Dr. Patrick Lucia, a registered civil and geotechnical engineer, testified at trial that the engineers knowing the soils had significant clay content with low permeability would have no expectation that there would be development of flow or significant hydraulic pressures under hurricane conditions. (TT of Lucia at 2925) Furthermore, he confirmed that flow and seepage are interchangeable terms in the geotechnical lexicon (TT of Lucia at 2927).

As to the Corps's stability analysis, it utilized undrained shear strengths to calculate the resisting force of the clay soils against the anticipated 13-foot storm surge that would rapidly load against the face of the floodwall (TT of Lucia 2950-51). Undrained shear strengths are universally used by geotechnical engineers for clay soils subjected to short-term loading conditions. Dr. Lucia explained that these measurements (undrained shear strengths) are appropriate to model undrained flooding conditions because hydraulic pressures are unknown and not predictable in these types of soils. (*Id.;* TT of Marr at 1899). Engineers in designing

these levees and floodwalls use equations using various geotechnical measurements that produce what is known as a Factor of Safety. In order for a floodwall to maintain global stability, that is to be able to withstand short term loading conditions by storm surge, that Factor of Safety must be equal to or greater than 1.3 for a flood condition. (JX-1777, Expert Report of Patrick Lucia ("Lucia") at-0066; DX-DM-1105-0038.).

The Corps also calculated a minimum control line which is a boundary line defining the critical area where disturbing soils could potentially undermine the stability of the floodwall during a storm surge loading condition. (TT of Lucia 2944-45; JX- 0004, Design Memorandum No. 3, Plate 38 at -0193). That control line ran roughly 15-20 feet from the center line of the floodwall. (TT of Lucia at 2946). Disturbing soils within this critical area could make it more likely that the floodwall would lose the resisting force necessary to maintain stability against the driving force of the projected storm surge–the force that the floodwall was designed to withstand–thereby increasing the likelihood the floodwall could destabilize and be toppled into the Lower Ninth Ward. (DX-DM-1005-0036-39; TT of Lucia 2944-45, 47; JX-1777-0066). Moreover, Dr. Lucia made clear that in his opinion, any excavation outside of the minimum control line would have no impact on the stability of the floodwall.

Lastly, the Corps considered the forces that could lead to "overturning moments" when the design flood condition reached the top of the wall, evaluating various sheet pile depths for stability against overturning forces using a factor of safety of 1.5. The final penetration depth was chosen based on the Corps's determination that the floodwall would retain stability against shear and overturning forces with floodwaters at the top of the wall. (JX -0004, Design Memorandum No. 3 at -0114, Plates 37, 38, 39, 35).

4. THE EBIA REMEDIATION

The East Bank Industrial Area consists of the land area between the subject floodwall and the IHNC upon which a number of marine related industrial sites were located. The Corps purchased the site between 2000 and 2007 in preparation for the construction of a new lock system to be located between the Mississippi River and Florida Avenue. (JX-1672, Expert Report of Silva, 3/12/12 at -0011). As part of the overall plan, a by-pass canal was to be dredged through this land. Thus, the Corps undertook the remediation of the area in 2004-2005. Two concerns were presented in this undertaking–environmental and mechanical. The Corps had to insure that any contaminated soil in the area caused by the previous industrial tenants would be removed safely. Also, any obstruction to the dredging process had to be eliminated. Thus, all remaining structures, both on land and subsurface, such as piers, pilings, slabs and the like, had to be removed.

The EBIA is approximately 32 acres in size and is subdivided into six properties based on historic land use. (JX-1780, Expert Report of Stark at -0027). These properties included (from north to south along the IHNC) Boland Marine, McDonough Marine, Indian Towing, Mayer Yacht, Saucer Marine and the International Tank Terminal. (*Id.* at 29, Figure 5-2). The North Breach occurred in the area of the Boland Marine property and the South Breach in the area of Saucier Marine property. Each propery had its own structures and detritus, and excavations were necessary to remove existing infrastructure and contaminated soils.

To that end the Corps utilized the services of WGI with whom it had an umbrella contract known as a Total Environmental Restoration Contract ("TERC"). (JX-00048). Issuing its Task Order 26, the Corps required WGI to draft a recommendations report and work plans to outline

what work was to be done in order for the site to be in compliance with Louisiana Department of Environmental Quality ("LDEQ") standards. (JX-00049). The work would include site characterization, demolition and environmental clean-up. Clearly from the evidenced adduced at trial, the Corps oversaw and approved virtually all activity WGI undertook with respect to this entire project.

The subsurface characterization consisted of the identification of buried structures and foundations that could interfere with construction of the bypass channel. The removal process involved a tremendous undertaking including building and slab removal, buried foundation removal, pile removal, soil remediation, transite (or asbestos containing material) removal and grid trenching, (TT of Morris at 129-30).[3] The contamination of the soil at the EBIA included that caused by fuels, oils, solvents and heavy meals deposited from dumping, spills and leaks. In addition to buildings, foundations, and other buried strictures, other items had been buried at the site, ranging from barges to garbage and debris. (JX-1672, Report of Silva, 3/12/12 at -0025).

In executing the contract, WGI was tasked with not only removing these obstructions but then backfilling those areas disturbed and tamping the soil to fill these holes. Breaches occurred opposite of the Boland Marine Site and the Saucier Site, thus a more specific review of the activities at those areas is required.

A. Boland Marine Site

Focusing on the Boland Marine site in the vicinity of the North Breach, activities included transite excavations, soil remediation excavations, excavations of structure, including

[3]For a comprehensive pictorial overview of the area and its history, see Figure 11-2:2003 EBIA found in JX-1672, Expert Report of Silva, 3/12/12, at -0018.

the "wedding cake" structure and piling, grid trenching and utility removals. (See Expert Report of Silva, 3/12/12, JX-1672- 0025; JX-01674, Silva Report, App. B, Figure 3, at -0004). The closest transite excavation to the North Breach was 85 feet away form the floodwall and the depth of such excavations was between 2 and 5 feet deep. These excavations were backfilled with either sand or borrow pit material.[4] Contaminated soil excavations were conducted in accordance with Louisiana's Risk Evaluation and Corrective Action Program (RECAP) in a total of sixteen areas on the Boland Marine site. The depths of these excavations ranged from 4 to 8 feet. These excavations were backfilled with native fill from the borrow pit and in some instances imported river sand. (See JX-1672, Expert Report of Silva, 3/12/12, at -0026). Grid trenching also occurred at this property on "25-foot spacings to a depth of 5 feet." (*Id.* at -0027). Furthermore, daily construction records indicate that spoil was used to backfill the trenches.

As to the structures that were demolished on the Boland Marine cite, those structures had pilings beneath their foundations. Also on the site were eight subsurface concrete and steel foundations beneath the building slab. The deepest of these was dubbed "the wedding cake" structure. According to Dr. Silva's report, that excavation was made to a total depth of 26.5 feet, 187 feet from the floodwall and 590 feet from the southern edge of the North Breach. *Id.* at -0028 and JX-1674, Silva Report, App. B, Figure 5 at -0006. A cofferdam was used in its removal. The excavation was backfilled with spoil from the excavation and borrow pit material in compacted 2 to 3 foot lifts. *Id*. (Silva Report).

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[4]The "borrow pit" was an area created at the McDonough Marine site and was the subject of the only geotechnical evaluation that was made. This pit provided most of the material used to backfill excavations undertaken at the EBIA and thus provided for native clays to be returned to the excavations. In fact the borrow pit remained unfilled at the time of Katrina and no breach occurred anywhere near it.

The pilings penetrated to the deepest point in the EBIA area ranging in depths from 30 to 65 feet. All of those pilings were at least 275 feet away from the North Breach. There were other deep pilings at the Mayer Yacht, Indian Towing, McDonough Marine and Saucer Marine sites that were removed. Some were backfilled; however, there is no proof presented that all were. The Court accepts Dr. Silva's opinion, however, that "any cavities left behind from pile extractions would close in a short time (days), due to the lateral stresses in the soft subsurface clays found at the EBIA.". *Id.* at -0028.

Finally, a gas line and water line was excavated at the Boland Marine area. As Dr. Silva described:

> WGI removed a two-or three-inch diameter gas line from the canal side of the floodwall. The line was excavated, the concrete encasement around the pipe was broken, and the pipe was cut with a pipe cutter. (QAR 691) The remaining pipe was then excavated back to Surekote Road and the trench was backfilled and compacted. (*Id.).* Excavations of the utilities were not expected to exceed two feet in depth. (QAR 688) The closest utility was more than 400 feet away from the North Breach.

Id.

B. Saucer Marine

At the Saucer Marine site, similar action was taken by WGI. Soil remediation excavations, structural excavations, including the sewer lift station and pilings, grid trenching and utility removal all were conducted. There were 15 areas of contaminated soil excavations. Their depths ranged from 3 to 13 feet. The excavations were backfilled primarily with borrow pit material. (*Id.* at -0029). Grid trenching was also conducted on 25-foot spacings to a depth of 5 feet. "Spoil" from the excavations was "apparently" used to backfill these trenches. *Id.*

A significant number of structures were removed from the Saucer marine site as well with two structures having pilings underneath their foundations which were also removed. Those piling depths were recorded as 39 ft and 28.6feet (See JX-1672, Report of Silva, 3/12/12, - 0030-31, JX-1674, Silva Report, App. B, Figure 10 at -0012). All of these pilings were at least 150 feet away from the South Breach. While some were backfilled with soil, the daily field records do not confirm that all were. Nonetheless, it appears to the Court that it is more likely than not that because of the nature of the soils in the EBIA, the holes or cavities left behind from the pile extractions would close in a matter of days or months due to the lateral stresses in the soft subsurface clays in the EBIA. (See JX-1672, Report of Silva, 3/12/12,- 0030-31; TT of Rogers at 723-24 citing Rogers Dep. II at 190:6-191:1).[5]

Another significant removal was that of a sewer lift station which was excavated to a total depth of 22 feet. This structure was located 87 feet from the floodwall, and 193 feet from the northern edge of the South Breach. (JX-1672, Report of Silva, 3/12/12,- 0030-31). A coffer dam was installed for the process which included the station being cut into sections and removed with a crane. Its slab foundation was broken up and removed as well along with exposed timber pilings. This excavation was filled with borrow pit material, "spoil", and sand in bucket-compacted 24-inch lifts. (*Id.*)

A gas line and water line were also removed. Dr. Silva describes the process as follows:

> WGI removed the lines from the canal side of the floodwall. The 4 September 2003 preparatory meeting called for the lines to be excavated and the concrete encasement around the pipes to be broken (QAR) The lines were cut and removed back to the Surekote Road curb. The shallow two-foot excavations were

[5]The Court was not overly impressed with Dr. Rogers' new found belief which he "researched" after his deposition that led him to equivocate with respect to his initial deposition testimony. (See TT-Jonathan Rogers at 723-24).

> backfilled in compacted one-foot lifts. (QAR 690) In October 2004, additional utilities were removed from under Surekote Road on the Saucer Marine site. The backfill material was semi-compacted with multiple passes of a dozer. (QAR 931) Figures II-7 9WGI016083) and 11-8 (WGI016083) are photographs taken during the waterline removal at Saucer Marine.

(Id. at -0031-32). It must be noted that similar activities were undertaken at all of the other sites along the canal and no breaching occurred anywhere else along the length of the EBIA floodwall–only the North and South Breaches.

c. McDonough Marine and the Borrow Pit

Perhaps one of the most telling excavations with respect to the non-failure of the floodwall concerns the Borrow Pit that was excavated at the McDonough Marine site. This location was chosen because of its relative lack of contamination and obstructions; furthermore, it is clear that no "clay layer" was installed there as the pit itself was made of silts and clays. Indeed, this excavation is one of only three excavations for which a contemporaneous geotechnical evaluation was made prior to its execution. (TT of Jonathan Rogers at 747-48).

The depth of this pit varied with the greatest being 18 ft., decreasing to 14.8 ft, 10 ft, 6, ft, 5 ft and 4 ft at various points in the pit[6] and the eastern edge was about 53 feet away from the floodwall at McDonough Marine (JX-1672, Report of Silva, 3/12/12, -0033-34, JX-1674, Silva Report, App. B, Figure 12 and 13, 0015-16). However, it is clear that the borrow pit pierced the lower organic clay lens and reached the lower organic clay level. (TT of Stark at 3428-29) . At the conclusion of its use, the berm on the canal side of the pit was breached to allow water to

[6]These depths are not corrected to NAVD88; for instance, a depth of 14.8 ft would translate to -11.4 ft. NAVD88. *Id.*

flood the excavation. (See JX-1672, Report of Silva, 3/12/12, at- 0033-34). Nonetheless, with an open, un-backfilled, un-tamped large pit, no breach occurred at the EBIA in its vicinity.

Finally, two 4-foot deep contaminated areas under Surekote Road and adjacent to the levee toe at McDonough were excavated with the Corps' geotechnical branch having provided instruction for the backfill and compaction of these area.

Thus, between February 2001 and May 2005, WGI performed numerous definable features of work, including but not limited to excavating the Borrow Pit, demolition and piling removal; grid trenching; the Sewer Lift Station removal at Saucer Marine; the "Wedding Cake removal at Boland Marine; soil remediation and utility line removals. WGI left the EBIA site on May 26, 2005. After the Technical Completion Report was completed and approved by the Corps on August 23, 2005, WGI's work was completed. (JX-1364 Technical Completion Report).

5. HURRICANE KATRINA

Hurricane Katrina hit Miami, Florida on August 25, 2005, as a Category 1 hurricane on the Safir Simpson scale. (Rec. Doc. 20920, Joint Pretrial Order, Uncontested Fact No. 65 at 36) ("PTO"). After crossing the southern tip of Florida, it entered the Gulf of Mexico on August 26th, where, under favorable conditions, it exploded into a Category 5 hurricane. (PTO, Uncontested Fact No. 66 at 36). It then peaked in intensity the afternoon of August 28, 2005, with maximum sustained surface winds of 175 miles per hour; hurricane force winds extending 100 miles from its center; and tropical force winds extending 22 miles from its center. (PTO, Uncontested Fact No. 67 at 36).

On August 29, 2005, Hurricane Katrina made landfall to the east of New Orleans at Buras, Louisiana at 6:10 a.m. It was a massive Category 3 hurricane with winds about 125 miles per hour and generated the largest storm surge elevations in the history of the United States. (PTO, Uncontested Fact No. 69 and 70 at 36). Storm surge is a wind driven process: the wind puts energy into the sea surface through the waves and currents. The greater the wind, the greater the storm surge will be. (PTO, Uncontested Fact 72, at 36).

With the existence of the MRGO and the massive destruction of the wetlands surrounding it caused by the Army Corps of Engineers' failure to armor the banks of that channel, the storm surge drove up the MRGO, into the GIWW and finally into the IHNC. By 5:00 a.m. on August 29th, the water level at the IHNC Lock was 10.3 ft NAVD88 (2004.65), increasing to 11.3 ft by 6:00 a.m., 12.3 ft by 7:00 a.m., 13.8 ft by 8:00 a.m., peaking at 14.3 ft. by 9:00 a.m. By 10:00 a.m. the height at the lock had reduced to 12.3 ft. (PTO, Uncontested Fact No. 1 at 29).

Because the storm landed to the east of New Orleans, New Orleans was in the northwest quadrant of Katrina's wind field with winds blowing from a north, north easterly direction prior to the passage of the eye of the storm (PTO, Uncontested Fact No. 4 at 30). Thus the wind direction did not shift to a westerly direction until after 10:00 a.m. on the morning of August 29, 20005.

The two aforementioned breaches occurred at the EBIA floodwall early on the morning of the 29th. The North Breach occurred at approximately 6:00 a.m. on August 29, 2005 (JX-1713-, Expert Report of Robert A. Dalrymple ("Dalrymple Report) at -0007, -00065) and resulted in a 180-foot gap in the floodwall. The South Breach occurred along the Saucer Marine

parcel of the EBIA at approximately 7:00 a.m resulting in a 793-foot gap in the floodwall. (*Id.* at -0008, -00065; PTO, Uncontested Fact No. 75 at 37). These failures caused the catastrophic flooding and immense damage to the Plaintiffs which resulted in their filing the instant suit.

B. ISSUES PRESENTED

1. Plaintiffs Allegations

Plaintiffs contend that by virtue of the defendants' failure to conduct a full and competent geotechnical site assessment, failure to evaluate fully the impact of their activities on the floodwall and failing to employ prudent engineering practices, WGI and the Corps breached their respective duties to maintain and protect the integrity of the levee and floodwall system along the EBIA. (Rec. Doc. 20945, Plaintiffs' Trial Brief, at 1). Plaintiffs posit:

> WGI's allegedly negligent work created and/or exacerbated subsurface pathways for Hurricane Katrina's surge water **pressures,** which were transmitted through the improperly backfilled and compacted excavations directly into the underlying swamp/marsh layer. This **pressure transfer** from the flood side to the protected side of the floodwall resulted in significant **uplift pressures** beneath the floodwall and played a substantial role in the ultimate failures at the North and South Breaches adjacent to the Lower 9th Ward. These **pressure transfers**, **uplift pressures** and floodwall failures could have been prevented had WGI and the Corps complied with industry custom and practice, as well as the myriad of policies and regulations mandating WGI and/or the Corps perform a geotechnical analysis on the potential impact of this excavation activity on the adjacent EBIA floodwall. Moreover, before Defendants completed their work, they knew (or reasonably should have known) that the IHNC and the soils beneath the EBIA were hydraulically connected; thus, an increased tidal or storm event in the IHNC would result in enhanced underseepage **and the transmission of hydraulic pressures** laterally across the EBIA site and beneath the floodwall.

Id. (emphasis added). For support of these theories, Plaintiffs primarily rely on the expert testimony of Dr. Robert Bea which will be discussed in detail, *infra.*

2. Defendants' Responses

In response to Plaintiffs' allegations, WGI maintains that it owed no duty to the Plaintiffs with respect to the harm they suffered as a result of Katrina because the risks were unknown and attenuated. As to geotechnical evaluations, WGI argues that there was no duty because (1) the Plaintiffs are not third-party beneficiaries of the WGI-Corps contract; (2) the Task Order 26 of the TERC did not obligate or otherwise provide for WGI to conduct any geotechnical evaluation of the levee and the floodwall; and (3) there is no other source of duty identified to create that duty on the part of WGI. Furthermore, WGI maintains that it performed its contractual duties with due care in all aspects.

Moreover, WGI contends that it is entitled to certain legal immunities. First it re-urges its immunity from suit based on the Government Contractor Defense. It also argues that it is immune from liability based on state law immunity pursuant to La. Rev. Stat. 9:2771 which provides that a contractor is not liable for damage or injury caused by alleged defects in work undertaken by him due to any "fault or insufficiency of the plans or specifications," assuming that he performs the work according thereto.

Finally, WGI maintains that its environmental remediation was not a contributing cause of the two EBIA floodwall breaches. In particular, WGI contends that Dr. Bea's analysis is fatally flawed and that he has created a "third type of pressure" to explain the breaches which is illegitimate and not based on proven scientific methodology. This argument is underscored by what WGI maintains is the erroneous application of certain computer models– SEEP/W and SLOPE/W.

The United States argues that Plaintiffs' claims are barred by the Flood Control Act of 1928, 33 U.S.C. § 702(c) because Plaintiffs' flood damages were caused by alleged negligence primarily or substantially related to a flood control activity with respect to the activities undertaken with respect to the lock replacement and the EBIA remediation. In addition, the United States maintains immunity under §702(c) because the damages were caused by deficiencies in the original design and construction of the EBIA floodwall. Moreover, the United States maintains that Plaintiffs failed to prove the WGI's activities were a cause in fact of the EBIA floodwall failures or that the Corps was negligent in approving WGI's work.

Likewise, the United States maintains that Plaintiffs' methodology and analysis used to prove that the breaches were caused by uplift pressures is unsupported by accepted geotechnical engineering principles. The United States contends that applying scientifically accepted soil and fluid mechanics to the EBIA clay soil demonstrates that Plaintiffs' allegation that underseepage and landside hydraulic uplift pressures were not contributing factors to either the North or South Breach.

C. Burden of Proof

Plaintiffs' claims rest on the United States' and WGI's alleged negligence. Under the Federal Tort Claim Act, the United States may only be held liable if, under the law of the place where the alleged act or omission occurred, a private party would be held liable under like circumstances. 28 U.S.C. §§ 1346(b)(1), 2674. Thus the same legal standard applies for a cause of action for negligence under the law of Louisiana as to both the United States and WGI.

A duty-risk analysis is the standard negligence analysis employed in Louisiana to determine whether to impose liability under La. Civ. C. art. 2315. As stated by the Louisiana Supreme Court:

> The approach provides an analytical framework for the evaluation of liability. One analysis requires proof by the plaintiff of five separate elements: (1) the defendant had a duty to conform his conduct to a specific standard (the duty element); (2) the defendant's conduct failed to conform to the appropriate standard (the breach element); (3) the defendant's substandard conduct was a cause in fact of the plaintiff's injuries (the cause-in-fact element); (4) the defendants' substandard conduct was a legal cause of the plaintiff's injuries (the scope of liability or scope of protection element); and (5) the actual damages (the damages element). *Fowler v. Roberts*, 556 So.2d 1, 4 (La. 1989), *reh'g granted on other grounds and original opinion reinstated as supplemented*, 556 So.2d at 13 (La. 1990). A negative answer to any of the inquiries of the duty-risk analysis results in a determination of no liability. *See Mathieu*, 94-0952 at 11, 646 So.2d at 326. *See also, Daye v. General Motors Corporation*, 97-1653, p. 9 (La.9/9/98), 720 So.2d 654, 660*; Perkins v. Entergy Corporation*, 98-2081 p.21 (La. App. 1 Cir. 12/28/99), 756 So.2d 388, 403, *aff'd*, 2000-1372, 2000-1387, 00-1440 (La.3/23/01), 782 So.2d 606.

Lemann v. Essen Lane Daiquiries, Inc. 923 So.2d 627, 633 (La. 2006).

The Supreme Court of the State of Louisiana has further noted that the initial inquiry to determine if a party may be liable under the duty-risk analysis is cause-in-fact. *Lasyone .v Kansas City Southern R.R.*, 786 So.2d 682, 690-91 (La. 2001). Plaintiffs have the burden of proving negligence and causation by a preponderance of the evidence, and proof is sufficient to constitute a preponderance when the entirety of the evidence, both direct and circumstantial, establishes that the fact or causation sought to be proved is more probable than not. *Cay v. State of Louisiana, Dept. of Transp. and Development*, 631 So.2d 393, 395 (La. 1994). Stated another way:

> The plaintiff must prove that the alleged defect in the thing was a cause-in-fact of the plaintiff's harm. *Brown*, 707 So.2d at1242; *Campbell*, 648 So.2d at 902. A party's conduct is a cause-in-fact of the harm if it was a substantial factor

> in bringing about the harm. *Graves*, 703 So.2d at 570 (citing Frank L. Maraist & Thomas G. Galligan, *Louisiana Tort Law*, § 4-3, at 86-88 (1996); *Edwards v. Horstman*, 96-1403 (La. 2/25/97), 687 So.2d 1007. For example, the act is a cause-in-fact in bringing about the injury when the harm would not have occurred without it. While a party's conduct does not have to be the sole cause of the harm, it is a necessary antecedent essential to an assessment of liability. *Theriot v. Lasseigne*, 93-2661 (La. 7/5/94), 640 So.2d 1305, 1310; *Dixie Drive It Yourself Sys. v. American Bev. Co.*, 242 La. 471, 137 So.2d 298, 302 (1962). Whether an action is the cause-in-fact of the harm is essentially a factual determination that is usually left for the factfinder. *Boykin v. Louisiana Transit Co.*, 96-1932 (La. 3/4/98), 707 So2d 1225, 1231; *Theriot*, 640 So.2d at 1310.

Laysone, 786 So.2d at 690-98. In this judge-tried case then, the Court is the ultimate fact finder.

As previously noted, trial of this matter took place over the course of three weeks. Prior to that time, the Court reviewed the deposition testimony of John Greishaber and more than 7 other witnesses from the Corps. As to WGI witnesses, the Court reviewed, *inter alia*, the deposition testimony of Steven Roe, Anne Veigel and Philip Staggs. During trial, the Court heard the testimony of the Plaintiffs, except for Ethel Coats who is deceased; her testimony was by deposition. Plaintiffs presented testimony of Chad Morris who evaluated the spatial characteristics of the EBIA and Dr. David Rogers who provided expert testimony concerning the engineering properties of the soils found at the EBIA and the standard of care for performing earthwork at the EBIA. However, the seminal witness for Plaintiffs' was Dr. Robert Bea whose credentials have been accepted by this Court and whose experience concerning the LPV floodwalls and failures has been a centerpiece of his work since Katrina and the devastation caused by the LPV's failures. Dr. Bea testified for a total of four days. The testimony of Dr. Bea's assistant, Diego Cobos-Roa, was presented by deposition. Thus, the overarching focus of the trial was the expert testimony with respect to causation and the geotechnical methods used to

support Plaintiffs' theory of causation. The Court will now focus on whether Plaintiffs have carried their burden of proof as to causation.

D. CAUSATION AS POSITED BY PLAINTIFFS

Plaintiffs maintain that the vertical and horizontal uplift pressures induced global and lateral stability failure resulting in the North and South Breaches. Plaintiffs contend that the excavations allowed certain pressure to move instantaneously through the soil skeleton. They posit that these uplift pressures compromised the entire system by essentially levitating the wall, which allowed the lateral forces from the canal to laterally displace the floodwall. Because the pressure from the storm surge loading did not dissipate, the excavations were a substantial cause of the North and South Breaches. This theory was developed by Dr. Bea based on his field observations at the 17th Street Canal piezometers and the EBIA sites and his use of the SEEP/W model and the SLOPE/W models to replicate the pressures which he observed at the 17th Street Canal and which he believes explain the failures at the EBIA floodwall.

As previously mentioned, global stability is a geotechnical term which refers generally to the ratio of the resisting landside forces to the driving canal-side forces trying to push a floodwall landside. Soil mechanics provide the tools to determine stability by quantifying the physical properties of soils and using mathematical equations to demonstrate how those physical properties affect the ability of soil to bear weight and resist water. This realm is that of geotechnical engineers who make the necessary tests and calculations to try to insure stability in the design and construction of floodwalls and levees, and they too are uniquely qualified to determine the cause of a stability failure.

Shear strength analysis is one benchmark used by scientists to determine whether a floodwall placed to a certain depth in a certain type of soil will remain stable during a defined flooding event. (TT of Marr at 1890-91). This type of analysis was done when the EBIA floodwall was designed and constructed in 1966 to provide protection for a 13-foot hurricane surge event. (JX-1777, Report of Lucia, at -0006). "The condition for inboard stability analysis during the design flood condition was evaluated. (USACE 1966 Design Memorandum No. 3). A short term critical factor of safety of 1.3 was targeted for the design criteria." *(Id.*) Furthermore, as previously noted, the minimum control line–a boundary line defining the critical area where disturbing soils could potentially undermine the stability of the floodwall during a storm surge loading condition–was determined. (TT, Lucia 2944-45; JX 0004, Plate 38). That control line ran roughly 15-20 feet from the center line of the floodwall. (TT, Lucian at 2946).

The EBIA floodwall breaches demonstrate that some force or forces were at play which destroyed that stability of that floodwall. Thus, Plaintiffs' burden of proof requires them to prove by a preponderance of the evidence what caused the global stability of the EBIA floodwall to fail with translational instability (the wall sliding landside while upright) and the lateral displacement in two places along the EBIA.

Prior to this trial, the Court had before it in 2008 a Motion for Summary Judgment that was filed by WG in this matterI. At that time, the focus of Plaintiffs's causation theory concerned instability that was caused by **the effects of underseepage of water.** Plaintiffs then maintained that the deep excavations of the sewer lift station at Saucer Marine site and the wedding cake structure at the Boland site, "'altered the **flow** of sub-surface ground water, opened portals to sub-surface permeable layers , and allowed the **unabated underseepage** through

permeable soils below the flood wall during Hurricane Katrina when the EBIA was covered with high water" which allegedly cause the North and South Breaches. *In re Katrina Canal Breaches Consolidated Litigation, (MRGO)*, 2008 WL 5234369, *1 (E.D.La. December 15, 2008) (emphasis added), *rev'd* 620 F.3d 455 (5th Cir. 2010). The previous espousal of this underseepage theory as cause for the failures of the EBIA floodwall by Dr. Bea was underscored at trial during Bea's cross- examination not only concerning of his testimony in this regard in this suit, but with specific discussion of his testimony as to the underseepage theory of causation presented in the *Robinson* and the *Barge* trials. (See TT, Bea at 893-399).

However, as a result of the jointly developed soils exploration program that took place over several months in the summer of 2011 for this trial, it became clear that the soil in question was substantially less permeable than previously thought.. Geotechnical engineers were retained by all the parties in this case, a protocol was established and locations were determined where soils would be tested. The program confirmed that the EBIA is predominantly clay.

1. PERMEABILITY

As the Court found previously, the soils of the EBIA are predominantly fine-grained, low permeability clays. (TT of Dunbar at 1754-64; TT of Rogers at 606). Dr. Joseph Dunbar testified convincingly concerning the characteristics of these soils particularly in light of his participation in an effort to understand the depositional environments and how they correlate to the engineering properties of the soils that define the work of geotechnical engineers. (TT of Dunbar at 1752). As such, notwithstanding the fact that there are "lenses" of other materials present in these soils, impermeable clay soils dominate both the North and South Breach sites.

This fact is bolstered by the borings and photographs taken during the aforementioned soil exploration program. (TT of Dunbar at 1779).

Permeability is synonymous with the term "hydraulic conductivity" In other words, permeability "is the ability of a porous material, such as soil or rock, to allow the passage of liquid, such as pore water." (TT of Silva at 3715). Water moves quickly through gravel and sand; however, clay does not allow water to flow freely. It is for this reason that clay is considered "impermeable." Hydraulic conductivity is a more precise term in that it refers directly to groundwater as the liquid source. *Id.* at 3716.

In Court Dr. Silva demonstrated credibly using a foot of material in a tube and applying half a foot of water to that material results in the following:

Material	Permeability	Time for material to flow through container
sand	10^{-2} cm/sec	10 minutes
silts	10^{-4} cm/sec	21 hours
clays	10^{-6} cm/sec	90 days

(TT, Silva at 3716-17). The parties stipulated that the permeability of the clay at the EBIA is 10^{-5} cm/sec. Dr. Stark presented compelling evidence which the Court accepts that the site-specific permeability of the organic clay soil at the EBIA would result in it taking one minute to generate four teaspoons of water to flow through that clay (TT of Stark at 3414). With this inexorable fact confronting Plaintiffs' experts, a shift in causation from **water seepage** to **pressure** as the primary cause of the uplift pressure and de-stabilization of the floodwall occurred.

2. HYDRAULIC PRESSURE CONDUCTIVITY AND UPLIFT PRESSURE

As Plaintiffs state in their Post Trial Brief (Rec. Doc. 21110 at 64 of 121 through 68 of 121), there are three types of pressure that could effect the global stability of a floodwall: (1) total stress pressures, (2) pore pressures due to flow, and (3) uplift pressures. Total stress pressure is exerted by the IHNC waters and is ever present; however, Plaintiffs do not posit that this played a causative role in the EBIA disaster. Pore pressures associated with water flow is another type of pressure. The time required for this kind of pressure is a function of the permeability and the compressibility of the soil. (TT of Silva at 3737: 11-16) . Plaintiffs do not contend that flow-related pressure was causative either.

Plaintiffs base their theory of causation on uplift pressure. Dr. Bea's testimony focused on this source of pressure which he maintains is “the near-instantaneous transmission of pore pressures that occurs in the saturated high water-content soils of the EBIA." (Plaintiffs' Post-Trial Brief, Rec. Doc. 21110 at 65 of 121). Plaintiffs opine that "[t]his third type of pressure is communicated through the pores in the soil, just as "flow" of water and its associated pressures communicate through the pores in the soil, but the terms of "flow" and "uplift" pressures are used to avoid confusion of these types of pore pressure." (*Id*.)

Dr. Bea used the analogy of a car brake to demonstrate his theory of uplift pressure. "There need not be a significant 'flow ' of brake fluid for the brake pedal to activate the brake pad against the shoe. The pressure from the pedal transmits immediately to the brake shoe and "flow" (i.e., a leak) would actually undermine the system." (*Id.* citing TT of Bea at 1299-1301). Dr. Bea testified, "The high-water content soils are the soils that are able to transmit hydraulic pressures. If the water contents are . . of the order of 30 percent, it will be the soil structure that

is transmitting pressure, and that's much less efficient at transmitting pressure. So water content is critical to pressure transmission." (TT of Bea at 1432, 1434). Thus, Bea concluded that high water content is synonymous with an effective pressure transmission. (Plaintiffs' Post Trial Brief, Doc. 21110 at 67 of 121, n. 205). Indeed, Plaintiffs contend that "[t]he flow of water through this soil skeleton may take time, but the pressure transmission is nearly instantaneous due to the high water content." (*Id.*). Indeed, Dr. Bea testified that "hydraulic pressures are relatively insensitive to the hydraulic conductivity we have called permeability." (TT, Bea, at 903). In essence, Dr. Bea maintains that the uplift pressures caused by the instantaneous pressure transmission compromised the entire system essentially levitating the wall, which allowed the lateral forces from the canal to laterally displace the floodwall. (TT of Bea at 3946).

3. PIEZOMETER PRESSURE

Bea testified that he arrived at this theory of uplift as a mode of levee failure beginning with testing done at the 17th Street Canal floodwall. Using piezometer readings collected from piezometers[7] installed on the Jefferson Parish side of that canal after Katrina, he stated:

> . . . So I pulled the data out and plotted it and something just becomes so crystal clear. As the water left rising and falling in the 17th Street Canal, the pressures in the water of the swamp-marsh layer is following it. It's almost like a dog on a leash, only the leash is damn short because the pressure responds is virtually instantaneously. It's minutes. The data acquisition is not rapid enough to carry it to seconds, but it sure as hell in hours. So you can track it up, you could track it down.
>
> And we said–or actually turned to a student and I said, "Do you have those pressures in your lateral stability analysis?" And the student came back and said, "No, that's not normal. We don't do that normally." And I said, "Well in this case, God doesn't believe you're (sic) normally. She refuses to separate the

[7]Piezometer is a method by which a scientist can measure the static liquid pressure.

> effect. Let's find out what those pressures are. Let's put them in the stability and let's see what happens."
>
> All I can say is God richly rewarded that trail because, at the end, we could predict where, when and how and why it failed and why it didn't fail and the answer was uplift pressures that had been omitted by all investigating teams. . . .

(TT of Bea at 843-44).

Dr. Bea also testified unequivocally that in his analysis, "flow" is where "that molecule of water on one side of that floodwall moves underneath the floodwall and up to the other side" and which is a form or element of underseepage. On the other hand, "uplift pressure" is "pressure transmission underneath the floodwall on the other side, but without the molecule of water itself having gone under the floodwall." (TT of Bea at 848-49). Thus, Dr. Bea continued:

> ". . . both breaches occurred crucially because of these uplift pressures transmitted from the East Bank Industrial Area, and particularly, the poorly backfilled excavations that contacts the swamp-marsh layer, which has some very unique characteristics and properties, to then communicate to the landside of the floodwall that produces and uplift force that then is the critical horse in this horse race of instability causing failure defines as I've got a breach and I'm flooding the Lower Ninth Ward. It's WGI's excavations [that] were a substantial contributing factor without which the breach would not have occurred."

(*Id*. at 849-50).

4. SEEP/W ANALYSIS

To prove his theory of pore pressure transmission, Dr. Bea used a computer model known as SEEP/W which computes flow and pressure based on basic inputs of soil properties and geometry. Mr. Diego Cobos-Roa performed the analysis for Dr. Bea. Within the program, a choice is available as to whether to use a "transient flow" analysis or a "steady-state flow" analysis. (TT of Bea at 911). Dr. Cobos-Roa testified that in running the SEEP/W model, he

used transient flow analysis option of the program.[8] However, in choosing a value for the parameter that represents the compressibility of the system due to change in pore water pressure (denoted as $\mathbf{m}_v$), (DX-DM-1006, Marr's Demonstratives at -105) rather than using the empirically proven value for $\mathbf{m}_v$, Dr. Bea used a value that is a 30,0000 times lower or 1 x 10^{-9} 1/psf or zero as his coefficient for compressibility.

Dr. Marr demonstrated this fact in his testimony synopsized in the following chart:

TEST DATA FOR COEFFICIENT FO COMPRESSIBILITY, $\mathbf{m}_v$, in $\mathbf{ft^2/lb}$

	Coefficient of Compressibility
Lab test data-JX-1864, Marr Report	0.00003
Field pumping test (Naymik S=0.002)	0.00003
Normally consolidated alluvial clays and organic alluvial clays and peats	0.00001 to 0.00007
Dr. Bea used in SEEP/W calculation	0.000000001

Id. Thus, Dr. Bea used a value for the compressibility (10^{-9}) and permeability (10^{-5}) for the EBIA clay that is analogous to that of sandstone–that is practically incompressible and impervious. (TT, Silva at 3805). In addition, Dr. Bea testified that based on his field experience with the piezometer and the "immediate" change in pressure, he sought to obtain that result using this computer model. The only way the sought-after result occurred was by using

[8]At page 70 of 121 of Plaintiffs' Post-Trial Brief (Rec. Doc. 2110), Plaintiffs state that Dr. Bea was not performing a transient flow analysis. As support for this proposition, they state, "Dr. Bea described the *event* and *conditions* as transient, *i.e.*, "time-dependent," but the analyses were based on steady flow conditions. (JX 01414 and DX 02688 (Bea Rebuttal Rep.) at 17-18 ¶ 20); *see also* JX- 0193 (Bea Rep. Appx. D at 1) ("the transient hydraulic conductivity analyses initiate from a steady state condition.") Unfortunately, this "proof" is indirect and circular in nature and is rejected by the Court. Furthermore, regardless, it is clear that Dr. Bea did not use values for compressibility in any of these computer models that jive with the actual soil that is present at the EBIA.

this extreme value for the compressibility coefficient rather than the actual value found in the field. (TT, Bea at 932-33).

5. SLOPE/W ANALYSIS–Slope Stability Analysis

Dr. Bea also evaluated the lateral stability (or slope stability) of the floodwall under maximum demands and capacity using the SLOPE/W program and the pressures generated by the SEEP/W analyses. (JX 1393 Bea Rep. Appx. D at 21). This inquiry examines the ability of soil to resist the weight or load being imposed upon it by, in this instance, a storm surge event. (TT of Brandon at 3159). A core variable used in this analysis is the value used to represent the **strength of soil** which is measured in two different ways, depending on the loading condition. One is **undrained** and the other is **drained.** If a scientist determines the soil is **undrained**, a **total stress analysis** should be used. Alternatively, if a scientist finds that the soil is in a **drained** condition, then an **effective drained analysis** should be used**.**

Whether a soil in geotechnical terms is in a drained or an undrained condition depends on the speed with which water can move in or out of that soil unit in comparison with the length of time that the soil is being subjected to some change in the load on that soil. (TT of Bea at 1099). Drained is the condition under which water is able to flow into or out of a mass of soil in the length of time that the soil is subjected to some change in load. Conversely, undrained is the condition under which there is no flow into or out of a mass of soil in the length of time that soil is subject to some change in load. (TT of Bea at 1100).

The reference to a "loading condition" in the context of the EBIA was the storm surge caused by Katrina that came up the IHNC and bore on the floodwall, putting stress on the soils at

the foundation. As stated by Dr. Marr, "If the loading is going to be very slow relative to how fast water can flow through these materials, we would measure drained shear strength. In the case of the EBIA, the geotechnical engineers setting up the testing program made an assessment that these **were slow-draining materials,** that the load would be very rapid relative to the rate at which they could drain and, therefore, the appropriate shear strength to use would be the **undrained shear strength**." (TT of Marr at 1895-96). The significance of this use is that it yields a higher shear strength because the soil is in a certain condition, the loading occurs quickly. The soil cannot change, so that shear strength remains. (*Id.*)

When one takes the combination of elements of soil and water and then applies a load, such as the tidal surge which occurred at the EBIA in Katrina, part of the strength of the soil depends on what happens to the pore pressure inside. If a load is applied rapidly, there is no time for water to flow in and out of the sample and the water content stays constant. (TT of Marr at 1896). Clay takes months to years to behave in a drained mode. (*Id.* at 1898). In Dr. Bea's analysis of uplift pressures, he used a drained mode in his calculations. (*Id.* at 1898). Since the clay soils of the EBIA were loaded in a matter of 30 hours maximum, any stability analyses of the floodwall involved the strength of the clay should be using undrained shear strength. (*Id.* at 1898)

In all stability analyses done for purposes other than and prior to this trial, Dr. Bea used an undrained strength in his Total Stress slope analyses. Clearly, a **"total stress"** analysis is the appropriate analysis to be used to measure the clay with **undrained strength**. (TT of Mar 1931-32). However, in his original expert report in **this** trial, he treated the organic clay layer as being in a "**drained"** condition, using an **effective stress analysis.** (TT of Brandon at 3183).

In his Rebuttal Report, Dr. Bea opines that regardless of whether the soil is treated as drained or undrained, the uplift pressures result in factors-of-safety that are "nearly identical" and are in essence unstable. The Total Stress (undrained) method resulted in a Factor of Safety of FS=1.1; the Effective Stress (drained) method resulted in a Factor of Safety of FS=0.99. (DX-1625, Expert and Rebuttal Reports of Bea, April 11, 2012, ¶¶ 11-14 at -0006-0007; TT of Marr at 1933). A Factor of Safety of 1 is unstable; thus, Bea posits that regardless of whether the soild is treated as drained or undrained, the factor of safety hovers at 1 meaning there is instability.. However, Dr. Marr demonstrated these results were unreliable given that it appears that Dr. Bea used different shear strengths in making his calculations. (TT of Marr at 1933-34).

6. BEA'S NORTH, SOUTH AND NEAR BREACH MODELS

These SEEP/W and SLOPE/W analyses were used to model three different scenarios–the North Breach (Boland Marine), the South Breach (Saucer Marine) and the Near Breach (McDonough Marine)–which Plaintiffs contend support their contention that uplift pressure exacerbated by the WGI excavations was a substantial cause of the failures at the EBIA floodwall. The summary of these evaluations can be found in Appendix D, "Analysis of Lower 9th Ward Floodwall Performance During Hurricane Katrina" to Dr. Bea's Original Report. (TT of Bea at 1319; JX-01393).

The Court finds these models unconvincing for a number of reasons. Dr. Bea used idealized excavations in his models; he did not attempt to recreate with any specificity the actual excavations at either the North Breach or South Breach. (TT of Bea at 1021-27; 4021, 4060-61). It was never clearly demonstrated how these idealized excavations comported with or compared

to the actual excavation. (*See generally*, TT of Bea at 1348-1350). No sufficient and clear explanation was ever given to the Court as to why the actual excavations were not modeled; furthermore, despite the Court's post-trial request to explain how the idealized excavations conformed to the actual geometry of the area on the canal side of each breach, no explanation was given.[9]

In addition, none of the models was ever run without **any excavations** which would have provided the ultimate proof as to what effect the excavations had on the stability of the EBIA floodwall at all three locations. (TT of Bea at 1337). In response to the Court's specific question in this regard, Dr. Bea stated that his "control" scenario–the one without any excavation penetrating the lower organic clay layer–was his "Near Breach" scenario at McDonough Marine. (TT of Bea at 1292-94). This basis for Bea's contention that the Near Breach serves as a "control" because those excavations did not pierce that "swampy-marsh" layer is inaccurate. It is clear that that layer was pierced in reality. (TT of Stark at 3428; of Bea at 4131-32, 4134-35). Thus, the Court finds that Plaintiffs have not provided the Court with any reliable data to demonstrate the difference that these excavations made; Plaintiffs ask the Court to make a leap of faith in this regard and the Court is not prepared to do so. In addition, Dr. Bea's initial contention concerning a clay layer having been added to the borrow pit was ill-founded and any assumptions based on that belief are likewise lacking merit. Finally, the Court finds that the inputs used for these models to achieve the results that Dr. Bea postulated do not jive with the

[9]In the Court's post-trial order with respect to issues it wished to be addressed, the Court asked Plaintiffs' to "discuss whether any specific excavations were used in Dr. Bea's failure analyses or were the excavations were idealized. If so, how do the idealized excavations conform to the actual geometry of the area on the canal side of each breach." (Rec. Doc. 21090 at 4). Plaintiffs did not accept this invitation nor any of the other 10 points as to causation the Court mentioned.

actual scientifically ascertained values for compressibility and undrained soil making these results suspect as explained in detail above.

E. PLAINTIFFS HAVE FAILED TO PROVE CAUSATION

Thus, the Court finds that Plaintiffs "proof" of a hydraulic connection and the resulting "uplift pressure" as a substantial cause of the North and South Breaches is unavailing. The Court found Dr. Bea's testimony not direct and quite circular. The North, South and Near Breach models presented were unconvincing. Moreover, the Court is not persuaded that the use of values in the SEEP/W modeling for compressibility that bear no relation to the field conditions constitutes a valid scientific method.

Furthermore, the genesis for Dr. Bea's determination that uplift pressure was the cause for the EBIA floodwall failures began with his observation of pressure readings in piezometers at the 17th Street Canal. However, considering that the soil at the 17th Street Canal is substantially different than that found at the EBIA renders the analogy suspect. Moreover, to the extent that the basis for liability at the EBIA is the presence of poorly filled excavations, and in fact, there were no excavations at the 17th Street Canal, further renders the underlying premise questionable, i.e., that those excavations were a significant factor in the breaches regardless of whether there was uplift pressure.

Simply put, Plaintiffs have not proven that it is more probable than not that the United States' and WGI's remediation, excavations and backfill methods created a "hydrologically charged" condition such that uplift pressures were transmitted through clay soil without any appreciable flow of water to destabilize the floodwall causing its demise. Plaintiffs failed to

convince the Court that their theory of instantaneous pressure wave transmission or dilatational wave theory had a valid application in solving levee and floodwall failures during hurricane storm surge events. The Court accepts Dr. Marr's testimony that the dilatational wave theory pertains to explosive shock waves that would increase stresses in the ground, both total stress and pore pressure; however, there would be no change in strength. (TT of Marr at 1936-37). Likewise, the decoupling of flow from uplift pressure did not seem sufficiently scientifically supported. (TT of Brandon at 3169). Finally, the Court cannot base a finding of causation using modeling that has used a value for the compressibility of the EBIA clay which is appropriate to that of sandstone. Thus, given that Plaintiffs' have failed to prove the first element, causation, in the duty-risk analysis, there is no need for further inquiry as to duty, breach, scope of liability or damages.

The Court cannot and will not find as a certainty what exactly caused these breaches. Clearly, it was not the Ingram Barge. Likewise, it is clear it was not the result of the subject excavations performed by WGI under the complete supervision of the Corps. In this procedural posture, the Court is not empowered to find the cause. It is noteworthy that the United States opines in its Post Trial Brief that the structural defect in the design and construction of the intersection between the shorter 1969 sheet pile and the longer 1982 sheet pile, which was driven deeper in ground, was identified by their experts Dr. Marr and Dr. Silva as undesirable and resulted in placing "far greater stresses on the older, shorter sheet pile than were accounted for in the original design. (Doc. 2111 at 83-84). Likewise, the existence of a crude field weld at the connection which had a very, very low resistance to tearing when stress was applied was likewise identified. These floodwall anomalies created a dangerous condition in the event of a

catastrophic storm surge event such as occurred with Katrina. In another trial, the Court was also shown that at the location of the South Breach, there was a slight kink in the line of the floodwall, likewise making it more susceptible to stress in the event of a loading condition. In addition, it is likewise noteworthy that there was no erosion protection on the land of the floodwall, which guaranteed that with any overtopping, scouring would occur which would encourage the floodwall's failure. In short, it appears that this floodwall, like the floodwalls at the 17th Street Canal, the Orleans Street Canal and the London Canal, was a disaster waiting to happen.

F. CONCLUSION

Since this opinion will likely be the last significant one issued by the Court regarding Hurricane Katrina, I will engage in a bit of judicial license.

I have been the judge presiding over this hydra-like "Katrina Umbrella" litigation for almost eight years. There are presently more than 21,166 entries in the consolidated docket, which for pretrial purposes combined nine categories that have comprised the *In re Katrina Canal Breaches Consolidated Litigation*. There have been many issues which have been vexing and unique. Throughout these proceedings, I have been greatly assisted by the excellent lawyers on all sides, as well as the outstanding work of Magistrate Judge Jay Wilkinson, Jr. in attempting to resolve in as timely a fashion as possible the legal aspects of the monumental disaster wrought by the failure of the levees surrounding New Orleans and vicinity as a consequence of Hurricane Katrina.

One central theme has been painfully obvious throughout this entire process; many of the levees protecting New Orleans and the surrounding area were tragically flawed. This fact has been documented and detailed in several of my opinions[10].

However, lamentably, there has been no judicial relief for the hundreds of thousands of people and tens of thousands of businesses impacted by these defalcations. The Flood Control Act of 1928 as interpreted over the years gives the United States Army Corps of Engineers virtually absolute immunity, no matter how negligent it might have been in designing and overseeing the construction of the levees. This Court did grant relief in the MRGO litigation (Doc. 19415, *In re Katrina Canal Breaches Consolidated Litigation*, 647 F. Supp. 644 (E.D.La. 2009)), because I found the Flood Control Act of 1928 and the discretionary function exception in the FTCA were not applicable in that instance.

In the trial of that case, it was proven being cavil that the Corps was aware that the drastic widening of the MRGO, due to the Corps' failure to maintain it, endangered the levees protecting St. Bernard Parish and the Lower Ninth Ward. Indeed, one memorandum from an agency of the Army Corps of Engineers stated that the resulting losses in the event of a major hurricane could be catastrophic. Therefore, this very real possibility was known by the Corps for almost 20 years prior to Katrina and the Corps did nothing to rectify the problem, nor did the Corps issue any specific warning to Congress or the public. Notably, the United States did not appeal this Court's findings of fact of its negligent actions in that case.

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[10] For example, Rec. Doc. 10984, *In re Katrina Canal Breaches Consolidated Litigation*, 533 F. Supp.2d 615 (E.D.La. 2008) dismissing Plaintiffs' claims against the Corps with respect to the floodwall breaches at the 17th St. Canal and other outfall canals.

A representative of the Corps admitted in trial that it was not "policy" for the Corps to blithely stand by and take no action in the face of such danger to human life and property. However, a higher Court in reversing itself and this Court found that the Corps was immune because such decisions were "susceptible to policy considerations" applying the Discretionary Function Exception to the Federal Torts Claim Act.

In the instant case, this Court has found the actions of the Corps in supervising the remediation project executed by WGI along the EBIA did not substantially cause the North and South breaches. As this Court has already noted that the floodwall that did not fail at the northern most end was 13 feet longer, therefore deeper, than the floodwall that did fail. Of course, if the levee was designed improperly the Corps is absolutely immune.

I feel obligated to note that the bureaucratic behemoth that is the Army Corps of Engineers is virtually unaccountable to the citizens it protects despite the Federal Tort Claims Act. The public fisc will very possibly be more jeopardized by a lack of accountability than a rare judgment granting relief. The untold billions of dollars of damage incurred by the Greater New Orleans area as a result of the LPV levee failures during Katrina speak eloquently to that point.

I take note that the Corps of Engineers has many excellent and dedicated engineers, supervisors, and staff. I also note that if individuals, corporations, and bureaucracies are never brought to task for substantial negligence, each will be much less assiduous in discharging their respective duties.

Accordingly, and based on the foregoing Findings of Fact and Conclusions of Law,

IT IS ORDERED, **ADJUDGED AND DECREED** that judgment be entered in favor of United States and the Washington Group International, Inc. and against Kenneth and Jeannine Armstrong, Fred Holmes, the Succession of Ethel Coats, Alvin Livers, and Clifford Washington, with each party to bear its/his/her own costs.

New Orleans, Louisiana, this 12th day of April 2013.

STANWOOD R. DUVAL, JR.
UNITED STATES DISTRICT COURT JUDGE