Mississippi Valley Division,
Regional Planning and Environment Division South

South Central Coast Louisiana

Hurricane Ike flooding in Delcambre, Louisiana 2008.

Appendix L – Wet Floodproofing Cost Development

June 2021

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Section 1
Background Information

1.1 INTRODUCTION

This appendix presents formal documentation of how the wet floodproofing costs were developed to inform mitigation of industrial warehouse structures. The development of wet floodproofing costs began in June of 2020 when the SCCL PDT reached out to the Association of State Floodplain Management (ASFPM)'s flood mitigation committee and the Flood Mitigation Industry Association (FMIA),a non-for profit, which became the foundational source of information used to develop wet floodproofing costs. Both organizations provided their services without cost to the federal government and USACE appreciates their support to this study and future efforts utilizing the wet floodproofing costs developed.

1.2 PURPOSE OF WET FLOODPROOFING COST ESTIMATE REFINEMENT

PDT further examined the RP (Alternative 1) following the Alternatives Decision Milestone held in March of 2020. Alternative 1 was the alternative that reasonably maximized net benefits, and included elevation of residential structures and dry floodproofed non-residential structures located in the 0.04 AEP storm surge floodplain. Residual risk calculations associated with the TSP reduced existing condition damages by 28 percent, meaning 72 percent of the existing condition damages would remain, even after investing the estimated project cost of $1.4 billion dollars (cost estimate at TSP). Despite the TSP having the highest net benefits and meeting minimal benefit cost ratio requirement, the estimated residual risk and associated damages were unacceptable. The PDT determined the first step in reducing residual risk was to analyze where damages remained following high frequency flooding (0.02 AEP events and more frequent).Results indicated dry floodproofing was only a marginally effective mitigation strategy for non-residential structures, meaning industrial and commercial structures were receiving damages above 3 feet at a relatively frequent occurrence (0.02 AEP 50 year event). The additional damages were due to the addition of wave action to existing still-water flood elevations that were added and refined to the hydraulic model post-TSP. Wave action increased flood depths to above three feet during frequent flood events in high commercial/industrial areas, impacting the benefit of dry floodproofing.

CEMVN team reviewed locations of high commercial/industrial areas within the SCCL study area. Commercial and industrial locations within the project area are often tied to oil and gas industry and support services. Commercial and industrial locations, within the study area, are often located in or near port facilities and are exempt from traditional floodplain regulations given a "functional dependence" under CFR 59.1. FEMA and the NFIP local ordinance requires a variance be provided for wet floodproofing. Structures that are functionally dependent on close proximity to water

"must be located near water are functionally dependent uses, as defined by section 59.1, and are permitted to be wet floodproofed after the issuance of a variance from NFIP elevation and dry floodproofing requirements. Structures may include certain types of docking, seafood, processing, and port facilities associated with marine activities. Variance criteria may include the structure be protected by methods that minimize flood damage and create no additional threat to public safety." https://www.fema.gov/sites/default/files/2020-07/tb_7_wet_floodproofing_requirements-1993.pdf

During PED, final designs for each structure should be coordinated with local floodplain managers to ensure compliance with local floodplain laws and ordinances. Development of costs presented within this appendix utilized the following National Flood Insurance Technical Bulletins to inform structure design criteria:

- Technical Bulletin #2- Flood Damage Resistant Materials, August 1, 2008,
- Technical Bulletin #3- Non-Residential Floodproofing-Requirements and Certification April 1, 1993,
- Technical Bulletin #7- Wet Floodproofing Requirements, December 1, 1993.

The Port of Iberia was identified as a representative location, a highly industrial area with commercial structures often tied to oil and gas industry. Structures within the Port of Iberia were selected as a representative structural architypes for refinement of assessed wet floodproofing methods. A template for the 185 structures identified within the Port of Iberia complex were utilized to assess the effectiveness of wet floodproofing warehouse relative to dry floodproofing. Figure L:1-1 shows locations and structural classification diversification of the Port of Iberia, residential structures were elevated, commercial structures were dry floodproofed, and industrial warehouse structures were identified as targets for potential wet floodproofing.

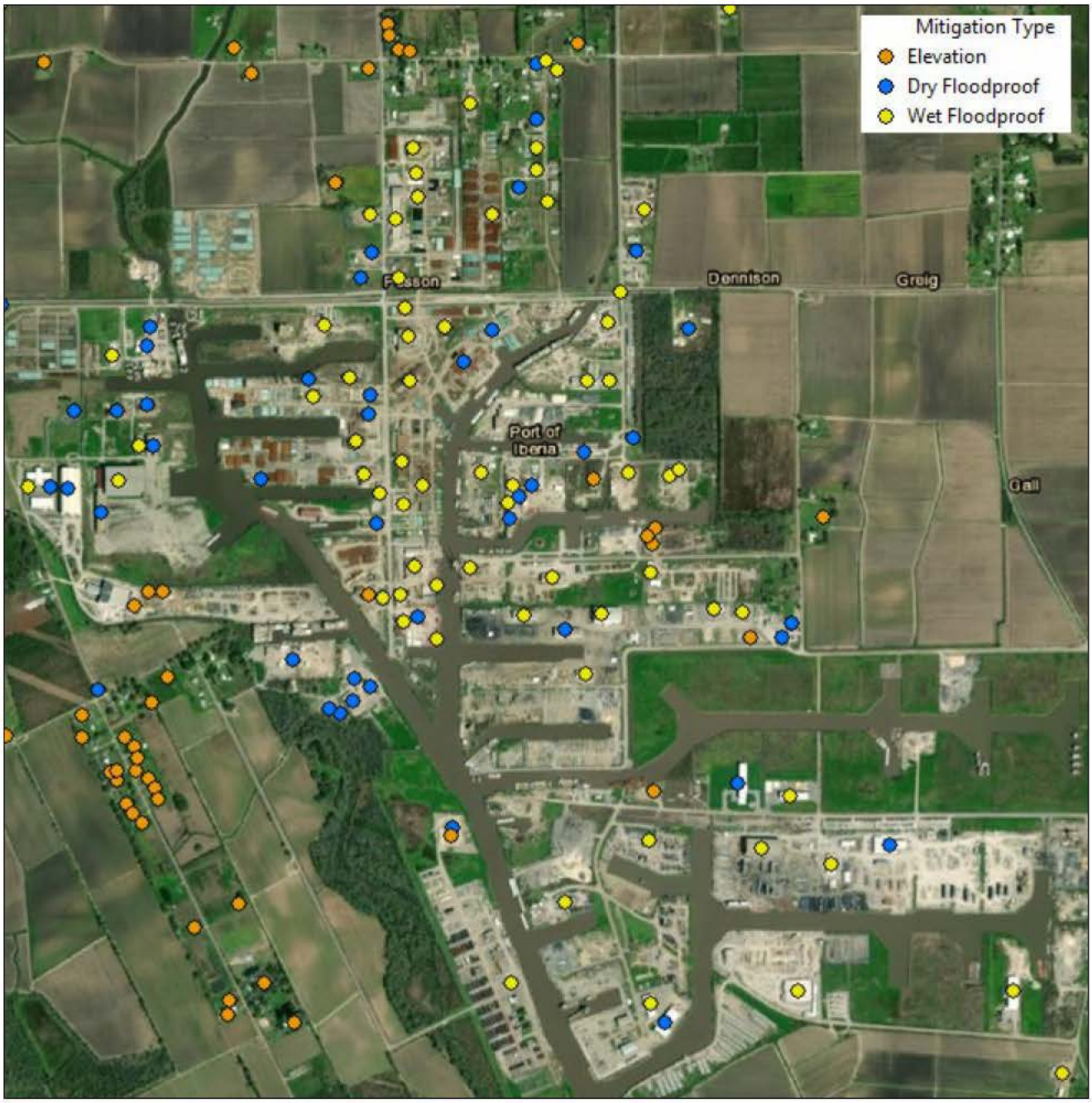

Figure L:1-1. Port of Iberia Recommended NED Plan Nonstructural Mitigation

Section 2
Methodology and Application

2.1 METHODOLOGY

The methodology to develop costs for wet floodproofing included the following:

1. Identify 5 or more warehouse structures within the Port of Iberia that vary in size, purpose, and occupancy status (vacant/operational)
2. Perform a physical survey of the warehouse structures that agree to be included within the study
3. Develop detailed wet floodproofing assessments for each of the structures surveyed that includes existing occupancy, condition, construction, configuration, and level of flood exposure
4. Identify wet floodproofing mitigation strategies for each of the structures surveyed
5. Develop cost estimates based on the mitigation strategies for each of the structures surveyed

The Port of Iberia assigned the Port's Architect to coordinate with the PDT to help in the identification and physical surveying process. The performance of the physical surveys were conducted during the COVID-19 pandemic, and as a result, travel was restricted for all USACE PDT members, and therefore the physical survey was led by the Port of Iberia and the Flood Mitigation Industry Association and supported with pictures as documentation.

2.2 APPLICATION – PHYSICAL SURVEYS & ASSESSMENTS

The Port of Iberia owns approximately 70 percent of the buildings within the port footprint, and rents out the buildings to tenants. The other 30 percent of the buildings within the port are privately owned. In July of 2020, the Flood Mitigation Industry Association and the Port of Iberia surveyed six port buildings, two of which were currently occupied, and the other four were vacant and owned by the Port to be leased to tenants. The structural assessment sheets completed for each of the six surveyed structure are included below. Iberia Parish has a 1 foot freeboard requirement, all references to elevation, not designated Base Flood Elevation (BFE), are notated as Design Flood Elevation (DFE) and include the local ordinance requirement. During implementation each structure would be assessed individually the general work process for wet-floodproofing installation is:

1. Complete program application.
2. Government obtains design build contract and works with approved contractors to develop Guide Plans and Individual Structure Specifications, and Estimates for phased increments.
3. Individual Site Specifications are approved.
4. Contractor obtains all necessary permits and Mobilize to site.
5. Electrical Work
6. Install elevated storage racks

7. Wet floodproofing
8. Protective coatings
9. Install flood vents
10. Install crane to raise contents
11. Install an elevated office.

STRUCTURE ASSESSMENT SHEET	
Structure ID	Structure Address
#1	1216 Unifab Rd Bldg B

Structure Photographs

Front

Rear

Structure Characteristics	
Characteristic	Description
Occupancy -	Commercial – service and repair, being converted to storage.
Configuration -	One story with one wing 125,000 sq ft and the other 40,000 sq ft.
Construction -	Concrete slab foundation. Steel framing with steel siding and roof.
Condition -	Good
Other -	The east west main section of the building has a large opening at one end, which is scheduled to be closed in. There are no flood vents in the building walls

Site Visit Observations

General: The large site features the large 90' high main section and 60' high north south oriented building. A relatively smaller, second wing of the building is oriented north/south. The site is relatively flat and has 2 slips. The building is not occupied at this time, however a lease has been finalized. There are several other buildings on the site.

Site: The structure is situated on an industrial port site and free standing on the property. The area around the structure is limestone. The grade at the front of the structure slopes slightly downward toward the access road. The grade at the sides of the structure slopes down from the building. The grade at the rear slopes down away from the structure.

Structure: The building needs flood vents in order to be wet flood proofed. The former administration office spaces are going to be converted to conditioned storage. Some minor repairs are needed to the exterior steel siding. The building has a new tenant and is scheduled to have the open end closed in and a large door installed.

Systems/Utilities: Systems and utilities are located below the DFE. Air conditioners need elevation to DFE. Electric service needs relocation to DFE. Toilet line needs back flow preventer.

STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#1	1216 Unifab Rd Bldg B

Structure and Flood Elevations

FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
5.6 ft	5ft	n/a	AE-11	6.6ft	6ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 6.6ft feet below the base flood elevation (BFE). The structure's construction, finishes, systems, utilities, storage and contents would incur substantial damage in a flood event. If wet flood proofed, the building would be subject to less damage due to letting the water in and out of the interior.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems to upper level above the DFE if applicable.
2. Elevate the exterior HVAC equipment onto platform(s), above the BFE.
3. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
4. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
5. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
6. Evacuate the structure during a flood event to prevent loss of life.

Notes:

1. The property owner indicated the structure experienced flooding on the first floor during past flood events. When a flood warning is given the property owner evacuates the structure contents and stores it off site. Interior finish materials need to be replaced with approved flood resistant construction materials
2. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

Note: The building qualifies as "functionally dependent" under CFR 59.1. FEMA/NFIP local ordinance requires a variance be provided for this work.

STRUCTURE ASSESSMENT SHEET	
Structure ID	Structure Address
#2	1216 Unifab Rd Building E

Structure Photographs	
	
Front	Rear

Structure Characteristics	
Characteristic	Description
Occupancy -	Commercial storage.
Configuration -	The building measures 200' X 200' = 40,000 sq ft and 20' high. There is an elevated office space in the rear approximately 8ft above grade.
Construction –	Concrete slab foundation. Steel interior frame, steel siding and roof.
Condition -	Good. The building has a few loose steel panels. The roof above the office spaces is relatively new.
Other -	Structure sited above the level of the access road. There are multiple door openings in the sides of the building. There are no flood vents in the walls.

Site Visit Observations

General: The site is relatively flat. There is a slip just north of the building.

Site: Industrial port site. The structure is situated on an industrial port site and free standing on the property. Interior finish materials need to be replaced with approved flood resistant construction materials. The grade at the front of the structure slopes slightly downward toward the access road. The grade at the sides of the structure slopes down from the building. The grade at the rear slopes down away from the structure.

Structure: The building needs flood vents in order to be wet flood proofed. Some minor repairs are needed to the exterior steel siding.

Systems/Utilities: Air conditioners for the upper level offices need to be elevated on stands to the DFE.

STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#2	1216 Unifab Rd Building E

Structure and Flood Elevations

FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
5.6ft	5ft	n/a	AE-11	5.4ft	6ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 5.4 feet below the base flood elevation (BFE). Structure's construction, finishes, systems, utilities, storage and contents/furnishings at the finished floor level (below the BFE) would incur substantial damage.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems / storage to upper level above BFE if applicable.
2. Elevate the exterior HVAC equipment onto platform or onto the roof, above the BFE.
3. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
4. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
5. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
6. Evacuate the structure during a flood event to prevent loss of life.

Notes:

7. The property owner indicated the structure experienced flooding on the first floor during past flood events and incurred extensive damages. When a flood warning is given the property owner evacuates the structure contents and stores it off site. Interior finish have been replace after previous flood event with easily removable water resistant construction in the showroom / office area. Some equipment is stored on mobile racks to facilitate evacuation.
8. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

Note: The building qualifies as "functionally dependent" under CFR 59.1. FEMA/NFIP local ordinance requires a variance be provided for this work.

STRUCTURE ASSESSMENT SHEET	
Structure ID	Structure Address
#3	1216 Unifab Rd Building D

Structure Photographs	
	
Front	Rear

Structure Characteristics	
Characteristic	Description
Occupancy -	Commercial – storage.
Configuration -	The building is a rectangular one story, gable roof that measures 180ft X 60ft = 10,800 sq ft. One end of the building is open.
Construction -	Concrete slab foundation. Roof and siding are steel.
Condition -	The siding and roof appear to be in good condition.
Other -	Structure sited above the level of the access road. There are 2 egress door openings in the sides of the building. There are no flood vents in the walls.

Site Visit Observations

General: The structure was viewed from the exterior and interior. The structure was not occupied and in good condition.

Site: - Industrial port site. The structure is situated on an industrial port site and free standing on the property. The area around the structure is Limestone. The grade at the front of the structure slopes slightly downward toward the access road. The grade at the sides of the structure slopes down from the building. The grade at the rear slopes down away from the structure.

Structure: The structure is steel framed with a steel siding and roof. The first floor is a concrete slab on grade. The exterior walls and roof have steel siding.

Systems/Utilities: The utilities are located below BFE.

STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#3	1216 Unifab Rd Building D

Structure and Flood Elevations

FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
5.6ft	5ft	n/a	AE-11	5.4ft	6ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 5.4 feet below the base flood elevation (BFE). Structure's construction, finishes, systems, utilities, storage and contents/furnishings at the finished floor level (below the BFE) would incur substantial damage.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems above BFE if applicable.
2. Elevate the exterior HVAC equipment onto platform or onto the roof, above the BFE.
3. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
4. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
5. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
6. Evacuate the structure during a flood event to prevent loss of life.

Notes:

7. The property owner indicated the structure experienced flooding on the first floor during past flood events and incurred extensive damages. When a flood warning is given the property owner evacuates the structure contents and stores it off site. Interior finish have been replace after previous flood event with easily removable water resistant construction in the showroom / office area. Some equipment is stored on mobile racks to facilitate evacuation.
8. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

Note: The building qualifies as "functionally dependent" under CFR 59.1. FEMA/NFIP local ordinance requires a variance be provided for this work.

STRUCTURE ASSESSMENT SHEET	
Structure ID	Structure Address
#4	5314 C.P Voorhies Rd Building C

Structure Photographs	
	
Front	Rear

Structure Characteristics	
Characteristic	Description
Occupancy -	Commercial – storage.
Configuration -	One story, concrete slab on grade, gable end steel roof. 16,000 sq ft.
Construction –	Masonry exterior walls with metal framed roof. Wood framed interior.
Condition -	Good. Several steel siding panels on the front of the building have been replaced with clear acrylic panels.
Other -	Structure sited above the level of the access road. There are 2 egress door openings in the sides of the building. There are no flood vents in the walls.

Site Visit Observations

General: The structure was viewed from the exterior. The structure was not occupied and in good condition.

Site: Industrial port site. The structure is situated on an industrial port site and free standing on the property. The area around the structure is sand and gravel. The grade at the front of the structure slopes downward toward the access road. The grade at the sides of the structure slopes down from the building. The grade at the rear slopes down away from the structure.

Structure: The gable end structure is steel framed with a steel siding and roof. The first floor is a concrete slab on grade. The exterior walls and roof have steel siding.

Systems/Utilities: The utilities and equipment is located at the rear and below DFE

STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#4	5314 C.P Voorhies Rd Building C

Structure and Flood Elevations						
FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
7ft	6.5ft	n/a	AE-11	4ft	4.5ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 4ft feet below the base flood elevation (BFE). The structure's construction, finishes, systems, utilities, storage and contents / furnishings at the first-floor elevation area are substantially below the BFE and will incur significant damage.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems / storage to above DFE.
2. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
3. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
4. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
5. Evacuate the structure during a flood event to prevent loss of life.

Notes:

6. The property owner indicated the structure experienced flooding on the first floor during past flood events and incurred extensive damages. When a flood warning is given the property owner evacuates the structure contents and stores it off site.
7. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

OCCUPIED STRUCTURE ASSESSMENT SHEET

Structure ID	Structure Address
#5	3705 Earl B Wilson Dr, New Iberia, LA

Structure Photographs

Front

Interior

Structure Characteristics

Characteristic	Description
Occupancy -	Commercial – Fabrication, service and repair
Configuration -	One story 35,700 sq ft
Construction -	Concrete slab foundation. Steel framing with steel siding and roof.
Condition -	Good
Other -	The building has 2 rolling door openings at either end. There are multiple non-engineered vents in the building walls. The building owner is gradually flood proofing the building. The electric transformer is at BFE. The interior electric needs elevating. The owner has an evac plan to get portable equipment into a shipping container and elevate with existing overhead crane.

Site Visit Observations

General: The large site features two double wide modular office modular buildings on an elevated structural steel frame. The fabrication building measures 357ft X 100ft X 50ft high.

Site: The fabrication building is situated on an industrial port site and free standing on the property. The area around the structure is limestone. The grade at the front of the structure slopes slightly downward toward the access road. The grade at the sides of the structure slopes down from the building. The grade at the rear slopes down away from the structure.

Structure: The building needs an engineered flood vent retro fit to be compliant with minimum square ft coverages required by FEMA/NFIP to be wet flood proofed. The administration office spaces are elevated to BFE +1FT. Some minor repairs are needed to the exterior steel siding.

Systems/Utilities: The site power transformer is elevated to BFE+1ft. The power distribution system inside the building needs to be elevated. Sanitary waste line needs back flow preventer.

OCCUPIED STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#5	3705 Earl B Wilson Dr, New Iberia, LA

Structure and Flood Elevations

FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
5.9 ft	5ft	n/a	AE-11	6ft	7ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 6ft feet below the base flood elevation (BFE). The structure's construction, finishes, systems, utilities, storage and contents would incur substantial damage in a flood event. If wet flood proofed, the building would be subject to less damage due to letting the water in and out of the interior.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems to upper level above the DFE if applicable.
2. Elevate the exterior HVAC equipment onto platform(s), above the BFE.
3. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
4. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
5. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
6. Evacuate the structure during a flood event to prevent loss of life.

Notes:

1. The property owner indicated the structure experienced flooding on the first floor during past flood events. When a flood warning is given the property owner elevates the structure contents. Interior finish materials need to be replaced with approved flood resistant construction materials
2. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

Note: The building qualifies as "functionally dependent" under CFR 59.1. FEMA/NFIP local ordinance requires a variance be provided for this work.

OCCUPIED STRUCTURE ASSESSMENT SHEET	
Structure ID	Structure Address
#6	3415 Earl B Wilson Dr, New Iberia, LA

Structure Photographs	
	
"Main" shop	"Spool" shop

Structure Characteristics	
Characteristic	Description
Occupancy -	Fabrication.
Configuration -	The main shop building measures 280' X 250' = 70,000 sq ft and 50' high. Concrete slab foundation. Steel interior frame, steel siding and roof.
Construction –	Good.
Condition -	The main 2 buildings are sited above the level of the access road. There are multiple door openings in the sides of the building. There are non-engineered air vents in the walls. The site has multiple exterior power stations for overflow welding. There is an autoclave oven on grade that needs mitigating along with a small building power distribution that needs elevating. The site needs an elevated platform with ramp to park the crawler crane and two large fork lifts.
Other -	

Site Visit Observations

General: The site is relatively flat. There is a slip on the north end of the site.

Site: Industrial port site. The 2 main structures are situated on an industrial port site and free standing on the property. All but two of the office space modular buildings are at BFE+1ft. The grade at the front of the structure slopes slightly downward toward the access road. The grade at the sides of the structures slopes down from the building. The grade at the front and rear slopes down away from the structures.

Structure: The building has existing non engineered air vents and needs engineered flood vents in order to be wet flood proofed.

Systems/Utilities: Air conditioners for the upper level offices need to be elevated on stands to the DFE. All site electric utilities need to be elevated to BFE+1ft.

OCCUPIED STRUCTURE DATA SHEET (CONTINUED)

Structure ID	Structure Address
#6	3415 Earl B Wilson Dr, New Iberia, LA

Structure and Flood Elevations

FF	LAG	B	BFE	Δ BFE-FF	Δ BFE-LAG	Δ BFE-B
6ft	5ft	n/a	AE-11	5ft	6ft	n/a

ABBREVIATIONS: FF – First Floor Elevation; LAG – Low Adjacent Grade Elevation; B – Basement Floor Elevation; CS – Crawl Space Ground Elevation; BFE – Base Flood Elevation; Δ – Delta (Elevation Difference); NA – Not Applicable; * - Estimated

Flood Risk

Flood Risk: The first floor is approximately 5 feet below the base flood elevation (BFE). Structure's construction, finishes, systems, utilities, storage and contents/furnishings at the finished floor level (below the BFE) would incur substantial damage.

Recommendation

Based on the structure characteristics, site visit observations, structure / flood elevation data and the flood risk, the following mitigations are recommended:

1. Relocate the building utilities / systems / storage to upper level above BFE if applicable.
2. Remove water damagable construction material and finishes and replace with water resistant construction and fininshes.
3. Wet flood proof the structure according to FEMA Technical Bulletin 7. Install engineered flood vents in the existing walls.
4. Plan for evacuation of moveable equipment and structure contents prior to flood event when adequate warning is given.
5. Evacuate the structure during a flood event to prevent loss of life.

Notes:

6. The property owner indicated the structure experienced flooding on the first floor during past flood events. When a flood warning is given the property owner elevates the structure contents. Interior finish materials need to be replaced with approved flood resistant construction materials
7. Loose equipment, containers and debris on the site will easily float away during a flood event, being lost or causing environmental hazard.

Note: The building qualifies as "functionally dependent" under CFR 59.1. FEMA/NFIP local ordinance requires a variance be provided for this work.

2.3 APPLICATION – EXPLORATORY MITIGATION STRATEGIES

The application of wet floodproofing was discussed between USACE, ASFPM, and the Flood Mitigation Industry Association. The following list includes all of the risk reduction options analyzed and are considered common for commercial occupancy type prior to settling on a template used for cost estimating purposes.

1. Risk Reduction of the Structural Envelope (walls)

The purpose of these methods is to reduce damages to structural wall during an event. FEMA design requirements discuss the priority for equalizing hydrostatic forces through appropriate number of vents within a given structure. Table L:2-1 lists wet floodproofing methods for structural stability considered, status of method, and rationale for screening (if applicable).

Table L:2-1. Screening of Wet Floodproofing Methods- Structural

Wet-Floodproofing Method	Method Status	Screening Rationale
Exterior cladding of the structure to be non-porous and resistant to chemical corrosion and debris deposits, and be conductive to easy cleaning	Method Screened	Method was screened because review of structures through NSI database, coordination with the Port, and site visits determined existing conditions of structures is already exterior cladding that is non-porous
If required, replace steel with galvanized or protected material with rust and corrosion retardant paint	Method included in cost estimate	Potential minor replacement needed on existing structures. This method was determined to be effective at reducing damages on the exterior of structures.
Sandblast interior walls and support beams to remove coatings and rust and replace with rust and corrosion retardant paint	Method included in cost estimate	Interior of structures do not have corrosion and rust retardant paint up to 12 feet. This method was determined to be effective at reducing damages on the interior of the structure.
Demo existing sheetrock, batt insulation, and electrical outlets to be replaced by rigid foam wall insulation, hardy dry board, and elevated electrical outlets. Seal concrete floor with sealer or stain.	Method included in cost estimate	Interior of structures do not have corrosion and rust retardant paint up to 12 feet. This method was determined to be effective at reducing damages on the interior of the structure.

2. Risk Reduction of Contents

The purpose of these methods is to reduce damages to contents. FEMA generally recognizes two overarching methods for contents damage reduction, 1- In-Place Protection or Isolation of contents from Floodwaters, both options were assessed during formulation. Table L:2-2 lists wet floodproofing methods for contents protection considered, status of method, and rationale for screening (if applicable).

Table L:2-2. Screening of Wet Floodproofing Methods- Contents

Wet-Floodproofing Method	Method Status	Screening Rationale
Install barriers and floodwalls on the interior of a structure to protect immobile high value contents	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area due to contents being mobile and of only moderate value. This method would be rational for warehouses with high value immobile machinery such as robotic arms, large lasers, or CNC machines.
Install hoists, cranes, pedestals, or overhead suspension to temporarily elevate contents	Method included in cost estimate	Method would allow for quick (~1 day) preparation time and protect mobile equipment such as welders, forklifts, and other contents. Method is being utilized at port facility and is effective at reducing damages and ensuring continuity of operations following an event.
Install a stage or platform on the interior of the structure	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area due as platform would need to be non-porous material and stable. Measure was determined to be more costly when compared to modular storage racks.
Lay down plastic sheeting below the contents, then wrap and tie the sheeting around contents during the flood event	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area due as installation of plastic would need to occur prior to an event and ensure no ripping. Risk of heavy equipment tearing and rendering method ineffective is high.
Using modular palletized storage racks to elevate mobile contents	Method included in cost estimate	Installation of modular racks was the least cost effective measure to reduce damages to contents and allow for customization to building layout. Modular palletized storage racks can be combined with other content risk reduction measures.

3. Risk Reduction of Utilities

The purpose of these methods is to reduce damages to existing utilities above the design grade BFE. Table L:2-3 lists wet floodproofing methods for utility damage reduction considered, status of method, and rationale for screening (if applicable).

Table L:2-3. Screening of Wet Floodproofing Methods – Utilities

Wet-Floodproofing Method	Method Status	Screening Rationale
Conversion to tank-less water heaters	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area.
Elevate electric service	Method included in cost estimate	Method would elevate existing services to above 12 feet.
Elevate HVAC condenser units	Method included in cost estimate	Method would elevate existing services to above 12 feet. HVAC condenser units are essential to dry out interior post event.
Elevate fuel systems (propane tanks)	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area.
Elevate sewage management system	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area.
Elevate potable water system and sump pump	Method Screened	Coordination with Port officials and site visits determined that this method was largely ineffective within the study area.

4. Conveying Flood Waters through the Structure

The purpose of this method is to allow floodwaters to enter enclosed area through vents. The water level inside the home rises and falls at roughly the same rate as the water level outside so the hydrostatic pressure equalizes. Table L:2-4 lists wet floodproofing methods for flood water conveyance considered, status of method, and rationale for screening (if applicable).

Table L:2-4. Screening of Wet Floodproofing Methods- Flood water conveyance

Wet-Floodproofing Method	Method Status	Screening Rationale
Flood vents or doors installed to reduce hydrostatic pressures	Method included in cost estimate	Flood vents were included in the cost estimate. Costs and number of vents per structure were based on NFIP Technical Bulletin #7 for wet floodproofing of structures.

5. Risk Reduction of Interior Office Operations

The purpose of these methods is to reduce damages to interior office locations and operations post and event. Table L:2-5 lists wet floodproofing methods for interior office operations damage reduction and continuity of operations considered, status of method, and rationale for screening (if applicable).

Table L:2-5. Screening of Wet Floodproofing Methods- Interior Office

Wet-Floodproofing Method	Method Status	Screening Rationale
Elevate office within the interior footprint of the building	Method Screened	Uncertainty in story height of warehouse structures within the study area and if elevating an office within the warehouse would be feasible.
Construct elevated steel modular building exterior to the building footprint	Method included in cost estimate	Coordination with Port officials and site visits determined this method of floodproofing office space already existed in the study area and could be applied to other warehouse structures assuming available space exists on the parcel. All newly constructed office buildings will be elevated consistent with local floodplain ordinances (BFE + X Feet)

2.4 APPLICATION – SITE SPECIFIC MITIGATION STRATEGIES

The PDT refined the wet floodproofing mitigation methods based on the types of structures and its associated operations that were surveyed within the Port of Iberia. Following screening of mitigation methods, structure were sorted into two types: general purpose warehouse structures and fabrication warehouses. The only significance difference as it relates to scope and cost of the cost estimate is that fabrication buildings require significantly more work to elevate as they tend to require large scale hoists and associated utilities as indicated in Figure L:2-1.

Figure L:2-1. Example of Significant Electrical Infrastructure Requiring Elevation

The following wet floodproofing methods were determined feasible and were used to develop cost estimates:

1. Risk Reduction of the Structural Envelope

    - Replace exterior steel with galvanized or protected material with rust and corrosion retardant paint
    - Sandblast interior walls and support beams to remove coatings and rust and replace with rust and corrosion retardant paint
    - Demo the first 4-6 feet of existing sheetrock, batt insulation, and electrical outlets to be replaced by rigid foam wall insulation, hardy dry board, and elevated electrical outlets. Seal concrete floor with sealer or stain.

2. Risk Reduction of Contents

    - Rehab floor of structure to install a 10-ton crane with supporting scaffolding
    - Install modular palletized storage racks to elevate mobile contents

3. Risk Reduction of Utilities

    - Elevate electric service
    - Elevate HVAC condenser units

4. Conveying Flood Waters through the Structure

    - Flood vents installed to reduce hydrostatic pressures

5. Risk Reduction of Interior Office Operations

    - Construct elevated steel modular building exterior to the building footprint

Cost estimates were based on surveyed structures: The wet floodproofing mitigation methods were selected as a comprehensive strategy based on availability of contract cost estimations and overall effectiveness of the flood mitigation, as the motivation of the effort was to maximize the level of risk reduction for warehouse structures.

The strategy includes sand blasting older exterior/interior coatings to remove corrosion and rust and applying two coats of new epoxy paint. Existing sheetrock, batt insulation, and electrical outlets would be removed to install rigid foam wall insulation, hardy dry board and elevate electrical outlets to 4-6 feet. The floor would be treated with a sealer or stain.

Portable equipment that will not be evacuated during a storm event will be either stored on elevated modular palletized storage racks, typically used by forklifts, or packed into a steel shipping container and lifted by a 10-ton crane to at least 6 feet above the interior flood elevation. The crane installation would be a standalone rigging with new footings installed with six steel legs per cane. Engineered flood vents would be installed around the perimeter of the building.

The scope assumed that not all warehouse structures would have the vertical capacity to accommodate the elevation of an office building and therefore it was assumed a 500 square foot modular steel office building would have to be constructed and elevated above the BFE, located outside the structure's footprint.

The wet floodproofing mitigation methods were determined by the PDT to provide flood risk reduction to warehouse structures of up to 12 feet for the structural envelope, and 6 feet for the structural contents.

2.5 APPLICATION – COST ESTIMATE

All cost estimates were developed by the Flood Mitigation Industry Association in partnership with USACE and local contractors that would be expected to bid on wet floodproofing solicitations. All cost estimates are presented in FY2021 dollars, reflective of cost in the Louisiana region, and exclude S&A, planning, engineering and design, construction management, and contingency costs. S&A, planning, engineering and design, construction management, and contingency costs were intentionally excluded to develop a unit cost per wet floodproofing method type. (S&A, planning, engineering and design, construction management, and contingency costs were then calculated on the aggregated

total cost of all floodproofing activities). While the costs are presented for warehouse structures between 2,500 and 300,000 square feet, they were originally scoped for 18,000 square foot warehouses, and therefore the uncertainty surrounding the cost estimates will increase the higher the square footage of the warehouse. Table L:2-6 shows costs associated with each dry floodproofing mitigation option. Table L:2-7 shows a summary of costs by square foot for general warehouse structures. Table L:2-8 shows a summary of costs by square foot for fabrication warehouse structures with more advanced electrical mitigation efforts required. Table L:2-9 shows a summary of the costs for commercial and fabrication warehouses.

Table L:2-6. Itemized Wet Floodproofing Cost Estimate

Reference Structure	
Building Square Footage (SF)	18,043
Perimeter Linear Foot (LF)	537
Item	**Cost ($)**
Wet Floodproofing ($35/LF)	18,805
10-Ton Crane ($496k/building)	496,000
Storage Racks (100 LF of racks @ $232/LF)	23,200
Paint Coatings ($20/LF)	10,746
Elevated Office ($100/SF Building +$71/SF Elevation)	85,500
Elevated Electrical for Warehouse	187,508
Elevated Electrical for Fabrication	288,708
Flood Vents ($2/SF)	36,086
Total Cost for Warehouse ($/Building)	**$857,846**
Total Cost for Fabrication ($/Building)	**$959,046**

Table L:2-7. General Warehouse Wet Floodproofing Cost per Square Footage

General Warehouse Square Footage	Cost ($)
2,500	732,825
5,000	754,506
7,500	775,128
10,000	795,200
15,000	834,394
20,000	872,813
250,000	2,527,200
300,000	2,880,199

Table L:2-8. Fabrication Warehouse Wet Floodproofing Cost per Square Foot

Fabrication Warehouse Square Footage	Cost ($)
2,500	834,025
5,000	855,706
7,500	876,328
10,000	896,400
15,000	935,594
20,000	974,013
250,000	2,628,400
300,000	2,981,399

Table L:2-9. Warehouse Wet Floodproofing Cost Summary

Warehouses					
	Number of Structures	Wet FP Unit Direct Cost ($/EA) (5)	Extended Direct Costs	Imple Admin @ $19,531/ea (4)	Total
Warehouses	161	$812,400.00	$130,796,400	$3,144,491	$133,940,891
Fabrication Warehouses	24	$945,600.00	$22,694,400	$468,744	$23,163,144

Section 3
Study Impacts

3.1 IMPACT OF INCORPORATING WET FLOODPROOFING ON RESIDUAL RISK

As previously described, the post-TSP existing condition led to the idea of exploring the possibility of wet floodproofing warehouse structures and determining its effectiveness relative to dry floodproofing. After scoping the wet floodproofing methodology and application, it was determined by PDT that wet floodproofing warehouse structures could mitigate up to 12 feet of flooding to the structure envelope, and 6 feet to the structure's contents. A sensitivity analysis determined risk reduction associated with 12 and 6 feet of provided warehouse structures with less than a 0.04 AEP level of protection when using dry floodproofing to approximately a 0.01 AEP level of protection when wet floodproofing methods were utilized. This statistic varies by location, but provides an approximate risk reduction estimate. The tradeoff for the increased level of protection was a cost estimate that increased approximately 3-5 times relative to dry floodproofing.

When examined as a whole, optimizing the nonstructural aggregation, elevation heights, and wet floodproofing for warehouse structures reduced residual risk for the recommended NED plan from 28 percent to close to 41 percent for year 2025 damages. This figure is for the entire study area, which encompasses thousands of additional structures that are not included within the 2,240 structures in the 0.04 AEP nonstructural aggregation. When calculating residual risk for just the nonstructural aggregation, the recommended NED plan reduces year 2025 damages by 66 percent, meaning only 34 percent of the existing condition damages will remain within the 0.04 AEP nonstructural aggregation after fully implementing the plan. Industrial warehouse structures make up approximately 30 percent of all existing condition damages, and therefore improving the level of risk reduction from 0.04 AEP to 0.01 AEP using wet floodproofing significantly contributed to a reduction in residual risk. The mix of applying wet floodproofing with optimizing structural elevations increased net benefits for the study by 213 percent, as shown in Table L:3-1.

The without wet floodproofing column of Table L:3-1 comes from the residential elevation optimization analysis that did not yet incorporate the effectiveness or updated cost of wet floodproofing, and as a result, Table L:3-1 shows zero wet floodproofing costs for the without condition. Additionally, costs were continually adjusted up until the final report, and therefore some costs, such as elevation costs are inconsistent with total project cost estimates.

Table L:3-1. Comparison of Impacts of Incorporating Wet Floodproofing on Net Benefits

	Without Wet Floodproofing	With Wet Floodproofing
Elevation Count	1,790	1,790
Dry Floodproofing Count	265	265
Wet Floodproofing Count	185	185
Total Structure Count	2,240	2,240
Elevation Cost	332,047,000	346,522,000
Dry Floodproofing Cost	95,556,000	24,651,000
Wet Floodproofing Cost	0	164,772,000
Total Nonstructural Cost	427,603,000	535,953,000
Contingency	156,075,000	185,976,000
Cultural Resource Preservation	1,947,000	4,527,000
Planning, Engineering and Design	21,380,000	37,959,000
Real Estate	34,168,000	36,401,000
Construction Management	8,552,000	14,561,000
IDC	1,982,000	2,770,000
Total Cost	651,707,000	818,147,000
Average Annual Cost	24,140,000	30,305,000
Equivalent Annual Damage Reduced	50,366,000	86,365,000
Net Benefits	26,226,000	56,060,000
BCR	2.09	2.85

*Cost rounded to the nearest thousand.

3.2 IMPACT OF INCORPORATING WET FLOODPROOFING ON FLOODPLAIN MANAGEMENT

Local floodplain ordinances are locally determined by individual counties or parishes and as a result, the acceptability of wet floodproofing will vary. The National Flood Insurance Program (NFIP) currently excludes wet floodproofing as a method to reduce the requirement for flood insurance. During the event that the cost of rehabilitation associated with wet floodproofing triggers a substantial improvement, a structure has the potential of requiring elevation. The cost estimate includes the cost of elevating office space, but not the actual warehouse portion of the structure. Warehouses located in or near port facilities commonly are exempt from traditional floodplain regulations given a "functional dependence" under CFR 59.1. FEMA and the NFIP local ordinance requires a variance be provided for wet floodproofing. Application of the wet floodproofing costs within this appendix should be consulted with local floodplain managers to ensure compliance with local floodplain laws and ordinances. As previously discussed, Port of Iberia owns approximately 70 percent of the buildings within the port footprint, and rents out the buildings to tenants. The other 30

percent of the buildings within the port are privately owned. In July of 2020, the Flood Mitigation Industry Association and the Port of Iberia surveyed six port buildings, two of which were currently occupied, and the other four were vacant and owned by the Port to be leased to tenants. The CEMVN team assumed during implementation leased building tenants would be eligible for Uniform Relocation Act Assistance (URA). URA cost assumptions are documented in Appendix E Real Estate. Cost assumptions for all nonstructural methods are included in Appendix M: Cost Appendix.

Section 4
Wet Floodproofing Contacts

4.1 WET FLOODPROOFING CONTACTS

For inquiries and questions on the development of wet floodproofing costs and its application to planning studies, please contact:

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