2023 COASTAL MASTER PLAN

NONSTRUCTURAL RISK REDUCTION EVALUATION RESULTS

ATTACHMENT E3

REPORT: VERSION 03

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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

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EXECUTIVE SUMMARY

This attachment compiles the nonstructural project results for the 2023 Coastal Master Plan. This attachment summarizes the mitigation measures derived from the nonstructural technical analysis conducted using the Coastal Louisiana Risk Assessment (CLARA) model and informs the benefit and cost competitive programmatic budgets selected by the Planning Tool. As such, a major change from the 2017 Coastal Master Plan is that there is not a recommended suite of nonstructural projects.

While there are not specific recommendations on the implementation of nonstructural projects in the master plan, the results may be informative to other state agencies, nongovernmental organizations, community advocates, and coastal stakeholders who are interested in developing coastal hazard mitigation plans, comprehensive plans, or other nonstructural mitigation projects. Nonstructural model results include:

- The attributes associated with different nonstructural variants;
- A comparison of expected annual damage in dollars (EADD) versus expected annual structural damage (EASD) benefits over time;
- An evaluation of different participation rates;
- Comparisons between communities;
- A sample of community-level results; and
- A methodological discussion of setting targets for Implementation Period 2 (IP2).

This attachment shows nonstructural results for a representative sample of 11 communities along the coast, with four communities compared in greater detail. While the Risk Assessment Team generated several variants, the team ultimately only selected two, in conjunction with the Planning Tool Team, for further analysis. The two variants correspond to a 14 ft 100-year flood depth buyout threshold for both Implementation Periods 1 and 2 (IP1 and IP2) in Years 0 and 30, respectively. The Planning Tool then used the results shown here to linearly scale the benefits associated with 25, 50, and 75% participation rates in their analysis.

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LIST OF ABBREVIATIONS

AEP .... ANNUAL EXCEEDANCE PROBABILITY
CLARA .... COASTAL LOUISIANA RISK ASSESSMENT
CPRA .... COASTAL PROTECTION AND RESTORATION AUTHORITY
EADD..EXPECTED ANNUAL DAMAGE IN DOLLARS
EASD .... EXPECTED ANNUAL STRUCTURAL DAMAGE
FWOA ....FUTURE WITHOUT ACTION
HSDRRS.................... HURRICANE AND STORM DAMAGE RISK REDUCTION SYSTEM
IP.. IMPLEMENTATION PERIOD
NS.. NONSTRUCTURAL
RCP .... REPRESENTATIVE CONCENTRATION PATHWAY

1.0 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

This attachment describes the mitigation measures derived from the nonstructural technical analysis conducted using the Coastal Louisiana Risk Assessment (CLARA) model and informs the benefit and cost competitive programmatic budgets selected by the Planning Tool to support Louisiana's 2023 Coastal Master Plan. As such, a major change from the 2017 Coastal Master Plan is that there is not a recommended suite of nonstructural projects.

Programmatic measures pertain to any activities, not involving physical construction, that use knowledge, practice, or agreement to reduce risks and impacts, in particular through policies and laws, raising public awareness, training, and education. CPRA understands that effectively reducing storm surge flood risk through nonstructural efforts requires the implementation of both physical projects and programmatic measures. Programmatic measures are often implemented through planning or policy initiatives and can include land use planning, hazard mitigation planning, flood ordinances, and building codes. These activities reduce risk to future development within communities, and therefore are integral elements of achieving risk reduction goals across coastal Louisiana.

1.2 THE CLARA MODEL

The CLARA model was originally created by researchers at RAND Corporation to support development of Louisiana's 2012 Coastal Master Plan. CLARA is designed to estimate flood depth exceedances, direct economic damage exceedances, and expected annual damage in the Louisiana coastal zone. The model uses high-resolution hydrodynamic simulations of storm surge and waves as inputs. Monte Carlo simulation and scenario analyses are used to estimate risk under a range of assumptions about future environmental and economic conditions and with different combinations of structural and nonstructural risk reduction projects on the landscape.

Prior peer-reviewed and published literature describes the foundations of the CLARA, so this report does not include detailed descriptions of the basic methodological approach and assumptions. For interested readers, an introduction to the model can be found in Johnson et al. (2021a), Fischbach et al. (2012), and Johnson et al. (2013). Model improvements for the 2017 Coastal Master Plan are described in Fischbach et al. (2017), and published examples of CLARA model results can be found in Fischbach et al. (2019), Meyer and Johnson (2019), and Fischbach et al. (2017). Model improvements for Louisiana's 2023 Coastal Master Plan are described in Fischbach et al. (2021).

This report should be of interest to CPRA, state officials, community advocates, and coastal stakeholders engaged in nonstructural risk mitigation planning processes. The report version reflects data upgrades and model improvements made as of December 2021.

1.3 ORGANIZATION OF THIS REPORT

There are three sections in this report. The first section (Section 2.0) describes attributes associated with different nonstructural variants, compares Expected Annual Damage in Dollars (EADD) versus Expected Annual Structural Damage (EASD) project benefits over time, and evaluates the impact of different participation rates. Section 3.0 looks at the community-scale impact, comparing 11 communities and Section 4.0 details the results of four sample communities. Section 5.0 is a methodological discussion of setting targets for the Planning Tool in IP2. Section 6.0 offers concluding observations.

2.0 PROJECT ATTRIBUTES

2.1 DEFINITION AND COST OF MITIGATION MEASURES

The CLARA model's economic damage module has the capability of estimating the risk reduction effects of various nonstructural mitigation measures. Mitigation measures could include one of the following approaches (see Section 2.3 for details on how mitigation standards are defined):

- **Elevation of residential structures.** Recommended in areas where the mitigation standard is greater than 3 feet but less than the elevation for voluntary acquisition (described below);
- **Floodproofing of single-family, multi-family and non-residential structures**. Recommended in areas where the mitigation standard is less than 3 feet;
- **Voluntary acquisition for residential structures**. Recommended in areas where the mitigation standard is greater than a pre-specified threshold (variants explored in this research utilized either 12 or 14 feet of flood depths).

The Risk Assessment Team then applied these measures to each structure within the modeling grid, with floodproofing and elevation costs as a function of the difference between the ground and mitigation standard's elevation as well as the structure's square footage. Acquisition costs additionally included the area of the property. More details about the cost database can be found in Attachment F6: Project Development Database Documentation.

2.2 KEY CHANGES IN THE 2023 COASTAL MASTER PLAN ANALYSIS

The risk assessment research for the 2023 Coastal Master Plan is heavily informed by the 2012 and 2017 master plans. For example, the Risk Assessment Team carried forward assumptions about nonstructural project attributes such as whether the acquisition threshold would be at 12 or 14 feet and updated cost tables for the different project types rather than beginning with a new set of analysis from first principles. In the 2023 analysis, CPRA asked the Planning Tool Team to identify a programmatic nonstructural budget rather than selecting specific nonstructural risk reduction projects by community. As such, the Risk Assessment and CPRA teams believed that the assumptions made in 2012 and 2017 were sound without extensive revision, as the Planning Tool would not be directly characterizing the wide variability in either type or location of nonstructural risk mitigation across different coastal communities. The Risk Assessment Team generated nonstructural results for four different asset type categories: single-family residential; multi-family housing; commercial, industrial, and agricultural; and other structures (public, educational, and religious). However, the Planning Tool

Team utilized only the aggregated cost effectiveness over all asset types in a community when determining a recommended nonstructural budget (again, given the programmatic nature of the nonstructural implementation).

While the Risk Assessment Team preserved core assumptions about nonstructural project attributes from the 2012 and 2017 master plans, the team also made several changes to risk modeling, which have indirect and direct implications for the analysis of nonstructural mitigation. For example, CPRA updated its environmental scenarios (Table 1), and the Risk Assessment Team utilized a new synthetic storm suite of 645 storms based on an augmented dataset (in comparison to the previous inputs of 446 storms), which permitted consideration of relatively mild tropical cyclones excluded from the scope of analysis in previous plans. The Risk Assessment Team, informed by CPRA and other lines of effort, updated the population growth scenario used to project asset growth into the future (Attachment E2: Risk Assessment Model Improvements). For more information on these updates to the CLARA model, see Fischbach et al. (2021).

Table 1. Environmental scenario definitions for the 2023 Coastal Master Plan

SCENARIO	EUSTATIC SEA LEVEL RISE (OVER 50 YEARS) *	SUBSIDENCE	PRECIPITATION, EVAPOTRANSPIRATION, TRIBUTARY FLOWS	TROPICAL STORM INTENSITY
LOWER	0.5 METERS (1.6 FEET)	DEEP SUBSIDENCE + 1ST QUARTILE OF SHALLOW SUBSIDENCE	RCP 4.5 50^{TH} PERCENTILE	+5% INCREASE
HIGHER	0.77 METERS (2.5 FEET)	DEEP SUBSIDENCE + MEDIAN OF SHALLOW SUBSIDENCE	RCP 4.5 50^{TH} PERCENTILE	+10% INCREASE

* RATE OF CHANGE IS NOT LINEAR.
NOTE: RCP=REPRESENTATIVE CONCENTRATION PATHWAY, A GREENHOUSE GAS CONCENTRATION TRAJECTORY ADOPTED BY THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE.

The most important change in the Risk Assessment Team's analysis for nonstructural protection in the 2023 Coastal Master Plan was that the team began to model flood damage at the level of individual structures, as opposed to using assumed structure counts at the census block level. The team combined data from the National Structure Inventory (Georgist, 2019), ATTOM Data Solutions, the Homeland Infrastructure Foundation-Level Data (secured and licensed through the Department of Homeland Security), as well as the results of a project leveraging machine learning techniques in conjunction with imagery to identify relevant attributes of certain structures (Chen et al., 2022) to produce a single structure-level dataset for the entire coastal region of Louisiana. Structure values and risk metrics were estimated for each structure based on its estimated attributes (e.g., first-floor elevation, square footage).

The use of structure-level damage estimates meant that the treatment of nonstructural mitigation could be handled more explicitly with respect to both the nonstructural attributes themselves and participation rates. For example, the nonstructural attributes were updated to include all structure types as candidates for floodproofing, whereas previous efforts limited floodproofing solely to commercial properties. While the Risk Assessment and Planning Tool Teams previously modeled nonstructural protection as a change in the aggregate building attributes of an affected census block in the 2017 Coastal Master Plan, the damage model now accounts for attribute changes for each eligible structure assuming full participation in nonstructural mitigation. Expected risk outcomes under alternative participation rates are identified by linear interpolation between the full participation case and a future without action (FWOA). The Risk Assessment Team then assumes that any new structures due to future growth in each census block will have the same attributes as the existing population after nonstructural mitigation has been applied. The damage model addresses future growth by simply multiplying the value of each structure by the proportional change in population. Note that these modeling choices implicitly assume that asset changes and participation in nonstructural mitigation occur uniformly within communities, i.e., without disproportionate mitigation or growth in areas with higher hazard.

In principle, the structure-level modeling approach could permit nonstructural analysis at any arbitrary spatial scale. However, residual uncertainty about the attributes of individual buildings could lead to biased estimates if reported using structures as the unit of analysis. Preliminary analysis, documented in Fischbach et al. (2021) found that aggregating risk metrics to the community level was appropriate for reducing bias in risk estimates. The Risk Assessment Team identified 204 communities using parish or municipal boundaries. In addition, the Risk Assessment Team categorized each community based on its location either inside or outside of existing structural protection as necessary, resulting in 291 distinct project geographic areas with non-zero available nonstructural investments (though the team conducted additional revisions to splits along levee features after it completed the main body of analysis for the purposes of the Planning Tool Team). The combination of 291 project areas with two variants and differential participation rates resulted in the suite of 1,164 potential nonstructural projects competed against structural projects in the Planning Tool.

2.3 GENERATION OF VARIANTS

Nonstructural project variants are defined by the standards for mitigation heights used to determine which structures should be elevated, floodproofed, or acquired. The standards are determined by median estimates of the 1% annual exceedance probability (1% AEP or 1 in 100-year) flood depths at each CLARA model grid point, under a specified landscape scenario and year, plus two feet of freeboard. The Risk Assessment Team excluded grid point locations with no 1% AEP flood depths from further nonstructural analysis. Project variants differ according to which landscape scenario and year these depths are drawn from, for example, future 1% AEP flood depths under Year 30 conditions (both environmental scenarios), Year 40 conditions (only the higher environmental scenario), and Year 50 conditions (both environmental scenarios). Table 2 shows how the combination of these attribute variables generated 12 variants for analysis (two of which, Variants 1 and 3, the Planning Tool Team used in subsequent calculations, as discussed in detail in Section 5.0).

Table 2. Nonstructural protection variants summary

VARIANT NUMBER	ENVIRONMENTAL SCENARIO	TARGET YEAR FOR 1% AEP FLOOD DEPTH	ACQUISITION THRESHOLD
1	LOWER	YEAR 0	14 FEET
2	LOWER	YEAR 0	12 FEET
3	LOWER	YEAR 30	14 FEET
4	LOWER	YEAR 30	12 FEET
5	LOWER	YEAR 50	14 FEET
6	LOWER	YEAR 50	12 FEET
7	HIGHER	YEAR 30	14 FEET
8	HIGHER	YEAR 30	12 FEET
9	HIGHER	YEAR 40	14 FEET
10	HIGHER	YEAR 40	12 FEET
11	HIGHER	YEAR 50	14 FEET
12	HIGHER	YEAR 50	12 FEET

3.0 COMPARISON OF BENEFITS IN SELECTED COMMUNITIES

The Risk Assessment Team's exploration of nonstructural benefits looked first at communities with the greatest reduction in risk in Years 20 and 50, then a representative selection of communities by the potential strategies across the coast. For the latter, the team considered socioeconomic and demographic variables that may influence stakeholder outreach, opportunities associated with implementation of a nonstructural investment program, or barriers to participation (including whether a building is physically capable of being elevated for a reasonable average budget).

3.1 COMMUNITIES WITH THE GREATEST POTENTIAL AMOUNT OF OVERALL RISK REDUCTION

The Risk Assessment Team used two key metrics to evaluate damage and compare benefits. First, EADD is a common indicator used in prior coastal master plans that monetizes impacts ranging from physical destruction of assets such as single-family houses to lost commercial and industrial inventory. Second, and newly implemented in the 2023 Coastal Master Plan, is EASD. EASD captures how many structure-equivalents are impacted by flooding, and to what degree, to reflect equity considerations in risk reduction investments. For example, assuming the same square footage cost and exposure of two single-family houses, the EADD metric would lend more weight to avoided damage to the larger home due to an estimated larger replacement cost, whereas EASD would consider risk to the two homes equally. Similarly, one commercial or industrial facility with a high assessed value may have the same EADD metric as a portion of a neighborhood of single-family homes, whereas the neighborhood would have a higher EASD value for that exposure.

Assuming a 100% participation rate, some communities could see significant risk reduction benefits. Table 3 shows the potential EADD reduction benefit (the difference between EADD with and without nonstructural mitigation) for the 16 most impacted communities under the lower scenario and how those results might differ under the higher scenario. The community names reflect the municipality, parish, region, and whether the Risk Assessment Team delimited the geography as being inside or outside of levee protection in the FWOA. For example, the largest absolute potential EADD benefit under both environmental scenarios is in Slidell/Eden Isle/Pearl River in St. Tammany Parish, which represents approximately three-quarters of the total FWOA exposure. In Table 3, EASD benefits in the right set of columns typically track EADD proportionally – though some communities may have greater percentages of commercial or industrial assets that shift the ratio of structure-equivalents to value.

Table 3. Benefit for 16 most-impacted communities by EADD reduction in dollars from FWOA for Variant 1 in the lower environmental scenario for Year 20

	EADD REDUCTION				EASD REDUCTION			
	LOWER SCENARIO		HIGHER SCENARIO		LOWER SCENARIO		HIGHER SCENARIO	
SLIDELL/EDEN ISLE/PEARL RIVER-ST. TAMMANY-PO-IN	$591M	-75%	$625M	-74%	711	-85%	754	-84%
LULING/BOUTTE-ST. CHARLES-BA-IN	$391M	-80%	$474M	-78%	309	-92%	374	-90%
SLIDELL/EDEN ISLE/PEARL RIVER-ST. TAMMANY-PO-OUT	$357M	-79%	$393M	-79%	298	-82%	325	-81%
MANDEVILLE/COVINGTON/ MADISONVILLE/ABITA SPRINGS-ST. TAMMANY-PO-OUT	$199M	-64%	$212M	-63%	178	-76%	190	-75%
DESTRAHAN/NEW SARPY/ NORCO-ST. CHARLES-PO-IN	$157M	-58%	$140M	-56%	126	-66%	113	-64%
LAFITTE/JEAN LAFITTE/ BARATARIA-JEFFERSON-BA-IN	$132M	-67%	$141M	-65%	227	-88%	242	-86%
BAYOU CANE-TERREBONNE-TE-IN	$86M	-48%	$102M	-44%	102	-54%	121	-51%
IRISH BAYOU / LAKE CATHERINE-ORLEANS-PO-OUT	$82M	-67%	$84M	-66%	104	-86%	107	-85%
HOUMA-TERREBONNE-TE-IN	$77M	-19%	$84M	-17%	125	-37%	139	-33%
CHAUVIN-TERREBONNE-TE-IN	$74M	-55%	$95M	-56%	115	-74%	144	-75%
NEW IBERIA-IBERIA-CC-IN	$70M	-33%	$78M	-32%	87	-62%	98	-60%
MATHEWS / LOCKPORT / LOCKPORT HEIGHTS-LAFOURCHE-TE-IN	$69M	-55%	$85M	-55%	95	-68%	118	-68%
MORGAN CITY / BERWICK / SIRACUSAVILLE-ST. MARY-TE-IN	$69M	-46%	$68M	-46%	73	-46%	72	-46%
RACELAND-LAFOURCHE-TE-IN	$65M	-60%	$83M	-60%	68	-60%	87	-59%
LAROSE-LAFOURCHE-TE-IN	$53M	-78%	$65M	-77%	58	-86%	71	-85%
LAROSE-LAFOURCHE-BA-IN	$52M	-67%	$53M	-65%	60	-88%	61	-85%

NOTE: BA=BARATARIA REGION, CC=CENTRAL COAST REGION, PO=PONTCHARTRAIN REGION, AND TO=TERREBONNE REGION. *IN* AND *OUT* INDICATE WHETHER THE COMMUNITY IS INSIDE OR OUTSIDE OF EXISTING LEVEE PROTECTIONS.

The absolute benefits of a given nonstructural formulation increase over time by Year 50, especially in the higher environmental scenario. In Table 4, however, the Risk Assessment Team notes that the relative EADD benefit declines, rapidly in some cases, relative to FWOA, which suggests that during IP2 a different threshold may be necessary. This attachment explores this further in Section 4 for a small selection of communities.

Table 4. Benefit for 16 most-impacted communities by EADD reduction in dollars from FWOA for Variant 1 in the lower environmental scenario for Year 50

	EADD REDUCTION				EASD REDUCTION			
	LOWER SCENARIO		HIGHER SCENARIO		LOWER SCENARIO		HIGHER SCENARIO	
SLIDELL/EDEN ISLE/PEARL RIVER-ST. TAMMANY-PO-IN	$987M	-70%	$1,282M	-59%	1,221	-82%	1,601	-71%
SLIDELL/EDEN ISLE/PEARL RIVER-ST. TAMMANY-PO-OUT	$698M	-78%	$960M	-69%	577	-79%	780	-69%
LULING/BOUTTE-ST. CHARLES-BA-IN	$613M	-66%	$515M	-44%	484	-80%	420	-53%
MANDEVILLE/COVINGTON/ MADISONVILLE/ABITA SPRINGS-ST. TAMMANY-PO-OUT	$294M	-56%	$328M	-39%	272	-67%	294	-48%
BAYOU CANE-TERREBONNE-TE-IN	$153M	-18%	$23M	-1%	179	-24%	47	-4%
HOUMA-TERREBONNE-TE-IN	$152M	-10%	$125M	-5%	341	-25%	298	-12%
CHAUVIN-TERREBONNE-TE-IN	$130M	-50%	$124M	-45%	180	-69%	173	-60%
RACELAND-LAFOURCHE-TE-IN	$129M	-32%	$30M	-5%	145	-32%	62	-9%
LAFITTE/JEAN LAFITTE/ BARATARIA-JEFFERSON-BA-IN	$126M	-59%	$127M	-51%	202	-81%	207	-70%
MATHEWS/LOCKPORT/ LOCKPORT HEIGHTS-LAFOURCHE-TE-IN	$123M	-34%	$40M	-8%	147	-41%	54	-11%
DESTRAHAN/NEW SARPY/ NORCO-ST. CHARLES-PO-IN	$119M	-57%	$126M	-56%	92	-65%	98	-65%
IRISH BAYOU/LAKE CATHERINE-ORLEANS-PO-OUT	$118M	-63%	$108M	-54%	157	-79%	151	-67%
NEW IBERIA-IBERIA-CC-IN	$115M	-31%	$160M	-25%	139	-54%	194	-42%
FRANKLIN-ST. MARY-CC-IN	$95M	-50%	$115M	-37%	142	-69%	174	-53%
LAROSE-LAFOURCHE-TE-IN	$93M	-72%	$83M	-62%	91	-79%	82	-68%
MONTEGUT-TERREBONNE-TE-IN	$80M	-58%	$79M	-53%	123	-70%	121	-62%

NOTE: BA=BARATARIA REGION, CC=CENTRAL COAST REGION, PO=PONTCHARTRAIN REGION, AND TO=TERREBONNE REGION. *IN* AND *OUT* INDICATE WHETHER THE COMMUNITY IS INSIDE OR OUTSIDE OF EXISTING LEVEE PROTECTIONS.

The tables above assume 100% participation, which is unlikely. In determining the size of the nonstructural program, participation rates are important for three reasons:

- A feasible participation rate (e.g., less than 100%) means that the budget set aside for nonstructural projects is more likely to be used to its fullest extent;
- Assuming an unrealistically high participation rate (e.g., 75% when it could be closer to 50%) means that, in aggregate, the Planning Tool will overestimate the potential benefits for a given cost;

- Assuming a low participation rate (e.g., 25%), the Planning Tool will not select enough competitive projects and prevent the appropriate allocation of resources between the implementation periods.

Participation rate linearly scales both the cost and benefit of nonstructural projects.

3.2 CHARACTERISTICS OF SELECTED COASTWIDE COMMUNITIES AND THEIR TYPES OF NONSTRUCTURAL MITIGATION

Participation rate, in addition to whether a structural protection project is selected benefiting that community, may be a function of other community characteristics, ranging from the types of structures (i.e., asset categories) to various socioeconomic variables. While the master plan only considers nonstructural mitigation at the programmatic level, it may be useful for stakeholder engagement and future studies to understand the variation across the coast.

This section shifts focus from the communities with the most potential damage reduction to a representative selection of 11 communities across the coast (shown in Figure 1). The Risk Assessment Team chose the communities so that at least two were drawn from each of the master plan coastal regions, with three being in the Pontchartrain region. The communities range in size from the largest in their respective region (Lake Charles/Prien or Houma) to among the smallest communities coastwide (Yscloskey).

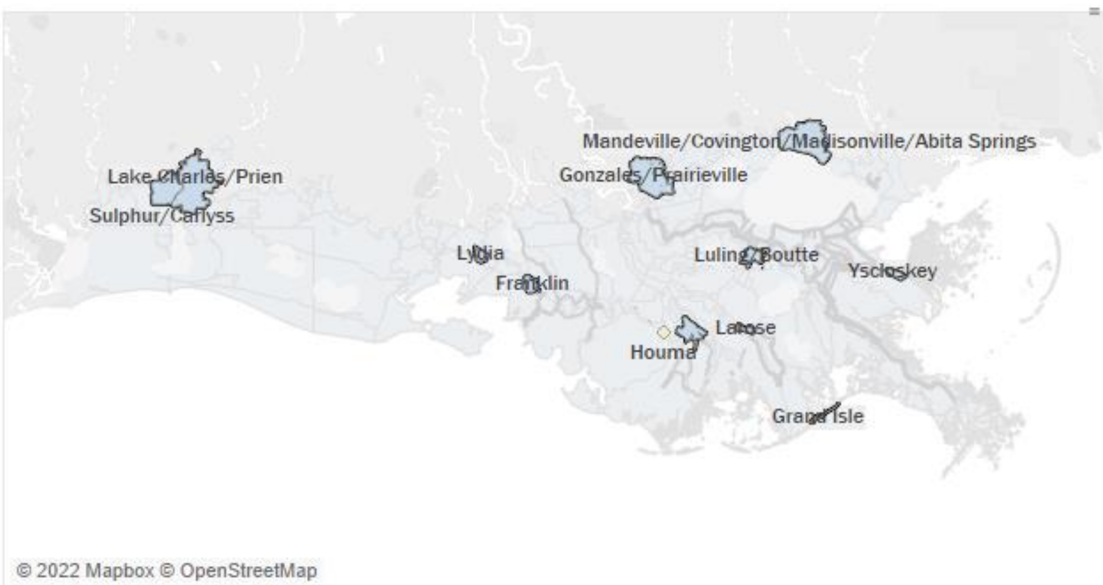

Figure 1. Map showing representative selection of communities.

Table 5 draws upon the Attachment C3: 50-Year FWOA Model Output, Regional Summaries – Risk and provides some context on the demographic breakdown of the included communities. The Risk Assessment Team considered a variety of factors, ranging from population counts, growth rates, experience with recovery processes, whether there are existing or planned flood protection structures, the balance of residential to other asset types, etc. For example, Grand Isle and Yscloskey are relatively small, substantially exposed communities, where the absolute number of structures mitigated may have a substantial impact on community health. In contrast, some communities are in areas that have experienced higher growth since earlier iterations of the master plan (e.g., Mandeville/Covington/Madisonville/Abita Springs), while others (like Gonzales/Prairieville) could experience rapid growth in the future.

Table 5. Demographic and socioeconomic characteristics of selected communities.

COMMUNITY	REGION	EXISTING STRUCTURAL PROTECTION?	TOTAL POPULATION	PERCENT NON-WHITE	PERCENT BELOW POVERTY LEVEL
SULPHUR/CARLYSS	CHENIER PLAIN	NO	33,594	17.7%	11.8%
LAKE CHARLES/ PRIEN	CHENIER PLAIN	NO	137,114	45.0%	17.6%
LYDIA	CENTRAL COAST	YES	2,493	47.2%	30.7%
FRANKLIN	CENTRAL COAST	YES	8,289	60.5%	19.6%
HOUMA	TERREBONNE	YES	41,925	43.3%	22.1%
LAROSE	TERREBONNE	YES	3,056	14.1%	15.3%
GRAND ISLE	BARATARIA	YES	1,004	6.6%	25.9%
LULING/BOUTTE	BARATARIA	YES	18,352	33.3%	13.6%
GONZALES / PRAIRIEVILLE	PONTCHARTRAIN	YES	102,787	32.5%	7.5%
MANDEVILLE/ COVINGTON/ MADISONVILLE/ ABITA SPRINGS	PONTCHARTRAIN	NO	113,856	18.9%	8.7%
YSCLOSKEY	PONTCHARTRAIN	NO	71	31.0%	11.3%

NOTE: COMMUNITIES ARE ORDERED FROM WEST TO EAST BY REGION.

Other communities, such as Lake Charles/Prien and Sulphur/Carlyss may have been disproportionately impacted by recent storms such as hurricanes Laura and Delta and have emerging data on participation rates from recovery processes. In addition, there are several locations, such as Franklin, where CPRA is considering structural protection projects. It may be of interest to have additional data to understand the relative distribution of investment and types of benefits planned for residents. The Risk Assessment Team also considers the impact of these investments at the asset type level, which might have significance for communities like Houma that contain extensive commercial and industrial structures.

In comparison to the rest of Louisiana, the communities range from below the state average non-white population of 37% in the cases of Grand Isle, Larose, and Mandeville/Covington/Madisonville/Abita Springs and Sulphur/Carlyss to above the state average in the cases of Franklin and Lydia. When considering population below the poverty line, these communities range from well above the state average of 19% in the case of Grand Isle and Lydia, to well below in the case of Gonzales/Prairieville and Mandeville/Covington/Madisonville/Abita springs. Figure 2 shows the 11 communities in the context of their peers' coastwide, by percent non-white and below poverty level, typically representing the span of the centrally focused distribution area.

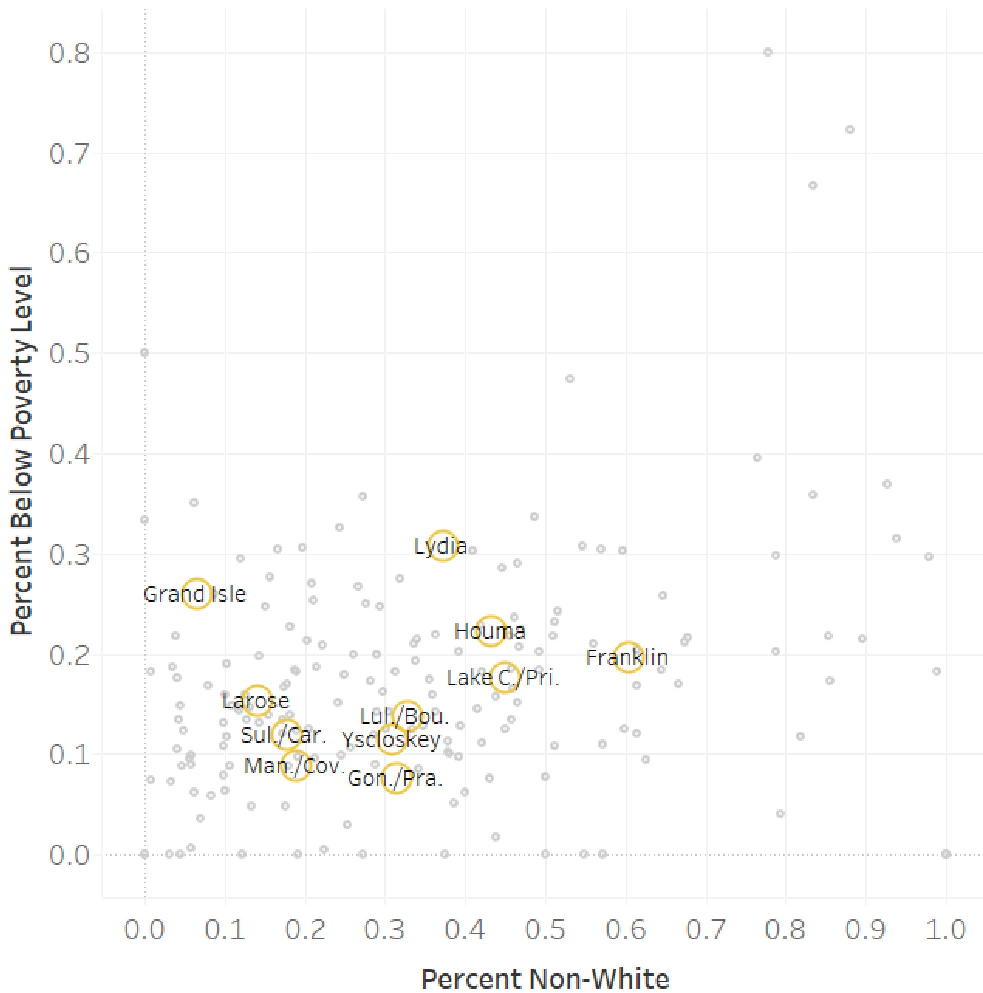

Figure 2. Distributions of non-white population versus poverty for both sample set and all the communities in the master plan.

NOTE: COMMUNITIES NOT INCLUDED IN THE SET OF 11 ARE DEPICTED IN GREY WHILE THOSE IN THE SET ARE SHOWN AS THE LARGER YELLOW CIRCLES. GON./PRA.=GONZALES/PRAIRIEVILLE, LAKE C./PRI.=LAKE CHARLES/PRIEN, LUL./BOU.=LULING/BOUTTE, MAN./COV.=MANDEVILLE/COVINGTON/MADISONVILLE/ABITA SPRINGS, AND SUL./CAR.= SULPHUR/CARLYSS.

All these communities have substantial nonstructural potential relative to their size. Table 6, however, shows that the communities vary in terms of expected benefit. For example, the two Chenier Plain communities show a relatively low percentage reduction in damage with proposed nonstructural projects, likely because of relative minor increases in expected flood depths under FWOA (though the magnitude of benefits is still quite large for the Lake Charles/Prien community due to its size versus adjacent Sulphur/Carlyss). For applications such as the Planning Tool, whether risk is evaluated on an EADD or EASD basis matters a lot for communities like Franklin, whereas other communities such as Gonzales/Prairieville have trivial differences.

Table 6. Summary of nonstructural exposure and benefits with Variant 1 in Year 50 under the lower environmental scenario for 11 selected communities.

	EADD			EASD		
COMMUNITY NAME	FWOA EXPOSURE	RISK REDUCTION	% CHANGE	FWOA EXPOSURE	RISK REDUCTION	% CHANGE
SULPHUR/CARLYSS	$569M	-$41M	-7%	433	-43	-10%
LAKE CHARLES/PRIEN	$5,151M	-$1,371M	-27%	5,106	-1,874	-37%
LYDIA	$1,333M	-$633M	-48%	7,471	-4,779	-64%
FRANKLIN	$6,881M	-$3,148M	-46%	48,814	-27,567	-56%
HOUMA	$54,065M	-$16,923M	-31%	6,289	-4,260	-68%
LAROSE	$7,610M	-$4,189M	-55%	1,325	-613	-46%
GRAND ISLE	$1,199M	-$341M	-28%	21,907	-15,038	-69%
LULING/BOUTTE	$33,682M	-$18,498M	-55%	3,943	-1,156	-29%
GONZALES/ PRAIRIEVILLE	$3,115M	-$775M	-25%	14,808	-8,910	-60%
MANDEVILLE/ COVINGTON/ MADISONVILLE/ ABITA SPRINGS	$19,077M	-$9,617M	-50%	127	-84	-66%
YSCLOSKEY	$451M	-$109M	-24%	433	-43	-10%

The communities also vary in terms of the type of strategy employed by the typical nonstructural program implementation (see Table 7). Many communities in the sample lead with elevation as their primary strategy, though the cost per structure ranges substantially, from $153,000 in Grand Isle to $262,000 in Luling/Boutte. There is similarly a wide range in acquisition cost per structure from $290,000 in Yscloskey to $873,000 in Mandeville/Covington/Madisonville/Abita Springs.

Table 7. Summary of nonstructural attributes by strategy for Variant 1 for 11 selected communities.

	COUNT			COST		
COMMUNITY NAME	ELEV.	FP.	ACQ.	ELEV.	FP.	ACQ.
SULPHUR/CARLYSS	192	385	1	$35.7M	$44.7M	$0.1M
LAKE CHARLES/PRIEN	1,443	1,880	71	$311.2M	$211.2M	$21.7M
LYDIA	662	187	0	$113.2M	$18.6M	$0
FRANKLIN	2,055	445	1	$374.2M	$46.9M	$0.5M
HOUMA	2,681	1,820	1	$491.6M	$198.7M	$0.3M
LAROSE	1,544	36	3	$379.6M	$3.7M	$1.3M
GRAND ISLE	382	114	0	$58.4M	$11.7M	$0
LULING/BOUTTE	3,308	179	0	$865.8M	$18.3M	$0
GONZALES/PRAIRIEVILLE	1,058	1,553	7	$214.4M	$166.2M	$2.5M
MANDEVILLE/COVINGTON/ MADISONVILLE/ABITA SPRINGS	3,243	1,876	35	$832.4M	$207.0M	$30.6M
YSCLOSKEY	97	4	59	$23.6M	$0.4M	$17.1M

NOTE: ELEV.=ELEVATION, FP.=FLOODPROOFING, AND ACQ.=ACQUISITION.

From the perspectives of equity and relative community impacts, acquisitions in Yscloskey would represent a transformational investment that reflects housing values and the wealth tied to them, whereas communities with more expensive properties on the Northshore of Lake Pontchartrain (for example, Mandeville/Covington/Madisonville/Abita Springs has a poverty rate of 8.3% versus a statewide average of 19.6%) might more readily absorb the community impacts of removing a few handfuls of houses and the economic change associated with their market-based valuations. There is substantially less variation in floodproofing cost per structure (this makes sense, as the costs do not vary by elevation target or replacement value). In communities such as Gonzales/Prairieville and Lake Charles/Prien, floodproofing is the dominant strategy. The following section examines the potential implications for four communities in more detail by asset type.

4.0 DETAILED EXAMPLES OF COMMUNITY-LEVEL RESULTS

To develop a deeper understanding of how CPRA and/or communities might implement a nonstructural protection program, the Risk Assessment Team focused on four communities selected from the representative sample of 11 indicated above:

- Mandeville/Covington/Madisonville/Abita Springs in St. Tammany Parish and the Pontchartrain region
- Luling/Boutte in St. Charles Parish and the Barataria region
- Franklin in St. Mary Parish and the Central Coast region
- Lake Charles/Prien in Calcasieu Parish and the Chenier Plain region

4.1 MANDEVILLE/COVINGTON/MADISONVILLE/ABITA SPRINGS

St. Tammany Parish faces the highest current exposure to flood risk of any parish, and it is also experiencing continued rapid population growth. Under FWOA conditions, St. Tammany is also the site of the largest increase in expected annual damage on the coast. While the risk in Mandeville/Covington/Madisonville/Abita Springs is not as severe as in nearby Slidell/Eden Isle/Pearl River, the EADD in year 50 is still substantial. However, the high risk comes with an opportunity for nonstructural projects to provide substantial damage reduction. For example, in the lower environmental scenario, the EADD reduction associated with 100% participation in Year 50 is $294M (-56%) and EASD is 272 structure-equivalents (-67%). Figure 3 shows the population density of Mandeville/Covington/Madisonville/Abita Springs relative to other Northshore communities. Additional details on this, and the following communities, can be found in Attachment C3: 50-Year FWOA Model Output, Regional Summaries – Risk.

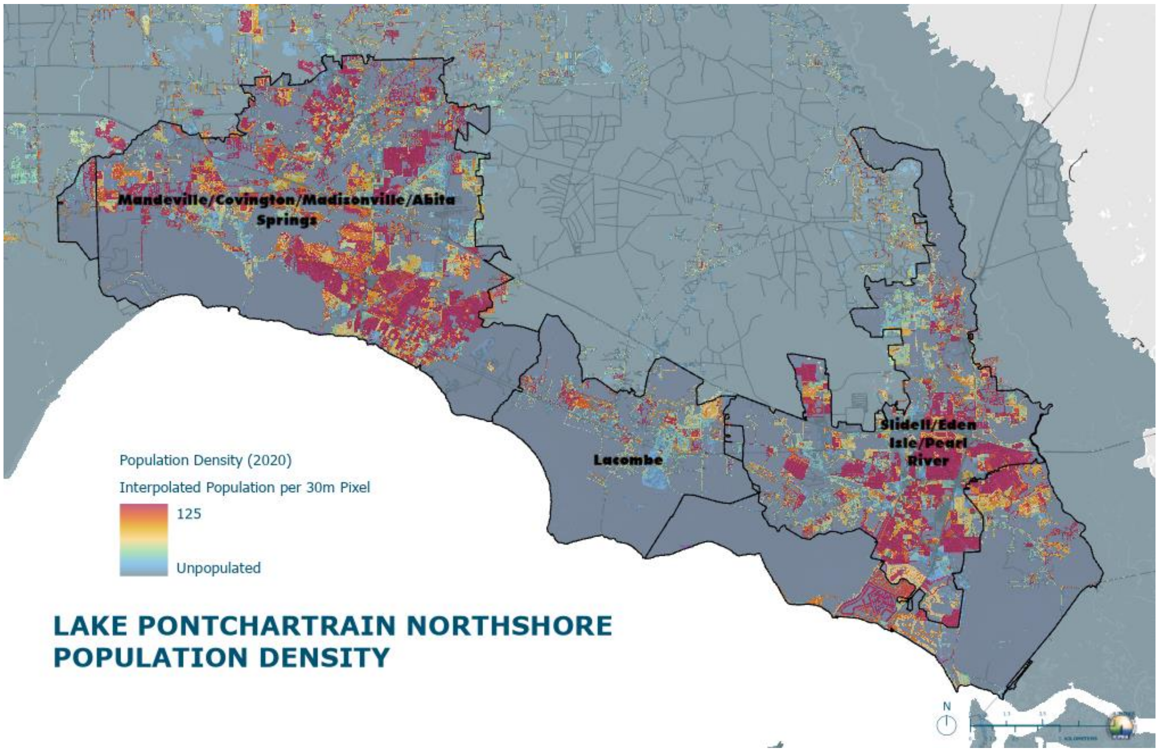

Figure 3. Mandeville/Covington/Madisonville/Abita Springs in the context of communities located on the Northshore of Lake Pontchartrain (reproduced from Attachment C3: 50-Year FWOA Model Output, Regional Summaries - Risk).

Within this community, Table 8 breaks down elevation, floodproofing, and acquisition costs and counts across multiple asset types. As a predominantly suburban, residential area, it is unsurprising that the mitigation approach applied most often is single-family residential elevation, with an estimated 3,225 structures based on an initial Year 0 threshold (Variant 1) versus approximately 15% more additional structures if using a Year 30 threshold (Variant 3). In contrast, the number of structures floodproofed does not change much by the different variants, whereas the number of acquisitions nearly quadruples, indicating that about 3% of elevations under Variant 1 are sensitive to the amount of sea level rise and other landscape impacts associated with thirty years of change.

Table 8. Summary of nonstructural attributes by asset type in Year 50 for Mandeville/Covington/Madisonville/Abita Springs outside of levee protection.

	SINGLE-FAMILY RESIDENTIAL		MULTI-FAMILY RESIDENTIAL		NON-RESIDENTIAL	
	VAR. 1	VAR. 3	VAR. 1	VAR. 3	VAR. 1	VAR. 3
ELEVATION COUNT	3,225	3,703	0	0	0	0
FLOODPROOFING COUNT	1,753	1,774	36	34	68	73
ACQUISITION COUNT	32	120	3	7	0	0
ELEVATION COST	$829M	$975M	$0	$0	$0	$0
FLOODPROOFING COST	$190M	$193M	$4M	$4M	$11M	$12M
ACQUISITION COST	$25M	$89M	$5M	$12M	$0	$0
TOTAL NS COST	$1,044M	$1,296M	$9M	$16M	$11M	$12M

NOTE: VAR.=VARIANT. NON-RESIDENTIAL STRUCTURES INCLUDE COMMERCIAL AND INDUSTRIAL AS WELL AS PUBLIC AND EDUCATIONAL.

4.2 LULING/BOUTTE

The population characteristics for Luling/Boutte are similar to the statewide average, like many of the other communities in the Barataria region. Though a portion of these communities is within the Hurricane and Storm Damage Risk Reduction System (HSDRRS) structural protection system, the CLARA model estimates sharp increases in EADD and EASD under FWOA conditions. Nonstructural measures, deployed in IP1 or IP2, could help lower exposure. In comparison to Mandeville/Covington/Madisonville/Abita Springs, a nonstructural program would cover a similar number of buildings. However, this would lead to a much larger increase in EASD (540 structural equivalents, representing an 89% reduction from FWOA) as well as in EADD ($667M, 71% less than FWOA) under the lower environmental scenario. While the raw values of both building equivalents and dollar damage are comparable in the higher environmental scenario, nonstructural measures cannot keep pace with the increased flood risk and benefits, with both EASD and EADD reducing FWOA by approximately 15%. Figure 4 shows the population density of Luling/Boutte relative to the West Bank communities in the New Orleans Metropolitan Area.

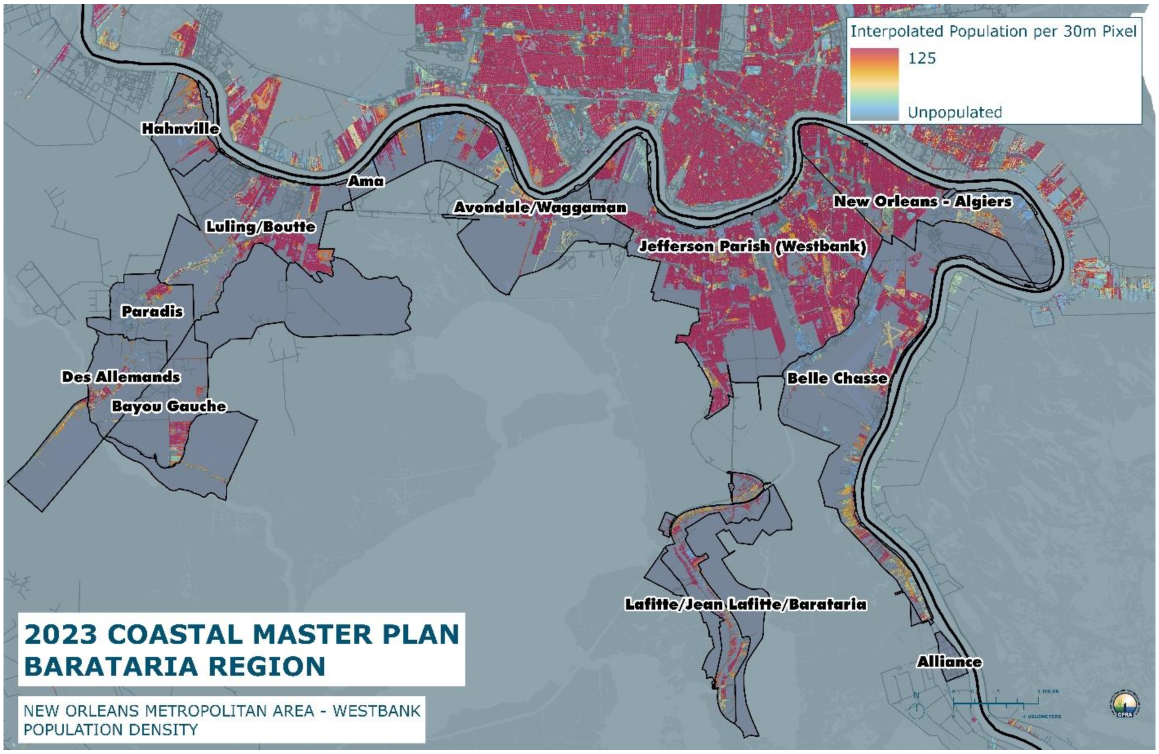

Figure 4. Luling/Boutte in the context of West Bank communities in the New Orleans Metropolitan Area (reproduced from Attachment C3: 50-Year FWOA Model Output, Regional Summaries – Risk).

As with the example in Table 8, Table 9 shows the difference between a Year 0 and Year 30 first floor elevation target. The elevation target impacts single-family residential structures almost exclusively, costing between $882M and $1,198M across the entire community. Under Variant 3, there is about a third more elevation and twice as many structures identified as floodproofing candidates, though no acquisitions.

Table 9. Summary of nonstructural attributes by asset type in Year 50 for Luling/Boutte inside of levee protection.

	SINGLE-FAMILY RESIDENTIAL		MULTI-FAMILY RESIDENTIAL		NON-RESIDENTIAL	
	VAR. 1	VAR. 3	VAR. 1	VAR. 3	VAR. 1	VAR. 3
ELEVATION COUNT	3,302	4,423	0	0	0	0
FLOODPROOFING COUNT	172	372	1	2	6	57
ACQUISITION COUNT	0	0	0	0	0	0
ELEVATION COST	$865M	$1,160M	$0	$0	$0	$0
FLOODPROOFING COST	$17M	$38M	$0	$0	$1M	$10M
ACQUISITION COST	$0	$0	$0	$0	$0	$0
TOTAL NS COST	$882M	$1,198M	$0	$0	$1M	$10M

4.3 FRANKLIN

Like many of the neighboring communities in the Central Coast region, Franklin has a larger Black population than the statewide average, and it is the community with the highest proportion of non-white residents in the sample of 11 discussed above. Like Luling/Boutte, Franklin has some degree of structural protection, but despite the levees, the CLARA model estimates some increases in flood exposure over the modeled period under FWOA conditions. Nonstructural measures could provide substantial risk reduction, for example, approximately $107 million in avoided EADD (-56% of FWOA) and 164 structure equivalents (-79% of FWOA) under the lower environmental scenario conditions. This community has a relatively minor change in damage reduction from nonstructural mitigation under the higher environmental scenario, with reductions of 53% and 76% (3% less than under the lower) for EADD and EASD, respectively. Figure 5 shows the population density of Franklin relative to other communities in the Central Coast.

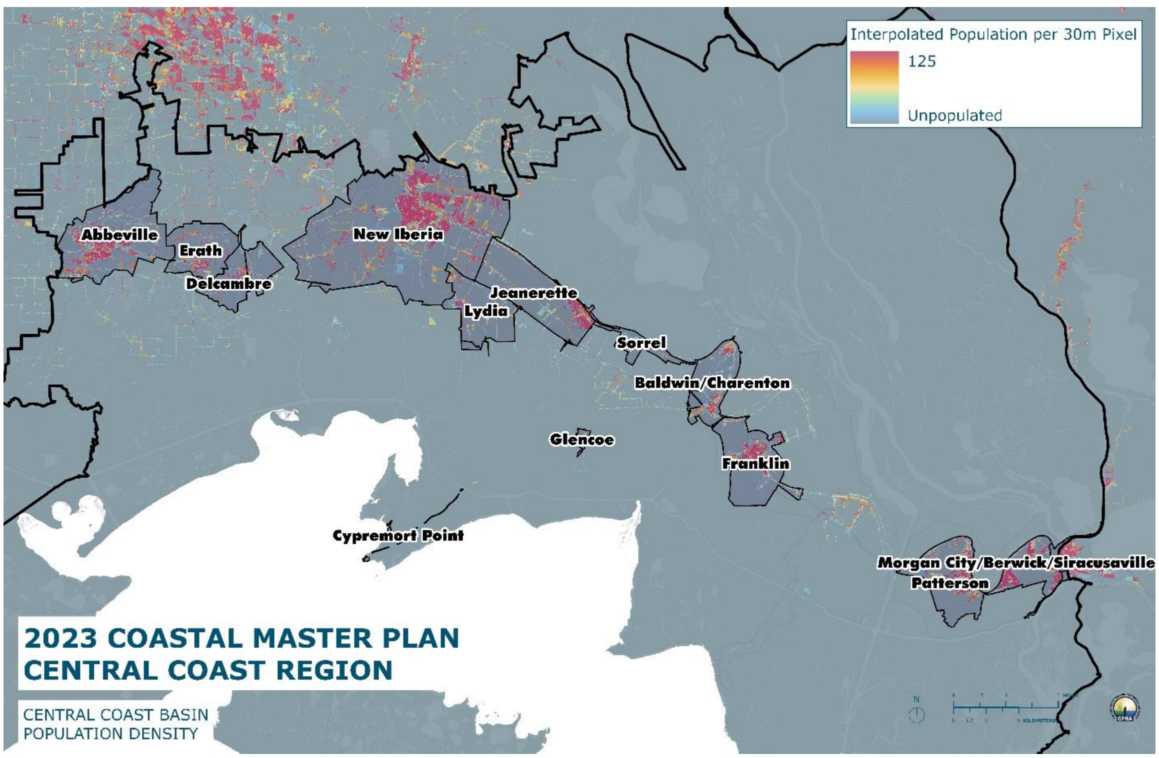

Figure 5. Franklin in the context of communities in the Central Coast region (reproduced from Attachment C3: 50-Year FWOA Model Output, Regional Summaries - Risk).

Comparing these numbers to those for Mandeville/Covington/Madisonville/Abita Springs, the Risk Assessment Team finds roughly proportional nonstructural damage reduction on an EADD basis, with approximately half as many buildings included in structural mitigation. As a result, there is approximately half as much risk reduction. The comparison in Table 10 is less favorable on an EASD basis, perhaps because some buildings selected for floodproofing under Variant 1 are selected for elevation or acquisition in Variant 3.

Table 10. Summary of nonstructural attributes by asset type in Year 50 for Franklin inside levee protection.

	SINGLE-FAMILY RESIDENTIAL		MULTI-FAMILY RESIDENTIAL		NON-RESIDENTIAL	
	VAR. 1	VAR. 3	VAR. 1	VAR. 3	VAR. 1	VAR. 3
ELEVATION COUNT	2,055	2,775	0	0	0	0
FLOODPROOFING COUNT	395	307	0	0	50	26
ACQUISITION COUNT	1	7	0	0	0	0
ELEVATION COST	$374M	$542M	0	0	0	0
FLOODPROOFING COST	$40M	$31M	$0	$0	$7M	$5M
ACQUISITION COST	$0	$2M	$0	$0	$0	$0
TOTAL NS COST	$414M	$576M	$0	$0	$7M	$5M

4.4 LAKE CHARLES/PRIEN

Lake Charles is the sixth largest city in Louisiana, and its demographic characteristics are similar to the statewide average. Prior to 2020, the community was experiencing some of the most rapid population growth in the country (see Attachment C3: 50-Year FWOA Model Output, Regional Summaries – Risk), though devastating storms and an ensuing housing crisis have led to outmigration. In the face of these countervailing trends, Lake Charles/Prien is still the largest community in the in the Chenier Plain region, and as such, has some of the highest absolute risk exposure. Despite its relative lower flood risk due to its location at the edge of the coastal region, it does have many (and perhaps more) moderately exposed, single-family residential structures and other assets. This profile is reflected in CLARA's calculations, where the percentage benefits of nonstructural projects are somewhat less than they are for other communities. Figure 6 shows the population density of Lake Charles/Prien relative to other communities in the Lake Charles metropolitan area.

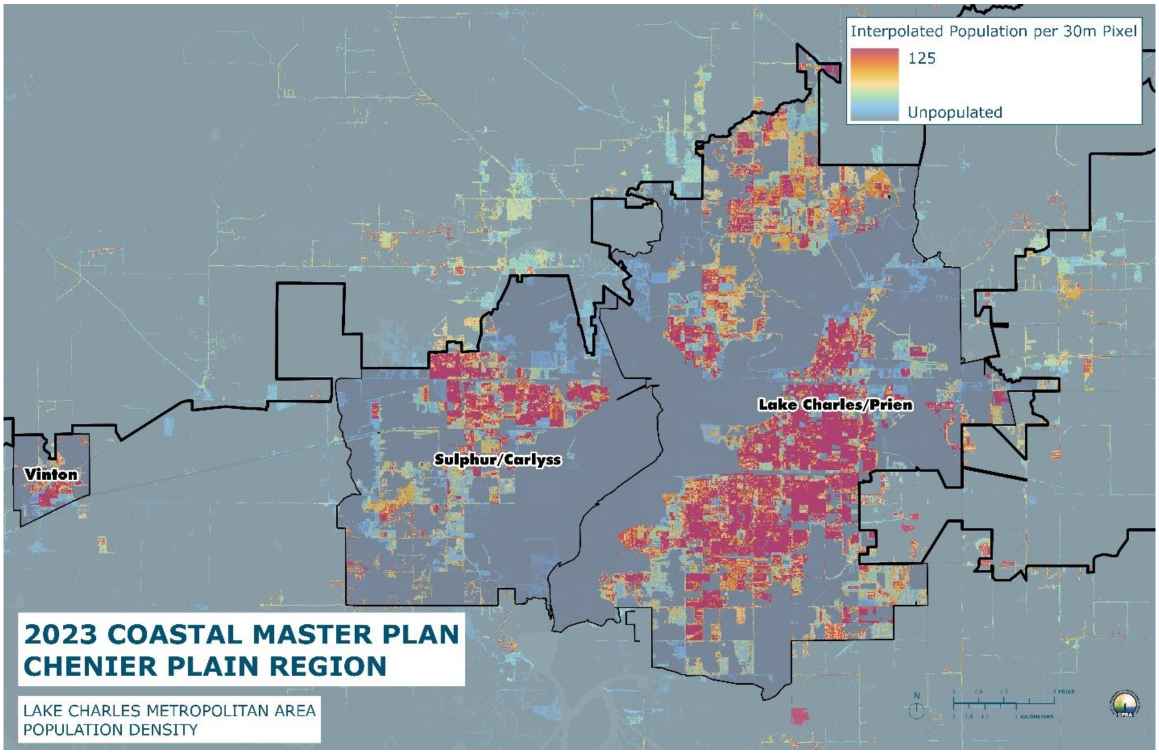

Figure 6. Population density of Lake Charles/Prien and surrounding communities in the Lake Charles Metropolitan Area (reproduced from Attachment C3: 50-Year FWOA Model Output, Regional Summaries – Risk).

For example, with one-fifth less nonstructural activity, the EADD and EASD benefits under the lower environmental scenario are approximately two-thirds those of Franklin. In part, the relatively low potential for benefit in Lake Charles/Prien is reflected by the kinds of nonstructural projects selected, with Table 11 showing more than half of the buildings are receiving floodproofing. In comparison, only around a third of the buildings are targeted for floodproofing in Mandeville/Covington/Madisonville/Abita Springs, with the other two communities receiving even less. Table 11 also shows that multi-family residential as well as commercial and industrial floodproofing is markedly more expensive than the same action for single-family residential. Furthermore, the benefit of nonstructural projects for Lake Charles/Prien does not change much in the higher environmental scenario, despite marked increase in flood risk for the region under this scenario. For example, Variant 1 provides 13 to 17% less EADD and EASD reduction, respectively, suggesting that the target selected in IP2 may need to shift upwards, like Variant 3. This may come with relatively small additional cost.

Table 11. Summary of nonstructural attributes by asset type in Year 50 for Lake Charles/Prien outside levee protection.

	SINGLE-FAMILY RESIDENTIAL		MULTI-FAMILY RESIDENTIAL		NON-RESIDENTIAL	
	VAR. 1	VAR. 3	VAR. 1	VAR. 3	VAR. 1	VAR. 3
ELEVATION COUNT	1,443	1,750	0	0	0	0
FLOODPROOFING COUNT	1,660	1,836	51	56	169	176
ACQUISITION COUNT	71	75	0	0	0	0
ELEVATION COST	$311M	$375M	$0	$0	$0	$0
FLOODPROOFING COST	$177M	$197M	$6M	$6M	$28M	$29M
ACQUISITION COST	$22M	$23M	$0	$0	$0	$0
TOTAL NS COST	$510M	$595M	$6M	$6M	$28M	$29M

For Lake Charles/Prien, in contrast to Franklin, the Risk Assessment Team sees a relatively large difference in FWOA exposure under a higher environmental scenario. Therefore, it is similar to Mandeville/Covington/Madisonville/Abita Springs and Luling/Boutte. The utility of having an additional target for nonstructural set by the Planning Tool in IP2 is explored in the next section.

5.0 SELECTING VARIANTS FOR IP1 AND IP2 TARGETS IN THE PLANNING TOOL

From the discussion of the example communities above, it is apparent that some communities face dramatically changing flood risks, particularly in the final two decades of the higher environmental scenario, as sea level rise rates of change accelerate. As the Planning Tool considers two implementation periods, and the goal is to have nonstructural investments that provide reliable risk reduction to resident and asset owners in the face of rising flood risk over time, it may make sense to establish a different target elevation for intervention to address the evolving threat.

Figure 7 compares the coastwide benefits and costs of all variants considered in this analysis, assuming Year 0 exposure. In the top half of the chart, total nonstructural costs increase linearly with the target year, and the difference between the acquisition thresholds and scenarios for those targets increases exponentially. In contrast, the EADD benefits decrease logarithmically, forming a declining benefit-cost curve. The lower half of the chart, on a per structure basis, mirrors the pattern. Given this profile, it is cost-effective to have a program designed around the initial flood risk, rather than anticipating a future flood risk threshold. The Planning Tool, therefore, used Variant 1, with a Year 0 elevation target and a 14-foot acquisition height for IP1.

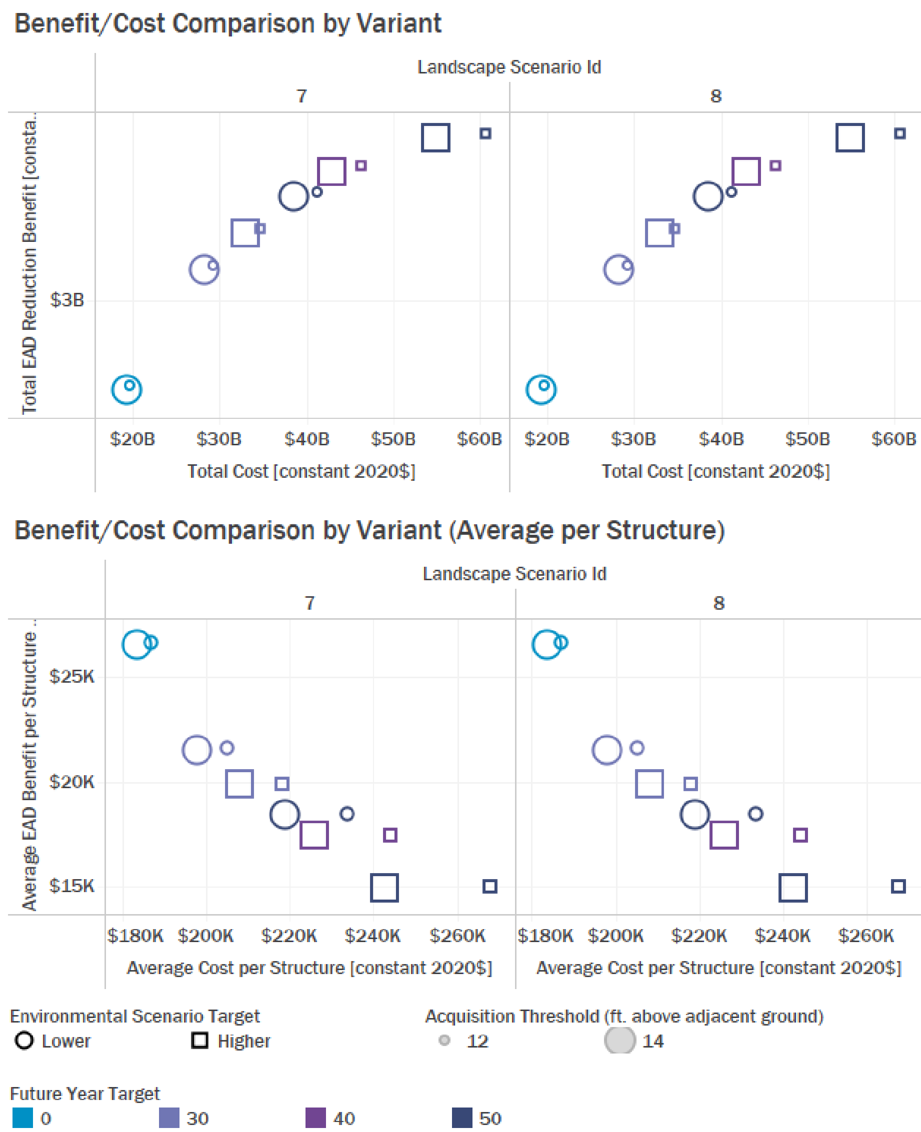

Figure 7. Coastwide comparison of EADD benefit-cost ratios for all variants with Year 0 exposure.

Year 50, shown in Figure 8, shows an entirely different pattern. In the top set of charts, the landscape scenarios now show substantial difference. For example, the benefit curve flattens much more quickly for additional nonstructural programmatic cost under the lower environmental scenario. The lower charts, however, show very clearly a local maximum to benefit-cost ratios around a Year 30 target. The results for EASD show a similar pattern, and this suggests that thePlanning Tool Team should consider a different target for IP2 than IP1.

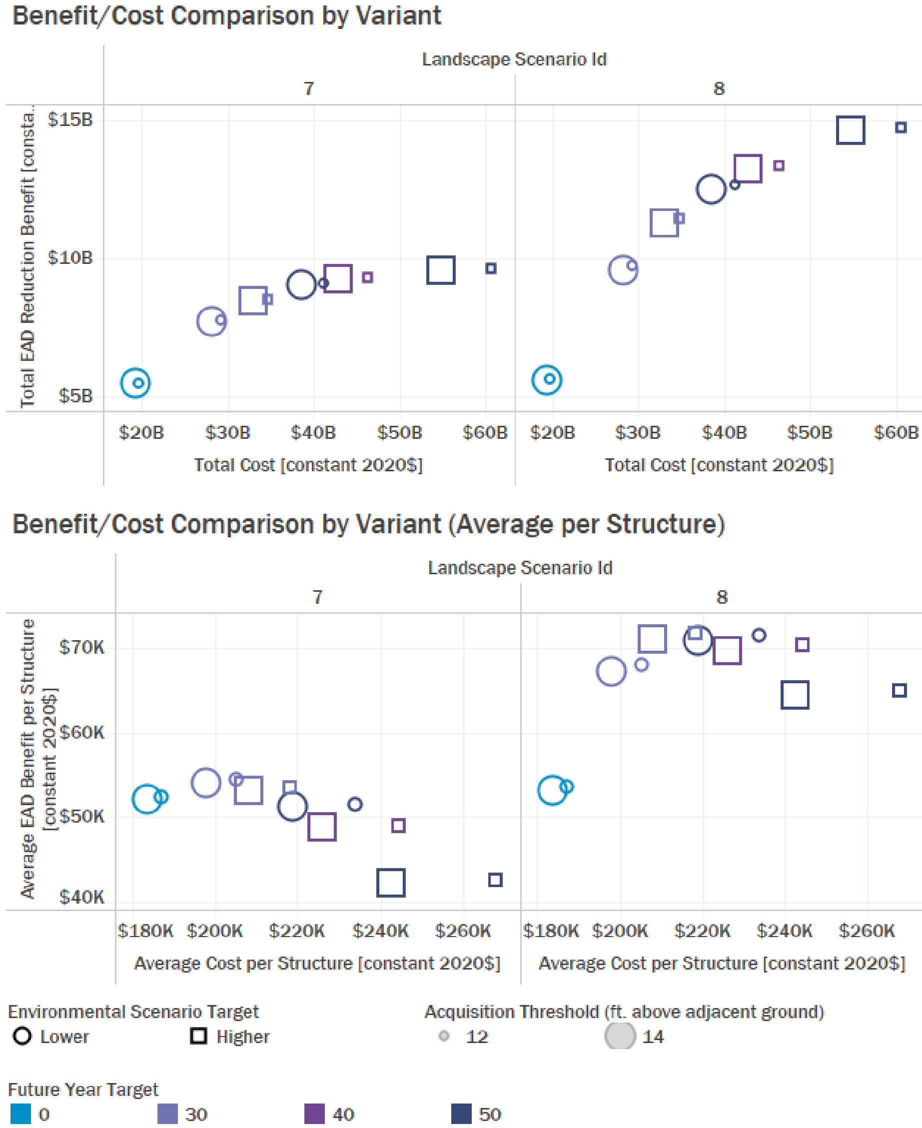

Figure 8. Coastwide comparison of EADD benefit-cost ratios for all variants with Year 50 exposure.

Given these results, CPRA decided to use Variant 3 with a Year 30 target and 14 foot acquisition threshold for IP2. As the landscape scenario defined slightly different flood depths, and therefore different costs, CPRA also decided to use the lower environmental scenario, as it was slightly more cost-effective on a coastwide basis (because there was four times more acquisition involved in the higher scenario). This implies that perhaps slightly more nonstructural protection was selected for the programmatic funds over less effective structural projects.

6.0 CONCLUSION

The 2023 nonstructural analysis largely builds upon the strategies formulated in the 2017 Coastal Master Plan, with the important change that in this iteration CPRA sought to establish the cost-effective amount of funds to set aside for a programmatic implementation (rather than selecting specific communities for projects). The Risk Assessment Team applied variants, based on landscape scenario, year, acquisition thresholds, and participation rates across the coast and evaluated them within a representative sample of communities to understand demographic implications and provide the basis for potential socioeconomic impacts for future analysis. Depending on asset type compositions unique to each community, there were sometimes greater or smaller reductions to FWOA EADD or EASD, but overall, these two metrics were approximately proportional coastwide.

The Risk Assessment Team's analysis pointed CPRA toward having the Year 0-based variants as an initial target but increasing flood risk in future years demonstrated that IP2 had a more cost-effective variant available based on a Year 30 target. This aligns with the lifespan of a typical 30-year mortgage for a home built or purchased today.

Finally, these results will differ if CPRA implements the structural risk reduction projects selected for both IP1 and IP2 as planned. The Risk Assessment Team plans to update the analysis by April 2023 to consider impacts to the nonstructural program alongside the structural projects selected for the master plan.

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