LOUISIANA COASTAL PROTECTION AND RESTORATION
FINAL TECHNICAL REPORT

DUTCH PERSPECTIVE APPENDIX

June 2009

U. S. Army Corps of Engineers
New Orleans District
Mississippi Valley Division

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PURPOSE

The Louisiana Coastal Protection and Restoration (LACPR) Technical Report has been developed by the United States Army Corps of Engineers (USACE) in response to Public Laws 109-103 and 109-148. Under these laws, Congress and the President directed the Secretary of the Army, acting through the Chief of Engineers, to:

- Conduct a comprehensive hurricane protection analysis and design in close coordination with the State of Louisiana and its appropriate agencies;
- Develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana;
- Consider providing protection for a storm surge equivalent to a Category 5 hurricane; and
- Submit preliminary and final technical reports.

The purpose of this appendix is to support the consideration of the Dutch perspective for LACPR, which is discussed in the main Technical Report.

INTRODUCTION

The United States Army Corps of Engineers (USACE) has a long-standing relationship with the Dutch and in particular with the Rijkswaterstaat, the Dutch agency in charge of the major flood protection efforts in the Netherlands. Prior to Hurricane Katrina, the USACE and the Rijkswaterstaat signed a Memorandum of Agreement that facilitated technical exchanges. Immediately after Katrina, the USACE requested that Dutch engineers come to New Orleans to assist the USACE in developing plans for higher level protection against storm surge that could be generated by Category 5 hurricanes. This exchange was followed by a visit by key personnel from the USACE to the Netherlands to meet with engineers from the Rijkswaterstaat. In addition to participating in a number of workshops and reviews, the Dutch Rijkswaterstaat and Netherlands Water Partnership, a Dutch consortium of government agencies, researchers, and

consultants, produced a report titled *A Dutch Perspective on Coastal Louisiana: Flood Risk Reduction and Landscape Stabilization.*

The purpose of the *Dutch Perspective* report was to obtain an independent view of risk reduction and restoration issues for the Louisiana coastal area from the Dutch based on their experience in dealing with similar issues in the Netherlands. Their report was prepared in parallel with the LACPR technical report and was not intended to provide information directly into the USACE's technical analysis; however, after reviewing the Dutch report, the team has concluded that the alternatives and issues in the *Dutch Perspective* report are not that different than those in the LACPR technical report. This consistency provided assurance that LACPR was taking the right approach.

The purpose of this appendix is to compare and contrast the *Dutch Perspective* report to the LACPR technical report. To that end, it contains the following:

- A brief summary of the *Dutch Perspective* report including maps of alternative and preferred strategies;
- A table comparing the measures, alternatives, and strategies in the *Dutch Perspective* report to those in the LACPR report; and
- The *Dutch Perspective* Executive Summary (Note: The report in its entirety is available on file at the District).

The *Dutch Perspective* report will be a continuing reference document for the USACE in ongoing and future studies. The continuing cooperation and exchange with the Dutch is, and should continue to be, an integral part of hurricane storm damage risk reduction efforts in South Louisiana.

SUMMARY OF FINAL DUTCH PERSPECTIVE REPORT

The perspective of Dutch flood control planning and engineering is generally considered to be relevant to similar efforts in southeast Louisiana. For over 800 years the Dutch have constructed incrementally stronger flood defenses and have lived with the varying consequences of their intensive efforts to reduce the risk of flood damage to the urban and rural areas of their country. These efforts have culminated in the development of the massive Deltaworks which was a specific response to the floods of 1953. The engineering and environmental debates that occurred in the Netherlands during the planning of the Eastern Scheldt barrier as well as long term observations of how Dutch flood defenses have performed along their extensive coastlines, can provide coastal Louisiana with the benefit of multiple lessons learned when considering what types of flood defenses should be considered. The Dutch perspective can also provide important information on the kinds of effects various flood defenses can have on estuarine environments. The focus of the Dutch perspective is limited to the Pontchartrain and Barataria basins, referred to in the LACPR technical report as Planning Units 1 and 2 respectively.

The objective of the Dutch perspective report is to present a "plan for the long term risk reduction of coastal Louisiana together with a plan to strengthen the natural ecosystem functions of the Mississippi Delta and thus stabilize the landscape" (p.9).

As recognized by the LACPR technical report and the State of Louisiana's Master Plan for coastal protection and restoration, the Dutch perspective emphasizes that restoration or at least stabilization of Louisiana's coastal wetlands and the long term ability to reduce flood risk are linked.

Planning Principles

The Dutch perspective is developed from five planning principals derived from lessons learned from the Mississippi River Delta and the Netherlands Delta and the idea that long term yet sustainable solution(s) must be developed while also coping with the uncertainties posed by sea level rise, subsidence, and the general transgression of the (Mississippi) Delta itself. The planning principles to be taken into account in the planning process are as follows:

1. Defend urban areas using levees and other structures at a protection level that balances cost with the reduction of flood risk.
2. Prefer easy to adapt flood risk reduction measures versus those that are difficult to change.
3. Maintain the natural systems (watersheds) and avoid obstructing natural upstream-downstream pathways.
4. Strengthen natural processes for restoration and flood protection.
5. Relocate the mouth of the Mississippi River and consider abandoning the 'birdfoot delta.'

Categories of Measures

From these principles, five categories of possible measures were identified that would accomplish the goals of reducing flood risk directly through levees or engineered features or by consolidating, restoring or changing the overall dynamics of the Delta. Nonstructural measures such as elevating structures were outside the scope of the *Dutch Perspective* analysis.

1. **Direct protection of built-up areas** (e.g. Upgrade or re-design existing levees, floodwalls, and gates protecting urban land uses).
2. **Closed basin hurricane surge protection** (e.g. close off the Pontchartrain and/or Barataria basins during a hurricane threat with gated barriers).
3. **Measures to consolidate and increase natural flood protection** (e.g. increase the areal extent of coastal wetlands, especially wetland forests).
4. **Basin surge reduction measures** (e.g. re-shape barrier islands or develop a string of 'ridge levees' which consist of a wide footprint, gently sloped barriers which allow for openings for canals and channels and which would generally maintain natural water flows.)
5. **Delta system intervention for long-term natural surge reduction** (e.g. develop crevasses in the lower Mississippi River).

Alternative Strategies

Five possible strategies or strategic alternatives were developed based upon the five categories of measures. Within these alternatives, 'the most important planning issue to be addressed is whether or not the Mississippi Delta should be closed off with flood defense systems'(p. 43).

The strategies include the following:

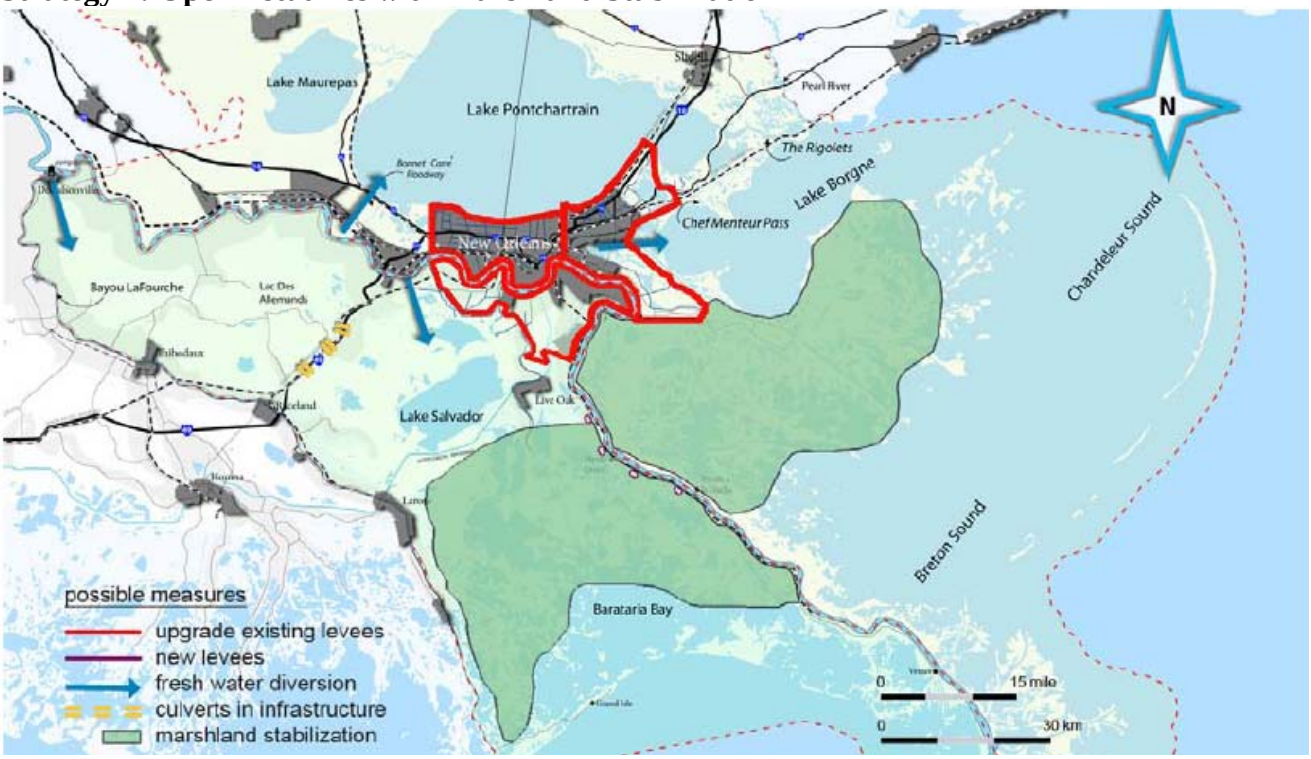
- Strategy 1, 2, and 3: Open Estuary System (three alternatives)
- Strategy 4: Semi-Open defense system
- Strategy 5: Closed Defense System

Measures that provide flood risk reduction to metropolitan New Orleans are considered under the heading “Protected City” (p.47). The types of risk reduction measures proposed vary according to the strategy; levee heights, for example, are lower or higher depending upon the strategy.

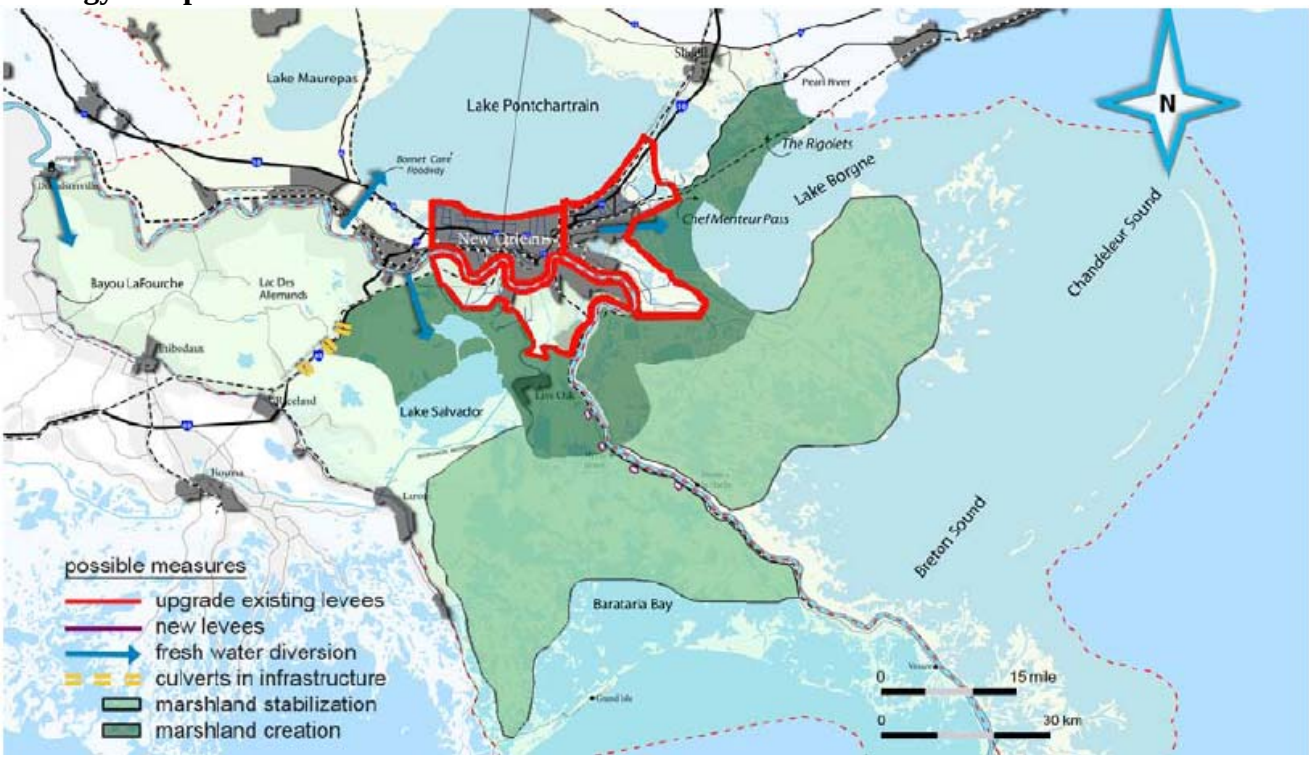
Strategies 1, 2, and 3: Open Estuary System

In Strategies 1, 2, and 3, the estuary system would remain in open connection to the Gulf of Mexico, and surge reduction would be accomplished by the marsh and open water areas within the two estuarine systems. Stabilization of these systems would occur through creation of marshland and minimization of sediment losses. A major emphasis would be placed upon landscape stabilization as additional flood risk reduction under these strategies would depend upon healthy and expanded ecosystems.

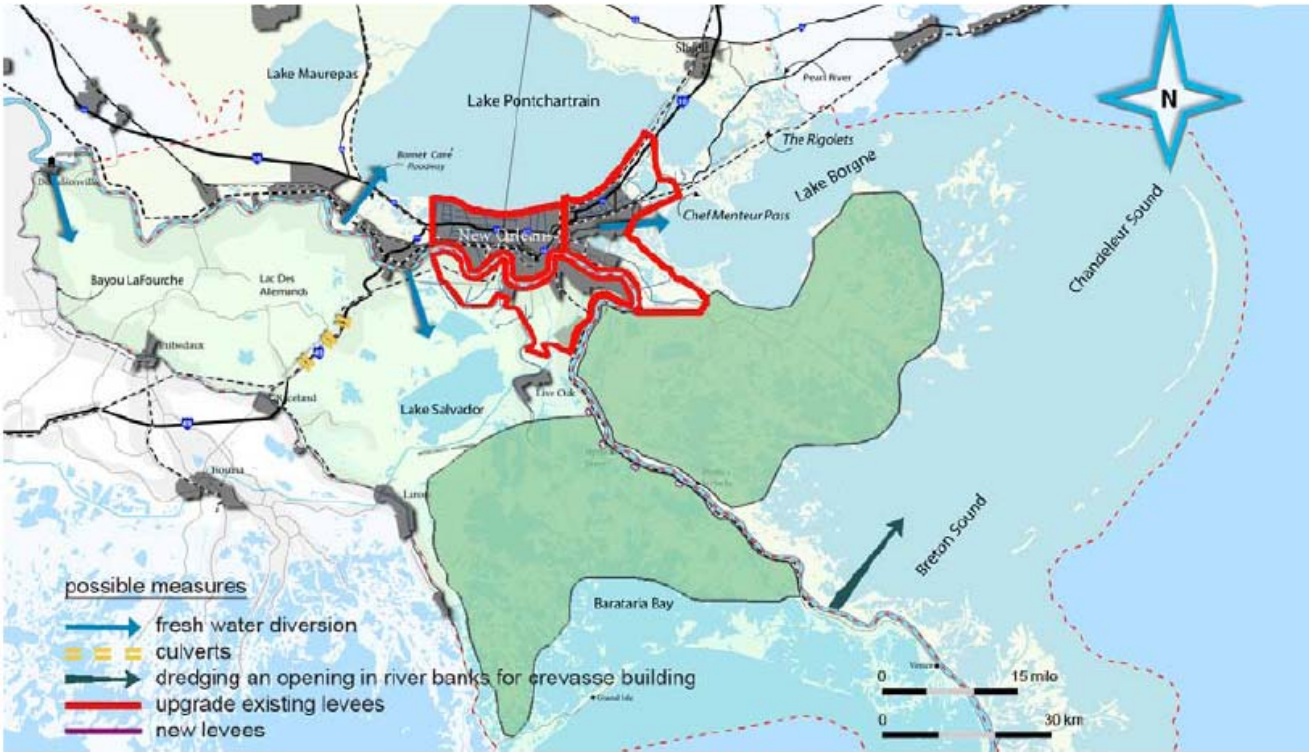
Strategy 1: Open Estuaries with Marshland Stabilization



Strategy 2: Open Estuaries with Marshland Stabilization and Creation



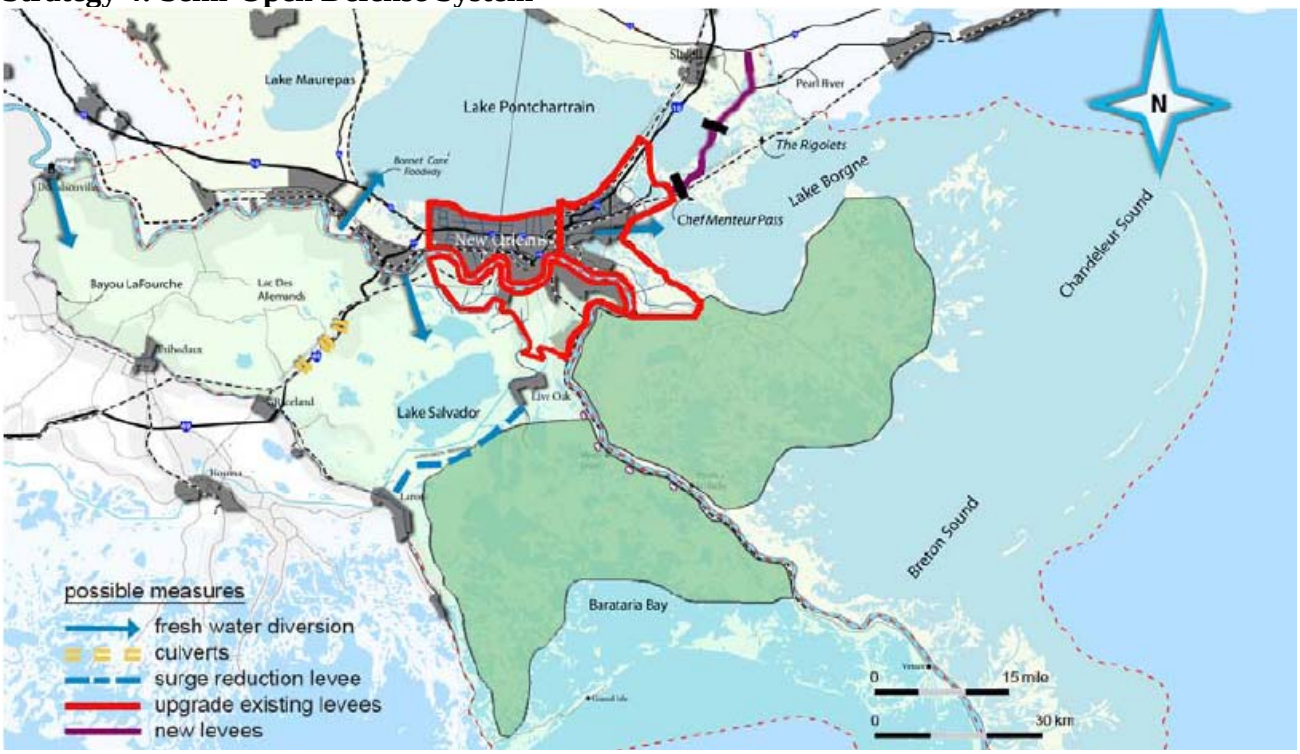
Strategy 3: Open Estuaries with Marshland Stabilization and Measures to Minimize Sediment Loss



Strategy 4: Semi-Open Defense System

In Strategy 4, there would be enhanced passive hurricane surge reduction by means of surge reduction 'ridges' that would attenuate surges but not stop them. Stabilization measures for natural systems would be included in this strategy, but 'Protected City' measures would not be as extreme when compared to Strategies 1, 2, and 3 because of the passive surge reduction measures.

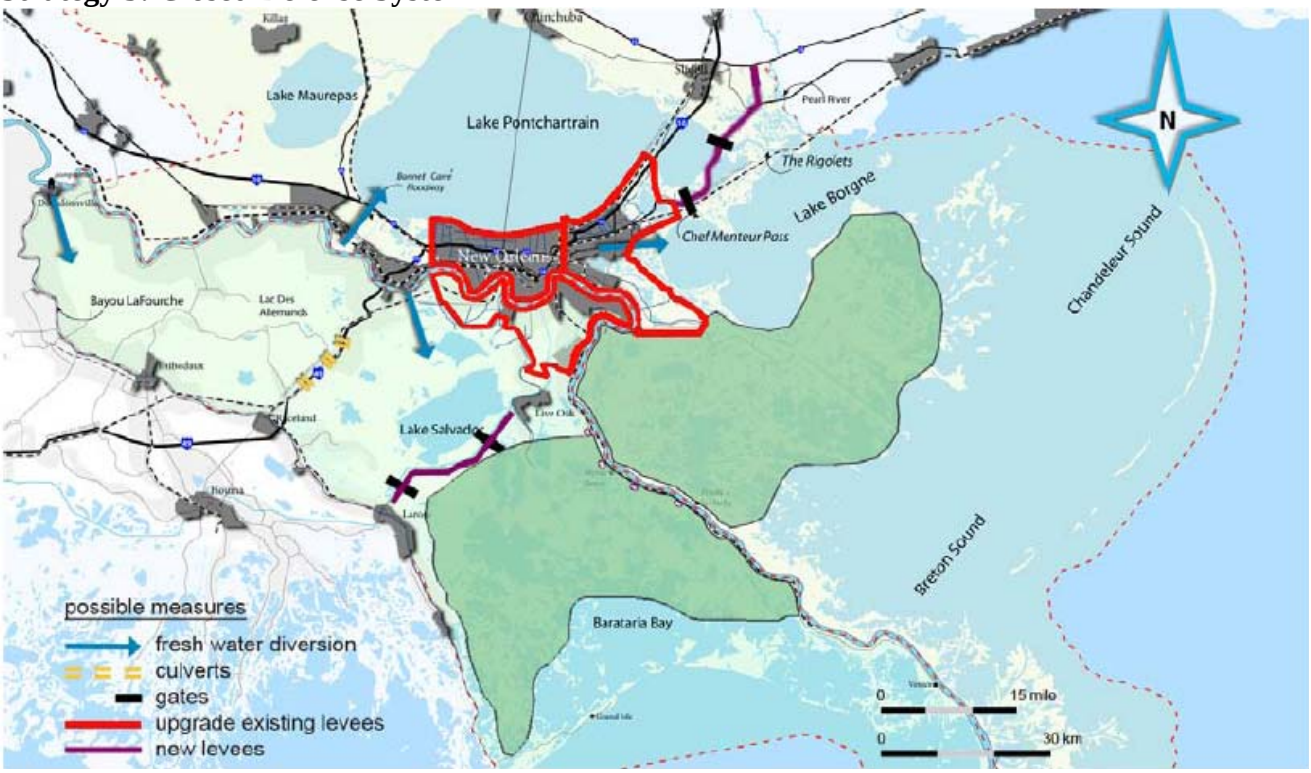
Strategy 4: Semi-Open Defense System



Strategy 5: Closed Defense System

In Strategy 5, there would be active surge reduction. Surge would be managed by outer levees and gates, and while active landscape stabilization would occur, these measures would not be depended upon for flood risk reduction. Also, the 'Protected City' measures would be less than for the other strategies including Strategy 4.

Strategy 5: Closed Defense System



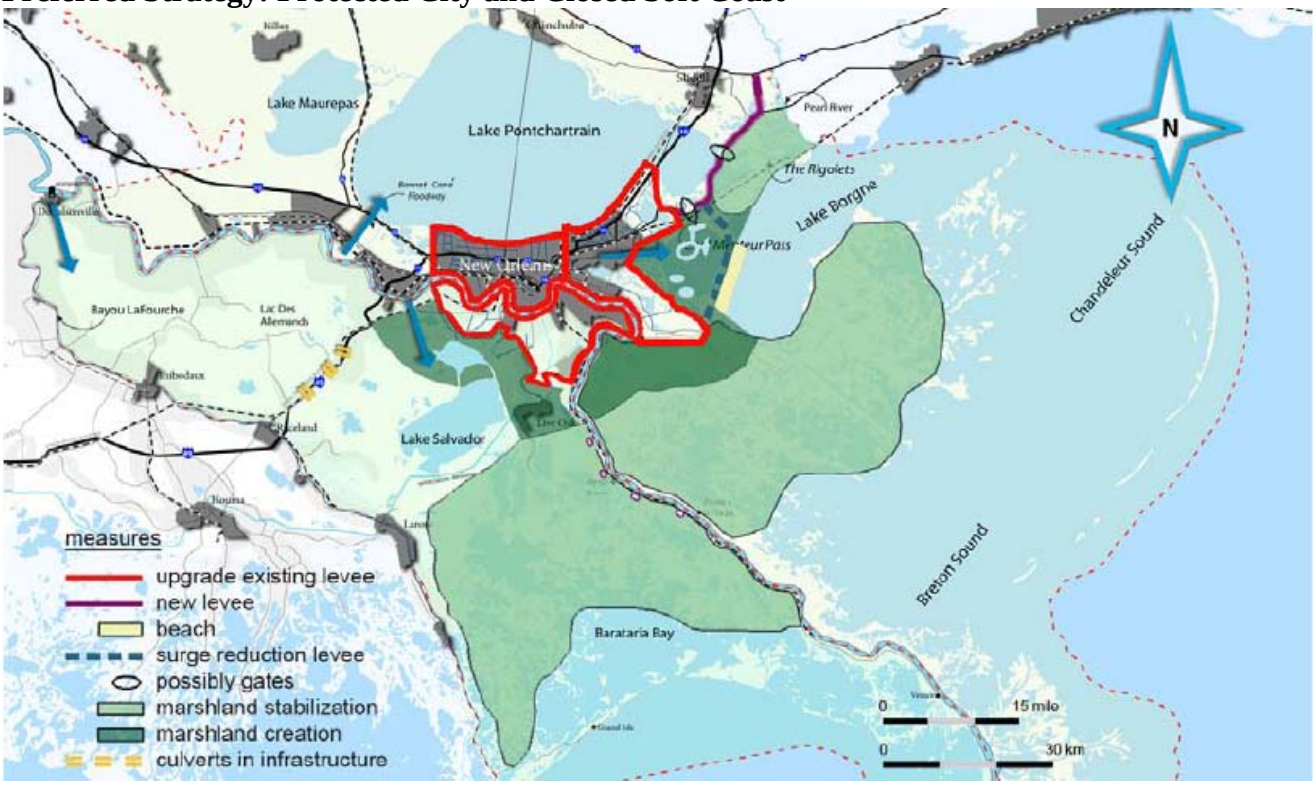
Preferred Strategy

The preferred strategy, 'Protected City and Closed Soft Coast,' combines various elements of the five strategies described above. The preferred strategy is intended to provide metropolitan New Orleans with a 1/1,000 per year or greater level of risk reduction, a level that the *Dutch Perspective* report states is economically justified. The *Dutch Perspective* report projects the net present value of the preferred strategy to be $20 billion.

The Protected City and Closed Soft Coast strategy is modeled after the flood risk reduction approach implemented by the Netherlands after the 1953 flood disaster. However, their approach to 'shortening' the coast using hardened structures such as barriers which disrupt the natural hydrology had major adverse environmental impacts. Based on the lessons learned in the Netherlands, the terminology of 'closed soft coast' implies a maximum shortening of the coastal defense, "while at the same time maintaining the un-hampered flow of water, sediment, and nutrients, utilizing and nurturing the potential of nature to add to coastal flood protection and produce a sustainable ecosystem and landscape." (p.61)

The preferred strategy combines landscape stabilization with active flood reduction. Different strategies were chosen for the Pontchartrain and Barataria basins. The Pontchartrain Basin would have gated structures in the Rigolets and Chef Menteur passes which would be closed under the threat of a major storm surge. The Barataria Basin would remain an open estuary with wetland stabilization being primary measure for hurricane surge reduction. Improving the culvert system under US 90 and other barriers in this estuary are proposed to allow more natural water flows in the estuary (p 63).

Preferred Strategy: Protected City and Closed Soft Coast



Levee protection around the metropolitan area of New Orleans would consist of three robust levee rings including storm surge barriers in the various navigation and drainage canals:

- Ring 1, the central part of the City with a protection level of 1/5,000 per year or better;
- Ring 2 and 3, the eastern and southern parts of the City, with a protection level of 1/1,000 per year or better.

Salt marsh stabilization includes restoring 750 square miles in the Pontchartrain basin and 600 square miles of marsh restoration in the Barataria Basin. As these measures are planned to take as long as 50 years, no immediate effect on surge or wave reduction was considered when determining levee heights around New Orleans. However, once in place, the marsh system could help reduce future costs of levee and barrier upgrades.

Freshwater marsh (cypress swamp) re-vitalization and creation are proposed in a wide zone (between 1 and 6 miles wide) immediately around the levee rings in the New Orleans area

totaling about 140 square miles. This measure could afford some surge reduction and, in particular, reduction in wave loads on the levees.

Converting part of Lake Borgne into a freshwater marshland could reduce surge on the eastern part of the City. This measure would require separating Lake Borgne from the Gulf by a ridge levee, partly filling in the lake and providing freshwater sufficient to establish a fresh water swamp in the lake.

Priority Studies Recommended

The *Dutch Perspective* report, while recommending expenditures for efforts that would stabilize the marsh landscape and encouraging the development of significant new areas of cypress swamp around metropolitan New Orleans is cautious about the flood reduction potential such landscape measures provide. The report recommends more study on 'how to improve the reliability of the analysis on storm surge levels and waves, with special emphasis on the effects of vegetation on water levels and waves' (p.79). As the report states, the effects of vegetation on water levels and waves 'remain difficult to estimate' (p.79). The lack of precise knowledge in this area affects a number of other areas including the hydraulic design parameters for infrastructure, their cost and their reliability. As a result, the report goes beyond simply requesting general studies in this area, but instead recommends 'Establishing the effect of different types of wetlands on the surge, wave, and wind reduction' (p.80). While the potential for reducing surge is high, the report indicates that 'uncertainties are large' (p. 80). Predictive models that ostensibly take into account the frictional factors of vegetation on hurricanes do not cohere in their predictions, differing 'a factor of two to four when compared to those reported in literature for other hurricanes' (p.80).

The report goes on to say that, 'If the effect (of surge and wave attenuation by vegetation) can be determined with sufficient accuracy, a sound balance can be made between the effects of hard defense measures such as levees and soft defense measures such as marshland stabilization, and hydraulic design parameters can be determined in a more reliable way' (p. 80).

This area of uncertainty, and the range of measures it affects, helps explain why the development and characterization of some of the strategies seemed to favor hard structure or active surge reduction measures, even for the Barataria Basin (p.35). Yet other effects of such levee systems (reduction in tidal amplitude affecting sediment delivery and salinity) still caused the Dutch report to recommend caution when considering a completely closed estuary. Nonetheless, the recommendation of 'ridge levees' or barriers with gentle slopes over a long distance (1000 feet or more) which attenuate surge and ridge levee waves while not stopping them altogether is strongly suggested as such a constructed project has the physical properties (mass and height) needed to compel some level of confidence as well as being able to be built within comparatively short time frames.

Another drawback to strong reliance on marsh development is the time to construct and be effective (if effectiveness can be shown). Effective stabilization could require decades, which leaves the issue of what is to be done in the interim unresolved.

Additional Recommendations and Other Report Features

The report's appendices contain a number of important features including extended discussion of the wave attenuation effects of vegetation, ecosystem restoration, and the use of soft soils for levees. In the section discussing the use of soft soils for levee construction there is more discussion on the concept of ridge levees which appears to be favored as a surge attenuator while marsh stabilization features are being implemented (p.182).

Other features include a discussion of design philosophy and risk analysis in which probabilistic calculations based upon the multiple elements in an event tree may predict the probability of failure of levees and other constructed projects. The report's appendices also recommend a unified design and operation/maintenance philosophy which incorporates climate change, subsidence, structural change, and social factors in the ongoing evaluation of the protective capabilities of built structures. A summary of the overall design and operation and maintenance approach of the Netherlands is also discussed with some emphasis on how the interrelationship of these elements has helped lead to a consensus of social confidence in the ability of the Dutch system to protect the country from catastrophic flooding.

Ultimately, the Dutch report does not recommend large scale diversions because of their potential effects upon salinity gradients and recommends instead piped sediment to locations where new marshland is desired.

Table 1 on the following page compares the specific measures, alternatives, and strategies in the *Dutch Perspective* report to those in the LACPR technical report.

Table 1. Crosswalk between LACPR and Dutch Perspective Report Measures, Alternatives, and Strategies.

Issue	Dutch Perspective Report	Comparison to LACPR
Categories of measures	P.11 – The Dutch report evaluated five categories of measures: 1. Direct protection of built-up areas 2. Closed basin hurricane surge protection 3. Measures to consolidate and increase natural flood protection (wetlands) 4. Basin surge reduction measures 5. Delta system intervention for long-term natural surge reduction	LACPR includes three categories of measures: structural, nonstructural, and coastal restoration. Dutch category 1 corresponds to the LACPR "high-level" structural plans Category 2 corresponds to the "barrier weir" structural plans. Category 3 corresponds to coastal restoration plans. Category 4 contains "eco-levees" or large cypress swamps and doesn't have an equivalent in LACPR, but is similar to coastal restoration plans. Category 5 is similar to the spillway concept in LACPR.
Integrating hurricane flood reduction with coastal restoration	P. 9 – "there was a desire to find out if Louisiana could protect its wetlands by adopting the recent Dutch policy of relying on a combination of "building with nature" and traditional approaches such as building levees and flood barriers."	LACPR adopted a multiple lines of defense strategy in which plans integrate a combination of structural, nonstructural, and coastal restoration measures.
Nonstructural measures	P. 11 – "Non-structural measures are outside the scope of this inventory." P. 12 – "Each strategy includes non-structural measures, but these measures are not detailed in concrete ideas for organizational changes, or ideas for laws and/or regulations."	LACPR contains broad stand-alone nonstructural alternatives at the 100-year, 400-year, and 1000-year risk reduction levels as well as complementary nonstructural measures included in comprehensive plans. The LACPR technical report goes into more detail than the Dutch report in evaluating nonstructural measures and describing State and local responsibilities.
Level of detail	P.10 – "This has produced a reconnaissance study, in which a first, preliminary identification of options has been carried out. This should be followed by more in-depth analyses before final decisions are made…it is noted that the level of detail, especially regarding hydrodynamic modeling, is less than the level of detail in the LACPR report.	The level of detail for the LACPR technical report is between a recon study and a feasibility study for most elements and at feasibility for hydromodeling. There is a higher level of detail in hydromodeling and benefits analysis for LACPR than for the Dutch report.

Issue	Dutch Perspective Report	Comparison to LACPR
Primary strategies (planning units 1 and 2)	P.12 - Open Estuary System, Semi-Open Defense System, and Closed Defense System	The Open Estuary System strategy relates to the high level or ridge alignments in LACPR and the Closed Defense System relates to the barrier-weir options. The Semi-Open Defense System (use of non-continuous levees as surge "speed bumps") hasn't been fully evaluated in LACPR.
Construction time estimates	P. 13 – "The various structural components of the strategies can be realized within a period of about **10 to 20 years**…landscape stabilization measures…will take at least **several decades**."	LACPR is slightly more optimistic about structural component implementation periods. LACPR construction times for the structural components ranged from **6 to 16 years**. The implementation time for coastal restoration measures in Planning Units 1 and 2 was estimated at **25 years**.
Cost estimates	P.13 – "The costs of the Strategies 1 to 5 range between **$18 and $23 billion**." Cost of the "preferred strategy" is **$20 billion**.	Costs for LACPR structural/coastal plans in Planning Units 1 and 2 range from **$35 to $126 billion** (with 25% contingencies added). The LACPR alternatives that most closely relate to the Dutch preferred strategy are PU1-LP-b-1000-1 (~$44B) and PU2-WBI-400-1 (~$78B) for a total of approximately **$78 billion**. A comparison of assumptions used by the Dutch team and the LACPR team follow this table.
Level of risk reduction economically justified for New Orleans	P. 13 – "A Cost/Benefit analysis, in which the cost of structural measures is compared with the reduction in flood risks that these measures bring about, concludes that a substantial increase in the flood protection level of the metropolitan area of New Orleans to a level of about **1/1,000 per year or better** (for example, 1/10,000 per year) is economically justified."	LACPR looks at **1/100, 1/400, and 1/1,000 per year** levels but doesn't reach a conclusion on the level that is economically justified. The conclusion in the Dutch report is based on different cost and benefit assumptions than were used for LACPR. See discussion on cost estimates following this table. The benefits in the Dutch report were based on running a single severe storm that definitely occurs rather than annualizing the benefits based on probabilities.
Structural measures for Plaquemines	P.12 – "…it is suggested that the existing, long and narrow levee rings are replaced with smaller rings of sufficient height around villages, and long stretches of	The *Plan Formulation Atlas* presented four alternatives: 1. Create ring levees/spillways (PL-RS) 2. Create a closed ring levee system (PL-RL) 3. Raise

Issue	Dutch Perspective Report	Comparison to LACPR
Parish	levees are removed in rural and empty spaces in order to allow hurricane surges to dissipate."	Federal levees (PL-FL) 4. Raise all existing levees (PL-EL). Alternatives 2-4 were later screened out because of cost and adverse impacts as described in the *Structural Plan Component Appendix*. The LACPR ring levee/spillway concept (Alternative 1 above) closely resembles the Dutch suggestion and was modeled; however, initial hydromodeling results do not show a regional benefit from the spillways. Knocking down all levees shows a benefit for surge reduction to the New Orleans area, but would have significant impacts on navigation and Plaquemines Parish. The ring levee/spillway concept would have to be addressed in future studies.
Option to create new navigation outlets along the Mississippi River	P. 13 – "Creating new navigation outlets that also keep the river sediments close to the shoreline is an expensive measure due to the large amounts of dredging involved. Other measures with similar or better effects on the ecosystem are most cost-effective and therefore **it is not recommended** to include this measure in the strategy of choice."	LACPR does not include alternatives for new navigation outlets.
Preferred strategy: "Protected City and Closed Soft Coast"	P. 13 – Upgrade New Orleans levees and enclose it where possible in a belt of freshwater cypress tree swamps of between 1 and 6 miles wide (wetland revitalization and creation of 140 sq.mi.). Lake Pontchartrain Basin: open, semi-closed or closed with wetland stabilization (750 sq.mi) and wetland creation (80 sq.mi.) including filling in Lake Borgne. Barataria Basin: Open system with wetland stabilization (600 sq.mi.) and careful management of freshwater diversions and infrastructure improvements.	As described previously, LACPR evaluates the open and closed strategies, but not the semi-closed strategy. LACPR does not consider a belt of freshwater cypress tree swamps or filling in Lake Borgne.
Freshwater diversions	P.14 – The Dutch report **recommends 3 freshwater diversions** in the following upstream locations:	The LACPR report includes 9 diversions in Planning Unit 1 and 9 diversions in Planning Unit 2 for a total

Issue	Dutch Perspective Report	Comparison to LACPR
	• PontFW1 - Towards the Lake Borgne area, possibly via the Industrial Canal and Inner Harbor Navigation Canal. • BarFW1 - Just upstream of New Orleans towards the Barataria Basin. • BarFW2 - Upgrade the existing fresh water diversions (Bayou Lafourche). The Dutch report does not recommend large scale diversions because of their potential effects upon salinity gradients and recommends instead piped sediment to locations where new marshland is desired.	of **18 freshwater diversions**. LACPR handles potential effects upon salinity gradients by including pulsed diversions as an option. A comparison of the locations of proposed diversions in the Dutch report and the locations in the LACPR report follows: • PontFW1 corresponds most closely with the location of the Bayou Bienvenu or Bayou LaLoutre diversions in the LACPR report. • BarFW1 corresponds most closely with the location of the Davis Pond diversion. BarFW2 corresponds most closely with the location of the State's proposed Bayou Lafourche Freshwater Diversion Project.
Adaptive management	P. 15 – "It will take 2 to 5 decades before the benefits of any implemented strategy are fully realized. During this period the strategic goals of the plan will probably have to be modified several times. This recognition needs to be reflected in a management and maintenance strategy for the project."	The LACPR implementation strategy will acknowledge the need for adaptive management.
Uncertainties that should be reduced	P. 15 – The following uncertainties should be reduced: • Improved estimate of extreme events (hurricanes and associated surge levels); • Improved knowledge about the movement of sediments in the delta; and • Improved knowledge on how to most effectively restore wetlands and create new wetlands.	LACPR is handling uncertainties consistent with the Dutch recommendations. • The extreme event analysis used for LACPR is state-of-the-art. • Sediment movement is part of the Regional Sediment Management action related to the response to the National Research Council's comments. • The CWPPRA and LCA programs have an extensive repository of data on effective

Issue	Dutch Perspective Report	Comparison to LACPR
		creation of wetlands and the LCA Science and Technology program will expand that knowledge.
Safety and risk assessments	P.15 – "The Dutch concept of regular safety assessment (every 5 years) including a risk assessment (every 25 to 50 years) **is highly recommended** for coastal Louisiana and the New Orleans area."	LACPR could propose these be consistent actions to accompany decisions for increased risk reduction. They could be addressed under existing authorities or through policy revisions.
Recommendations on pilot projects	P. 15; 75-78 – "a series of pilot projects has been **recommended** to be carried out in the short term." Pilot projects include: 1) Overtopping erosion tests on existing levees 2) Ridge-levees 3) Canal infilling 4) Increase the effect of fresh water discharge 5) Lake segmentation and land formation 6) Accelerated natural fresh water marshland creation 7) Natural salt or brackish water marshland development 8) Accelerated saltwater marshes development	These types of pilot projects are examples of the types of projects that could be investigated by a science and technology program as described in the LACPR *Adaptive Management Appendix*.
Recommendations on priority studies	P.79 -80 – 1) Priority study on risk assessment 2) Priority study on the effects of vegetation on surges and waves	These types of priority studies are examples of the types of projects that could be investigated by a science and technology program as described in the LACPR *Adaptive Management Appendix*.

Notes on cost assumptions in the *Dutch Perspective*:

- Levee cost estimates are based on unit prices in the Netherlands (pg 227). Review of the draft report found that most unit prices compared were in the low range. The report states that a typical (Dutch) price for dredging and delivering of sediment from nearby sources is about $4 - $6/cubic meter (or $3 - $4.6/cubic yard). USACE levee fill costs were in the range of $34 - $44/cubic yards for the levees around New Orleans.

- Levee elevations used for the Dutch design were different than levee elevations used for the USACE plans. Dutch surge elevations were based on draft results from the IPET study extrapolated for higher return periods. Wave heights were also calculated differently. Allowable overtopping was also calculated differently.

- Levee sections used for the Dutch design assumed flood side slopes of 1:6 and protected side slopes of 1:4 with no stability berms. USACE designs have 1:4 side slopes with significant stability berms.

- Dutch estimates assumed hydraulic fill construction with strip drains for levees. USACE estimates use haul or barged in fill with geotextile reinforcement or soil improvement. For the Dutch design all levee fill material was assumed to be pumped from Mississippi River. No information on pumping distances assumed is included.

- Levee rings do not include St. Charles levees which were included in all LACPR alternatives and Laplace levees which were also included in some of the LACPR alternatives.

- Information on most assumptions for marsh creation is not presented. One assumption was that borrow was available from nearby sources. This assumption would be unlikely for all areas. Also, given the limited information, it is hard to compare the magnitude of coastal features such as diversions and marsh creation.