

THE WATER INSTITUTE OF THE GULF®



Robinson Design Engineers

FEBRUARY 2021

Perimeter Protection Analysis Discovery Report

WAGGONNER & BALL ARCHITECTURE/ENVIRONMENT 2200 PRYTANIA STREET NEW ORLEANS, LA 70130 +1 504 524 5308 WBAE.COM



This analysis was conducted under the direction of the City of Charleston Mayor's Office of Resilience and Emergency Management and the Department of Planning, Preservation & Sustainability. The analysis was funded through a public-private partnership between the City of Charleston and a group of private funders.

Funders:

City of Charleston Historic Charleston Foundation South Carolina Ports Authority Lowe Enterprises Middle Street Partners Origin Development The Beach Company Preservation Society of Charleston Coastal Conservation League

Perimeter stakeholders engaged:

Medical University of South Carolina Roper Hospital VA Hospital Palmetto Railroad Citadel SC Aquarium Charleston Yacht Club Wagener Terrace Neighborhood Association

Project Team

Waggonner & Ball: David Waggonner, Andy Sternad, Lex Agnew The Water Institute of the Gulf: Dale Morris Moffatt & Nichol: Johnny Martin, Maarten Kluijver Arcadis: Piet Dircke, Walter Baumy Robinson Design Engineers: Joshua Robinson

Dutch Dialogues is a registered trademark of Waggonner & Ball. All graphics and images are attributed to Waggonner & Ball unless otherwise noted.

Table of Contents

Introduction & Summary	4
Background	6
Summary of Observations	8
Recommendations	12
Timeline	16
Analysis Framework	22
Design Criteria	24
Defining the Alignment Zone	40
Alignment Options	46
Eastside	48
Ports	56
Low & High Battery	68
Lockwood Corridor	84
Citadel Marsh	94
Wagener Terrace	100
	110
Appendix	110

Introduction & Summary

s they

Contents

1

Background

source the second

Summary of Observations

Recommendations

Background

Purpose

This team was invited to advise the City of Charleston on its approach to the US Army Corps of Engineers' (USACE) perimeter protection study in alignment with Dutch Dialogues[™] principles and recommendations. This document does not propose a design vision for a wall, nor does it propose alternatives to the USACE process. It aims to preface how that process can be navigated to address the peninsula's multiple flood reduction needs without sacrificing its essential character. The USACE project is highly constrained but presents an opportunity for the City, if taken, to leverage federal funding support for storm surge protection as one part of a holistic, integrated strategy for urban water solutions on the Charleston Peninsula.

Team

Led by Waggonner & Ball with David Waggonner at the helm and Dale Morris of the Water Institute of the Gulf—leaders of Dutch Dialogues Charleston—the team includes engineers from the Dutch Dialogues effort with specific expertise in surge protection design, in working with the US Army Corps, and in Charleston's water and ecology. Moffatt & Nichol reviewed the USACE analysis, including water level projections, design storm events and the risk of overtopping. Arcadis contributed operations and maintenance perspective based on projects in the Netherlands and with the USACE around the country, as well as ideas of nature-based offshore elements. Robinson Design Engineers contributed guidance on Lowcountry ecology, the environmental regulatory framework and long-term marsh resilience.

Process

The analysis began in late October 2020. The team conducted a technical analysis of the USACE study to date, virtual stakeholder listening sessions and meetings, and a 3-day working session in Charleston in November 2020 with City officials and staff, key perimeter stakeholders and USACE project leadership and technical staff. (A robust engagement process is recommended to involve stakeholders missed in this conceptual analysis.)

The analysis progressed both within the USACE process and alongside it, an effort to determine if its potential benefits justified the City's further participation. The team identified gaps, functional concerns, alternative pathways and design criteria not factored into the USACE 3x3x3 process that are nevertheless of primary importance to the City, and documented other public and private initiatives, goals and investments that should guide the City's engagement with USACE process going forward. After a preliminary review of USACE documents, the team advised the City that a Locally Preferred Plan (LPP) was impractical and untimely given limited funding and schedule. Instead, we recommended the initiation of a broader planning and coordination effort to incorporate design inputs beyond the limited, storm surge risk-only scope of the USACE study to better align future phases of the USACE process with the City's wider interests.

The team proposed multiple perimeter options and zones of immediate and future investigation between the early 2021 release of the USACE optimized plan and the future USACE Preliminary Engineering & Design (PED) Phase. These options present a zonal approach with an expanded menu, rather than a single delineation, including more desirable options that lessen impacts, protect additional properties, and recognize the critical need for the City, beyond the USACE coastal storm surge charge and purview, to manage water, other chronic flooding and future sea rise challenges.

Finally, the team worked with City staff to understand better the potential consequences for the City, its commitments and decision impacts within upcoming USACE study milestones.



USACE Optimized Alignment Overview. *Credit: Waggonner & Ball*

Summary of Observations

Perimeter Context & the Nature of Protection

- 1. Some type of raised, protective perimeter will be required to preserve the Peninsula as sea level continues to rise this century. Charleston has a long history of building protective structures at waters edge, and environmental change demands adaptation anew. As described in the Dutch Dialogues, it is likely the Peninsula will eventually function like a Dutch polder, or self-contained water management entity, similar to the City of New Orleans today. Barriers will be needed to keep high tides as well as storm surge out and pumps will be needed to manage rainfall and groundwater within. Once a polder perimeter is established it must be operated and maintained in perpetuity, as investments will increasingly depend upon it.
- 2. <u>The team believes storm surge protection on the Peninsula is necessary given the potential for significant—if infrequent—storm surge impacts.</u> A damaging, deadly surge event would substantially impact life, mobility and economic activity on the peninsula for many years. Recovery would be costly. Surge protection alone, however, does not address the immediate and increasing challenge of tidal flooding and it is not sufficient for overall Peninsula flood risk mitigation. The USACE proposed structure will have a measurable impact on storm surge risk reduction, but will have to be raised over time as sea level rises to maintain the same level of protection. The City's 2019 Flooding & Sea Level Rise Strategy anticipates an increase of 2 to 3 feet within the 50 year design life of the USACE structure.
- The 12' NAVD88 structure elevation proposed by the USACE is designed to protect against a 2% annual recurrence event (or 50 year storm) and is low as planning standard for coastal risk reduction. FEMA Community Rating System (CRS) standards for insurance rate reductions in other cities are based on higher levels of protection (1% annual recurrence event (or 100 year storm) in New Orleans; 0.3% annual recurrence event (300 year storm) on Staten Island).
- 4. <u>Resilient, raised perimeter systems are built on the principle of multiple lines of defense with both man-made and natural features.</u> Reliance on one structure or line concentrates risk and lacks redundancy. In New Orleans, multiple lines of defense include natural ridges and wetland buffers outside the levees. In the Netherlands, these include primary and secondary levees, dikes and dams, redundant pump and drainage infrastructure, and internal sub-basins and space for runoff storage. The USACE-proposed structure would provide significant risk reduction but should not be imagined or depended upon as the only aspect of the future risk reduction system.
- 5. The many water-related projects already completed or underway give Charleston momentum and a planning advantage, but plans may need revision and coordination to anticipate a future raised perimeter system. The transition to a polder model within an enclosed perimeter will require fundamental adaptations to internal hydrology and retrofits for existing drainage infrastructure. A raised perimeter fundamentally changes the operating environment for some City infrastructure and presents new opportunities—and plans must be adapted in response. Related projects include the Comprehensive Plan Update (2021), Parks & Recreation Master Plan (2021), Stormwater Project Prioritization Effort (2021), All Hazards Vulnerability & Risk Assessment (2020), Stormwater Design Standards Manual (2020), Sea Level Rise Strategy (2019), Dutch Dialogues Report (2019), and drainage improvements such as check valves, Spring Fishburne and Calhoun West tunnels and Huger and King Street work (ongoing).



Proposed Alignment Zone overview. PED segments & phasing (red dashes) as decribed to the analysis team by USACE project leadership in November 2020. Analysis team segments (black dashes) largely correspond, with additional subdivisions. Credit: Waggonner & Ball

USACE Process & Expected Outcomes

- 6. The City should not expect the USACE process to deliver a solution for holistic water management. The USACE perimeter study is limited to a single risk driver, storm surge; is constrained by rules and regulations to factor a narrow set of possible strategies and benefits; and must seek the lowest initial cost option (not necessarily lowest operating cost or highest value option). If not properly planned, designed, engineered, operated and maintained, the surge structure will constrict the City's ability to manage many future needs. The team recommends a role for the USACE in Charleston's future perimeter system, but to make the investment worthwhile the City needs a broader strategy to a) set its own terms of engagement with USACE and b) enable the development of a comprehensive water strategy for all types of flood risk.
- 7. <u>The typical 3x3x3 study requires a 50/50 cost share between the USACE and local partner (the City). Uniquely, the Charleston perimeter study is fully funded by the federal government, saving the City money in the short term but limiting its ability to influence the process as an equal partner. An upcoming Environmental Impact Statement (EIS) provides an opportunity for the City to state impacts and priorities yet to be identified and documented.</u>
- 8. <u>A portion of the City's cost share may be eligible for State support</u> where regional and state-level interests overlap, such as for state-owned roads, the South Carolina Port Authority and Medical University of South Carolina.
- 9. <u>The USACE Benefit Cost Ratio (BCR), by regulation, excludes some costs and assets of real value to the City and State.</u> The values of USACE-excluded costs and assets should nevertheless factor into City decision-making surrounding this project. These exclusions include the value of transient cargo (such as automobiles awaiting shipment), non-permanent structures, structures raised above the floodplain (even if access is subject to flooding), the projected value of future development and a full accounting of operations and maintenance costs to the City (such as frequent operation of gates for high tide events). The team was not able to verify the figures used for repair costs of historic structures, but questions whether the BCR accounts for the high cost and specificity of historic buildings on the Peninsula.
- Mitigations for documented impacts, similar to overall project cost, are cost-shared 65% USACE / 35% local partner. Betterments are City-requested changes that may be made for any reason, and are paid 100% by the City.
- 11. <u>"Movable" and "temporary" structures are red flags for risk and reliability.</u> Movable elements such as road, rail and tide gates, removable floodwall panels and temporary pumps create operational complexities: all elements must be maintained, and staff must be trained and available, to perform properly when called upon in emergencies. Movable parts are risk and cost multipliers and concentrate potential for technical and human operator failure. The need for each gate and temporary feature should be highly questioned and avoided everywhere possible.
- 12. <u>Significant changes can be expected in PED phase</u>, including the structure type, alignment, number and type of gates, and size and location of pumps. The USACE Optimized Alignment is the basis of cost estimating and risk modeling to prove overall feasibility, not a final design proposal.
- 13. If the City chooses to proceed through the USACE project development process it will be required to fund a percentage of design and construction costs in phases. These costs grow over time and with inflation; the full cost of the project is also paid over time and will span at least one, if not two,

decades. The City will have opportunities to stop the project, and its cost share, at future interim phases, even after its initial financial commitment for the full construction amount (expected to be required in late 2021). With negotiation, a Locally Preferred Plan may be developed at each PED phase.

- 14. <u>The City's decision to proceed with the USACE process may provide additional short-term</u> <u>benefits:</u>
 - A) Potential economic benefit to the local economy. The City's cost share portion can take the form of professional services, such as hiring its own designer or engineer, as long as the work conforms to USACE standards (USACE remains "lead designer" in PED).
 - B) Preliminary Engineering & Design phases will generate significant survey and geotechnical data which may prove valuable for other infrastructure and development projects on the Peninsula.
- 15. <u>The City's decision not to support the next steps of the USACE process, now or at future phases,</u> <u>may come with tradeoffs:</u>
 - A) A loss of momentum for resilience and flood mitigation. No other prospects for a federal cost share of needed perimeter flood protection infrastructure are on the horizon.
 - B) Sea level and tidal flood risk will continue to increase; these increase the damage potential of any significant future surge event. 2020 saw the most +8' tides in the recorded history of Charleston harbor in a year with no hurricane-driven surges.
 - C) An incomplete system. The City may elect to end its cost share before all phases are designed and constructed, but would be left with a partial system that does not mitigate surge risk.
 - D) If a major storm event strikes near term, a signed Chief's Report "on the shelf" may be implemented as-is with full federal funding. It is therefore necessary to engage the USACE to produce a study with acceptable outcomes for the City at every stage of planning.
 - E) An acceleration of private sector flood retrofits in the absence of holistic City plan. Private sector adaptation is a necessary part of a layered flood defense strategy. Individual, ad-hoc responses, however, erode the likelihood of future large-scale projects by effectively removing at-risk properties from the cost/benefit calculation. This conflict between the goal of safety and USACE cost/benefit methodology should be understood, and may be addressed through integrated systems planning.

Recommendations

1. Proceed incrementally with the USACE process.

- A) <u>Continue to work with the USACE as a partner for federal cost sharing but understand the</u> <u>limits, set of rules and narrow focus of its surge-only process.</u> The team believes that flood risks justify continued engagement with the USACE process and that there are pathways for the City to achieve its desired outcomes. However, these pathways require strategic, deliberate navigation of the USACE 3x3x3 process to assert the City's priorities at every opportunity, and a parallel process led by the City to clarify and develop its broader flood risk reduction goals before PED phase begins.
- B) <u>Identify and understand key decision points in time and their consequences for the City,</u> including:

EIS: Scope the USACE's recently announced Environmental Impact Statement (EIS) for as much flexibility as possible to capture the breadth of impacts of the barrier on the existing hydrological, ecological, historical, cultural and economic context. Through this process, the City can clarify impacts, possible mitigation measures, and refine costs before committing to a cost share. Required mitigation measures identified through the EIS are cost-shared with the USACE.

NED: anticipated at the end of 2021, the National Economic Development (NED) milestone will require the City to commit to the project's overall cost share. The report is then submitted for approval at USACE headquarters in Washington, DC.

PED: If the study's recommendation is approved and funded by the USACE, the City's first cost share for the first PED phase is expected to occur in 2023. PED begins the comprehensive planning, engineering, design and siting work for the surge structure. PED phase one is currently planned in the Lockwood Corridor.

Construction, and construction costs, are not anticipated before 2025 for phase one.

- 2. Integrate water issues and opportunities with land use, development and ongoing efforts through a spatial, nature-based, design-driven approach as recommended in the Dutch Dialogues[™] Charleston report.
 - A) <u>A Charleston water plan would build on the foundation of plans and projects completed and underway.</u> The water plan can be imagined as an update to the Downtown Plan (1999) in that it focuses on water but encompasses interrelated urban systems, stakeholders and spaces. The City does not need another study, but rather a specific approach to design, coordination and implementation of significant projects and up-to-date plans.
 - Building on the Vulnerability Assessment and other existing data, perform an analysis specific to the Peninsula for how a perimeter structure will affect related risks, planned projects, and overall sustainability goals.
 - C) Surge and flood mitigation infrastructure must, wherever possible, be multi-functional and adaptable. It must not constrain other land-use, development, transportation, occupation, aesthetic, ecological and cultural considerations on the Peninsula. It must be integrated with current and future tidal, stormwater and groundwater solutions. Flood mitigation infrastructure must enable and not impair the temporal, physical, social,

environmental and economic adaptations that today are unknown but will surely surface in coming decades. The Charleston Peninsula is an iconic, irreplaceable historic asset in a dynamic natural environment, and surge protection and water management must be designed to respond over time to these changing conditions.

- D) Design multiple lines of defense that include internal water management and external naturebased features, like breakwaters and oyster banks, that will grow and adapt over time. Internal lines of defense may include multi-functional detention areas, networked pump and conveyance systems, and, crucially, passive natural features that reinforce Charleston's landscape and character.
- E) Integrate and coordinate Peninsula investments. Every capital improvement project drainage, public space and recreation, ecosystem protection and restoration, transportation infrastructure—can leverage flood mitigation opportunities. This is smart, efficient investment.
- F) Begin planning for the organizational structure that will be needed to operate and manage the <u>future Peninsula water system</u> (tide, surge, stormwater, groundwater). This includes a framework for the future tax base and revenue stream required to operate and maintain the perimeter system. These costs may be minimal at first but will grow over time.
- G) <u>Develop a decision-making framework that includes operations and maintenance costs</u> as well as long-term replacement cycles with necessary capital reinvestments to sustain the system over its lifecycle.
- Define City goals and values in advance of major projects. A water plan could be used to develop and build public consensus for infrastructure investments and to ensure the USACE and other design processes are accountable to the City's stated priorities (not the other way around).
- <u>Get ahead of PED.</u> The USACE process must conform to City's stated priorities and planning framework once it is a cost share partner. An early and integrated planning process underway—or completed—before further commitments will create significant efficiencies, leverage points and cost savings for the City if and as the surge protection project proceeds.

3. Develop a clear stakeholder engagement & communication process for flood mitigation work.

- A) <u>Continue the City department leadership working group.</u> Include and coordinate with State agencies, like SCDOT, to align objectives and investments.
- B) Engage the public. Create a Citizens Advisory Council to facilitate public input and review. Engage the local and regional business community to uncover additional challenges and ideas. Engagement should focus not just on the perimeter alignment itself, but on the internal watersheds and communities behind the alignment who have yet to be reached. All Peninsula residents and organizations, and indeed all of Charleston, should be heard in this effort.
- C) <u>Remove from consideration alignments and related options that are unacceptable and do so</u> <u>as early as possible to eliminate negative public feedback and wasted community effort.</u>
- D) <u>Devise an information strategy or portal</u> so the larger Charleston community can access planning and project information. Develop information sharing and educational processes to build community awareness and gather input to build support.

MARSH

Alignment Zone & Urban Watersheds

WAGENER

ASHLEY RIVER

T.

Legend

Current USACE Alignment 12 ft NAVD 12 ft NAVD Land Surface Elevation Alignment Zone Optional Alignment Possible Pump Station Location (USACE) Watershed Deep Tunnel Projects

LOCKWOOD

CORRIDOR

- 🐨 🛛 Drop Shaft
 - Deep Tunnel Pump Station

LO BATT

