GREENING INGLESIDE FRONT-TO-BACK

Seeking Sustainable Solutions for Sea-Level Rise, Flood Management, and Water Quality Challenges

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Executive Summary

This project seeks to create a resilience strategy for the Ingleside neighborhood of Norfolk, Virginia in the face of sea-level rise. To develop this strategy, a University of Virginia (UVa) research team collaborated with local organizations (Elizabeth River Project, Wetlands Watch, Ingleside Civic League), residents of Ingleside, and the City of Norfolk to design resilient solutions to local flooding and pollution associated with rising sea-levels in the areas surrounding Broad Creek and the Elizabeth River. The primary research question for the team was how to create lasting and sustainable solutions to sea-level rise, flooding, and poor water quality that are both effective and engaging for the Ingleside community. After collecting information from three community meetings held at Ingleside Baptist Church, reviewing relevant case studies of resiliency projects in other cities, and analyzing data from geographic information systems (GIS), the team has identified three primary intervention tactics: living shorelines, stormwater management and community engagement. These three strategies each encompass a variety of solutions and together comprise a holistic plan for the Ingleside community. This proposal suggests site specific interventions throughout Ingleside. The possible sites of implementation include Ingleside Road, Townsend Place, Kentucky Avenue, and Westminster Avenue, along with non-site specific interventions that can be implemented on both public and private land throughout the neighborhood. The plan research will be used by local organizations and the City of Norfolk to apply for multiple resiliency and community improvement grants in the near future.

Introduction

CLIMATE CHANGE AND COASTAL RESILIENCE: SEA-LEVEL RISE

As climate change continues to increase, the stress on coastal communities will grow due to rising sea-levels. A survey conducted for a 2007 edition of the magazine *Architecture 2030* concluded that the Earth maintained 383 parts per million (ppm) carbon dioxide (CO_2) in the atmosphere with a steadily increasing concentration of 2ppm projected annually.[1] The research suggests that at 450 ppm of CO_2, the Earth will experience "potentially irreversible glacial melt and sea-level rise," causing damage to coastlines that is "out of humanity's control."[2] In March 2017, scientists observed a level of 407.05ppm CO_2 in the Earth's atmosphere.[3]

The global rise of sea-levels resulting from climate change has been measured over the past several decades. The 2007 Intergovernmental Panel on Climate Change (IPCC) noted that, between 1993 and 2003, the rate of sea-level rise accelerated to 3.1 ± 0.7 mm/yr, almost double

[1] Mazria, Edward, and Kristina Kershner. "Nation Under Siege: Sea Level Rise at Our Doorstep." *Architecture 2030* (2007): Print.
[2] Mazria, 2007.
[3] "Earth's CO2 Home Page."*CO2.Earth*. ProOxygen, 2017. Web. 17 Apr. 2017.

the estimated rate of sea-level rise of 1.7 ± 0.5 mm/yr during the 20th century. During that same ten-year period, between 1993 and 2003, the IPCC estimates that ocean heat content and associate ocean expansion increased to an estimated 1.6 ± 0.5 mm/yr, while glacier and land ice melt has increased ocean mass by approximately 1.2 ± 0.4 mm/yr. The IPCC reports clearly indicate a connection between the statistically observable rising sea-levels and rising global temperatures, specifically stating, "the near balance for 1993 to 2003 gives increased confidence that the observed sea-level rise is a strong indicator of warming."[4] Additionally, the IPCC collected evidence supporting with "high confidence" that climate change and increasing global temperatures are resulting in "increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, and warming of lakes and rivers in many regions, with effects on thermal structure and water quality".[5]

Sydney Levitus, the Chief Scientist at the National Ocean Climate Laboratory, outlines the processes that contribute to sea-level change as follows:[6]

1. Transfer of meltwater between ice caps and glaciers to the ocean
2. Haline contraction and expansion based on salinity changes
3. Thermal expansion and contraction based on overall temperature
4. Changes in basin shape
5. Uplift of sediments due to sediment loading or dredging
6. Changes of wind and ocean circulation
7. Transfer of groundwater between continents and oceans

These processes are influenced by a number of environmental changes, but data from the IPCC indicate a strong correlation between global average temperature increases and sea-level rise.[7] Data collected by U.S. Tidal Gauge Stations indicate that there are currently slight decelerations in average sea-level rise, but the statistical significance of these data are questionable, and thus there is no definitive determination as to whether sea-level rise is, in fact, decelerating. While the rate of sea-level rise may be decelerating, evidence shows that sea-levels are continuing to rise and impact coastal communities.

There is currently no model that accurately describes the amount sea-levels will rise by the year 2090, but multiple simulations conducted by the IPCC indicate that in the next 100 years, global sea-levels could rise between 0.1 and 0.2 meters. As a result, scientists with the IPCC currently estimate that, by the end of the century, 100 million people around the world will be affected by

[4] Solomon, Susan et al., eds., *Climate change 2007: the physical science basis* (Cambridge: Cambridge University Press, 2008).
[5] Rajendra K. Pachauri, Andy Reisinger, and The Core Writing Team, eds., *Climate Change 2007: Synthesis Report,* (Cambridge: Cambridge University Press, 2008).
[6] Bilal M. Ayyub and Michael S. Kearney, eds., *Sea Level Rise and Coastal Infrastructure: Prediction, Risks, and Solutions* (Reston: ASCE, 2012), 23.
[7] Rajendra K. et al., 31.

sea-level rise.[8] Even as various governmental organizations around the world push for a decrease in carbon emissions in the coming decades, seawater levels will continue to experience the effects of human-generated CO_2 emissions, "for more than a millennium, due to the time scales required for the removal of this gas from the atmosphere."[9] Based on their models, IPCC estimates that, by the 2080s, "many millions more people than today are projected to experience floods every year due to sea-level rise."[10] Currently, low elevation coastal zones, which are located less than 10m above sea-level, contain only two percent of the world's land area, but hold 10 percent of the global population and 13 percent of the global urban population.[11] These areas in particular will continue to be heavily affected by sea-level rise in the coming years.

Climate change already poses significant threats to the health and safety of communities globally. As these threats become more apparent, simply focusing on mitigating climate change through reductions in emissions is not enough. In their 2007 Synthesis Report, the IPCC stated,

> "There is *high confidence* that neither adaptation nor mitigation alone can avoid all climate change impacts. Adaptation is necessary both in the short term and longer term to address impacts resulting from the warming that would occur even for the lowest stabilisation scenarios assessed. There are barriers, limits and costs that are not fully understood. Adaptation and mitigation can complement each other and together can significantly reduce the risks of climate change."[12]

The immediate need for adaptation, alongside mitigation, has increased federal, state, and local interest in introducing and improving coastal resiliency, or "the capability to anticipate, prepare for, respond to, and recover from multi-hazard threats—with minimum damage to socio-economic well-being and the environment."[13] With over 50 percent of the world's population living in coastal areas, the need to protect people and property from increasingly extreme storm events through coastal resilience efforts is evident.[14] The United States, in their report *Federal Actions for a Climate Resilient Nation*, reiterates the importance of nature-based infrastructure nationally, such as coastal wetlands and shellfish beds, in reducing the impacts of storm events.[15] Likewise, the Department of the Interior has identified the need for projects that "reduce communities' vulnerability to growing risks from coastal storms, sea-level rise, flooding, erosion, and associated threats while simultaneously strengthening natural ecosystems that benefit fish and wildlife."[16]

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[8] Ibid,10.
[9] Ibid, 47.
[10] Ibid, 48.
[11] Bilal M. Ayyub and Michael S. Kearney, eds., *Sea Level Rise and Coastal Infrastructure: Prediction, Risks, and Solutions* (Reston: ASCE, 2012), 20.
[12] Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report*.
[13] Ariana Sutton-Grier, Kateryna Wowk, and Holly Bamford, "Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems," *Environmental Science and Policy* 51 (2015): 138, PDF.
[14] Ibid, 145.
[15] *Progress Report of the Interagency Climate Change Adaptation Task Force*, October 28, 2011.
[16] "Hurricane Sandy Coastal Resiliency Competitive Grant Program," National Fish and Wildlife Foundation,

Coastal resilience strategies can be useful in reducing small runoff volumes or nuisance flooding, in addition to protecting against larger storm events. Living shorelines, for instance, are one example of a coastal resilience strategy. Rising sea-levels and sediment depletion have led to increased coastal erosion. Living shorelines are a method of shore stabilization that create new habitat and enhance the existing ecosystem, while simultaneously protecting people and property from storms and sea-level rise.[17] To further enhance the protective benefits of living shorelines, natural shellfish reefs can supplement vegetation in order to reduce wave energy, stabilize bottom sediment, and increase habitat for fish and shellfish. While living shorelines can be adapted and designed to thrive in many different environments, many other coastal resilience techniques must be contextualized to fit the needs of a specific community. An example of a community that could benefit greatly from coastal resilience solutions is Hampton Roads, Virginia, a coastal region of Virginia that is already experiencing the effects of sea-level rise.

CLIMATE IMPACTS IN HAMPTON ROADS, VIRGINIA

The Hampton Roads region, located on the southeastern coast of Virginia and containing important port cities like Norfolk, is uniquely positioned to experience the effects of climate change on rising sea-levels. While centuries of dense, urban development along the fragile coastline has certainly expedited the effects of sea-level rise, the factors which contribute to the region's severe flood conditions predate human settlement. Stretching back 35 million years, a bolide hit at the mouth of the Chesapeake Bay and created a 50-mile-long zone of weakened sediment which ends just outside of Norfolk's tidal plane, and climate scientists suggest it likely impacted the region's susceptibility for land subsidence.[18] Since the early 1940s, land subsidence — the gradual sinking of the Earth's surface — has been observed as increasing at rates of 1.1 to 4.8 millimeters per year in the southern Chesapeake Bay region.[19] Running parallel to the gradual sinking of the coastline are rates of sea-level rise due to global warming, which have been measured at Sewell's Point in Norfolk since 1927 (Figure 1.). By 2006, the research collected at Sewell's Point documented an average rate of increase in sea-levels of 4.4 mm/yr.[20] As the rapid increase of CO_2 levels in the last decade threatens unprecedented rates of increase for the region's sea-levels, foundations such as the Georgetown Climate Center, a research initiative conducted at the Georgetown School of Law, project that "Virginia will experience at least 1.5 feet of sea-level rise during the next 20 to 50 years."[21] These predictions, in addition to ongoing land subsidence,

[17] Sutton-Grier, et al., "Future of our coasts…" (2015).
[18] Allen, Jessica L., and James C. Lendemer. "Quantifying the Impacts of Sea-level Rise on Coastal Biodiversity: A Case Study on Lichens in the Mid-Atlantic Coast of Eastern North America." *Biological Conservation* 202 (2016): 119-26. Print.
[19] Eggleston, Jack, Jason Pope, and Hampton Roads Planning District Commission. "Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region." *U.S. Geological Survey* (2013): 1-19. Web.
[20] Eggleston, 2013.
[21] Steinfeldt, Tom, Chris Coil, and Hans-Pete Plag. "Understanding Virginia's Vulnerability to Climate Change." Blog post. *Georgetown Climate Center*. Georgetown School of Law, 17 Feb. 2017. Web.

position the greater Hampton Roads area and the City of Norfolk as the second most vulnerable region in the United States to the impact of sea-level rise.

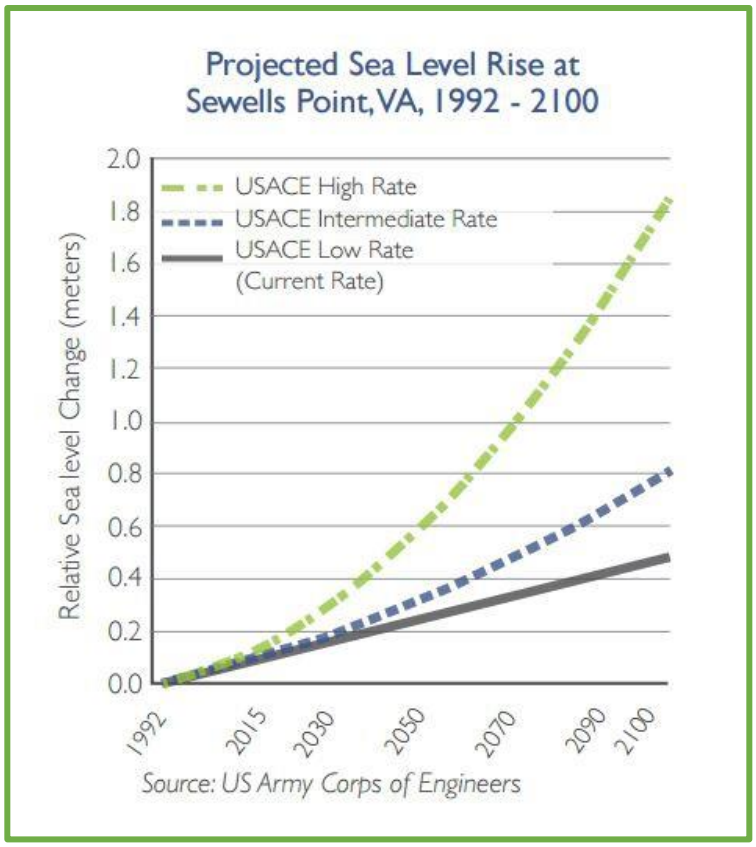

Figure 1. Sea-Level Rise at Sewells Point, Virginia
Source: US Army Corps of Engineers

Under the surface, these severe rates of rising sea-levels indicate an impending series of drastic and rapid changes for the incredibly delicate and complex Chesapeake ecosystems which surround the Hampton Roads area. Due to the effects of erosion and washover in the past several decades, the southern Chesapeake Bay region has experienced one of the most rapidly dwindling populations of four species of lichen. While the presence of lichen may appear arbitrary, the fungi serves as an indicator species for the health of over 193 coastal species.[22] Therefore, sea-level rise, when compounded with water pollution from urban coastal settlements, will negatively impact the biodiversity balance within Hampton Roads.

In addition to the threats facing coastal ecosystems, sea-level rise also poses a threat to the safety and well-being of Hampton Roads' residents. Norfolk, the second largest city in the Hampton Roads Region, is home to the world's largest naval base, deepwater ports, shipyards, maritime

[22] Allen, 2016.

industry, and recreation. Coastal resilience in Norfolk has gained national attention since it is a matter of national security. In order to protect the people and places of Norfolk from sea-level rise, storm surges, and persistent flooding, the city of Norfolk has designed a coastal resiliency strategy unique to its needs. Not unlike the majority of the American population, just over 53% of which inhabits these coastlines in question, more than 100,000 people in Virginia live less than five feet above the high tide line.[23] Exceeding this number, "more than 400,000 homes in Virginia are at risk for storm surge damage with projected reconstruction costs of $92 billion;" the majority of which are in Hampton Roads.[24] In order to protect neighborhoods, Norfolk has implemented strict building codes to ensure that homes are built no lower than 3 feet above the expected water level in flood events. Additionally, Norfolk recommends that homeowners reduce flooding impacts through restoring natural shorelines, planting trees, installing rain barrels, and incorporating landscaping like rain gardens. While Norfolk is investing in large-scale projects like floodwalls and tide gates, more localized solutions can mitigate the negative effects of flooding and storm surges in residential communities.[25]

WHY INGLESIDE?

Climate Impacts

This project focuses on the neighborhood of Ingleside in Norfolk. A residential community along the Eastern Branch of Norfolk's Elizabeth River, Ingleside is already experiencing the troubling effects of sea-level rise. Staged at the confluence of the Elizabeth River and Broad Creek, with conflicting tides drawn from both Northeast and coastal winds, the peninsula on which the Ingleside community resides is particularly inclined to flood. Streets often become completely flooded during high tide, leaving entire divisions of the neighborhood isolated from work, school, and emergency services. The Elizabeth River and Broad Creek, the two waterways which surround the Ingleside neighborhood, are two of the most polluted waterways in the nation, earning a "C" and "F" health rating, respectively (Figure 2). Among the greater concerns discussed by the Ingleside community are the high premiums they are required to pay in flood insurance which seek to prevent these damages. While these premiums are a burden for Norfolk residents in the short-term, the flooding derived directly from sea-level rise, also referred to as tidal, surge, or, more colloquially, "sunny-day" flooding frequently damages private property and serves as a significant impediment to daily lif

[23] Mazria, 2007.

[24] Steinfeldt, 1.

[25] City of Norfolk, *Coastal Resilience Strategy*, accessed May 2, 2017.

Scorecard Measures	Broad Creek	Indian River
Bacteria (human contact criteria)	F	F
Dissolved Oxygen	F	B
Nutrients - Nitrogen	D	F
Nutrients - Phosphorous	D	F
Phytoplankton/ Chlorophyll	D	D
OVERALL	**F**	**F**

Figure 2. "Scorecard" for Water Quality in Broad Creek and the Indian River
Source: Elizabeth River Project

Background and Demographics

Ingleside is a diverse residential neighborhood in Norfolk, Virginia. It is bordered by Virginia Beach Boulevard to the North, Amtrak's Northeast Region railroad to the West, I-264 to the South, and Broad Creek to the East.[26] The neighborhood's main street, Ingleside Road, connects the bordering highways, Route 58-Virginia Beach Boulevard and I-264. The significance of Ingleside Road is increased through its unofficial function as a symbolic barrier, dividing the neighborhood into two demographic sections to the west and east. For the purpose of this demographic analysis, the section bordered by Ingleside Road to the east and by I-264 to the south will be referred to as western Ingleside and the section bordered by Ingleside Road to the west and the entire peninsula south of I-264 will be referred to as eastern Ingleside. Ingleside is located just south of the Army National Guard's military-industrial complex, which serves as a site of employment for many Ingleside residents as well as a broader source of regional income. The community's major facilities include Ingleside Elementary School, Ingleside Recreation Center and Park, and Ingleside Baptist Church, which are each located along Ingleside Road

[26] "Northeast Regional," Amtrak.

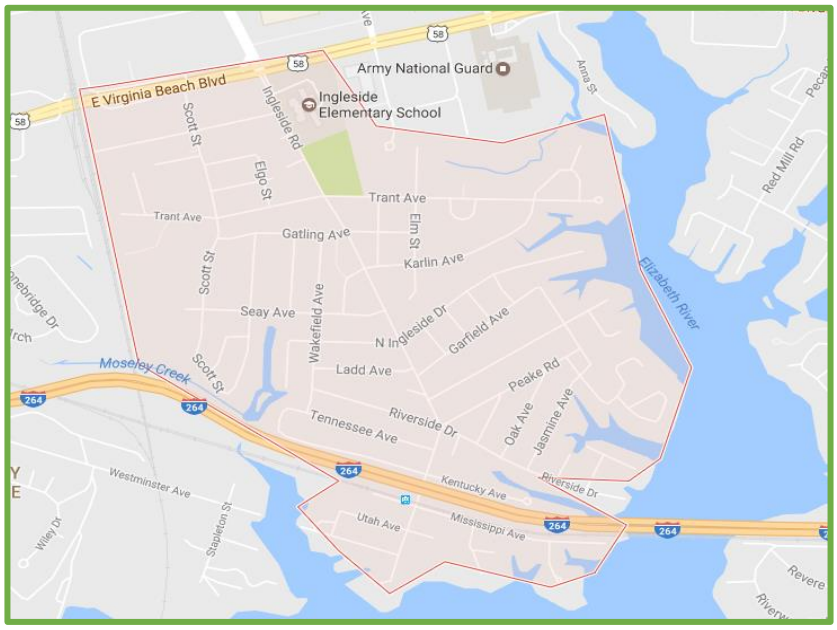

Figure 3. The Borders of Ingleside
Source: Google Maps

In terms of income level and homeownership rates, residents of eastern Ingleside have more financial resources. For instance, 2015 data depicts the median household income for homes on the east side of Ingleside Road to be $63,725-$84,375, while the west side shows a significantly lower average income of $31,395-$41,563 (Appendix 1. Income). These income levels are further verified when viewing the home rental versus home ownership data layers for the two "sections" of Ingleside. The eastern half of the neighborhood holds a homeownership rate of 69.64%-83.99% and a rental occupancy rate of 19.26%-29.13%, while the western side of Ingleside reads essentially vice versa, with a homeownership rate of 47.11% or less and a rental occupancy rate of 61.61%-100.00% (Appendix 2 and 3. Ownership and Rental).

In terms of median age of population and predominant racial divisions, the two "halves" of Ingleside are notably congruent. The median age for West Ingleside is 32-35 years old and the median age for East Ingleside is 36-39 (Appendix 4. Age). "Black" populations are the predominant racial group across the neighborhood, accounting for 70-90% of the residents west of Ingleside Road and 50-70% of the residents to the east (Appendix 5. Race). In conclusion, Ingleside has a varied set of demographics, even within its own borders, which is why the UVa team has offered numerous suggestions and solutions that can be implemented in different areas of the community.

Community Strength & Engagement

While the residents of Ingleside face severe threats from encroaching tidal waters, the strength of public engagement observed within the Ingleside Civic League, fueled by a deep and innate passion for their small community, suggests that they have the support and initiative required to combat present and future flooding. The city should use this sense of community pride as a powerful resource given that public interest can be a significant driver of change. For example, in reference to self-sufficient entities capable of managing their own environmental waste products, such as stormwater, Peter Newman, a Professor of Sustainability at Curtin University, and Isabella Jennings, a graduate student in the School of Environmental Science at Murdoch University, suggest that effective change must begin at the grassroots level. Furthermore, they conclude that locally-driven solutions, rather than those which rely on centralized power, are more likely to "reflect the unique characteristics of place such as the need for water sensitive urban design."[27] Thus, backed by the support of an engaged community and strong civic leadership, Ingleside is well-positioned to develop a locally-tailored and comprehensive plan for managing and living with flooding.

Methodology

INTRODUCTION

The research process that generated this proposal draws from aspects of social survey method, comparative and participatory action-based approaches. The primary focus has been comparative in nature, seeking to integrate several tactics of qualitative and quantitative research to develop a more holistic proposal. These methods include a comparative, textual analysis of case studies and examples of built precedents, visual analysis through the development and use of GIS maps of the Ingleside community, and continual integration of the specific points brought up by community stakeholders. In maintaining an action-based approach, the UVa team sought to address the weaknesses of a primarily methods-focused study, and ensure that communal input was not overshadowed by tactics of outside research. Throughout the construction of this proposal, the UVa team has simultaneously sought to develop and employ the best practices regarding the engagement of local perspectives.

FRAMEWORK

Nine students and three faculty members from the University of Virginia worked alongside Nikki Southall of the Ingleside Civic League, Joe Rieger of the Elizabeth River Project (ERP) and Skip Stiles of Wetlands Watch to develop this proposal. Additionally, local officials from the City of

[27] Newman, Peter, and Isabella Jennings. *Cities as Sustainable Ecosystems: Practices and Principles*. Washington D.C.: Island Press, 2008.

Norfolk - Scott Smith of the Planning Department and Justin Shafer and Dr. Katerina Oskarsson from the Department of Environmental Management Office of Resilience, project managers from River Star Homes and a considerable number of Ingleside Civic League and community members provided primary source information that has had a substantial impact on all project decisions. ERP and Wetlands Watch have been key resources because of their knowledge and experience with similar issues including their work in nearby Norfolk community, Chesterfield Heights. The data, surveys, and research have been combined into a comprehensive resilience plan for Ingleside.

COMMUNITY MEETING: JANUARY 28, 2017, 12:00 PM – 3:00 PM
INGLESIDE BAPTIST CHURCH

The initial presentation held on January 28th, 2017 established a relationship between the UVa Norfolk Resilience Team, Elizabeth River Project, Wetlands Watch, officials from the City of Norfolk and members of the Ingleside Civic League and community. The presentation also highlighted resilience efforts already made by these organizations, as well as a 2016 resilience plan developed with Old Dominion University (ODU), Hampton University, and Wetlands Watch to address similar challenges in the Chesterfield Heights neighborhood. Following the presentation, the community members were invited to mark specific locations of high-risk or potential intervention on three, large maps of the Ingleside community and surrounding areas. University of Virginia partners collected personal accounts and qualitative descriptions to map onto each physical point. Additional information was collected through surveys designed to gather residential demographics, to gauge the perceived impact of the problems anticipated by the three partnering organizations, as well as to highlight new challenges and possible solutions proposed by community members. The design, content and results of these surveys are detailed in a later section. The January 28th meeting description can be found in Appendix 10.

COMMUNITY MEETING: MARCH 18, 2017, 12:00 PM – 2:00 PM
INGLESIDE BAPTIST CHURCH

The objectives for the UVa research team on the second meeting with the Ingleside community was to collect additional field research on the specific sites for a sustainability recommendation, present the team's research to the Ingleside community, receive feedback from the community, and conduct additional interviews of the affected residents.

Before meeting with the Ingleside community, the team took additional photographs and further investigated the Westminster, Kentucky and Fontaine Avenues sites to understand the tidal range of each area to better understand the natural environment for incorporating living shorelines. This step was necessary in order to see the low tide marks for each site, which allowed the team to more accurately analyze where the living shoreline should be implemented.

During the second meeting with the Ingleside community, the UVa team presented to the community and partnering non-profits. The objective of the presentation was to break down the research that the team performed based on the information received from the first Ingleside meeting. The presentation consisted of explaining the three aspects of the project: living shoreline implementation, stormwater management and community engagement. Immediately following the presentation, the team gathered feedback from the community on the presentation.

After the presentation concluded, the team revisited the sites from before the meeting to take more pictures and collect high tide data for the living shoreline portion of the project. The team had the opportunity to speak with the residents of 3771 Brennan Avenue and 3551 Westminster Avenue to gather first-hand information on houses and associated damage to these structures from storm surges and sea-level rise. The UVa researchers used the qualitative data from the community presentation, field research, and interviews to re-evaluate their final recommendations that they then presented to the community at the third meeting. The March 18th meeting description can be found as Appendix 11.

COMMUNITY MEETING: APRIL 22, 2017, 12:00 PM – 2:00 PM
INGLESIDE BAPTIST CHURCH

The objective of the third community meeting was to receive feedback on a set of site specific solutions proposed by the UVa team before synthesizing a final set of recommendations for the Ingleside community. Joe Rieger and Skip Stiles of Elizabeth River Project and Wetlands Watch, respectively, opened the meeting with introductions and a review of the overarching goals of the project as well as some examples of similar large-scale projects the non-profits have been part of.

Following this introduction, the UVa team presented their set of recommendations for the community, based largely on feedback from the previous two meetings in Ingleside. Included in this presentation were explanations of different recommended strategies such as living shorelines, green infrastructure, and community art installations, how they addressed concerns raised by community members, examples where such strategies have been implemented previously, and recommendations for site specific implementation in Ingleside. Most recommendations were well-received by the community; however, during this meeting, concerns were raised by homeowners living at the end of Westminster Avenue regarding the creation of a public park, citing the property as a location for illicit activities and a concern that public ownership of the land could exacerbate the issue. Many residents were still in favor of a park and public access point at the end of Westminster Avenue, and this feedback was incorporated into the final set of recommendations from the UVa team.

At the conclusion of the meeting, attendees were invited to plant saplings in order to mark the beginning of change in the Ingleside community and emphasize the role of residents in such improvements. The meeting description for the April 22nd meeting can be found as Appendix 12.

SOCIAL SURVEY METHOD

Social survey method proved integral to the UVa's team's initial assessment of the Ingleside residents' expectations, concerns, and needs. An informal survey was developed between the UVa team and Joe Rieger of the Elizabeth River Project for distribution at the January 18th meeting (Appendix 8). Collected at the conclusion of the meeting, these surveys sought to supplement verbal conversations in order to capture information residents may not have had time or an opportunity to share, or felt comfortable sharing in front of the group. Additionally, the surveys were intended to provide a more concrete means of attaching demographics regarding location of residence and age to comments and concerns.

After reviewing survey responses, the average age was determined to be 55, the average time living in the area was 20 years and 95% of the residents owned their homes. Additionally, the UVa team found that respondents have had to change their commute to work and school an average of 2.5 times over the past year with a maximum of 10 times, and 67 percent of respondents have noticed changes in flooding frequency and severity over the past five years. Also, residents described that most incidences of flooding and stormwater backup were reported at the end of Westminster Avenue, Jasmine Avenue, the intersection of Ingleside Road and Garfield Avenue, Townsend Place, and Townsend Court. Respondents indicated a desire to preserve a sense of community pride, diversity, trees, homes, wildlife, walkability, public transportation, safety, and attractiveness. Community members also reported a desire to increase the lack of public access to Broad Creek, as well as a desire for better sidewalk systems, recreation center, and more ways to enter and exit Ingleside. When asked about potential solutions to reported problems of stormwater backup and flooding, respondents reported opportunities for solutions such as living shorelines, creation of a park at the end of Westminster Avenue, a boat ramp, rain gardens, rain barrels. They also sought after a better relationship with the City of Norfolk because multiple respondents specifically stated they did not think the City has adequately updated infrastructure in the neighborhood to mitigate flooding and storm surges. In conclusion, the surveys resulted in quantitative and qualitive demographic information that was used as a baseline for all recommendations and further responses can be viewed in Appendix 16.

COMPARATIVE RESEARCH

As a major component of their research, the UVa team relied on comparative research tactics to help inform a set of best practices for designing and implementing a solution to problems identified in the Broad Creek-Ingleside community. As part of the Tidewater Rising Resiliency Design Challenge, participants from Wetlands Watch, Old Dominion University, and Hampton University created a set of potential solutions to sea-level rise and consistent flooding in the Chesterfield Heights community in Norfolk. These solutions were based on empirical information

provided by community members and quantitative analyses of environmental factors such as water and soil content and quality.[28]

The UVa team used the Chesterfield Heights project as a key comparison for their solution to Ingleside's problems. However, it was crucial for the team to consider the points of comparison, as well as, the points of departure. The UVa team recognized that each community is unique, and they strived to focus on the personal experiences of residents when considering potential resilience strategies for Ingleside. Other key points of comparison for the Broad Creek-Ingleside resilience intervention were sourced from studies and solutions conducted by the Hudson River Project and Chesapeake Bay Foundation. Both of these organizations have a plethora of projects and data sets regarding water quality remediation, storm water management, and flooding resilience that has been used to inform their research.

While a focus on comparable studies when synthesizing a set of potential solutions for the Broad Creek-Ingleside area is incredibly informative, it does have limitations. Specifically, each location and set of conditions is unique both geographically and temporally — even in projects very close to the sites the UVa team have focused on, the experience of flooding and storm conditions can vary widely within just a few city blocks. As a result, the team used comparative research as a baseline, but focused more heavily on their input from community members themselves when creating an implementable set of solutions.

PARTICIPATORY ACTION RESEARCH

The UVa team engaged in participatory action research — specifically through civic and public engagement — by creating a coastal resilience plan for direct implementation for the Ingleside community within Norfolk. The method of participatory action research "seeks to understand and improve the world by changing it" and requires researchers and participants alike to undergo "collective, self-reflective inquiry" throughout the research process.[29] This process is exemplified by three primary characteristics: a focus on research intended to enable participant action, careful attention to power relationships with an effort toward equitable distribution of power between participants and researchers, and active involvement of participants and context in the research process.[30] While the team has drawn research from similar projects, the final report outlines an improved, analogous series of suggestions that can be realistically implemented in the Ingleside community.

The plan recommends several small-scale interventions in the existing context of Ingleside including installing living shorelines, improving road drainage systems, creating a common community space, and increasing community engagement. The UVa team applied a participatory

[28] "Tidewater Rising Resiliency Design Challenge", 2016.
[29] Fran Baum, Colin MacDougall, and Danielle Smith, "Participatory action research," Journal of Epidemiology & Community Health 60, no. 10 (2006): , doi:10.1136/jech.2004.028662.
[30] Ibid.

action strategy when they designed a specific procedure to manage a defined problem—coastal resilience in Ingleside. The following action plan is intended for the use of non-profits such as Wetlands Watch and the Elizabeth River Project to secure grant funding for solution implementation. Once the solutions are realized within Ingleside, monitoring and evaluation will be used to assess their effectiveness in serving the needs of the Ingleside community.

Three-Pronged Approach: Living Shorelines, Stormwater Management, and Community Engagement

Responding to the needs identified by community residents over the course of the four month process, as well as those outlined by community partners at Wetlands Watch, the Elizabeth River Project, and the City of Norfolk, the UVa research and design team has developed a proposal for the future of Ingleside that seek to meet three guiding objectives:

1. MITIGATE THE IMPACT OF LOCALIZED FLOODING

The primary objective of each intervention will be to target and manage the severe flooding that the Ingleside community habitually experiences. Flooding within Ingleside is derived from both storm and surge sources, and persists both during times of heavy rainfall, persists under normal, "sunny-day" conditions. The dire state of this flooding and the need for improved methods of intervention was immediately apparent upon the first meeting. Documentation of this need included personal accounts of entire portions of the neighborhood stranded from work, school, and emergency services for several days at a time, and photographic evidence of five inches of standing floodwater persisting nearly a week after the most recent rainfall.[31] As the severity of this flooding poses a direct threat to residential safety and exhausts private and public resources towards prevention and resolution of water damages, the mitigation and improved management of flood levels must be the primary concern of any proposed solution for the Ingleside neighborhood.

2. IMPROVE THE ENVIRONMENTAL HEALTH OF THE INGLESIDE ECOSYSTEM

The primary concern of our community partners is the environmental health of the Ingleside ecosystem. This concern was drawn with particular attention to the health of neighboring waterways, the Elizabeth River and Broad Creek, which earn a "C" and "F" rating, respectively. Therefore, the UVa team based their solutions on environmental quality. While community interests did not directly align with environmental interests at first, community members showed investment in Ingleside's natural resources after

[31] Ingleside community meeting. March 18, 2017.

attending the first meeting.

3. DEVELOP A HOLISTICALLY SUSTAINABLE COMMUNITY "FROM FRONT-TO-BACK"

The UVa team developed tactics that will not only address the most severe challenges of flood level management and environmental health, but additionally serve to improve the day-to-day experience of living within Ingleside. This approach is grounded in various urban planning case studies which connects the expansion of greenery and vegetation within neighborhoods to positive increases in communal health, mental well-being, and civic engagement. The desire for solutions in Ingleside that are both practical and aesthetically enriching was made evident when members of the Ingleside Civic League explained their interest in a sustainable, holistic neighborhood plan. In response to proposals for "green" and "living" solutions to stormwater management and flood mitigation, attending residents enthusiastically began to inspire a holistic vision for the future of their community as a sustainable neighborhood. This was perhaps best voiced by resident and former Ingleside Civic League President, Nikki Southall, who stated, "We should be the first to have a fully sustainable neighborhood, front to back."[32] It is from this vision, greening Ingleside from "front to back," that the UVa team derived their final proposal for solutions that will simultaneously mitigate challenges posed by sea-level rise and develop a local identity and sense of communal investment surrounding sustainable living. In addition to developing aesthetic solutions, the plan targets improved accessibility as a means of fostering communal engagement, improving and expanding the neighborhood's network of sidewalks to increase safe walkability, and pursuing the development of a public coastal access point.

In seeking to develop a strategy that will meet these three goals and achieve a more holistically sustainable Ingleside from "front to back," the UVa team proposes three primary tactics. These tactics include:

1. LIVING SHORELINES

Integrating vegetated, "living" barriers to sea-level rise and coastal erosion on all unprotected shorelines and in lieu of more traditional, "harder" solutions such as bulkheads and seawalls

2. STORMWATER MANAGEMENT INFRASTRUCTURE

Integrating various "living" solutions to stormwater collection, filtration, and management along Ingleside's roadways, public spaces, and private residences through green street

[32] Nikki Southall, Ingleside community meeting, Ingleside Baptist Church, Norfolk, VA, March 17, 2017.

development and more immediate, accessible means of tactical urbanism

3. COMMUNITY ENGAGEMENT STRATEGIES

   Integrating communal participation in the design and implementation of creative strategies to beautify and "rebrand" Ingleside as a center of sustainable investment, including the pursuit of public coastal access points

While, for purposes of definition, these tactics fall into three larger categories, each encompasses a variety of solutions which must be individually selected to meet site specific needs. Furthermore, each tactic represents a singular part of a more holistic, three-pronged strategy, where each will often be simultaneously integrated at the various implementation sites. Each tactic in this strategy focuses on integrating "living" solutions to meet the inefficiencies of traditional, hard infrastructure, relying on vegetated barriers where concrete pipes and walls once stood, and local civic engagement in favor of top-down, public maintenance. Ultimately, this proposal suggests that living solutions will allow Ingleside to meet the present goals for a holistically sustainable neighborhood identified by residents and outlined above, benefiting flood safety, environmental health, and communal livability. The versatile nature of these "living" solutions will help to develop an Ingleside that is resilient to physical, fiscal, and environmental concerns and better equipped to adapt to future shifts in sea-levels.

1. LIVING SHORELINES

As sea-level rises, the community of Ingleside will continue to face threats from increased storm surges, flooding, and wave intensity. These events will lead to additional shoreline erosion and property loss. Currently, many Ingleside residents utilize armored structures including bulkheads, stone revetments, and seawalls to create a barrier between land and water, which further exacerbates the effects of sea-level rise on coastal erosion. As public and private development continues to expand in the Norfolk region, hard shorelines are increasingly constructed along waterways to unnaturally hold back rising water levels.[33] Often times in coastal neighborhoods, if one resident builds a hard shoreline to protect their property from erosion, then surrounding neighbors believe that they should as well.[34] By establishing the importance of living shorelines, the UVa team hopes to reverse this trend and direct social conformity to value living shorelines over traditional hard shorelines. As the threat of sea-level rise continues to grow, new and innovative alternatives to traditional shoreline armoring, such as living shorelines, are gaining popularity. To properly mitigate damage attributed to sea-level rise such as erosion and storm surge, it is necessary to return shorelines back to their natural condition. One of the best and arguably the most cost-effective approaches is to reintroduce more ecologically-sound natural

[33] Scyphers, "Participatory Conservation of Coastal Habitats: The Importance of Understanding Homeowner Decision Making to Mitigate Cascading Shoreline Degradation." *Conservation Letters*, vol. 8, no. 1, 2015, pp. 22.

[34] Ingleside community meeting. January 28, 2017.

shorelines. According to estimates by Virginia Institute for Marine Science (VIMS), in 2014 the cost of maintenance for living shorelines was five times less per linear foot compared to hard shorelines in the Chesapeake Bay area. Reasons for the dramatic difference in cost include material, transportation of material, labor for installation of structures, and the continual cost of maintenance of a hard shoreline. In comparison, a living shoreline requires much less in material cost and once established will become self-sustaining and require minimal maintenance.[35] Therefore, one of the three recommendations that this proposal makes for the Ingleside community is to implement living shorelines along private and public property to effectively mitigate damage associated with sea-level rise.

A COMPARISON OF LIVING SHORELINES AND HARD SHORELINES

The National Oceanic and Atmospheric Administration (NOAA) supports a shift towards living shorelines in the face of sea-level rise. NOAA defines living shorelines as:

> "a broad term that encompasses a range of shoreline stabilization techniques along estuarine coasts, bays, sheltered coastlines, and tributaries. A living shoreline has a footprint that is made up mostly of native material. It incorporates vegetation or other living, natural "soft" elements alone or in combination with some type of harder shoreline structure (e.g. oyster reefs or rock sills) for added stability. Living shorelines maintain continuity of the natural land–water interface and reduce erosion while providing habitat value and enhancing coastal resilience."[36]

The benefits that living shorelines provide are two-fold. First, they can be designed to stabilize shorelines and decrease coastal erosion, which is particularly important in extremely low-lying coastal communities such as Norfolk. Second, they improve natural habitats and therefore lead to increased biodiversity and better water quality.[37] By designing living shorelines to incorporate marshes, erosion can be slowed through these marshes dissipating wave energy. As these wetlands, along with plants and oyster reefs, grow and stabilize overtime, living shorelines will continue to improve the ecosystem and animal habitat while accruing very limited maintenance costs.[38] In areas like Ingleside that are expected to face increasingly intense weather patterns in the coming decades, the performance of living shorelines during storm events is important. Researchers found that during Hurricane Irene in 2011, marsh and sill shorelines in the Outer Banks of North Carolina simply accumulated sediment, whereas 75 percent of bulkheads and seawalls experienced damage.[39] From an environmental perspective, living shorelines create a healthier ecosystem overall. Research shows that armored shorelines change coastal ecosystem composition and negatively impact organisms that burrow in sediment close to the shoreline stabilization structure. Reductions in these organisms can lead to reductions in predators and

[35] Mason, Pam. "Living Shoreline Implementation: Challenges and Solutions." 6.
[36] U.S. Department of Commerce National Oceanic and Atmospheric Administration, *Guidance for Considering the Use of Living Shorelines*, 7, 2015.
[37] Ibid., 9.
[38] Ibid., 10.
[39] Ibid., 11.

ultimately a decrease in the shoreline system's productivity.[40]

In order to protect infrastructure and ecosystems in the face of sea-level rise, a shift from traditional hard shoreline techniques to sustainable shoreline stabilization is necessary. Bulkheads, a shoreline armoring technique typically used in coastal areas, often increase coastal erosion. Wave energy reflects off of the bulkhead, leading to erosion at the base of the structure.[41] Additionally, these artificial hard shorelines have negative impacts on the natural environment. Bulkheads and seawalls degrade marshes and shallow aquatic habitats. Furthermore, bulkheads constructed from treated wood may contain chemicals that leach into the coastal environment.[42] Comparative research of shoreline techniques suggest that the future of coastal protection and ecosystem health depends on implementing more living shorelines, both in public spaces and in coordination with private residences.

CASE STUDIES

Hudson River

By drawing evidence from case studies, the UVa team has examined the best practices for improving water quality while also improving community health as sea-level rises. One of the greatest success stories for water quality improvement in the United States is the Hudson River. Similarly to Broad Creek and the Elizabeth River, the Hudson River experiences the stress of providing livelihood to a city. From the settlement of New York until today, the Hudson River has experienced the boom of industry, dredging, and pollution—all contributing to detrimental environmental implications.[43] The first major step towards combating pollution in the Hudson River Estuary came when New York passed the Estuary Management Act in 1987.[44] This act led to the creation of the Hudson River Estuary Action Agenda, aimed at promoting clean water, resilient communities, healthy estuarine ecosystems, conservation of fish and habitat, preservation of natural scenery, and enhanced opportunities for education.[45] The Hudson River Estuary Program acts in a similar capacity to the Elizabeth River Project by using an approach that combines grants and restoration projects, education, resource conservation, and community planning assistance.[46]

Through eliminating many harmful discharges into the Hudson River, New York has increased water quality markedly from 1960. Raw sewage dumping and the discharge of polychlorinated biphenyls largely contributed to the poor water quality of the Hudson and required major legal

[40] Ibid., 11.
[41] Ibid., 10.
[42] Ibid., 10.
[43] Stephen Stanne and Maude Salinger, *The Hudson Then and Now: A Brief History of Water Quality*, 50, 2016.
[44] Ibid, 51.
[45] Ibid, 51.
[46] Ibid, 52.

actions to be banned.[47] Today, improvements in water quality in the Hudson River continue to improve on a more micro level. Beyond regular river cleanups, The River Project is promoting citizen action through oyster restoration and water quality testing.[48] Hudson River Sustainable Shorelines considers more specifically how living shorelines affect water quality and biodiversity. In evaluating sites on the Hudson River for green shoreline implementation, scientists considered hydraulic conditions, erosion and sediment conditions, construction considerations, estimated costs, project operation and maintenance, and expected benefits.[49] After these considerations, research estimated that shoreline restoration modifications at five points along the Hudson River would range in cost from $75 per foot to $983 per foot.[50] Following implementation of living shorelines, metrics like bank stability, assessment of riparian plantings, emergent vegetation assessments, assessment of spawning habitat and fish use, and overall assessment of riparian wildlife habitat have been consistently measured.[51] Currently, the Hudson River National Estuarine Research Reserve recognizes the importance of sustainable shorelines, as promoted by the Sustainable Shorelines program, and is in the process of gathering data to assess the ecological and physical performance of sustainable shoreline structures in partnership with NOAA. As living shorelines become a more widely utilized alternative to armored shoreline construction, more data on the effectiveness of this technique will continue to be gathered and analyzed.

Chesapeake Bay

Progress made in the Chesapeake Bay watershed concerning living shorelines is extremely pertinent to implementing living shorelines on the Elizabeth River. Other living shorelines in the Chesapeake Bay region share similar geographic and climate characteristics to the land bordering Broad Creek and the Elizabeth River. Many places in the Chesapeake Bay region have faced similar issues to those facing Ingleside—waterfront homeowners want to use bulkheads and rock walls to separate their land from the erosive waves, without realizing that these shoreline armoring techniques can cause greater erosion than if a living shoreline was installed.[52] The Chesapeake Bay Foundation recommends that homeowners create the "ideal" shoreline by using riparian buffers above the tide line, installing tidal wetlands, implementing oyster reefs where appropriate, and planting underwater grasses in the shallow water. Additionally, they recommend that all materials used to create a living shoreline are native to the locality in which they are being used.[53]

From 1981 through 1987, the VIMS and the Virginia Department of Conservation and Recreation (DCR) evaluated the effectiveness of living shorelines through the Vegetative Erosion

[47] Ibid, 52.
[48] "About Us," The River Project, last modified 2017.
[49] Ibid.
[50] Gregory Allen et al., *Hudson River Shoreline Restoration Alternatives Analysis*, 3, March 2006.
[51] Ibid, 3.
[52] *Living Shorelines for the Chesapeake Bay Watershed*, 3.
[53] Ibid, 4.

Control Project (VEC).[54] Twenty-four wetland sites were planted with marsh grasses, varying in terms of shore setting and existing substrate. This project found that living shoreline success largely depended on the fetch, shore geomorphology, and shore orientation. Areas with a low fetch of <1.0 nm had a high probability of success from simply planting marsh grasses, with any sites experiencing a fetch over 1.0 nm having low to no probability of success.[55] Researchers also concluded that south facing shorelines had a better chance of success. The main lessons learned from this experiment implementing living shorelines on the Virginia coast showed that areas with a low fetch succeeded by just planting existing substrate. However, areas with a higher fetch needed more careful design considerations, like using coir logs or marsh toe revetments, in combination with plantings, in order to create a successful living shoreline that combatted erosion.[56]

The Elizabeth River has seen as estimated 50 percent loss in tidal wetlands since the 1950s.[57] By proposing living shorelines at two public locations in Ingleside and providing homeowners with the information and incentives to create private living shorelines, the Elizabeth River can begin to regain wetlands, the absence of which has led to increased coastal erosion and decreased water quality. Both the Elizabeth River Project and Chesapeake Bay Foundation are continuously working towards creating a healthier Elizabeth River, both by encouraging the installation of living shorelines and oyster restoration projects in the Norfolk area.

NOAA has developed a framework of questions to consider when determining the suitability of any shore stabilization approach for a specific site. In considering the implementation of living shorelines in public spaces in the Ingleside community, the UVa team used these questions to guide their analysis of suitability and best practices. The questions are:[58]

1. What are the physical site conditions?
2. Are ecologically valuable aquatic habitats or animals living along the shoreline at the site?
3. How should the effects of sea-level rise, or water level changes, be factored into living shoreline project
4. What balance between green (softer) and gray (harder) stabilization is appropriate given particular site conditions?
5. How can functional habitats be added to a necessary hard structure?
6. What kind of maintenance is associated with the living shoreline?

LIVING SHORELINE IMPLEMENTATION IN INGLESIDE: PUBLIC SPACES

[54] Bhaskaran Subramanian et al., "Current Understanding of the Effectiveness of Nonstructural and Marsh Sill Approaches" (paper presented at Living Shoreline Summit), 38.
[55] Ibid, 39.
[56] Ibid, 39.
[57] *Star Power: Toward a Thriving Urban River*, 6, January 28, 2016.
[58] U.S. Department of Commerce National Oceanic and Atmospheric Administration, *Guidance for Considering*, 15-19.

The UVa team has identified two specific public sites where the City of Norfolk can potentially invest in living shorelines. At both sites, the team recommends building a "non-structural" living shoreline consisting primarily of grasses. Living shoreline interventions will incorporate marsh grasses that are suitable to the conditions of the existing environment. The most common type of marsh grass that would be ideal for the Broad Creek and Elizabeth River watershed is *Spartina alterniflora.* According to guidelines provided by the Chesapeake Bay Foundation, a non-structural, vegetative shoreline is ideal for creeks, with a water depth of less than 1.0 foot and is exposed to low wave and wind energy. In addition, the non-structural approach is among the most cost-effective of the living shoreline approaches with an estimation of $10-100 per foot of installation.[59] While residential feedback regarding areas of severe flooding and potential living shoreline implementation were taken into account, potential sites for living shorelines were primarily identified using Norfolk Air, the address information resource software used by the city of Norfolk. Furthermore, this software allowed the UVa team to discern private property from city-owned property dictating which is living shoreline approach would be most effective.

LIVING SHORELINE IMPLEMENTATION IN INGLESIDE: PRIVATE RESIDENCES

The easiest way for the residents of Ingleside to create living shorelines is to participate in the Elizabeth River Project's River Star Homes program. Many waterfront homes in Ingleside are facing increasingly imminent threats from severe flooding, storm surges, and sea-level rise. Installing a living shoreline helps to protect infrastructure by decreasing the rate of coastal erosion and land loss. Living shorelines also have other positive benefits for private residences, like reducing polluted runoff from yards, attracting butterflies and songbirds with native plants, and discouraging geese from entering yards. In addition to providing living shoreline cost estimates, design services, and installation, Elizabeth River Project will pay up to 50 percent of the cost of installation — up to $4,000 for living shorelines and $1,000 for a shoreline buffer. As part of this partnership, the Elizabeth River Project will have experts meet with homeowners to design and discuss which native plants to include in exchange for homeowners agreeing to commit to planting at least 60 linear ft. of shoreline with native plants and grasses. This funding opportunity is currently available to waterfront River Star Homes located in Chesapeake, Norfolk, and the Eastern Branch area of Virginia Beach. The living shorelines project is sponsored by the Elizabeth River Project, with support from the National Fish and Wildlife Foundation, the City of Norfolk, and the City of Chesapeake.[60]

2. STORMWATER MANAGEMENT INFRASTRUCTURE

As sea-level continues to rise and encroach upon Norfolk's heavily-developed coast, new tactics in urban design which can successfully adapt to flooding are increasingly necessary. Recognizing the limitations of existing solutions of hard infrastructure such as sea walls, paved channels, and

[59] "Living Shorelines for the Chesapeake Bay Watershed." Chesapeake Bay Foundation, March 2017.
[60] "Living Shorelines & Shoreline Buffers." Elizabeth River Project.

stormwater drains, the City of Norfolk began to outline a plan for design solutions which engage the strategy of "living with water," as a component of their 2015 Comprehensive Resilience Strategy.[61] Seeking to foresee changing threats and limit residential exposure to risk, the City of Norfolk participated in a series of collaborative design symposia with foreign peers, including the 100 Resilient Cities conference in Rotterdam during October of 2015, and the Virginia Dutch Dialogues (VDD) which Norfolk hosted the June prior. The objective of the 2015 VDD, which convened experts from The Royal Netherlands Embassy, the Hampton Roads Planning District Commission, the City of Norfolk, and two neighboring cities, Newport News and Hampton, was to "generate innovative ideas for living with water…using water management as a way to protect and revitalize neighborhoods." [62] However, the solutions proposed from these collaborations, many of which have yet to come to fruition, are highly inequitable in the neighborhoods they seek to "revitalize."[63] The majority of these design tactics are directed towards the city's downtown and the development of centers for high-income real estate, commercial space, and tourism, such as the Arts District initiative profiled within the 2015 Resiliency Strategy as a promising collaboration with the University of Pennsylvania School of Design and the Rockefeller Foundation.[64] At present, the "Tidewater Rising Resiliency Design Proposal" for Ingleside's neighboring Chesterfield Heights is one of the few publicly-funded coastal resiliency projects within the Norfolk metropolitan area which targets the mixed-income, residential space.[65] Ultimately, there is a pressing need to seek greater results regarding "living with water" urban design tactics, particularly those intended to channel public investment towards high-risk, mixed-income residential neighborhoods along Norfolk's shorelines.

> "We need to expand our thinking and our solutions and develop creative new infrastructure systems at both the edge and within the city. We need to think differently about how we build, how we connect, and how we live with and embrace the water."[66]

If living shorelines embrace flooding at the water's edge, tactics in stormwater management infrastructure offer solutions to disruptive flood waters on land. Like living shorelines, these solutions utilize layers of vegetation, living organisms, mulch, sand, and gravel to collect, filter, absorb, and channel excess water from storm and surge sources. Furthermore, the benefits of these solutions in comparison to existing management structures made of "hard" materials such as concrete and clay, are similarly multi-layered. First, the porous qualities of vegetated buffers are inherently better equipped to retain and slow the movement of heavy storm surges than flat storm-water channels made of dense, man-made materials. In this process, layers of vegetation, sand, and mulch absorb much of the harmful nutrients and waste products present in stormwater

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[61] Norfolk 100RC Initiative Leadership. "Norfolk's Resilience Strategy."*100 Resilient Cities*, 2016, 28

[62] Ibid, 29.

[63] Ibid, 29.

[64] Ibid, 29.

[65] William A. Stiles Jr., Mason Andrews, and Mujde Erten-Unal,*Tidewater Rising Resiliency Design Challenge*, Hampton University and Old Dominion University , 2016.

[66] Norfolk 100RC Initiative Leadership. "Norfolk's Resilience Strategy."*100 Resilient Cities*, 2016, 29

runoff before it reaches local waterways and impacts coastal ecosystems. Finally, the integration of vegetation into communities through private and public interventions, including the expansion of sidewalks and stormwater management infrastructure, offers immense benefits for the physical, mental, and social health of residents.

The plan recommends the implementation of diverse stormwater management solutions throughout the Ingleside neighborhood. Each solution is intended to minimize the impact of excess stormwater on residential property, mitigate localized flooding, reduce the toxicity and ultimate amount of runoff into Broad Creek and the Elizabeth River watershed, beautify shared and public spaces, improve accessibility and walkability, and ultimately develop a more holistically livable community.

The solutions fall into two primary categories:

1. RAIN GARDENS: versatile, vegetated features designed to absorb and filter excess water on unpaved space – capable of being implemented as public infrastructure or on private, residential lots

2. GREEN STREET DESIGN: versatile, public infrastructure projects along streets and other paved surfaces which utilize both natural and physical elements to absorb and filter excess water

RAIN GARDENS AND VEGETATED BUFFERS

Rain gardens, also referred to as bio-retention or bio-infiltration cells, are shallow, vegetated depressions designed to collect, retain, and filter excess rainwater and storm runoff from impermeable surfaces such as pavement and roofs.[67] These solutions can be implemented along streets and other public spaces, or developed on a smaller-scale within private, residential yards. As a tactic in stormwater management, rain gardens reduce the volume of excess water which collects following moments of flooding from storm or surge sources. In the residential context, water collected in rain gardens can reduce water damage to private property and, in public spaces, such as a flooded street, can prove integral in mitigating threats of accessibility and public safety. Additionally, particular vegetation is selected to filter and purify the water that is collected. Selection is critical in a low-lying, coastal neighborhood such as Ingleside, as vegetation must be sturdy enough to withstand severe changes in moisture, as well as possess immense filtering retention, for much of the runoff from these sources will return to the Broad Creek, the Elizabeth River, and the Chesapeake Bay Watershed.[68]

In both public and residential cases, rain gardens are generally placed in areas of lower elevation

[67] EPA, "What Is Green Infrastructure," Environmental Protection Agency (EPA), September 23, 2016.
[68] Ibid.

or at the end of a gradual slope, allowing excess water and runoff to naturally filter into them. The garden acts as a vegetated filtration system, collecting and absorbing any pollutants in the excess water as it passes through layers of mulch, soil, and roots. According to the Environmental Protection Agency (EPA), "this process mimics natural hydrology by infiltrating, and evaporating and transpiring – or "evapotranspiring" – stormwater runoff."[69]

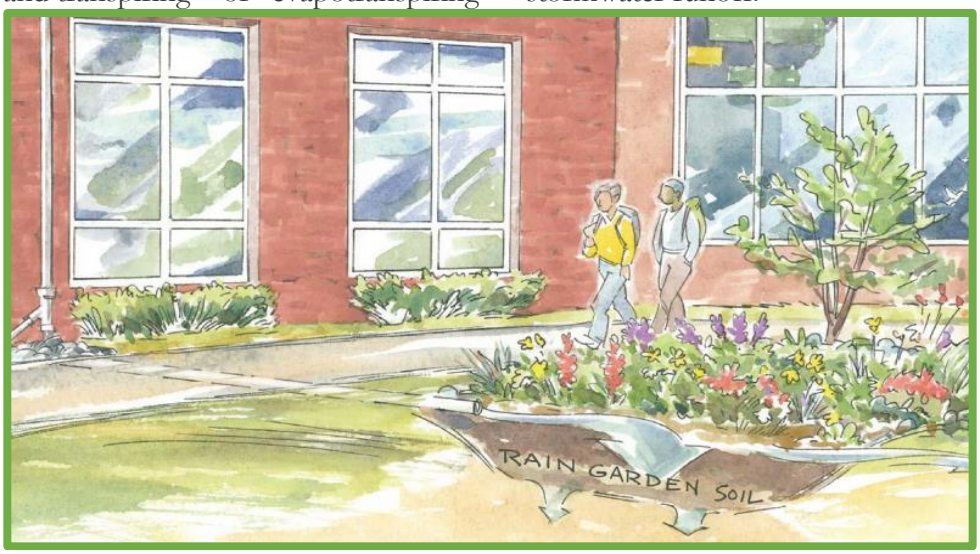

Figure 4. Rain Garden Example
Source: Green Infrastructure Primer

Design Considerations

As the function of the rain garden requires excess water to filter into them, they are best developed on gentle slopes. In their study of rain gardens, the Delaware Department of Natural Resources and Environmental Control (DNREC) concluded that these slopes should ideally range from a one to ten percent incline.[70] Additionally, rain garden installations should be positioned at least 10-30 feet away from any building, as to limit water damage to the existing structure.[71] Vegetation should be selected from native species and capable of tolerating both wet and dry conditions, with particular consideration to the need and existing moisture conditions of the specific site in question.

GREEN STREET DESIGN

There are just over four million miles of road in the United States of America, about 3 million of

[69] Ibid.

[70] Jennifer De Mooy, "Green Infrastructure Primer: A Delaware Guide to Using Natural Systems in Urban, Rural, and Coastal Settings,"*Delaware Department of Natural Resources and Environmental Control (DNREC)*, September 23, 2016, 11

[71] Ibid.

which are paved in asphalt.[72] Furthermore, these figures do not account for the miles of flat roofs, parking lots, and playing courts which make up America's grayscapes. In addition to demolishing natural ecosystems and reflecting harmful rays of heat back into the Earth's atmosphere, further contributing to the effects of global warming, the nation's dependence on paved surfaces proves detrimental to its ability to manage excess water. Asphalt, and other forms of pavement and "hard" infrastructure such as concrete and clay, are all relatively impermeable surfaces, which allow water to build up, collect, and flow rapidly, all the while accumulating waste and debris. Methods of green street design integrate minute greenscapes made up of various types of vegetation, mulch, and sand into the existing infrastructure of the streetscape in order to collect, filter, and slow the movement of runoff water along paved surfaces.

The format of green streets can be highly variant, tailored to the unique needs and limitations of the existing streetscape. In comparison to rain gardens and vegetated buffers, green street designs provide interventions for stormwater management that are typically more expensive, labor-intensive, and time-consuming to install, as well as noticeably more permanent. As elements of public infrastructure that impact the existing streetscape and public space, proposed designs for green streets must be approved by community groups, city government officials, and the local Department of Transportation.[73]

The UVa team's proposal for green streets in the Ingleside neighborhood has a residential focus. The EPA suggests that "residential streets offer the greatest potential for building green streets in new neighborhoods or retrofitting existing streets because the streets are typically slower, less trafficked, and are likely to already have some landscape elements."[74] While green street designs can include a variety of elements, the following proposal for Ingleside includes: bioswales, street-side trenches, permeable pavement.

1. BIOSWALES

Bioswales, also referred to as vegetated swales, are shallow trenches filled with dense vegetation, mulch, and xeriscape.[75] Like rain gardens, they offer retention and purification of excess water and storm runoff through vegetation and soil filtration systems. However, bioswales are uniquely designed to manage the flow of excess stormwater. Typically implemented along public, paved surfaces, such as streets and parking lots, bioswales filter and mitigate overflow within existing drainage and sewer systems.[76]

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[72] CIA, "CIA – The World Factbook – Field Listing: Roadways.," Central Intelligence Agency (CIA).

[73] EPA, "Green Streets: A Conceptual Guide to Effective Green Street Design Solutions," Environmental Protection Agency (EPA), 2009. 1-9

[74] Ibid, 2.

[75] EPA, "Green Streets: A Conceptual Guide to Effective Green Street Design Solutions," Environmental Protection Agency (EPA), 2009. 1-9

[76] Ibid.

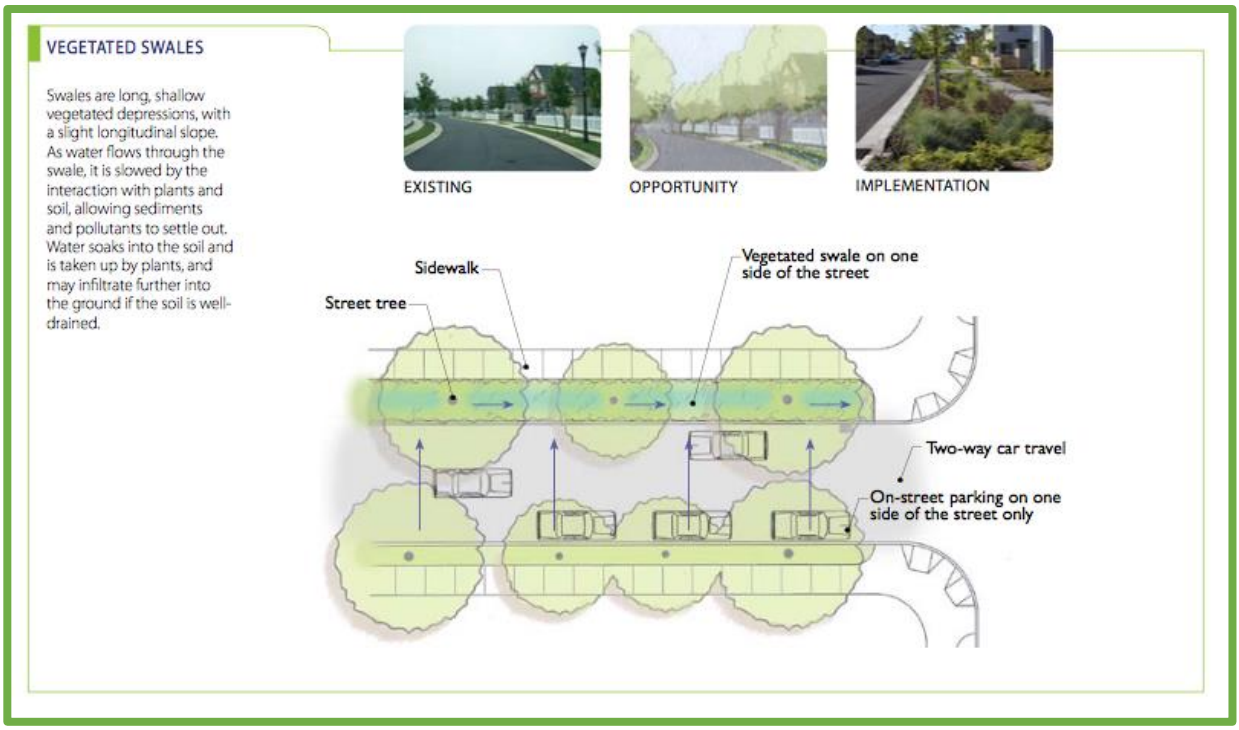

Figure 5. Bioswale Design
Source: Environmental Protection Agency, 2009.

Design Considerations

Bioswales must meet many of the same design requirements as rain garden interventions, including a gradual slope and vegetation capable of immense water and pollution retention. According to the DNREC, most bioswales are constructed with a 6 percent slope on either side, allowing for water to flow into and be retained within the trench.[77] As bioswales are most typically designed along streetscapes and parking lots, these paved surfaces must be engineered to meet the needs of this slope and allow water to flow both into the bioswale and, ultimately, into existing drainage systems.[78]

2. STREET-SIDE INFRASTRUCTURE

The term "street-side infrastructure" refers to a series of green street elements which can be adapted to fit into larger networks of street sidewalk infrastructure including planter boxes and tree trenches. Both solutions, like rain gardens and bioswales, are forms of bio-retention systems, which serve to collect and filter pollutants from excess water through dense layers of mulch, soil,

[77] Jennifer De Mooy, "Green Infrastructure Primer" *(DNREC)*, September 23, 2016, 12.
[78] Ibid.

vegetation, and roots.[79] Planter boxes, occasionally referred to as vegetated "bump-outs" depending on the individual design, act as rain gardens contained within the structure of the sidewalk, with vertical walls and either open or closed bottoms."[80] While planter boxes utilize shorter forms of vegetation, tree trenches or tree boxes are similarly designed with added space to allow a tree to serve as the primary filtration system.

In addition to managing and purifying excess water and storm runoff, the implementation of street planter boxes, tree trenches, and vegetated bump-outs offer an opportunity to develop more engaging, beautiful streetscapes within a neighborhood. Tree trenches offer the added benefits of providing shade, reducing the urban heat effect, and improving air quality.[81] In the case of Ingleside, where sidewalks are infrequently and inconsistently placed at present, the addition of sidewalks throughout the neighborhood along with these strategies will increase walkability and community engagement.

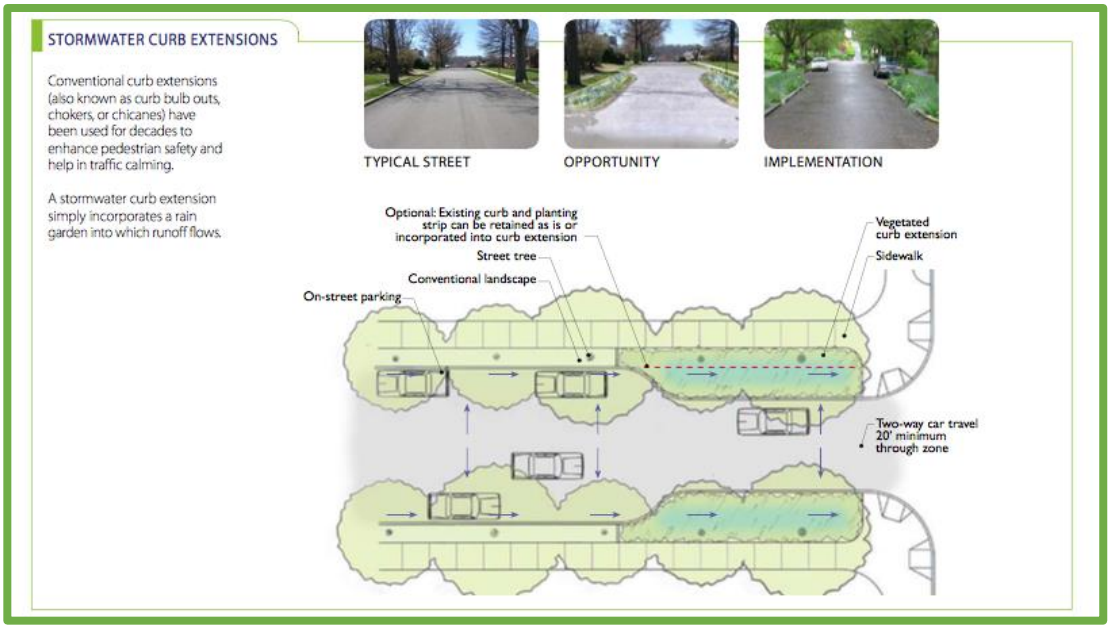

Figure 5. Stormwater Curb Extension Design
Source: Environmental Protection Agency, 2009.

Design Considerations
Several limitations of the existing infrastructure must be considered when planning the implementation of these methods. As the solutions require digging trenches, they must be

[79] Ibid, 11.

[80] Rob Lukes and Christopher Kloss, "Managing Wet Weather with Green Infrastructure: Municipal Handbook - Green Streets,"*Low Impact Development Center - Environmental Protection Agency (EPA)*, December 2008, 7.

[81] Ibid.

carefully designed to avoid underground utilities, particularly water and sewer lines.[82] Tree trenches prove a more complicated intervention in this case, as the network of roots requires more space to grow and thrive.[83] Several creative solutions to this issue include constructed concrete "root paths," Silva cells – more permeable supports for the sidewalk structure constructed of plastic milk-crate frames, or permeable sidewalks.[84] In addition to challenges of existing infrastructure, according to the DNREC, bio-retention systems are limited in that they are "not suitable in areas with high water tables or within designated floodplains."[85] This is the primary concern in integrating street-side infrastructure solutions into a neighborhood as low-lying as Ingleside.

3. PERMEABLE PAVEMENT

Permeable pavement offers a stormwater management system within the streetscape itself, by developing street surfaces that allow water to seep through the superficial layer and collect in underground basins or natural absorptive basins such as those present in other bio-retention systems. According to the EPA, "Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded."[86] The EPA constraints for these four designs are detailed below.

> "Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption. Aside from a rougher unfinished surface, permeable concrete and asphalt look very similar to their impervious versions. Permeable concrete and asphalt and certain permeable concrete pavers are ADA compliant."[87]

[82] Jennifer De Mooy, "Green Infrastructure Primer"*(DNREC)*, September 23, 2016, 15.
[83] Rob Lukes, "Managing Wet Weather with Green Infrastructure," *(EPA)*, December 2008, 7.
[84] EPA, "Green Streets: A Conceptual Guide to Effective Green Street Design Solutions," Environmental Protection Agency (EPA), 2009. 1-9.
[85] Jennifer De Mooy, "Green Infrastructure Primer"*(DNREC)*, September 23, 2016, 15.
[86] Rob Lukes, "Managing Wet Weather with Green Infrastructure," *(EPA)*, December 2008, 7.
[87] Ibid.

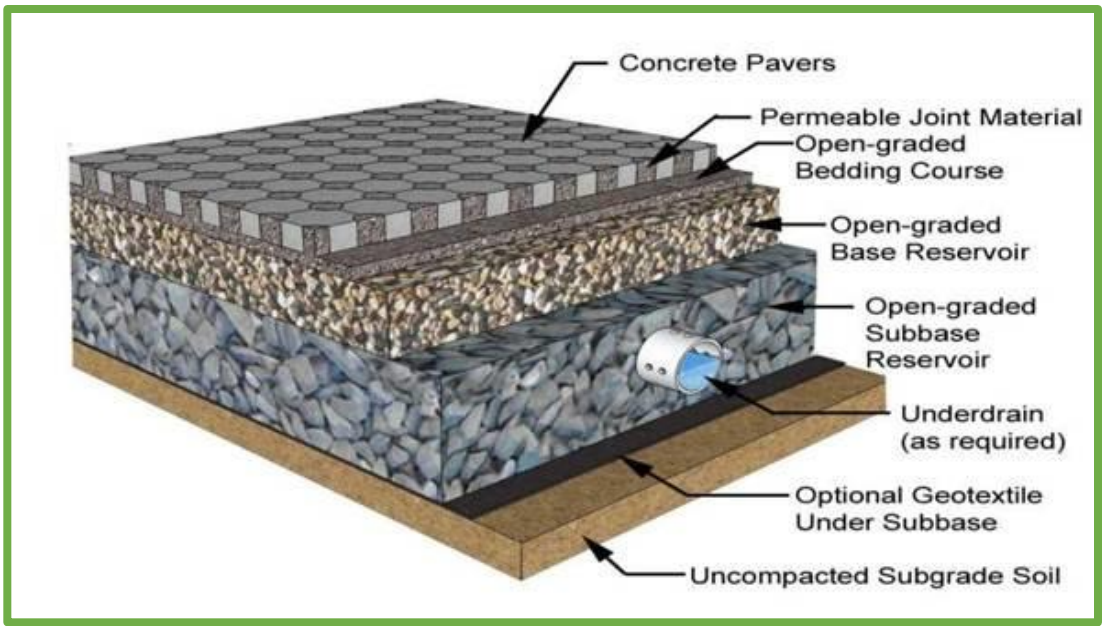

Figure 6. Concrete Pavex Type, Permeable Pavement Cross-Section
Source: Drake, Jennifer, Andrea Bradford, and Tim Van Seters. "Winter Effluent Quality from Partial-Infiltration Permeable Pavement Systems." American Society of Civil Engineers (ASCE), 2012.

Design Considerations

Permeable pavement solutions are the elements of green street practices which Departments of Transportation are most cautious to implement. These hesitations are drawn from their relative higher expense and the present perceived lack of long-term performance and maintenance data, causing government organizations on the national and local level to doubt their ultimate sustainability in comparison to other methods. Additional concern for the use of permeable pavement in Ingleside is reduced functionality within floodplains and the need for frequent, significant maintenance in comparison to other stormwater management solutions.[88] However, more application and research is needed to accurately assess the validity of these concerns as a cost analysis by Olympia, WA found that the maintenance cost for pervious pavement was still lower than traditional pavement when the cost of stormwater management was considered.[89] Therefore, this might be a viable option for Townsend Place in Ingleside.

[88] Rob Lukes, "Managing Wet Weather with Green Infrastructure," *(EPA)*, December 2008, 7
[89] Ibid, 6.

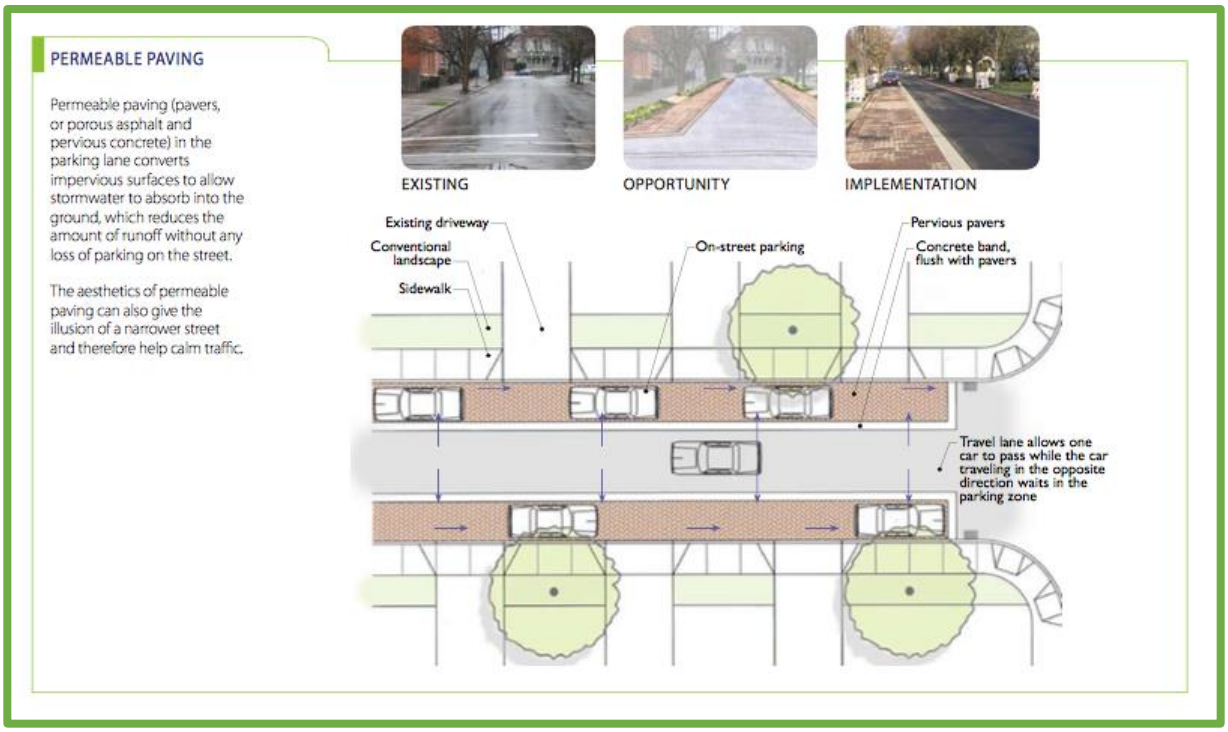

Figure 7. Guide to Permeable Pavement
Source: Environmental Protection Agency, "Green Streets."

3. COMMUNITY ENGAGEMENT

During the three community meetings, Ingleside residents indicated their desire to stay in the neighborhood indefinitely as well as their desire to preserve the "close" and "wonderful" community of Ingleside and the "sense of pride in the city" that is present in the neighborhood (see Appendix 16 for survey data); still, many revealed they would like to see public improvements. Many residents had been living in Ingleside for generations and are deeply invested in the community.[90] Consequently, the UVa team elected to build upon the strong connection residents have with the area. Fortunately, Ingleside has already established organizations that are dedicated to community improvement, the most influential being the Ingleside Civic League. The Ingleside Civic League is a volunteer organization that keeps residents updated on Ingleside news and plans activities, meetings and events for the community.[91] In addition to observing the residents' existing desire to enhance the Ingleside community, this project was developed to focus on the needs of residents and stakeholders. These two values combined to influence the design of a community engagement plan with strategies almost entirely initiated by community member concepts, researched thoroughly by the UVa team and then

[90] Ingleside community meeting, Ingleside Baptist Church, Norfolk, VA, January 28, 2017.
[91] "Ingleside Civic League Home," Ingleside Civic League, Inc. ~ Norfolk, Virginia.

presented to the residents for feedback throughout the four-month process. Based on the findings from relevant case studies and community input from surveys and meetings, the UVa team recommends implementing a community entrance sign, public water access, a community-designed park, and public and educational art.

COMMUNITY ENTRANCE SIGN

The pride Ingleside residents feel about their neighborhood quickly became evident during the community meetings. One of the most important features of a "green" Ingleside, residents concluded, is a community-designed entrance sign prominently featured on Ingleside Road, with the goal of both welcoming residents and informing visitors.[92] Ideally, a community entrance sign will highlight Ingleside's new green infrastructure, both through its language and the materials used to create it. The residents also recommended signage for other sustainable interventions in the community equipped with educational material on environmental stewardship.[93] An innovative way to engage children in this project would be for the nearby schools to research and write the information for the signs. Seattle Parks and Recreation utilizes the creative benefits of educational signage in New Kinnear Park by providing signs with valuable information about the trees that inhabit the park. Specifically, landscape architect Aaron Luoma explains that, "People enter and exit the park in different ways and seeing a sign might encourage exploration."[94] For all signage, but especially the main entrance sign, the UVa team encourages the community to build signs that connect with the natural environment around them. The pictures below offer options for the community to use as inspiration. Figures 8 and 9 are mock-ups created to be used as baselines in the design process. Figure 9 was especially well-received at the third community meeting because residents noted that it better represented the natural environment.[95] The final two pictures, Figures 10 and 11, are of informational park plaques in Richmond and Virginia Beach, respectively.

[92] Ingleside community meeting, Ingleside Baptist Church, Norfolk, VA, March 18, 2017.
[93] Ingleside community meeting, March 18, 2017.
[94] Katie McVicker, "New Kinnear Park Tree Signs Encourage Environmental Stewardship," City of Seattle, Parkways: Seattle Parks and Recreation, (April 15, 2015).
[95] Ingleside community meeting, Ingleside Baptist Church, Norfolk, VA, April 22, 2017.

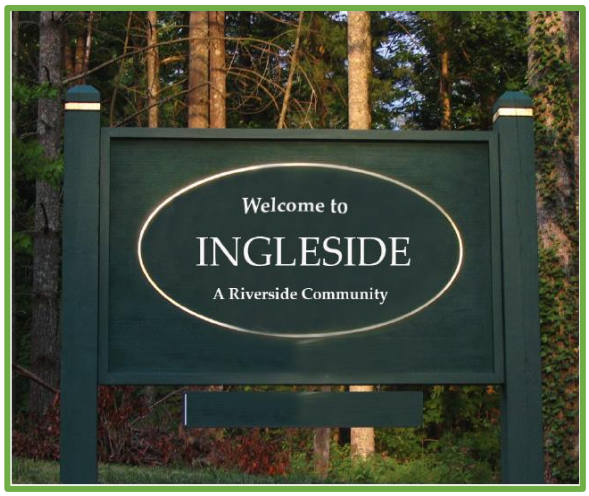

Figure 8. Example of an Ingleside entrance sign
Source: Hung Truong

Figure 9. Example of an Ingleside entrance sign
Source: Elizabeth Wilkin

Figure 10. James River in Richmond, VA park sign
Source: tripadvisor.com

Figure 11. Seashore State Park in Virginia Beach, VA park sign
Source: markerhistory.com

PUBLIC WATER ACCESS

In 2013, Norfolk City Council adopted a new General Plan, "plaNorfolk2030," which states the city wants a public access point every ¼ mile along city shorelines (Action DL1.1.7).[96] Independently of the Norfolk City General Plan, several attendees of the first community meeting in Ingleside mentioned in written surveys a desire to incorporate "more community access to Broad Creek," specifically in the form of "a park with access to the water," (Appendix 16).

[96] City of Norfolk, "plaNorfolk2030 - The General Plan of the City of Norfolk," January 2017.

In keeping with this plan and in order to create a community gathering place that exemplifies Ingleside's new commitment to green infrastructure and environmental sustainability, the UVa team proposes public access points to Broad Creek. Public access points allow community members to experience the river first-hand and thus, encourage them to take part in practices that improve the river's health. Currently, most of the shore is privately-owned, so many of the community members have no access to the river at all, even though most of them declared they would like to.[97] Fortunately, there are a few shoreline areas owned by the City that may be converted for public access. The team also recommends that the City consider acquiring low-lying private property, with the goal of creating public green space in exchange for city-wide flood insurance rate reductions.

Throughout the United States, public water access has become an increasingly popular approach to improving water quality. For instance, Riverkeeper, an organization dedicated to cleaning up the Hudson River believes that public access is of the utmost importance. They found, "If people are allowed to use the river, then they will appreciate it, and they will defend it."[98] The Hudson River was extremely polluted during the Industrial Era and through hard work and community involvement, the Hudson's water quality has seen vast improvements over the past 30 years.[99] For most of New York's history, the Hudson was off-limits to the general public because it was surrounded by industrial factories, private fencing, and railroad tracks. In the early 1990's, the City decided to build access points in multiple locations along the river and the public had an overwhelmingly positive response to it. Now that the water quality is improving and there are points for people to reach the water, the public enjoys fishing, swimming, canoeing, studying nature, and producing art at the waterfront.[100] At the March 18th meeting, community members positively responded to a waterfront park in their neighborhood.[101] Ingleside residents could be as involved with their river as New Yorkers are with the Hudson. The area could be a multi-use space the community can use for small public events, watercraft recreation, outdoor play, and a connection with nature and relaxation. Public access will simultaneously improve the already strong social connections within the area, make people aware of the river's poor health condition and compel them to take action to improve it.

COMMUNITY-DESIGNED PARK

In order to promote the highest level of community engagement, a public park should be designed with the concepts of the people who will use it. As mentioned previously, community members in attendance for the first Ingleside community meeting on January 28th expressed through surveys a desire for a "nature park" with "access to the water" as well as a desire to increase walkability within the Ingleside community (Appendix 16). At the March 18th meeting,

[97] Ingleside community meeting, January 28, 2017.
[98] "Public Access," Riverkeeper, 2009.
[99] Ibid.
[100] "Access to the Hudson River Estuary," New York State Department of Environmental Conservation.
[101] Ingleside community meeting, March 18, 2017.

the UVa team asked the community members for their ideas.[102] The main points mentioned included signage, which inherently adds a sense of pride and protection over the area and educational materials about the river, wildlife and the threats they face. Some members also suggested a small boat launch and/or fishing dock, and the UVa team felt that the type of launch pictured below would be an attainable goal. Figure 12 is a photograph of the Lewis Road Kayak Launch in Maryland. The area was originally used as a municipal and rubble landfill and was eventually cleaned up and then opened to the public in 2007.[103] The organizations and volunteers involved planted marsh grasses to restore the shoreline and used a thin, netted mat to make the entrance to the water.[104] The material is not solid or heavy so it does not result in substantial erosion, yet is stable enough for people to walk across. However, at the April 22nd meeting, residents expressed concern with having a public park near their house.[105] The UVa team recognizes these concerns, especially since this plan is meant to engage the community. Conversely, Figure 13 depicts a Henrico, Virginia riverside park design that does not have a kayak launch and thus, requires less construction and maintenance, and could be implemented without the creation of a park.

Figure 12. Lewis Road Kayak Launch - Berlin, MD
Source: mdcoastalbays.org

[102] Ibid.
[103] "The Lewis Road Kayak Launch," The Maryland Coastal Bays Program.
[104] Ibid.
[105] Ingleside community meeting, April 22, 2017.

Figure 13. Deep Bottom Park - Henrico, VA
Source: Henrico.us

Butterfly Park in San Diego, California presents a relevant case study of a community-built park. The UVa team recommends following the same general structure they used in consulting the surrounding neighbors. The Butterfly Park project was part of a larger effort of converting unused or abandoned areas into outdoor space in San Diego County.[106] Figure 14 depicts the construction process that was four days of, "…men, women and children ages 5 to 80 participat[ing] in woodworking, masonry and gardening to enhance the desolate area."[107] Along with the volunteer residents and members from the Municipal Government, multiple organizations and donors helped National City win a grant from the San Diego Foundation. The residents were fully engaged throughout the entire process; starting with the planning phase – they even chose the butterfly theme, and participated in the design phase. Meanwhile, the organization "A Reason to Survive" held weekly community art workshops to help the residents prepare for the build.[108] The project was extremely successful in creating a gathering place, promoting environmental stewardship, supplying community members with organic produce, building relationships with artistic fellowships, starting a ripple effect into surrounding cities and fostering civic engagement.[109] The Ingleside community originally responded well to the idea of a community-designed park and the Butterfly Park strategy is an effective model.

[106] Allison Sampite-Montecalvo, "National City Creates Colorful Gathering Place," San Diego Union-Tribune, April 22, 2013, Online edition.
[107] Sampite-Montecalvo, "National City Creates Colorful Gathering Place."
[108] Ibid.
[109] Ibid.

Figure 14. Volunteer construction of Butterfly Park – San Diego, CA
Source: pomegranatecenter.org

Responding to concerns brought p by residents in the final April 22nd meeting, this plan also includes methods of maximizing general park safety.[110] Village Green Park in Macon, Georgia offers an applicable case study of safe park practices and infrastructure. This park serves two neighborhoods that were orginally afflicted by crime, drugs and gang activity. The park was intended to provide a recreaction space to the community, but because of the troubled surrounding areas, was underutilized. In attempts to make the park safer and more appealing, the City added a picnic shelter, tables, grills, a new playground unit and basketball courts. These added facilities for communal engagement have increased park use by more than 25 percent. Furthermore, incidents of crime and violence have decreased by more than 50 percent in the surrounding area. In observing these changes, the success of Village Green Park is attributed to the philosophy that it is, "critical in any effort to reduce crime and increase safety in a local park…that the community needs to be included in planning and programming of the open space."[111] With this goal in mind, the UVa team suggests an integrated planning and design process to make the public park safe and pleasurable for all residents.

PUBLIC ART

Public art is an exciting way to engage the community and beautify the neighborhood. Art designed by the people who will enjoy it can foster a deeper connection between the current residents and the space around them, while also making the area more attractive to potential residents. The plan suggests a few options so residents can collaborate with the City and the Norfolk Public Arts Commission to choose and design the most respected and feasible options of

[110] Ingleside community meeting, April 22, 2017.

[111] National Recreation and Parks Association, "Issue Brief: Creating Safe Park Environments to Enhance Community Wellness," news release, Nrpa.org.

painted murals, sculpture gardens and various forms of street art. Figure 15 is sculpture in Norfolk, Virginia surrounded by plants and vegetation that can be used as an inspiration to Ingleside's first sculpture garden.

Figure 15. "Mermaid Flower Garden" sculpture in Norfolk, VA
Source: gonavis.com

Susan Weiler, an architect at OLIN firm, and Marc Pally, a public arts consultant, brilliantly explained the positive impacts public art can have on cities in the 2012 American Society of Landscape Architects Annual Meeting.[112] One of the benefits that relates to Ingleside is that public art is free. Ingleside is a mixed-income community (Appendix 1. Income) and public art may allow residents to experience art when they otherwise could not. Another valuable benefit is that "community art creates attachment to one's community."[113] For instance, a survey conducted in 43 American cities found that "aesthetics of place" including green spaces, parks and art ranked higher than safety, education and the local economy as "drivers of attachment" to cities.[114] Since Ingleside is experiencing an extensive amount of sea-level rise and flooding, safety is often compromised. Public art can bring residents together to assist the most vulnerable members of the community. Beautifying public areas can also invite residents to collaborate on steps to improve their community as a whole.

1. STORM DRAIN PAINTINGS

[112] Jared Green, "Why Public Art Is Important," The Dirt, October 15, 2012.
[113] Green, "Why Public Art Is Important."
[114] Ibid.

There are many examples of ways that street art can be used for a purpose other than just beauty. For Ingleside, art can be a tool for environmental awareness, specifically water pollution. Baltimore is a coastal city that has promoted water clean-up by painting storm water drains to remind citizens that their trash ends up in the Chesapeake Bay.[115] This program was developed by Blue Water Baltimore, an organization created in 2010 that is dedicated to cleaning up Baltimore's rivers, streams and Harbor in the pursuit of a healthy environment and a happy community.[116] The organization partners with the City of Baltimore to offer workshops, training sessions and stenciling and painting kits for any students, teachers, residents or youth groups who apply.[117] The paintings are typically of colorful sea life and may have a note that informs passersby that drains lead to the Bay. Ingleside, and Norfolk in general, could benefit from implementing a simple and easy program just like Blue Water Baltimore's. Likewise, painting storm drains can reduce the disconnect that Ingleside residents have with Broad Creek. Frequent flooding increases the amount of trash, chemicals and pollution that flows to the Elizabeth River, so it is even more important to show people they need to be cautious of how they dispose of waste. Furthermore, Blue Water Baltimore created a "Storm Drain Art Manual" that educates other cities on how to adopt the program and the Ingleside Civic League, Ingleside Elementary or any other community group can use this guide as a starting point.[118]

Additionally, the City of Richmond Department of Public Utilities has developed a similar program in the form of an annual competition for young, Richmond-based artists called the "Storm Drain Art Project."[119] The main goal is to remind residents that "It All Drains to the James."[120] Another noteworthy point is that both the Baltimore and Richmond storm drain websites are very interactive, easy to read, bright, colorful, and most importantly, up-to-date. Ingleside, and Norfolk in general, can develop modern, easy-to-use technology to promote all of their resiliency efforts. Below are examples of painted storm drains from Baltimore and Richmond that can be used as encouragement for beautifying Ingleside streets.

[115] "Stencil A Storm Drain," Blue Water Baltimore, December 23, 2014.
[116] "About Us," Blue Water Baltimore, February 28, 2014.
[117] "Stencil A Storm Drain."
[118] Blue Water Baltimore, "Storm Drain Art Manual," March 26, 2014.
[119] City of Richmond Department of Public Utilities, "Storm Drain Art Project," RVAH2O.
[120] City of Richmond Department of Public Utilities, "Storm Drain Art Project."

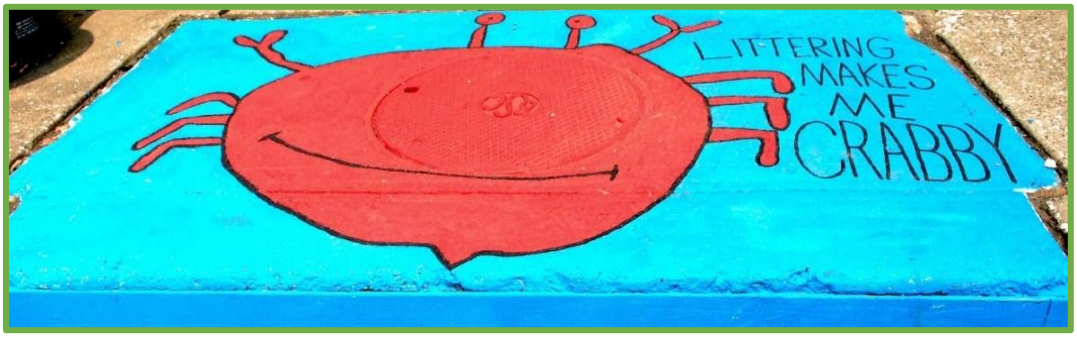

Figure 16. Baltimore storm water example
Source: bluewaterbaltimore.org

Figure 17. Richmond storm drain example
Source: rvanews.com

2. PUBLIC MURALS

Public murals are typically painted on unsightly walls and in a "shrinking" city[121] like Norfolk, which has a large military-industrial complex and a fair amount of vacant lots, there are blank, concrete walls that could benefit from a charming painting. The UVa team recommends painting

[121] Harry Minium, "Census Bureau Says Norfolk Fastest-Shrinking City in U.S.," Virginian-Pilot, June 21, 2006.

the "jersey wall" near the cul-de-sac on Kentucky Avenue, if possible, as the residents are unhappy with its current appearance and would like to brighten up the neighborhood.

Many other industrial cities, including Philadelphia and Chicago, have used community-designed murals to invigorate their downtown areas. Also, the actual painting of the mural requires neighbors to meet and socialize. The finished mural itself stands as a symbol of strength and inseparability between the residents and their city. The UVa team encourages local artists to assist in the design and painting process, giving them a stake in the neighborhood and a place to showcase their talents. The more people who participate from the community, the more special and diverse the mural can become. The general public, local artists and unique attributes of each neighborhood can combine to create a painting that simultaneously feels intimate, yet behaves as the widely-visible focal point for the entire area. This is why the team suggests a painting that involves coastal grasses, sea life and water, so long as that is what the community would like to see. Below are a couple of community-designed murals already in Norfolk, Virginia. Figure 18 is an example that connects with the coastal environment of the area. Figure 19 is called "Portrait of a Neighborhood" and was designed by the Governor's School for the Arts and Ingleside Elementary. The last photograph, Figure 20, is called "Teens with a Purpose" which was designed by teenagers at the Vivian C. Mason Center.

Figure 18. Granby Street in Norfolk, VA
Source: norfolkpublicart.org

Figure 19. Ingleside Station Norfolk, VA
Source: norfolkpublicart.org

Figure 20. Olney Road Norfolk, VA
Source: norfolkpublicart.org

Greening Ingleside: Coastal Resilience from Front-to-Back

During the second Ingleside Civic League meeting, the idea of greening Ingleside from front to back began to take shape. The community members wanted to see their neighborhood develop into a green and sustainable example for all coastal areas. Working off of this concept, the UVa team focused on site specific locations as the first steps in achieving this goal. Ingleside Road

functions as the spine of the community plan and is the main entrance point of the neighborhood. For that reason, this street was the first area of interest. The next area the team honed in on was Townsend Place. This street was among the top concerns for the community members because of its constant standing water and safety concerns. Further down in the community, towards the Elizabeth River, is Kentucky Avenue. This area seeks improvements in all of the UVa team's focuses - living shorelines, stormwater runoff management, and improved aesthetics for the community. The fourth and final area of focus was Westminster Avenue, situated at the southernmost point of Ingleside, which has potential to be a main green space within the community, further demonstrating their efforts to create a sustainable and resilient neighborhood.

INGLESIDE ROAD

Neighborhood Entrance Sign

The community members were especially enthusiastic about incorporating a neighborhood sign into the design of Ingleside Road. Specifically, former Civic League President Nikki Southall vocalized it would be an excellent way to show that the community is going green "from the front to the back."[122] While the plan includes suggestions for design and placement, the design for this sign should be primarily created by the community to reflect what they value about Ingleside and how they want to mark themselves as unique from other neighborhoods in Norfolk. This design could be created during the annual Inglefest community gathering in Ingleside. Residents were particularly interested in a wooden sign with minimal environmental impact in both its fabrication and installation.[123] The design for the sign should be nature-based and incorporate a selection of native plants around the sign itself, potentially in the form of a rain garden, in order to reduce the problem of flooding and convey a message about green stormwater management in Ingleside.

Green Street Infrastructure

Ingleside Road has the potential to be a model street for green infrastructure in the Ingleside community and the Norfolk area. The beginning of the street, especially near Ingleside Elementary School, provides a good location for stormwater planters along the sidewalks. Not only would it help with the stormwater, but it could also slow traffic around the school if the planters were bump outs. Slowing traffic in this area is important for any students that walk to and from school. These planted features would make the Ingleside entrance more attractive and help reduce stormwater flooding in Ingleside. Stormwater planters, on average, cost $8 per square foot but this is dependent on the vegetation used within the planter. They also require up to $500 in maintenance every year per 500 square feet. There are around 1000 square feet at the top of Ingleside Road where stormwater planters could be implemented. Therefore, if the planters were

[122] Nikki Southall, Ingleside Civic League meeting, Norfolk, Virginia, March 18, 2017.

[123] Ingleside Community Meeting. April 22, 2017.

4 feet wide, the implementation cost would be around $32,000 and maintenance $4,000 annually.[124] Although there were few issues of flooding in this area, this green infrastructure will divert water from travelling to flood-plagued areas or into the over-exerted drainage system throughout the community.

Further down the street, stormwater ditches are located between the Ingleside Church and Seay Road. These ditches are unattractive and not functioning well, retaining stormwater for days after a storm. To solve both of these problems, these ditches should be turned into bioswales. The plants in the ditches would consume and hold water, decreasing the flood levels. Bioswales would also reduce the velocity of stormwater into the current drainage system.[125] Costs for a vegetated swale tends to fall between $4.50 and $8.50 per linear foot when vegetated from seed. When vegetated from sod the price increases to $15 to $20 per linear foot. Annual maintenance is $1 and $2 per linear foot for the respective planting types. The initial strip of road from the beginning of Ingleside Church to Seay Ave is around 850 feet long, so implementation costs could be anywhere between $12,750 to $17,000 because most of the current ditch has sod in it. Maintenance costs would be at most $1,700 annually.[126] On the east side of the street there are sidewalks; the addition of tree trenches as infiltration storage on this side of the street would further reduce flooding risks. Tree trenches are bioretention systems that use mulch, soil, and root layers to collect and filter stormwater. The implementation of the tree trenches would further assist in reducing stormwater accumulation in the sewer system.[127] Not only would these additions to Ingleside Road be beneficial for flood mitigation, but it would also improve water quality and beautify the street. This is the central spine and busiest street in the community. Framing the street with beautiful plants and full trees will make the community more inviting and pleasant.

[124] "Stormwater Planters." Promoting Healthy and High-Performing Places to Live, Work, Play, and Learn. 2016. Accessed April 02, 2017. https://www.go-gba.org/resources/green-building-methods/stormwater-planters/.

[125] Mooy, Jennifer De , Miriam Balgos, Susan Love, and Michael Skivers. "A Delaware Guide to Using Natural Systems in Urban, Rural, and Coastal Settings." Green Infrastructure Primer. January 2016. Accessed April 10, 2017. http://www.dnrec.delaware.gov/GI/Documents/Green%20Infrastructure/Green_Infra_Primer2016_FINAL%20web%20version.pdf.

[126] "Vegetated Swale." Vegetated Swales. Accessed March 15, 2017. http://www.middletowntownship.org/vertical/sites/%7BE08CD8FE-6BF2-4104-AF8F-C16770381A63%7D/uploads/%7B87A8F0B2-8B5A-466C-AF87-71F2CF830CE3%7D.PDF.

[127] Mooy, Jennifer De. "A Delaware Guide." (2016).

Figure 21. Ingleside Church Drainage Ditch
Source: Shereen Hughes, 2017.

Figure 22. Potential Bioswale Implementation
Source: Hung Truong, 2017.

FONTAINE AVENUE AND TOWNSEND PLACE

Townsend Place is well known in the Ingleside community for its constant flooding. Engulfed in a flood zone, Townsend's drainage system proves to be inefficient for the amount of water in this area. This road is adjacent to an inlet from Broad Creek and lies on top of what used to be marsh land. This area is in danger of large floods not only from stormwater but also the compound effect from storm surge. The bend is pooled with water at almost all times, rain or shine. This is cause for concern for the citizens of this area. Not only does this water-filled bed cause an inconvenience, creating a one lane road on most days, but it also can be a danger to the residents' safety. When large rain events occur, the bend on Townsend Pl. floods so severely that it is impossible to drive through and this is the only route out of this area. Figure 23 demonstrates the standing water days after a rain event. Since the current situation in this area is problematic, Ingleside residents were extremely receptive to proposed solutions for this street.

Figure 23. Townsend Place Standing Water
Source: Shereen Hughes, 2017.

Elevated Street and Open Space Creation

Due to the clear danger to the community members' safety, a solution must be made. There is no quick and easy solution but several preventative practices could help to temporarily alleviate the flooding. The first piece to the puzzle is to raise the Townsend Place road surface above the flood plain level. This would keep the road from being constantly under water. Asphalt costs between $3 and $4 per square foot. The piece of road that would need to be taken out, elevated, and repaved is about 200 feet long and 25 feet wide. After the elevation, repaving this portion of the road would cost roughly $17,500.[128] The second part of the plan would be to create storage places for the runoff until it could seep into the soils. The house on the inside of the bend, 832 Townsend Place, has been vacant for some time now, most likely because of the constant severe flooding. This lot could be bought by the city and turned into green infrastructure for water storage. According to NorfolkAir, the value of 832 Townsend Place is estimated to be $171, 400. In September of 2016 it was sold for $97,900.[129] In this lot, a wooded wetland or an open space could be a good way to store water. Planting a few trees would help to absorb some of the excess water and it is relatively cheap. Furthermore, to help mitigate some of the runoff issues, the small area of land between the outer part of the bend and the Broad Creek inlet should be turned into a

[128] "Learn how much it costs to Install Asphalt Paving." 2017 Asphalt Paving Cost & Pricing | HomeAdvisor. 2017. Accessed April 25, 2017. http://www.homeadvisor.com/cost/outdoor-living/install-asphalt-paving/.
[129] "832 Townsend Pl, Norfolk, VA 23502 - 3 beds/2 baths." Redfin. 2017. Accessed April 27, 2017. https://www.redfin.com/VA/Norfolk/832-Townsend-Pl-23502/home/49192070.

buffer zone. Some native grass and plants will help lessen any surges as well as help clean polluted runoff before entering the creek.[130]

Emergency Exit Route

Given the severity of the flooding in this area a contingency plan should be in place. The citizens should have an alternative route in the case of an emergency. Creating this option on the closed portion of Fontaine Avenue would be the best solution. The closed part of this road is also in the old marsh area and therefore implementing a road with hard surfaces, like residents originally suggested, would cause more flooding problems for the houses along this stretch. This alternate route was a suggestion at the first meeting that got the most support and excitement from the community. The UVa team researched possible methods to make this possible, but traditional pavement and infiltration methods would not be sufficient. Figure 24 below, shows the low-lying nature of the area and the close proximity to the houses. Therefore, an emergency road in that location would involve elevating the surface and using interlocking pavers was ultimately recommended. Interlocking concrete pavers range in cost from $5 to $10 per square foot. Depending on the storm water management system that will be implemented with this street though, it could cost around $10 more per square foot. This extension would be roughly 200 feet long and an average emergency access street is 20 feet wide.[131] Therefore the price for this project would be roughly $20,000 to $40,000 prior to additional stormwater management systems being put in place.

Figure 24. Location for Emergency Exit Route
Source: Shereen Hughes, 2017.

[130] Mooy, Jennifer De. "A Delaware Guide." (2016).
[131] McCutchan, Steve. "How Wide Should a Neighborhood Street Be? - Part 1." PlannersWeb. January 15, 2014.

Living Shoreline Implementation for Private Residences

A prime example of private residences that could positively benefit from the living shoreline services that the Elizabeth River Project has to offer are the homes that surround the road bend on Townsend Place and the Broad Creek tributaries that are adjacent to these homes. Since the tributaries located along Townsend Place are all privately owned, they are a great place to implement the River Star Homes program to establish living shorelines. Planting living shorelines along these waterways will help reduce the amount of flooding that frequently occurs along this road as well as reduce the amount of erosion that is already occurring. The tributaries along Fontaine Avenue were chosen not only because the location to mitigate damage from storm surge but also for the environmental characteristics. The marsh grasses the plan recommends for installation in a living shoreline in this area have very high solar exposure requirements. *Spartina alterniflora* require nearly full sun exposure year around to properly establish roots in the soil and flourish as a living shoreline grass. By using Google Map images taken during each season of the year, the UVa team found that the Fontaine Avenue tributary site provided enough sun exposure for living shoreline grasses (Appendix 17-19). After comparing the seasonal images, the UVa team believes there is enough sunlight exposure to allow for proper living shoreline growth. Figures 25, 26, and 27 depict the sites where living shorelines could be placed and demonstrate the erosion that could be reduced.

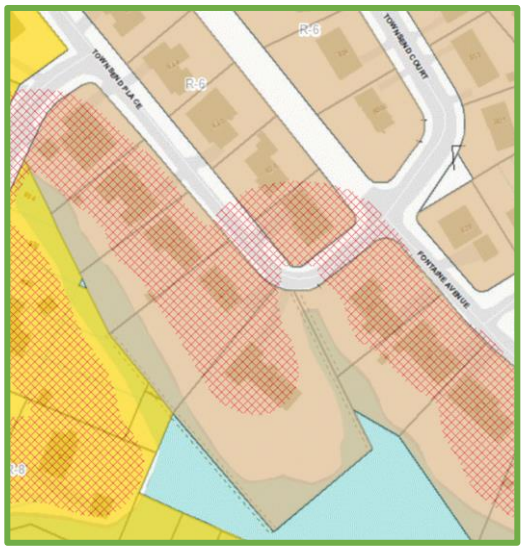

Figure 25. Private homeownership around the tributaries along Townsend Place.
Source: Norfolk Air

Figure 26. Erosion of private residence (Facing bend at Townsend Place).
Source: Sam Friday

Figure 27. Water mark during extra high tides that spills into the yard of Townsend Place resident (Facing Northwest, Townsend Place to the right of this Picture)
Source: Sam Friday

KENTUCKY AVENUE

During the Ingleside Civic League meetings, the community members stressed the unattractive nature of the area around the cul-de-sac on the west end of Kentucky Avenue. In this location, there is a large grass-filled circle within the cul-de-sac, as well as a noise barrier to separate I-264 from the neighborhood. Residents on the street complained that the barrier and cul-de-sac are gray and unsightly, and indicated that they would appreciate some modifications to the area to improve the general atmosphere of the street.[132] Based on this feedback and visits to the area itself, the plan recommends aesthetic improvements made through community-based art and plantings. As portions of the area are owned by the City of Norfolk, the Virginia Department of Transportation, and private residents a set of options based on varying levels of cooperation from stakeholders is proposed.

Community Art Installation

One option for a community art installation is a mural painted on the noise barrier itself. This barrier could be designed and implemented by a team consisting of four key organizations: the Virginia Department of Transportation, who own the noise barrier and would need to provide approval for the project; the Norfolk Public Arts Commission, which is a city government entity responsible for approving all public art installations; the Norfolk Governor's School for the Arts, which is an advanced art school that previously facilitated a team of its own students and Ingleside Elementary School students to create murals that decorate the light rail station in

[132] Ingleside Civic League meeting, Norfolk, Virginia, January 28, 2017.

Ingleside; and the Ingleside Civic League, which could recruit community members and their families to help design and paint the mural itself.[133] The mural would ideally reflect the aspects of Ingleside that residents believe make the community unique, creating a focal point for community expression. However, because the noise barrier is owned by the Virginia Department of Transportation (VDOT), the requirement of their approval for implementation could serve as a barrier to this proposed project. The use of the noise barrier would require a permit from VDOT. There is no permit specifically for the installation of community art; however, stakeholders such as the Ingleside Civic League or Governor's School for the Arts could contact the Land Use Administrator for VDOT Hampton Roads — currently Jason Fowler — for guidance in applying for a permit.[134] If permission is not obtained from VDOT for the use of the noise barrier, the Norfolk Public Arts Commission, the Norfolk Governor's School for the Arts, and the Ingleside Civic League could instead work to implement a small sculpture garden in the green space contained within the cul-de-sac. The sculpture garden could be designed through a similar process as a mural, but would be more readily implementable. The garden could also include various native plants and small trees among the sculptures, which would help mitigate air pollution from the interstate and prevent standing water in the cul-de-sac following rain storms.

Buffer Zone Addition

Kentucky Avenue's cul-de-sac would benefit from implementation of flood mitigation practices. After even the slightest rains, the cul-de-sac begins to pool with water. The main approach to solve this problem is by adding buffer zones near the Broad Creek inlet. Creating a pathway for the water to flow from the pavement into this buffer zone would allow the water to be cleaned by the plants and then slowly disseminated into the creek. There is currently a forested area at the end of the street, but the buffer zone could expand further into the muddy and less utilized zones that can be seen in Figure 28. Buffer zones would likely have similar costs to living shorelines.[135]

[133] "Ingleside Station – windscreen – Governor's School for the Arts," Norfolkpublicart.org, , accessed March 30, 2017, http://norfolkpublicart.org/ingleside-station-windscreen-governors-school-for-the-arts/.
[134] Paula Miller, "Norfolk's Ingleside Neighborhood — Noise Barrier Mural," e-mail to Katherine Wilkin, April 18, 2017.
[135] "LID Urban Design Tools - Bioretention." Low Impact Development Center, Inc. Accessed April 25, 2017. http://www.lid-stormwater.net/bio_costs.htm.

Figure 28. Kentucky Avenue Buffer Zone
Source: Sam Friday

Living Shoreline Implementation for Publicly-Owned Space

The first site for city living shoreline implementation is located at the end of Kentucky Avenue, just north of I-264 West. The UVa team recommends living shoreline implementation to be placed on the southern edge of the tributary to Broad Creek just to the north of Kentucky Avenue. There are several reasons as to why the Kentucky Avenue location was chosen. Living shorelines were chosen for this location to reduce damage from erosion. For example, the outflow drain for Kentucky Avenue has cracked and has begun to separate from the concrete foundation and slide into the tributary, which can be seen in Figure 30. Additionally, the UVa team used Norfolk Air software to determine the Kentucky Avenue site is partially owned by the City of Norfolk and partially by the residents of Ingleside. By looking at the aerial image of the Kentucky Avenue tributary from Norfolk Air, it is clear that the northern half of the inlet is privately owned, marked in yellow in Figure 29, and the southern half by the City of Norfolk. This 50/50 ownership is advantageous because instead of relying entirely on the collaboration of River Star Homes with private funding for this project, the City of Norfolk will also have the ability to implement living shorelines. This site was chosen based on natural sunlight exposure, similar to the Fontaine Avenue site. Again, the team used seasonal Google Map images to approximately determine how much sunlight the Kentucky Avenue tributary would receive. The approximate linear footage for this living shoreline is 667 feet, which would cost approximately $6,600.

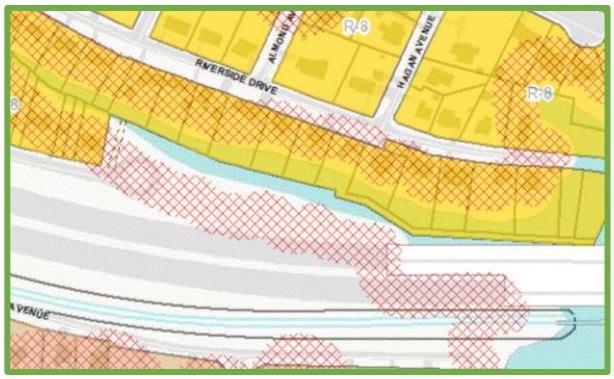

Figure 29. Aerial view of Kentucky Ave.
Source: Norfolk Air

Figure 30. Damaged outflow pipe
Source: Sam Friday

Figure 31. Kentucky Ave. tributary during low tide and where the living shoreline would be introduced
Source: Sam Friday

WESTMINSTER AVENUE

Public Access Point

Through the surveys administered during the first Ingleside Civic League meeting on January 28th, several residents indicated a desire for a "nature park at the end of Westminster Ave." One respondent said they "would love a boat ramp to be put in and a living shoreline at the end of Westminster so the community can spend time together" (Appendix 16). Based on these surveys and verbal community feedback during the first two Ingleside Civic League meetings, as well as taking into account land currently owned by the City and adjacent water levels, Westminster Avenue would be the best location to implement a public access point and park. Currently, the area is used as a dumping space for construction materials and large household items.[136] This public space would allow community members to access the water in a neighborhood where the shoreline is primarily privately owned. By creating a space for public access, ideally a park in which community members can not only gain access to the water but enjoy time in close proximity to the creek itself, community members will feel more connected to the natural environment in which they live and improve their perception of their community.

This plan recommends that the City of Norfolk explore purchasing the home and property at 3543 Westminster Avenue. According to residents, the home has been uninhabited and listed for sale for several years. As of July 2016, Norfolk City's assessed value of the property was $224,200.[137] Through the federal Coastal Zone Management Act of 1972[138] as well as FEMA's Flood Mitigation Assistance program, the city could apply for funds to acquire the home, reducing the direct cost to the city for the project.[139] Additionally, since the space would be used for public access and recreation, the City of Norfolk could apply to the Land and Water Conservation Grant through the Virginia Department of Conservation and Recreation, which offers a 50 percent cost-share grant for the purchase of land, as well as funding for amenities that might be implemented in the park.[140]

At the final community meeting on April 22nd, two residents who live directly across from the area proposed for a public park and who inherited the property recommended for city acquisition opposed the proposed park, citing safety concerns in the area. The residents referenced incidences of individuals parking at the end of the street and participating in illicit activities in the darker regions of the property, problems with wandering individuals who pose a potential danger to themselves and others, and a lack of adequate police response when called during these sorts of

[136] First Ingleside Community Meeting.
[137] "Norfolk AIR," Norfolk Address Information Resource v2.1, April 24, 2013.
[138] Federal Emergency Management Agency, Department of Homeland Security, "Hazard Mitigation Assistance Guidance," February 27, 2015.
[139] "Virginia CZM Program Funds and Projects," Virginia Department of Environmental Quality.
[140] Joe Rieger, feedback given during meeting for the Broad Creek-Ingleside Team, Charlottesville, Virginia, April 12, 2017.

events. The residents expressed concern that, if the vacant property they currently own were to be acquired by the City of Norfolk and turned into a public park, the property could fall into disrepair and management of safety concerns would continue to be the responsibility of the surrounding homeowners, who would no longer be able to ask that people leave the property because the land is public. Overall, the couple seemed to have little faith that a park design would help mitigate these safety concerns. However, other members of the community, some who live on Westminster Avenue and agree with the safety concerns raised, still supported the creation of a community park with public water access.[141]

If the land for the park is acquired, the design for the park should be created with community input and desired features. Since this segment of shoreline at the end of Westminster Avenue has been selected as a key location for living shoreline implementation, the plan recommends that there be educational signage explaining how living shorelines work and how they serve the community. These education materials could also highlight the history of the Ingleside community. This will help the community remain informed about the reason for the specific intervention and could increase emotional investment in the area, which would promote proper maintenance and care as well.

While the safety concerns raised in the final community meeting are valid and should be addressed, there are a number of strategies that have been used in park design to mitigate similar safety concerns and could be applied here. For example, a clear intention and design for the park is crucial in encouraging specific uses while discouraging others. Increased visibility through strategic street and park lighting along with signage indicating park hours, such as dawn to dusk, and the ability of law enforcement officials to remove people from the park after hours could discourage individuals from using the space for illicit activities. Community members could even implement an informal surveillance system indicating to park users that residents of the area are keeping an eye on the park and will report any unsavory activities to the authorities.[142] Additionally, city maintenance is crucial to the safe use of the park; if the park remains in top shape and looks like an intentional destination rather than an abandoned property, individuals may be discouraged from using the park outside of its intended use.[143] Even solutions preventing parked cars from accumulating at the end of the street, such as very limited parking options complemented by ample bike racks will prevent inappropriate use of the park.[144]

Based on community feedback, some proposed design elements for a park include: a kayak launch, playground equipment, fishing space, trash and recycling receptacles, bike racks, community-inspired art, educational materials, and picnic tables. If the residents of Ingleside ultimately decide to create a park at the end of Westminster Avenue, the plan recommends that

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[141] Third Ingleside Community Meeting.
[142] "What Role can Design Play in Creating Safer Parks?," Project for Public Spaces, January 1, 2009.
[143] National Recreation and Parks Association, "Issue Brief: Creating Safe Park Environments to Enhance Community Wellness."
[144] "What Role can Design Play in Creating Safer Parks?"

the Ingleside Civic League work with landscape designers and architects in a design charrette to work out the specific details of the design itself. This charrette could take place at the annual Inglefest celebration, and community members could organize workdays during which the park itself could be constructed. If the community remains involved throughout the design and implementation of the park, they are more likely to feel an increased sense of pride not only in the space, but the community itself.

If the land proposed for the public park and water access point is not acquired by the City of Norfolk, various flood mitigation and coastal resilience strategies can still be implemented. One alternative solution is the placement of a conservation easement on the property restricting development and providing a variety of tax benefits for the landowners. The Living River Restoration Trust — established in 2004 by the Norfolk District of the Corps of Engineers, the Virginia Department of Environmental Quality, and the Elizabeth River Project — operates a land conservation program intended to help landowners hold property in trust with the intention to conserve the environment of the Elizabeth River.[145] Through this program, landowners have the option to place a conservation easement on a parcel, which is permanently attached to the deed of the land and stipulates that landowners can incorporate environmentally-friendly projects on the parcel such as rain gardens or living shorelines, with the understanding that no further development of the land can take place.[146] Through this option, the landowners who expressed concerns about the public park at the end of Westminster Avenue could still implement numerous resilience strategies to help mitigate flooding and erosion, while maintaining ownership and control over the land itself.

Whether or not the parcel at the end of Westminster Avenue becomes a public park with water access, implementing some flooding mitigation tactics will be very important. This is in the flood zone and storage techniques are the only viable options. Therefore, a rain garden, small forested wetland and/or trees planted throughout the park are recommended. Along with the living shoreline, a buffer zone of plants that can live in very saturated zones would also be beneficial. This buffer zone will help with stormwater runoff pollution and slow storm surge infiltration.

Living Shoreline Implementation for Publicly Owned Spaces

The second public site for living shoreline implementation, outlined in red in Figure 32, is located at the end of Westminster Avenue in the southwest corner of the Ingleside community. Using Google Maps and its distance measuring tool, the UVa team was able to determine that there are approximately 1,164 linear feet for living shoreline structures. Considering this dimension and the estimated installation cost we can assume that the maximum approximated cost would be $11,600. Figure 33 provides a ground-level view of the area of the area identified in Figure 32.

[145] "Living River Restoration Trust: Who We Are," Living River Restoration Trust.
[146] Living River Restoration Trust, "Preserve Your Land for Generations."

This site was chosen for multiple reasons. This is a location that experiences low wave and wind energy, the proper tidal range, low overhead shading and proximity to the proposed Ingleside community park. Similar to the previous two sites, the UVa team used Google Maps software to better understand the lighting conditions for the Westminster Avenue site. After reviewing the images, the team determined that there is minimal shading year-round at this location. Thus, the plan recommends implementing living shorelines in this location because of minimal shading and City ownership of the property. As with Kentucky Avenue, using the City's funds to implement living shorelines may help to incentivize residents to work with River Star Homes to install their own living shorelines and help reduce erosion damage. It is important to plant a living shoreline along this area to reduce the amount of erosion that is occurring along the shoreline of Westminster Avenue. Figure 34 depicts an outdated sea wall and the resulting erosion that is occurring behind the seawall due to rising sea-levels.

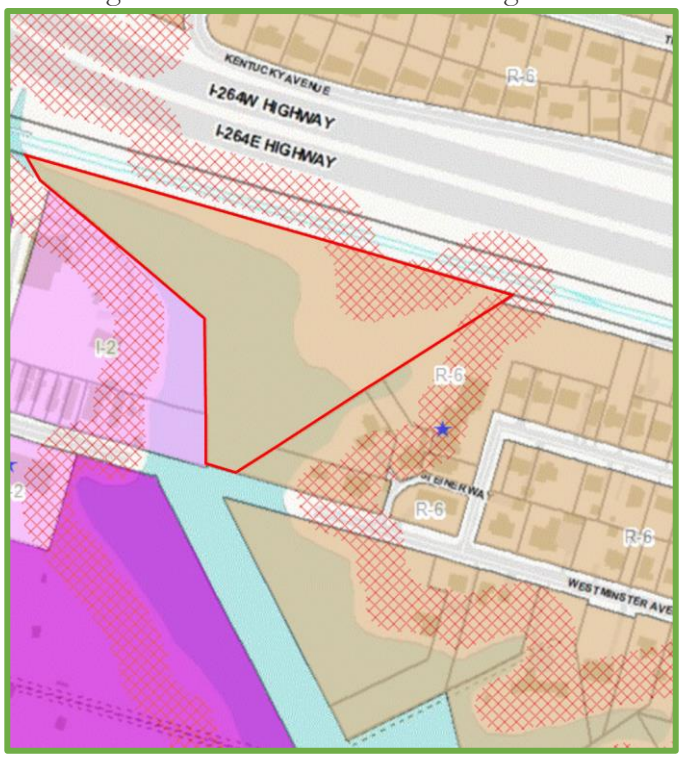

Figure 32. The outlined shape in red marks the city owned section along the Westminster Ave site for introducing living shorelines Source: Norfolk Air

Figure 33. Ground-level view of the area depicted in Figure 32.
Source: Sam Friday

Figure 34. Outdated seawall and the resulting erosion that is occurring behind it due to rising sea-levels and intensified storm surge.
Source: Sam Friday

Non-Site Specific Solutions

Because the selected sites detailed above impact certain segments of the neighborhood more than others, the plan recommends a set of potential projects that could be implemented throughout the Ingleside community. In order to educate community members about where water flows once it enters a drop inlet or storm drain, students and artists in the community could design and paint small art installations indicating that anything that enters the storm drain flows into Broad Creek and the Elizabeth River. This will not only help prevent community members from allowing chemicals and fertilizers to drain into the river, but it directly connect residents to the waterways that surround the neighborhood, whether or not they live directly on the shoreline. Additionally, the Ingleside Civic League could continue to work with the Norfolk Public Arts Commission to implement additional art pieces and sculptures, thereby creating a cohesive thread of reflection and expression throughout many areas of the community. Finally, in accordance with Norfolk's goal to incorporate a public water access point for each ¼ mile of city shoreline, various passive boat launches and publicly-owned shorelines could be added throughout the community, creating a closer connection between Ingleside residents and the eastern branch of the Elizabeth River.

In order to create a community with better stormwater management practices, increased participation in the Elizabeth River Project's River Star Homes program is also recommended. The existing program currently has several ways to help a private property suffering from stormwater flooding become more resilient. Rain gardens are the top solution for those in areas that are enough above the floodplain that some infiltration can occur. River Star Homes offers to pay 50 percent of the costs, up to $2,000, to implement a rain garden. They also aide in the design and implementation of such strategies. Installing rain gardens throughout Ingleside will decrease the amount of standing water in lawns and help clean stormwater runoff before it enters Broad Creek and the Elizabeth River. This program has other options for residents as well, such as rain barrels and free lawn advice. It has been welcomed by the community and many Ingleside residents are already members. Therefore, the River Star Homes program should be advertised more to incorporate all Ingleside neighbors.

Next Steps

The Elizabeth River Project has already used this research proposal as a primary reference piece for a National Fish and Wildlife Grant application in May 2017. Later in the month, the Ingleside Civic League will present this plan to the Norfolk City Council for their approval as well. This meeting is important for gaining the support of the City in Ingleside's improvement endeavors. Notification on the acceptance or rejection of the grant proposal is expected in August. Assuming that the Ingleside Civic League wins the grant, the proposed work can begin implementation as early as November 2017. In the meantime, the Elizabeth River Project, along with River Star Homes, will complete projects on privately-owned land throughout the community.

Conclusion

Moving Forward – Recommendations

In seeking to integrate the solutions outlined throughout this proposal into tactile interventions for costal resilience within Ingleside, the UVa team recommends further dedication to a conversation-driven and community-centric approach. While the members of this team were initially introduced in the role of a visiting expert – as a research and design consult for the project, the final proposal is primarily a reflection and response to the needs, interests, and ideas voiced directly from the project's community stakeholders – Ingleside's local experts. These include the interests of our local partners within Wetlands Watch and the Elizabeth River Project, whose interest in the environmental state of Broad Creek and the Elizabeth River watershed as a whole introduced sustainability as a central consideration for the future of Ingleside. However, the primary source of these solutions have been the diverse perspectives and feedback provided by the residents of Ingleside

The three primary objectives which these solutions strived to address, to mitigate the impact of localized flooding, to develop a holistically sustainable community, and to strengthen livability and residential engagement, were derived directly from communal input collected over the course of three meetings with these residents.

1. Initial firsthand accounts of the severe impacts of sea level rise identified water management, and most notably public safety, as our primary objective and concern in proposing solutions.
2. The collective excitement and positive response following the presentation of "living" solutions to these tactical challenges on March 18th, further expanded the proposal's objectives to meet the progressive, collective vision of Ingleside residents, who imagined their neighborhood as an exemplar of sustainability and livability in design – the first of its kind in Norfolk.
3. While excitement regarding this vision remained intact throughout the conclusion of our work with Ingleside, the arrival and input of new stakeholders on April 21st began to call in to question some the feasibility of certain solutions, highlighting the need for future conversation.

While it could be perceived that these questions and debates set the project back, the UVa team would suggest that they indicate the health of a conversational, community-centric approach. Maintaining this process of continuous, open, and equitable conversation with community stakeholders will prove integral throughout future steps of implementation. pen channels of conversation in order to maintain strong, united communal investment, and in rallying community support,

We suggest that interventions be implemented slowly, over time, and ideally through a series of stages. A gradual process will make best use of existing local resources, as well as address the present difficulties in mobilizing top-dow, government support and investment. Furthermore, a gradual process seeks to accommodate existing hesitations among community members. It is integral that members of the community feel heard, and feel as if their fears and suspicions, as well as their excitements and creative suggestions are perceived as valid and constructive to the project, and neighborhood as a whole. The gradual success of projects will hopefully meet the concerns of ineffective change, and motivate continued efforts and maximize community buy-in.

We propose the process take on the following steps in implementing strategies over time:

1. **Strengthen connections to local partnerships and motivate residents to apply solutions at home:**

The first solution will seek to capitalize on community excitement regarding existing resources for resilience certification and intervention assistance facilitated by the Elizabeth River Project, primarily through the River Star Homes program. Through River Star Homes, Ingleside residents can begin to integrate proposed solutions including rain gardens, vegetated buffers, and living shorelines along the neighborhood's predominantly privatized shoreline. These efforts will immediately begin to defend the entirety of the neighborhood from the threat of sea level rise as well as improve the conditions of neighboring waterways. Furthermore, the gradual implementation of these shorelines will seek to stimulate increased buy in into a holistically sustainable neighborhood by proving that change does not necessarily require dramatic solutions or heavy top-down investment, but can begins at home.

2. **Storm Drain Interventions:**

Following interest voiced by Ingleside residents and local officials with the City of Norfolk in integrating an "Adopt A Drain" program, Ingleside can leverage local resources, government funding, and smaller grant amounts towards individual projects to clean, protect, and engage their storm drains. These solutions will serve to integrate diverse community investment – with potential for partnering with local classrooms and community organizations, and create an array of aesthetics and individualities throughout the neighborhood.

3. **Community Sign Design Workshops:**

Following the trend of community engagement and solutions of bottom-up tactical urbanism, Ingleside can hold design charettes and community workshops to design, propose, and test surfaces for a Community Sign. As this solution may serve as one of the first tactics in defining the neighborhood as a center of sustainability and community engagement, design partners and local leadership should continue to present natural materials and encourage members to think outside the realm of traditional neighborhood signs and masonry.

4. **Adaption of a Bioswale next to Ingleside Church:**

Hopefully utilizing funding derived from grant applications, the U.Va team proposes Ingleside integrate a bioswale within the existing trench along Ingleside Rd as the first large-scale, public solution. The construction and planting of the trench, presented as a neighborhood "Planting Day," will offer an opportunity for community engagement in the "greening" of Ingleside. The

success of this first intervention will additionally serve to introduce residents to the practicality of solutions which seek to "live with water," with particular consideration of present hesitations regarding the standing water and maintenance.

5. **Expansion of Sidewalk Networks with and Storm-water Management Retrofitting**

Expanding from the first bioswale, the community can select to place money accumulated from grant funding and inspired by public support towards further, site-specific interventions in roadside stormwater management. The UVa team has identified the expansion of sidewalk networks throughout Ingleside, and the retrofitting of existing curbs to green street elements as a tactic in this process.

6. **Continued Pursuit of a Public Water Access Point:**

While respecting the concerns brought up by residents regarding the integration of a public, shoreline park, Ingleside should seek to continue to honor the demonstrated interest and excitement for a communal water access point. The search for a possible site and potential solutions to maintenance and surveillance should remain a topic of conversation throughout the staged process of intervention. It is the final hope of this proposal that the success of earlier interventions within Ingleside motivate residential support and local government engagement in meeting the needs of a public access point.

Living Solutions for Coastal Resilience

In identifying and seeking to address Norfolk's unique need for facilitated tactics of costal resilience, the UVa team is my no means alone. The City of Norfolk represents one of only a hundred global cities selected to participate in the Rockefeller Foundation's 100 Resilient Cities program. Created in 2013 as a celebration of the foundation's centennial anniversary, the 100 Resilient Cities movement is a response to the global trends of urbanization, globalization, and climate change.[147] The respective challenges and sources of opportunity which these three forces pose to coastal cities become increasingly relevant each year, as climate change progresses and global sea levels continue to rise. In the opening letter to the Norfolk Resilience Strategy released on October 28th, 2015, Paul Fraim, the Mayor of Norfolk provided the following observation.

> "The City of Norfolk is a model of resilience. Through four centuries we have withstood disruptions, weathered storms, and survived wars and pandemics."[148]

While not yet a model *of* resilience in the context of modern cities, due to the heavy level of development along the fragile Chesapeake coastline, the UVa. team concludes that Norfolk is indeed staged as a pivotal site *for* tactics of costal resilience.

147 Norfolk 100RC Initiative Leadership. "Norfolk's Resilience Strategy." *100 Resilient Cities*, 2016, 28

148 Ibid.

This proposal seeks to fit into the costal resilience narrative within Norfolk both optimistically and critically, in highlighting the Ingleside neighborhood as an ideal site for intervention. The outlined strategy follows several themes brought up by the 100 Resilient Cities Program in collaboration with the City of Norfolk through incorporating living solutions and a "living with water" approach. However, this proposal also seeks to respond to the inequitable focus of Norfolk's 100RC projects thus far in identifying diverse, community partnerships as an integral element of these living solutions. The Ingleside Resiliency Plan should serve as evidence to the unique needs and resources available to resilience projects which target residential, mixed-income neighborhoods. Furthermore, the proposal seeks to suggest that a gradual, living solutions approach grounded in conversational strategies and continuous communal investment offers the best means to facilitate resilience programs both within Ingleside and costal neighborhoods at large.

The Extent of Resiliency – Opportunities for Further Research

Considering Equity Within Ingleside

As seeking to address gaps in equity regarding resilience strategies was heavily considered throughout the four-month process, this proposal must acknowledge its own shortcomings.

In the coming planning and design process, the UVa team recommends more engagement with areas of the neighborhood that were not heavily represented during the Ingleside Civic League meetings. Specifically, many of the solutions proposed for implementation throughout the community could be included in areas such as Ingleside Elementary School and West Ingleside. Because these areas were not largely represented during meetings, the UVA team is hesitant to propose large-scale solutions for these sections of the neighborhood and resident population. However, targeted incorporation of stakeholders within Ingleside Elementary School and West Ingleside is crucial to the future of this initiative and in truly developing a holistic sustainability project from "front to back."

The Future of Ingleside

While the importance of Ingleside as a living, social community is integral to to the primary goals of this proposal, with the state of climate change and sea level rise as it is, and as it is anticipated to be, the UVa team suggests considering more drastic solutions for long term resilience. While living solutions offer the most sustainable and resilient solutions to these changing levels, it is

likely that they will not be sufficient in protecting Ingleside over the course of the next one hundred years.

Within a 2016 survey of the state of coastal cities conducted by The New York Times, Uva's partner with Wetlands Watch, Skip Stiles, suggested that "Norfolk alone, a town of 250,000 people, has a wish list of $1.2 billion — or about $5,000 for every man, woman and child in the city,"[149] a figure which, he suggests, offers ultimately little more than a "down payment." Considering future solutions for sea level rise within Ingleside and similar communities, local leaders and residents alike should consider whether such heavy investment, particularly of public funding is holistically sustainable in the long-term.

Property acquisition and residential migration may offer a veritable alternative for long term solutions. FEMA's hazard mitigation program can work with the city to cover large percentages of property acquisitions. In New Jersey, after Hurricane Sandy, FEMA covered one hundred percent of the costs. This buyout program's purpose is to mitigate long term risk for homes insured under the national flood insurance program. In pursing future resilience efforts, the FEMA program should be proposed and openly and respectfully discussed amongst residents.[150]

149 Justin Gillis, "Flooding of Coast, Caused by Global Warming, Has Already Begun," *The New York Times*, September 3, 2016.

150 "Flood Mitigation Assistance Grant Program," Flood Mitigation Assistance Grant Program – FEMA.gov

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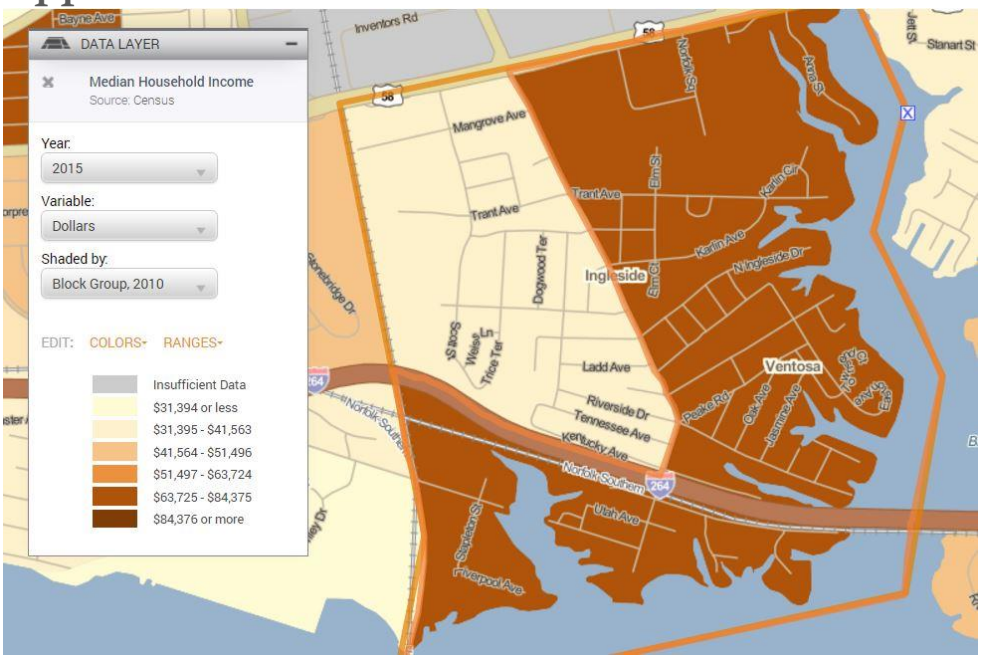
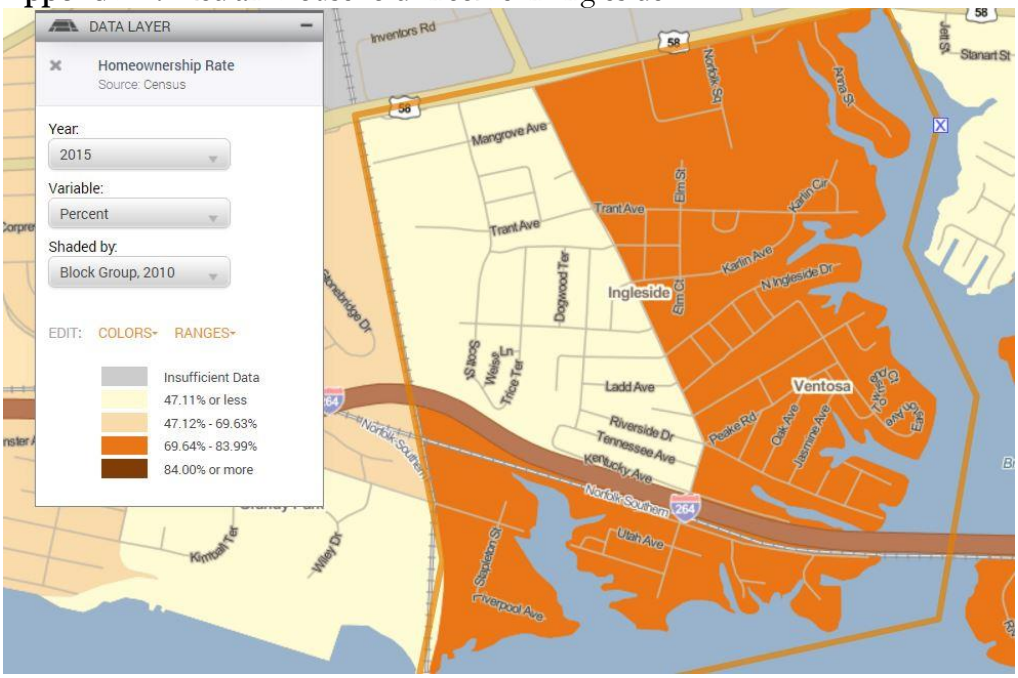
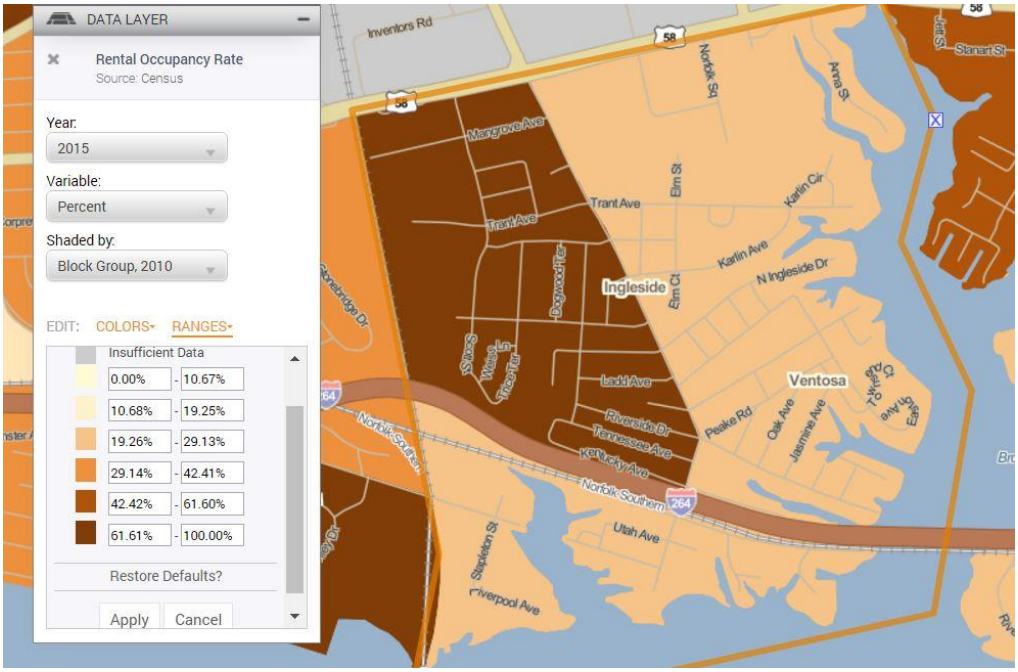
Appendix



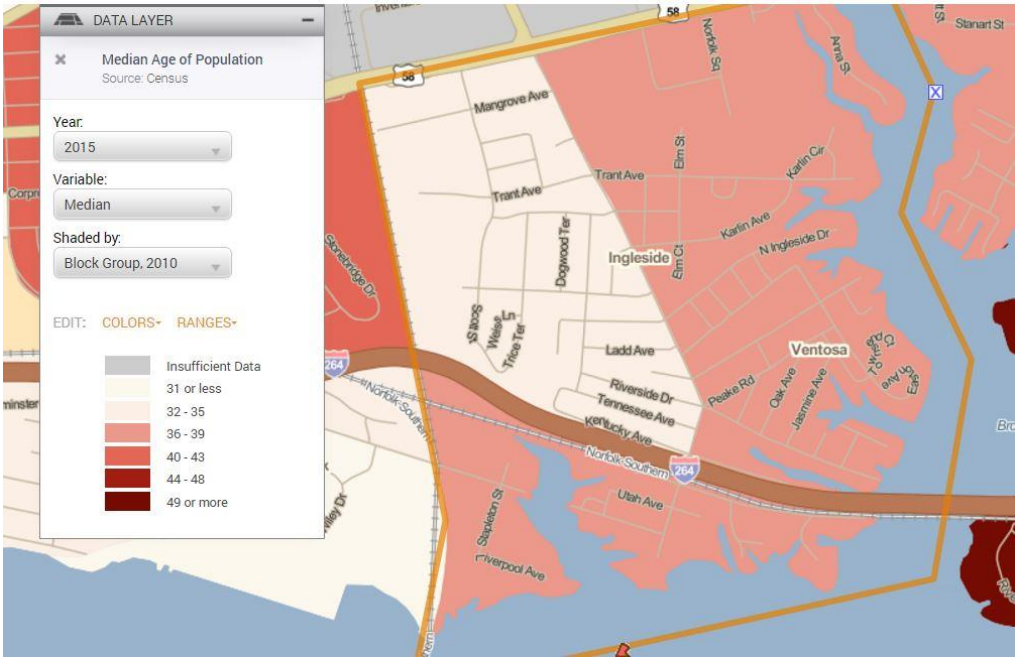
Appendix 1. Median Household Income in Ingleside



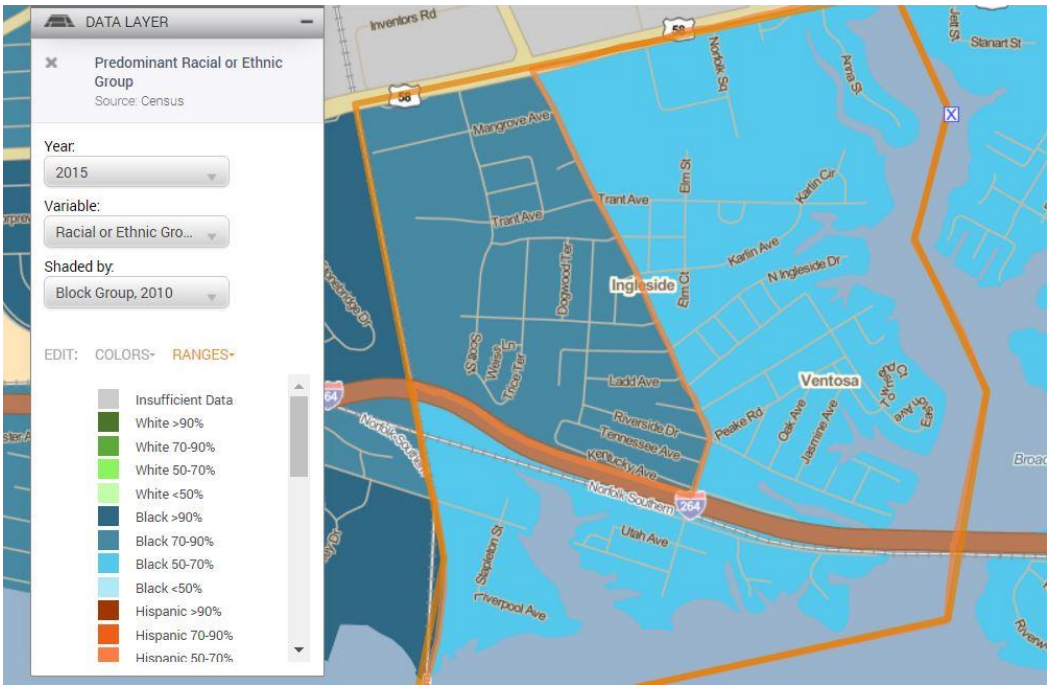
Appendix 2. Homeownership Rate in Ingleside



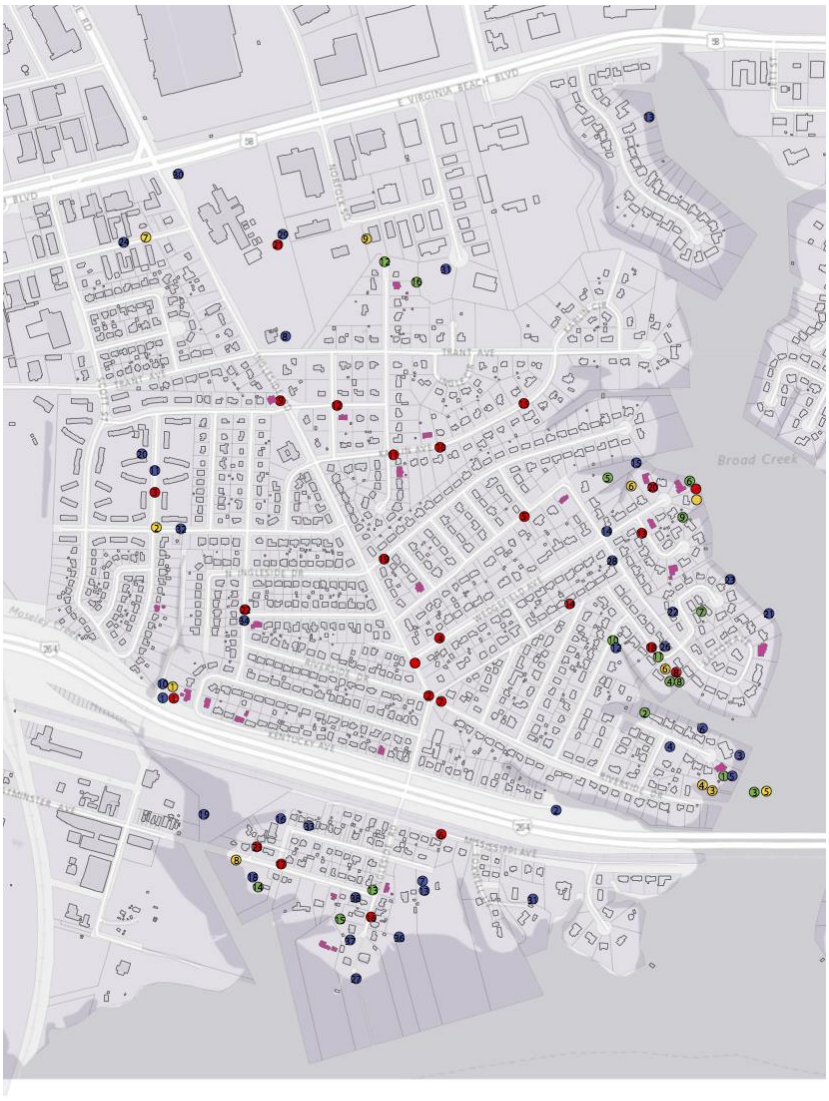
Appendix 3. Rental Occupancy Rate in Ingleside



Appendix 4. Median Age of Population in Ingleside

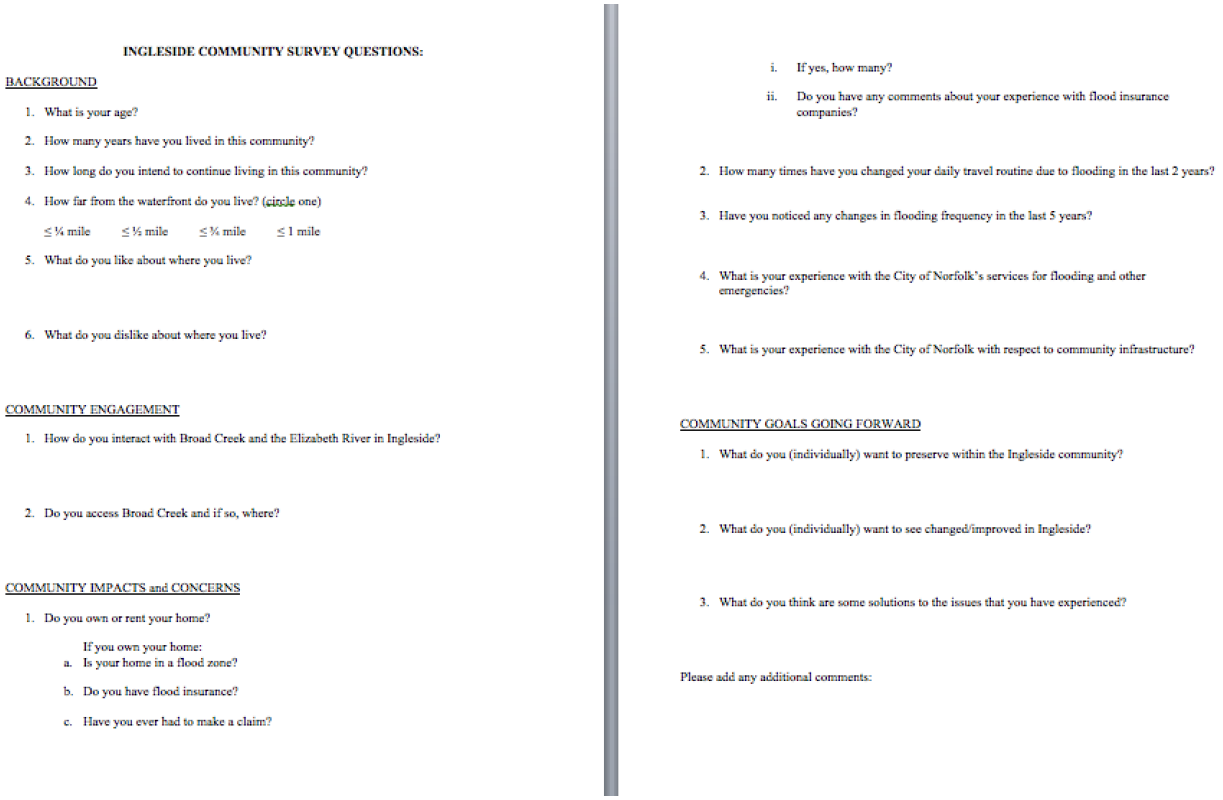


Appendix 5. Racial Composition of Ingleside



Appendix 6. Problem Areas Reported During the 1st Community Meeting (1/28)

Appendix 7. Proposed Areas of Green Infrastructure Implementation in Ingleside



INGLESIDE COMMUNITY SURVEY QUESTIONS:

BACKGROUND

1. What is your age?
2. How many years have you lived in this community?
3. How long do you intend to continue living in this community?
4. How far from the waterfront do you live? (circle one)

   ≤ ¼ mile ≤ ½ mile ≤ ¾ mile ≤ 1 mile
5. What do you like about where you live?
6. What do you dislike about where you live?

COMMUNITY ENGAGEMENT

1. How do you interact with Broad Creek and the Elizabeth River in Ingleside?
2. Do you access Broad Creek and if so, where?

COMMUNITY IMPACTS and CONCERNS

1. Do you own or rent your home?

   If you own your home:
   a. Is your home in a flood zone?
   b. Do you have flood insurance?
   c. Have you ever had to make a claim?
      i. If yes, how many?
      ii. Do you have any comments about your experience with flood insurance companies?
2. How many times have you changed your daily travel routine due to flooding in the last 2 years?
3. Have you noticed any changes in flooding frequency in the last 5 years?
4. What is your experience with the City of Norfolk's services for flooding and other emergencies?
5. What is your experience with the City of Norfolk with respect to community infrastructure?

COMMUNITY GOALS GOING FORWARD

1. What do you (individually) want to preserve within the Ingleside community?
2. What do you (individually) want to see changed/improved in Ingleside?
3. What do you think are some solutions to the issues that you have experienced?

Please add any additional comments:

Appendix 8. Blank Copy of Survey Administered during the 1/28 Ingleside Community Meeting

Appendix 9. January 28th Ingleside Community Meeting Flyer

Points for Further Research:

In the weeks following, the University of Virginia team compiled information from the three maps and corresponding dialogues into a holistic GIS presentation.

Through the consolidation of these maps and deeper analysis of community members' comments and survey responses, the student team drew the following key points of concern:

1. Significant evidence of sea level rise
2. Locations of persistent, severe flooding from both storm and surge sources, which often immobilize and isolate community members from work, school, and emergency services. Of particular concern are areas experiencing severe "sunny-day" surge flooding (areas with standing water without recent precipitation).
3. Locations where standing water following floods does not properly drain, remaining for days or weeks
    a. Need for improved storm drain maintenance
    b. Need to investigate the potential presence of solid waste in blocked drains and standing water
4. Habitual dependence on municipal cleanup and water bailout intervention
5. Spread of pollution from within and outside Ingleside exacerbated by flooding
6. Poor water quality influenced by surge flooding and runoff
7. The use of several vacant or city-owned lots as anonymous dumping grounds for waste including small waste such as litter or lawn debris, as well as larger sources such as concrete slabs and construction materials
8. Conservation of local wildlife populations in polluted waters
9. The challenge of private flood management solutions impacting adjacent private properties
10. Lack of communal public space with coastal access

Possible Strategies for Resilience:

Considering these key points of concern, the University of Virginia team is beginning to identify possible next steps:

- Improvement of water drainage infrastructure
- Development of constructed wetlands on privately and city-owned shoreline to prevent further erosion, mitigate flood impacts, provide habitat, and improve water quality
- Create shoreline public space to engage community members in their surrounding wetlands and empower them to become stewards of their local environment
- Linking members of the community to existing parcel-level flooding alleviation strategies

Ingleside + Broad Creek Coastal Resilience: Seeking Sustainable Solutions for Sea Level Rise, Flood Management, and Water Quality Challenges
First Community Meeting | February 28th, 2017 | *Ingleside Civic League* | *Elizabeth River Project* | *Wetlands Watch* | *University of Virginia* | *City of Norfolk*

Event Description:

On Saturday, February 28th 2017, the community members of the Ingleside Civic League, led by League President Amelia Coppage, met with nine students and three faculty members from the University of Virginia, Joe Reiger and several colleagues from the Elizabeth River Project, Skip Stiles of Wetlands Watch, and officials from the City of Norfolk – Scott Smith of the Planning Department and Justin Shafer from the Department of Environmental Management Office of Resilience. The meeting began with a presentation by Reiger and Stiles regarding the unique challenges facing Broad Creek and its surrounding neighborhoods, including statistics of poor water quality and projections for future sea level rise. The presentation concluded by highlighting efforts by both organizations and several Ingleside residents, as well as a 2016 resilience plan developed with Old Dominion University, Hampton University, and Wetlands Watch to address similar challenges in the Chesterfield Heights neighborhood.

Following the presentation, the community members were invited to mark specific locations of high-risk or potential intervention on three, large maps of the Ingleside community and surrounding areas. University of Virginia partners collected personal accounts and qualitative descriptions to map onto each physical point. Additional information was collected through surveys designed to gauge the perceived impact of the problems anticipated by the three partnering organizations, as well as to highlight new challenges and possible solutions proposed by community members. The maps and surveys were then condensed and analyzed by the University of Virginia students.

At the conclusion of the meeting, the students identified five potential areas for future study:

- The permanent street closure on Fontaine Ave.
- The bend on Jasmine Ave.
- The Brennan Ave. cul-de-sac
- The uninhabited coastal land at the end of Kentucky Ave.
- The Antebellum House on Westminster Ave. and nearby homes

The students visited each location, collected photographs, and expanded on the qualitative notes derived from community members.

Appendix 10. January 28th Meeting Description

Ingleside + Broad Creek Coastal Resilience: Seeking Sustainable Solutions for Sea Level Rise, Flood Management, and Water Quality Challenges
Second Community Meeting | March 18th, 2017 | *Ingleside Civic League* | *Elizabeth River Project* | *Wetlands Watch* | *University of Virginia* | *City of Norfolk*

Event Description:

1. The first objective of the day was to take additional pictures of each potential site that we plan to improve for the Ingleside Community. We visited Westminster Ave., Kentucky Ave. and Fontaine Ave. respectively, to understand the tidal range for each location. Additional photos were taken to visually understand what lowtide looks like.
2. The second objective was to host a collaborative presentation with Joe Rieger from ERP, Skip Stiles from Wetlands Watch and the UVa Norfolk Resilience Team to discuss our research topics on living shoreline management, stormwater management and community engagement. We also discussed River Star Homes services with the community to explain how individuals can get immediate support for flood management. After presenting our findings, we opened the meeting to questions and concern from community members. The Ingleside community members were receptive to our recommendations and expressed interest in several of the recommendations:
    a. Reconnecting Fontaine Ave. to provide a secondary access route for Townsend Crt. and designing it green infrastructure and stormwater runoff specification. The new road named "Green St." would work as an example of green infrastructure that would help stormwater damage and inaccessibility due to sea-level surge.
    b. Opening up the end of Westminster Ave. to become a community designed and constructed park. Enlarging this property for public access would be possible through the city's purchase of neighboring real estate. The park would provide community outdoor space, recreational water accessibility and educational components to inform citizens on the ecology of the Ingleside community.
    c. Turning the center area of the Kentucky Ave. Cul-de-Sac into a community garden. The focal point would act as an additional source for community engagement and education.
3. In addition to providing feedback on our recommendations, the community members expressed willingness to work with River Star Homes to improve their shoreline structures.
4. Following the community engagement meet we returned to the tidal sites to photograph high tides. We also went to a few community members houses to understand their specific flooding concerns better (3771 Brennan Ave. and 3551 Westminster Ave.). Community members from each of these sites showed and explains the height of sea-level and the damage to their property associated with storm surge.

Point of Further Research:

1) *Coastal Resilience*
    a) Ways to get coastal private property owners to work with River Star homes to implement coastal resilience practices
    b) Determining where the city of Norfolk can effectively implement living shoreline outside of private property
2) *Stormwater Management*
    a) Research options to reopen Fontaine that will account for it being in flood plain
    b) Map out areas with sidewalks and curbs, street side ditches, or neither for green infrastructure options
    c) Research homes and land for sale for city to buy back to make wetlands (save the city money and lower flood insurance?)
    d) See if a rain garden would be suitable for the end of Kentucky Ave
    e) Research other large areas suitable for public rain gardens
    f) Begin to get estimates of costs for these projects
3) *Community Engagement*
    a) Community Beautification/Landscaping Grants - community art projects, repurposing land for parks
    b) Environmental Enhancement Projects - rain gardens
        i) Send any information to Nikki before the project end
        ii) https://www.norfolk.gov/DocumentCenter/View/1184
    c) Members want a community-designed park (Butterfly Park, SD)

Appendix 11. March 18th Meeting Description

Ingleside + Broad Creek Coastal Resilience: Seeking Sustainable Solutions for Sea Level Rise, Flood Management, and Water Quality Challenges
Third Community Meeting | April 22nd, 2017 | *Ingleside Civic League* | *Elizabeth River Project* | *Wetlands Watch* | *University of Virginia* | *City of Norfolk*

Event Description:

1) To begin our final presentation to the Ingleside Civic League, Joe Rieger and Skip S delivered a short presentation on the overarching points of our project and the goals hoped to achieve. They also presented a timeline for the remainder of this project ar when our suggestions could potentially begin to be implemented.
2) We then presented our final set of suggestions to the community, which were based their needs, desires, and concerns for their community. We presented on site-specif interventions and then finished with home solutions, flood insurance information, an reminder to attendees about the benefits and potential aid offered by the River Star Homes program offered by the Elizabeth River Project.
    a) During the Ingleside Rd portion of the presentation, we suggested the creatic an entrance to the community, featuring a welcome sign, painted storm drain bioswales, and tree trenches. The community remained positive about the welcome sign and liked the idea of decorating storm drains, as long as the p was long-lasting and there was a maintenance plan. The main concerns fron citizens were whether or not bioswales would actually help mitigate flooding issues closer to the shoreline in the neighborhood, what strategies could be implemented to help solve the problems of flooding and debris on the streets adjacent to Ingleside Rd, and how these strategies would be maintained. Th issues were resolved with the clarification of bioswales capabilities, the explanation that these green infrastructure tools could eventually be impleme on other roads as needed, and the explanation that when the designers com to build these intervention styles, they also create a maintenance plan.
    b) Townsend Place was the next site we discussed. The community remained interested in the solutions we presented, which included raising the road, bu out the corner lot to create an open area for water storage, and implementing emergency route to Fontaine Avenue with a pervious pavement. They also v accepting of the idea of a living shoreline in this area.
    c) Our suggestions for Kentucky Avenue — especially the living shoreline and installations including native plantings — were also received well by the community. Several community members were unclear about the details of c suggestion to beautify the road with plants, as they felt the area had sufficient tree cover. However, they indicated that they were not necessarily opposed to additional plantings in the area.
    d) When we began to talk about our suggestions for a park and public access point at the end of Westminster Avenue, a couple who lived across from the proposed location opposed this suggestion, citing concerns about traffic, pollution, and personal safety. The same couple currently own the house and parcel that we suggested the city acquire to create the park. However, other community members stated that they felt a park, if executed well, would increase the safety and maintenance of the parcel. At the end of the meeting, it was unclear whether the creation of a park at the end of Westminster would be possible. However, the current owners of the property and the rest of the community were receptive to implementing a living shoreline in the area.
    e) To conclude the presentation, we detailed the role of River Star Homes in implementing various resilience strategies on private property and referred them to further information about flood insurance.
3) Following the presentation, members of the team spoke with the couple who lives at the end of Westminster Avenue about the possibility of creating a conservation easement on the property as an alternative to a public park with water access. This would allow the property to remain privately owned, but still be a site of coastal resilience and stormwater mitigation strategies to benefit the community as a whole. The couple indicated interest in this possibility, as they would still be able to manage access to the land and would not need to rely on city maintenance to keep the area safe.

Point of Further Research:

Based on the final set of feedback we received from the community, there are some slight alterations to be made in our final product. We will explain that our intervention suggestions were site specific based on areas of concern the community had previously highlighted, but many of the solutions presented can be implemented in multiple areas. We will also have to investigate Norfolk's preliminary research regarding a city-wide adopt-a-drain program and programs emphasizing "right tree in the right place" interventions to improve our suggestions.

The negative feedback regarding the proposed park at the end of Westminster Ave will be discussed in our final paper. While we do not want to implement a solution that the community is not in favor of, we think it would be valuable to address the major concerns about safety and maintenance in our discussion of the park in such a way that a compromise could be

Appendix 12. April 22nd Meeting Description

Summary of Survey Results

Survey Total: 21 Respondents

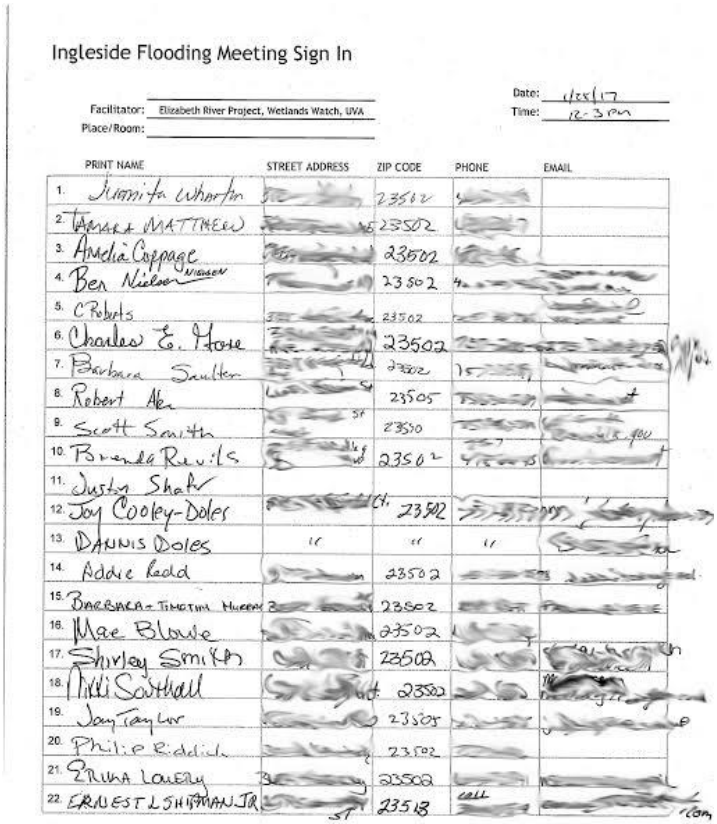
Demographics:

- Median Age: 60
- Median Time Living in Community: 17 years
- 95% of respondents own their homes
- 53% of respondents have flood insurance
- 24% of respondents have made flood insurance claims
- Respondents have had to change their commute on an average of 2.5 times over the past year with a maximum of 10 times.
- 67% of respondents have noticed changes in flooding frequency and severity over the past 5 years

Publicly Observed Points of Interest

- Most incidences of flooding reported at: the end of Westminster Ave., Jasmine Ave., the intersection of Ingleside Rd. and Garfield Ave., Townsend Pl. and Ct.
- Most incidences of stormwater backup reported at: end of Westminster Ave., Jasmine Ave., Brennan Ave.
- Most incidences of sewage overflow reported at: Brennan Ave.
- Respondents believe Broad Creek pollution comes from: BAE Shipyards, Concrete Plant, Industrial Park, Homes, Cars, Litter, Commercial Businesses
- Respondents do not think the City of Norfolk has adequately updated infrastructure in the neighborhood to deal with flooding and storm surges
- Respondents want to preserve: a sense of community pride, diversity, trees, homes, wildlife, tightknit community, walkability, public transportation, safety, attractiveness
- Respondents want to change: lack of public access to Broad Creek, poor drainage, better sidewalk system, better Recreation Center, more ways to get into and out of Ingleside
- Respondents see opportunities for solutions as: living shorelines, park at the end of Westminster Ave., boat ramp at public access point, rain garden, plant trees that produce little leaf debris, rain barrels, better relationship with the City of Norfolk

Appendix 13. Summary of January 28th Survey Results



Ingleside Flooding Meeting Sign In

Facilitator: Elizabeth River Project, Wetlands Watch, UVA
Place/Room:
Date: 1/28/17
Time: 12-3pm

	PRINT NAME	STREET ADDRESS	ZIP CODE	PHONE	EMAIL
1.	Jumita Wharton		23502		
2.	TAMARA MATTHEW		23502		
3.	Amelia Coppage		23502		
4.	Ben Nielsen		23502		
5.	C Roberts		23502		
6.	Charles E. Hose		23502		
7.	Barbara Sadler		23502		
8.	Robert Ak		23505		
9.	Scott Smith		23510		
10.	Brenda Revels		23502		
11.	Justin Shaw				
12.	Joy Cooley-Doles		23502		
13.	DANNIS DOLES	"	"	"	
14.	Addie Redd		23502		
15.	BARBARA + TIMOTHY HUFFM		23502		
16.	Mae Blount		23502		
17.	Shirley Smith		23502		
18.	Nikki Southall		23502		
19.	Jay Taylor		23502		
20.	Philip Riddick		23502		
21.	ERUHA LOVERY		23502		
22.	ERNEST L SHIPMAN JR		23518		

Appendix 14. List of attendees at January 28th meeting

Appendix 15. Poster created by the UVa team describing the coastal resilience project

Complete Survey Responses - Ingleside Community Meeting 1/28/17

Survey 1.
-Likes that the neighborhood is very established and she has good neighbors, but wishes the recreation center was better and there was more to do
-Only engages with Broad Creek/Elizabeth River when she seems them while driving
-Notices flooding at Jasmine Ave., Corner of Riverside, Ingleside, and Garfield Ave.
-City of Norfolk has not done anything about flooding/serious infrastructure issues
-Believes Broad Creek pollution is coming from industrial areas around the Campostella Bridge and Chesterfield Heights
-Preserve? A Sense of pride in the city, diversity.
-Change? Recreation center, front of neighborhood improvement (Scott St. corridor)
-Solutions? Renovating the recreation center, upgrading landscape with rain garden

Survey 2.
-Likes the tree-lined streets and yard size in Ingleside
-Dislikes the water gathering after/during storms
-Intersections with no drainage flood most
-Broad Creek pollution comes from watershed, shipyards, homes
-Preserve? The trees, their home
-Change? Better street drainage
-Solutions? Clean the streets of leaves and debris, clean drains out regularly, city should install and maintain drains

Survey 3.
-Likes? Proximity to water, friendly neighbors, wildlife
-Dislikes? Mosquitos, rising water levels
-Noticed high high tides this past year as compared to 2012. The end of Westminster Ave. has experienced more standing water after rain as well
-End of Westminster Ave. floods frequently
-Homeowners take care of and create community infrastructure, not the city of Norfolk
-See stormwater backing up at the end of Westminster Ave.
-Pollution in Broad Creek comes from BAE shipyards, concrete factory
-Preserve? Wildlife, close community
-Change? "We would love a boat ramp to be put in and a living shoreline at the end of Westminster so the community can spend time together. This would also alleviate flooding at the end of our street. And less mosquitos!"
-Solutions? Maybe an area to put a bat sanctuary in the neighborhood to eat more of the bugs.

Survey 4.
-Likes? Wonderful community, close to the light rail, river views
-Dislikes? Mosquitos
-Tides are much higher now than when they moved away in 2012
-The end of Westminster Ave. floods badly
-Stormwater backs up at the end of Westminster.
-Pollution comes from commercial businesses along Broad Creek, litter from cars
-Preserve? Sense of community, nature

Survey 11.
- Pier + shed were damaged after hurricane Isabel + flood insurance was claiming that HOA(?) should pay for it, both travelers. In the end, had to get small business loan to pay for it.
- Unaware of low water quality level + somewhat surprised b/c brown water.
- Bought house in 2000 + they first said they don't need flood insurance @ at closing they said they needed minimum (Assuming closing as in closing deal on buying house). When first flood came, traveler's(insurance?) charged extra b/c it wasn't enough + then they paid for most of the damage. They won't pay for anything except for the house flood insurance almost as expensive as mortgage.
- Charge extra for the garage b/c it's not on crawl space, patio is the same.
- When flooding occurs water level rises to knee high.
- Preserve?: "Older neighborhood so ppl die + architects build multiple houses on 1 lot. 1 house per lot rather than crowding the lot" prefers suburban lifestyle. Keeps the houses as they are to preserve the community.

Survey 12.
No real comments

Survey 13.
- Preserve?: "Historic Trees"
- Change?: "Improved recreation center and a park with access to the water. Another exit out so that it is not one way in and one way out (Assuming they're talking about Jasmine st."
- Solutions?: "Homeowners can stop trash being thrown on the side of the road and onto interstate. Less talk, more action!"

Survey 14.
- Change?: "Recreation center, park area"
- Solutions?: More rain gardens, trash receptacles

Survey 15.
- Change?: "More drainage"
- Solutions?: "Have area survey during/after rain session"

Survey 16.
- No real comments

Survey 17.
- Dislikes "little yappy dogs" (LOL)
- "Water collects in backyard + takes awhile to drain after storm event"
- Preserve?: "Road access to parts"
- Change?: "Water abatement off of Ingleside rd"
- Solutions?: "on **Nottaway St/ Jersey Ave**, city installed a clean out manhole- collected water goes in on side of Jersey to other side out down Nottaway St. down to swamp area/ previously it would be clogged and not drain for several days"

Survey 18.
- Preserve?: "Sense of community."
- Change?: "More community access to Broad Creek. Nice community Park near railroad tracks"
- Solutions?: "City official taking better interest in Ingleside"

-Change? More sidewalks, better maintenance of shared spaces

Survey 5.
No additional comments

Survey 6.
-Likes? Great people, quiet, large trees and old homes
-Dislikes? Litter and lack of sidewalks
-Flooding at the end of Westminster, south end of Ingleside, the turn onto Jasmine
-Stormwater backing up at Jasmine, and end of Westminster
-Pollution coming from litter, BAE yards, downtown, concrete plant
-Preserve? Attractiveness, walkability, public transportation, safety
-Change? Fix the end of Westminster
-Solutions? Build a living shoreline at the end of Westminster

Survey 7.
-Flooding at Garfield and Ingleside Rd.
-Wants to see more parking space and an improved Rec Center

Survey 8.
-Likes? Nature, wooded area, relatively crime free, lots of space between houses
-Dislikes? Exposed Jersey wall (possibly put living garden on the wall), occasional flooding due to blocked storm drains
-Noticed driveway flooding, city of Norfolk was slow to respond
-Stormwater backs up from rain
-Preserve? Wooded area by Moseley Creek
-Change? Drainage
-Solutions? Rain garden in unused area, living shoreline, sewage problem ruined their vegetable garden, plant trees with low leaf debris so they don't block storm drains or break up the sidewalk

Survey 9.
-Likes? Quiet, nature, good neighbors
-Dislikes? Apt. complex at beginning of the neighborhood is aging
-Flooding in south end
-Stormwater backing up on Brennan
-Sewage overflowing at Brennan and Wedgefield and Ingleside
-Pollution coming from yards, historic pollution, roads
-Change? Living shorelines, nature park at the end of Westminster Ave. (property is for sale)
-Solutions? Living shorelines, rain barrels

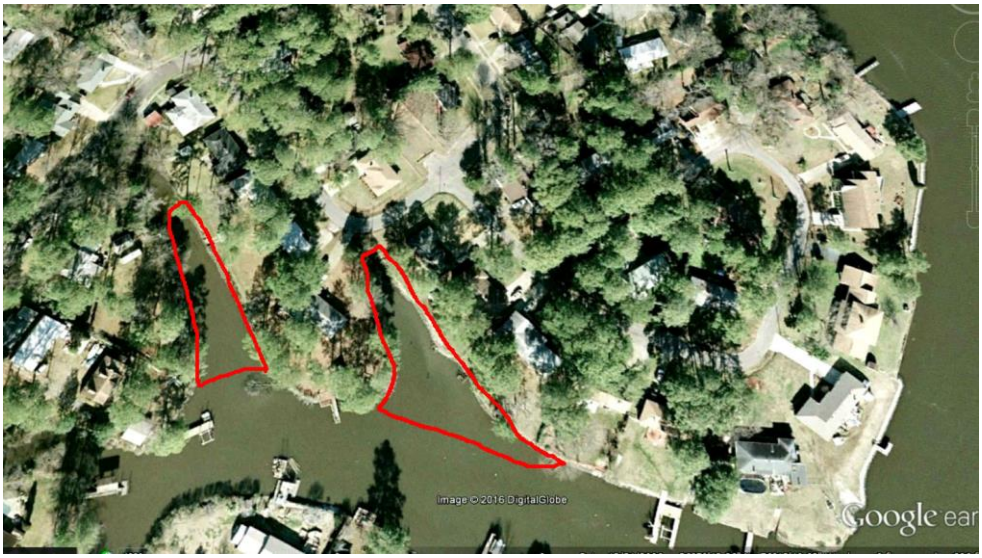
Survey 10.
-Likes? View and location
-Dislikes? Flooding and how dirty the water gets
-Townsend place at the curve floods frequently
-City of Norfolk is not helpful, he needs a second way in and out of his home
-Pollution coming from industrial park or waterfront homeowners
-Change? A second way out of his area (Fountain, Easton Ave., Townson Place, Townson Court.)

Survey 19.
- "Don't think the [flood insurance] premiums are fairly priced
- Preserve?: "Trail along water" (Did not provide location)
- Change?: " Trail along water"

Survey 20.
- "Met with City planner in Department who wrote letter to grandfather us in relation to payment of flood insurance."
- Preserve?: "preserve Property"
- Change?: "Flooding, water quality"

Survey 21.
- Dislikes: "Flooding, decreasing diversity among neighbors, people in neighborhood burning trash"
- Preserve?: "Diversity/inclusion"
- Change?: "Better drainage"
- Solutions?: "Drainage Ditches"

Appendix 16. Survey Results from January 28th meeting



Appendix 17. Fontaine Avenue tributary site January 2007.

Appendix 18. Fontaine Avenue tributary site September 2011.

Appendix 19. Fontaine Avenue tributary site April 2014.

Appendix 20. Living Shoreline Information – Westminster Ave.

Appendix 21. Living Shoreline Information – Low vs. High Tide at Westminster Ave.

Appendix 22. Living Shoreline Information – Proposed Sites

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Implementing Living shorelines on Kentucky Ave, Norfolk Air

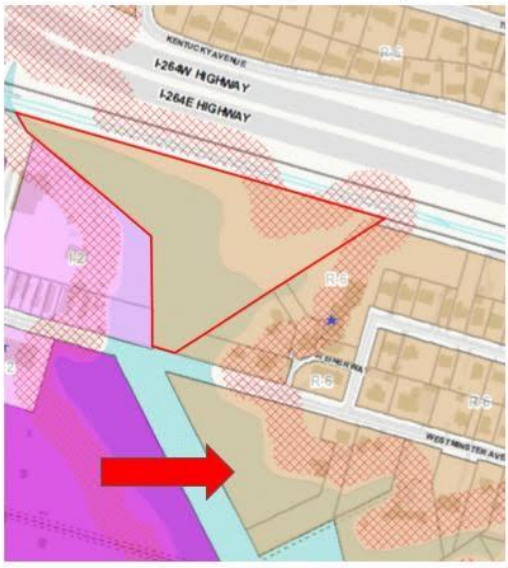
-We assume that the private residences in the Yellow can use
-River Star Homes to introduce living shorelines
Should we assume that the State can fund living shorelines in the checkered area?

Private Residence = Yellow
Chesapeake Bay Protected Area (CBPA) = Red pattern

Appendix 23. Living Shoreline Information – Kentucky Ave.

Implementing Living shorelines on Kentucky Ave, Norfolk Air

- Red Triangle = City owned
- All other plots are privately owned
- Triangle Property *Arrow Could be purchased by city of park/shoreline



Appendix 24. Living Shoreline Information – Proposed City Purchase on Kentucky Ave.