EARTHJUSTICE

October 26, 2022

Sent via email

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Re: Complaint under Title VI of the Civil Rights Act of 1964, 42 U.S.C. § 2000d, Regarding Civil Rights Violations by the City of Corpus Christi for the Siting of the Inner Harbor Desalination Plant in the Hillcrest Neighborhood

Dear Regional Director Lewis, Acting Director Hoang, and Deputy Chief Neal,

On behalf of the Hillcrest Residents Association and Citizens Alliance for Fairness and Progress, we file this complaint under Title VI of the Civil Rights Act of 1964 and its implementing regulations ("Title VI"). For the reasons stated below, we request that the United States Department of Housing and Urban Development ("HUD") and the United States Environmental Protection Agency ("EPA") investigate whether the City of Corpus Christi ("the City") is in compliance with Title VI based on the City's decision to locate a new industrial facility – the Inner Harbor desalination plant – in the Hillcrest neighborhood. The City's ongoing actions to site the Inner Harbor desalination plant in the historically African American Hillcrest neighborhood violate Title VI because they have the purpose and effect of subjecting the Hillcrest community to discrimination.

We further request that the Civil Rights Division of the United States Department of Justice ("DOJ") play a coordinating and oversight role to ensure "the consistent and effective implementation of Title VI across the federal government."[1]

I. Introduction

The City of Corpus Christi is in violation of Title VI by choosing to site its planned Inner Harbor desalination plant in the historically African American Hillcrest neighborhood. Hillcrest is an environmental justice community in Corpus Christi, Texas, right across the fence line from an area known as "Refinery Row," which houses a dense concentration of refineries. The construction and operational impacts of the City's Inner Harbor desalination plant would exacerbate the existing disproportionate health and safety harms from decades of industrialization, isolation, and pollution in this predominately African American and Hispanic neighborhood.

The City's desalination plant would pull in seawater from the Inner Harbor ship channel through an intake pipe to the plant, which would remove salts through a reverse osmosis process to make potable water.[2] The plant would discharge highly saline brine (concentrated salts) back into the ship channel and Corpus Christi Bay through a discharge pipe.[3] The Inner Harbor desalination plant would be located in the Northwest corner of the Hillcrest neighborhood, within blocks of residents' homes and neighborhood parks such as the historic Dr. H.J. Williams Park (see Figures 1 & 2, below).

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[1] DOJ, Title VI Legal Manual, at Section III (Updated Feb. 3, 2021) (hereinafter "DOJ Title VI Legal Manual"), https://www.justice.gov/crt/fcs/T6manual5#:~:text=Under%20Title%20VI%2C%20a%20private,to%20contract%20with%20a%20recipient.

[2] *See* City of Corpus Christi, TCEQ Industrial Wastewater Permit Application (Jan. 17, 2020), https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf.

[3] *See id.;* Section VI.B.1.i. *infra.*

Figure 1, Map showing satellite image of proposed desalination plant site[4]

[4] City of Corpus Christi, file number 220920 (May 24, 2022) (follow "4. Inner Harbor Plant Site Map" link), https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=5653980&GUID=4D8E17BC-0EDE-4409-A5AA-ADC47CBD01F9.

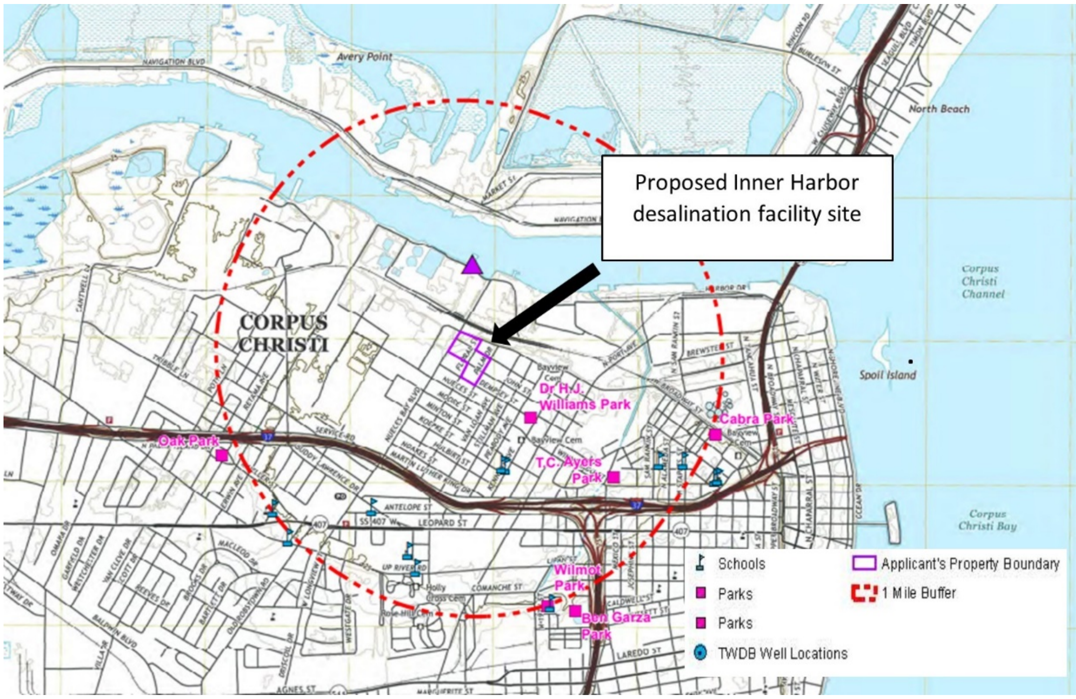

Figure 2, Map showing proposed Inner Harbor desalination facility site (purple outline) in the Hillcrest neighborhood along the Northside of Corpus Christi with the pipe discharge site (purple triangle), neighborhood parks, schools and a 1-mile buffer[5]

II. Complainants

The **Hillcrest Residents Association ("HRA")** is an advocacy group comprised of Hillcrest residents and their allies. HRA's membership mirrors the population it serves, which is predominantly African American and Hispanic. HRA works to protect public health, safety, the environment, and the quality of life for all residents of the Hillcrest neighborhood and the immediately surrounding area, and to combat community deterioration. Additionally, HRA aims to help Hillcrest residents expand economic and educational opportunities and to obtain safe and affordable housing.

The **Citizens Alliance for Fairness and Progress ("the Alliance")** is a community advocacy group of residents from the Hillcrest and Washington-Coles neighborhoods along Refinery Row in Corpus Christi, Texas. It was founded out of concern for the deteriorating conditions in the neighborhoods resulting from heavy industry.

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[5] City of Corpus Christi, TCEQ Industrial Wastewater Permit Application, Attachment C (Jan. 17, 2020), https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf .

Both HRA and the Alliance have a long history of fighting for the rights of Hillcrest residents and against the encroachment of industrial development in their neighborhood, including filing two successful Title VI civil rights complaints.[6] In 2007, HRA filed a Title VI complaint against the City for discrimination in the siting of a new sewage treatment facility and in 2015, Hillcrest residents and the Alliance filed another Title VI complaint against the Texas Department of Transportation ("TxDOT") for discrimination in siting the new Harbor Bridge. Now, HRA and the Alliance are concerned about the City's actions to site the new Inner Harbor desalination plant in Hillcrest because if built, it will exacerbate the harms created by the ongoing targeted industrialization of their neighborhood.

III. Jurisdiction

Federal civil rights laws apply to recipients of federal financial assistance like the City.[7] Title VI provides that "[n]o person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."[8] Once an entity receives federal financial assistance, jurisdiction under Title VI attaches.[9] As discussed below, the City is a "program or activity" that receives federal funding from the HUD and EPA and is therefore required to abide by Title VI.

A. Program or Activity

A "program or activity" is defined as "all of the operations of . . . a department, agency, special purpose district, or other instrumentality of a State or of a local government . . . any part of which is extended Federal financial assistance."[10] An entire local government is considered a "program or activity" that may be liable under Title VI

[6] *See* Section IV.D. *infra*; Complaint under Title VI of the Civil Rights Act of 1964 by Hillcrest Residents Association vs. City of Corpus Christi (April 5, 2007), available at https://www.epa.gov/sites/production/files/2015-02/documents/04r-07-r6_complaint_redacted.pdf, attached as **Exhibit 1**; Complaint Under Title VI of the Civil Rights Act of 1964 on behalf of residents of the Hillcrest neighborhood vs. Texas Dept. of Transp. (Mar. 15, 2015), attached as **Exhibit 2**.

[7] EPA, U.S. EPA's External Civil Rights Compliance Office
Compliance Toolkit (Jan. 18, 2017), https://www.epa.gov/sites/production/files/2020-02/documents/toolkit_ecrco_chapter_1-letter-faqs_2017.01.18.pdf.

[8] 42 U.S.C. § 2000d.

[9] DOJ Title VI Legal Manual, at Section V.

[10] 42 U.S.C. § 2000d-4a.

"if it is partially responsible for the discriminatory conduct, is contractually obligated to comply with Title VI, or has a responsibility to monitor subrecipients."[11]

B. Federal Funding

Funding either directly or indirectly from a federal agency through federal grants, cooperative agreements and loans are clear examples of Title VI-covered federal financial assistance.[12] The City is subject to Title VI compliance because it receives direct and indirect federal grants and loans from HUD and EPA. The following examples of federal funding from HUD and EPA fall within the scope of Title VI:

HUD has awarded $4.2 million in federal grants to the City for a home investment partnership program from September 20, 2021 to September 30, 2030.[13]

In January 2022, the Texas Water Development Board ("TWDB") approved $4.751 million in financial assistance from the Texas Clean Water Act State Revolving Fund to the City to address the flooding of Oso Creek through stormwater system improvements.[14] The TWDB funds for these stormwater improvements came from EPA,[15] making the City an indirect recipient of federal funding.

C. Timeliness

Title VI complaints are considered to be timely when the complaint has been filed within 180 calendar days of the date of the last alleged act of discrimination or if the complainant alleges a "continuing policy or practice" of discrimination.[16] A complaint alleging a continuing discriminatory policy or practice must "allege facts that are sufficient to indicate either a series of related acts of which one occurred within the

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[11] DOJ Title VI Legal Manual, at Section V.E.2.

[12] *Id.* at Section V.C.1.a. ("An entity may receive grant money directly from an agency or indirectly through another entity. In either case, the direct recipient as well as the secondary or subrecipient are considered to have received federal funds.").

[13] USA Spending, Grant Summary: Home Investment Partnership Program Grant from HUD to City of Corpus Christi, https://www.usaspending.gov/award/ASST_NON_M21-MP480502_8620 (last visited Oct. 13, 2022).

[14] Hinojosa, *City of Corpus Christi to Receive $4.751 Million from the Clean Water State Revolving Fund* (Jan. 6, 2022), https://senate.texas.gov/press.php?id=20-20220106a.

[15] Personal communication with Mireya Loewe, South Region Manager, Texas Water Development Board (phone, July 2022) (confirming that City of Corpus Christi is a recipient of EPA funding from the TWDB for floodwater mitigation).

[16] *See* 40 C.F.R. § 7.120(b)(2); *see also* EPA, *Case Resolution Manual*, at 8 (Jan. 2021), https://www.epa.gov/sites/default/files/2021-01/documents/2021.1.5_final_case_resolution_manual_.pdf.

180-day filing period or a systematic policy or practice that operated within the 180-day period."[17]

The City's discriminatory conduct consists of continuing policies and practices, including actions within the past 180 days. Since at least 2020, the City has enacted policies and taken actions to move forward with the Inner Harbor desalination plant, including applying for required permits and securing state loans to fund its construction.[18] Examples of the City's recent actions within the past 180 days include:

1. On May 10, 2022, the City authorized the City Manager, Peter Zanoni, to proceed with preparation of the purchase documents for the property for the Inner Harbor desalination plant in the Hillcrest neighborhood.[19] The City will pay $300,000 for 3 years in exchange for an option to purchase the property for over 5 million dollars.[20]
2. On May 23, 2022, the City Manager met with officers of the Hillcrest Residents Association and the Citizens Alliance for Fairness and Progress at the Brooks AME Worship Center in Hillcrest to discuss the desalination plant. Mr. Zanoni confirmed that the City was proceeding with locating the desalination facility in Hillcrest instead of any alternative sites the City had considered. The City staff provided a detailed map of the site location, including the location of a new power substation, all to be located in the Hillcrest neighborhood.

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[17] *Id*.

[18] *See* City of Corpus Christi, TCEQ Industrial Wastewater Permit Application (Jan. 17, 2020), https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf; City of Corpus Christi, TCEQ Water Rights Permit Application (Jan. 17, 2020), available at https://www.desal.cctexas.com/_files/ugd/d9f0ec_ed0c427f1a514adf9ddcdc4dd459ff11.pdf; *see generally* City of Corpus Christi, *City Council Gives Final Approval on Loan Program for Seawater Desalination Project*, October 20, 2020, available at https://news.cctexas.com/news/city-council-gives-final-approval-on-loan-program-for-seawater-desalination-project.

[19] City of Corpus Christi, Motion to authorize preparation of final contract documents for the purchase of approximately 12.5 acres of property and 11 acres of easements from Flint Hills Resources Corpus Christi, LLC and related entities in the vicinity of Nueces Bay Boulevard, Broadway Street, and the Inner Harbor for a seawater desalination plant in an amount of $5,455,000, which will include an option period of 3 years and potential additional option time to allow for permitting and prerequisites related to a development agreement pursuant to Texas Local Government Code Chapter 212, a right to repurchase in the event of termination of the project, and requirements related to insurance, soil management, environmental sampling, and limits on use of the property, File number 22-0765, (May 10, 2022), https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=5561252&GUID=C28B3E7E-FA10-4D73-A7E2-3F16FEC2CE2B.

[20] *Id*.

3. On May 24, 2022, the City Council passed a motion authorizing a professional services contract with American Electric Power, Texas, to provide preliminary engineering and regulatory work associated with interconnection of the City's Inner Harbor desalination plant to the Texas electric transmission grid.[21]
4. On July 19, 2022, the City Manager invited the Chief Operating Officer for Water Utilities, Michael Murphy, to discuss water supply project updates at a City Council meeting.[22] Mr. Murphy gave an update on the desalination process and stated that the City's legal team is reviewing the Inner Harbor land purchase agreement.[23]
5. On September 6, 2022, the City Council approved an ordinance adopting the Corpus Christi Fiscal Year 2022-2023 Capital Budget.[24] As proposed, the budget included a projected $220,736,326 in funding for seawater desalination for fiscal years 2023 to 2025.[25] Notably, the only site location named in the proposed budget is the Inner Harbor seawater desalination plant.[26]
6. On October 10, 2022, the City received a water rights permit from the Texas Commission on Environmental Quality ("TCEQ") for the Inner Harbor Desalination Plant.[27] HRA requested a contested case hearing on several

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[21] City of Corpus Christi, Motion authorizing a professional services contract with American Electric Power, Texas, to provide preliminary engineering and regulatory work associated with interconnection of the City's Inner Harbor Seawater desalination plant to the Electric Reliability Council of Texas electric transmission grid in an amount not to exceed $100,000.00, located in Council District 1, with FY 2022 funding available from State Water Implementation Fund Texas Loan-2020, file number 220920(May 10, 2022) (follow "Action details" link), https://corpuschristi.granicus.com/player/clip/1648?view_id=2&meta_id=331985&redirect=true.

[22] City of Corpus Christi, Drought Response and Water Supply Project Updates, at 12:00 (July 19, 2022) (City Manager's Comments and Update on City Operations), https://corpuschristi.granicus.com/player/clip/1665?view_id=2&redirect=true.

[23] *Id.*

[24] City of Corpus Christi, Ordinance adopting the Corpus Christi Fiscal Year 2022-2023 Capital Budget in the amount of $628,234,271, file number 22-1472 (Sept. 6, 2022) ("passed on second reading as amended"), https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=5769320&GUID=389B46D3-2554-4042-8001-DEA8CC3B6898.

[25] City of Corpus Christi, Proposed Capital Budget, at 318 (July 26, 2022), https://www.cctexas.com/sites/default/files/FY-2022-2023-Proposed-Capital-Budget.pdf.

[26] *Id*. at 321.

[27] TCEQ Water Use Permit No. WRPERM 13676, issued to the City of Corpus Christi on October 10, 2022, available at https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=984460112022285&doc_name=OrderPermit%202020%2D1559%2DWR%2Epdf&requesttimeout=5000; *see* City of Corpus

> deficiencies in the permit and raised civil rights and environmental concerns,[28] but the City argued that HRA's members, including HRA President Rev. Henry Williams who lives blocks from the proposed plant, did not have standing to challenge the permit because their interests "are common to members of the general public."[29] TCEQ agreed with the City and issued the permit, despite HRA's request for a hearing. The City also has a pending application for a wastewater discharge permit for the Inner Harbor location before TCEQ.[30]

The City has chosen to take steps to move forward with the purchase of the property in the Hillcrest neighborhood for the proposed Inner Harbor desalination plant despite a clear history of discrimination by the City and other governmental entities in the Hillcrest neighborhood and vocal opposition to this proposed location from Hillcrest residents and faith leaders. These ongoing actions reveal the City's prioritization of industrial development in the Hillcrest community that will exacerbate existing disparate harms based on race. The City's decision to move forward with the Inner Harbor location threatens the health, safety and well-being of the Hillcrest community and its ongoing actions to site this facility constitute a continuing violation of Title VI.

D. Other Jurisdictional and Prudential Concerns

This complaint satisfies all other jurisdictional and prudential considerations laid out in Title VI and its implementing regulations. This complaint is in writing, describes

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Christi, Press Release: *Project Milestone: City of Corpus Christi Awarded Water Rights Permit for Seawater Desalination* (October 5, 2022), https://news.cctexas.com/news/releases-20221005.

[28] Hillcrest Resident Association, Comments and Hearing Request regarding Application of City of Corpus Christi for Water Rights Permit No. 13676 (March 18, 2021), available at https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=172689672021077&doc_name=2021%2E03%2E18%20HRA%20Public%20Comment%20and%20Hearing%20Request%2Epdf; *see also* Hillcrest Residents Association, Reply to Responses to Hearing Requests (Sept. 26, 2022) (TCEQ Docket No. 2020-1559-WR, Water Use Permit No. WRPERM 13676), available at https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=964586062022269.

[29] City of Corpus Christi, Applicant's Response to Hearing Requests, at 15-17 (Sept. 12, 2022) (TCEQ Docket No. 2020-1559-WR, Water Use Permit No. WRPERM 13676), available at https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=628477112022255.

[30] City of Corpus Christi, TCEQ Industrial Wastewater Permit Application (Jan. 17, 2020), https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf.

the alleged discriminatory acts and the entity that performed them, and is filed with the associated agencies by Earthjustice on behalf of HRA and the Alliance in response to the City's Title VI violations.[31]

IV. Factual Background

A. Segregation and Isolation of Hillcrest

The historically African American community of Hillcrest makes up one neighborhood in what is commonly known as the Northside neighborhoods of Corpus Christi (see Figure 3, below).

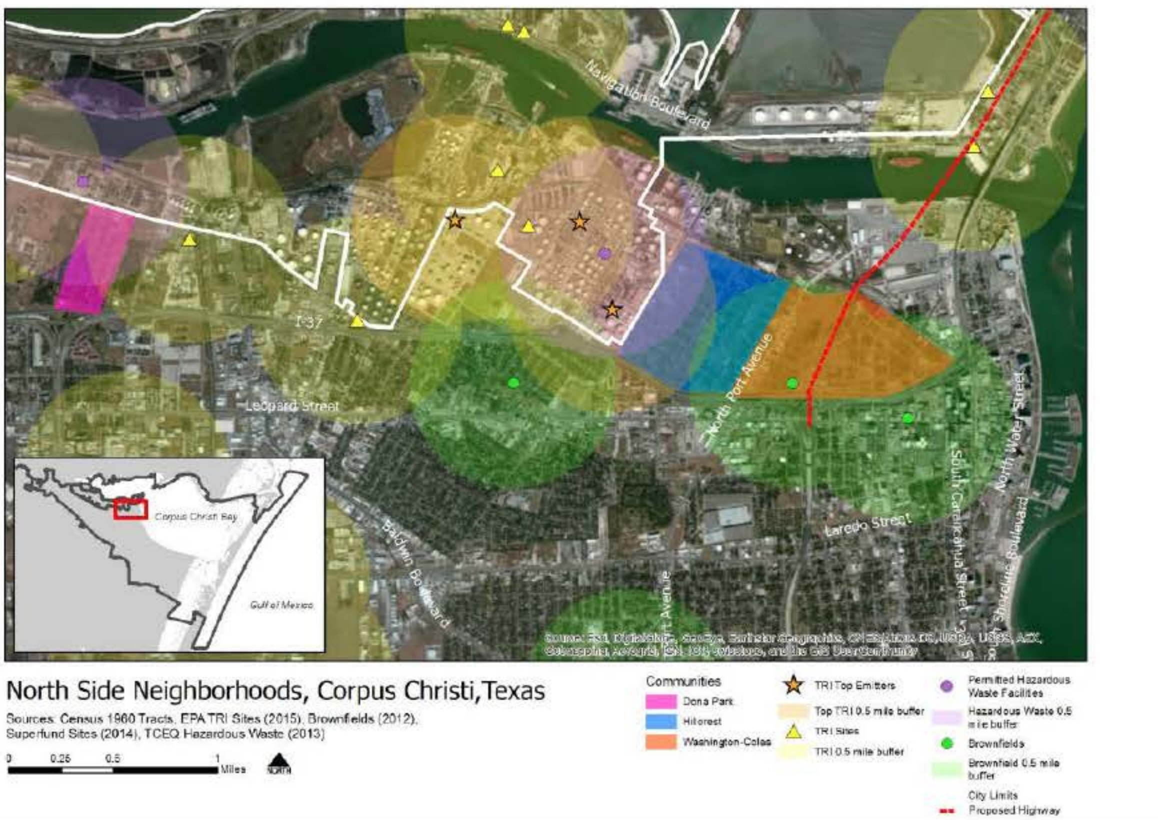

Figure 3, showing locations of Hillcrest (in blue), Washington Coles (in orange), and other Northside neighborhoods with surrounding industrial sources[32]

Over two generations, the City enforced policies of racial segregation that required all African Americans who lived within Corpus Christi city limits to live in the Northside neighborhoods, while also targeting the area for industrial development.

[31] 40 C.F.R. § 7.120(a), (b).

[32] Melissa Morgan Beeler, *The Effect of Local Planning Actions on Environmental Injustice: Corpus Christi's Refinery Row Neighborhoods*, at 13 (2015), attached as **Exhibit 3**.

These policies have resulted in dire health outcomes for Hillcrest residents, who suffer from disproportionately high incidences of cancers, asthmas, and birth defects.[33] During the Jim Crow era, the City's Planning and Zoning Commission imposed zoning restrictions on African Americans. These racist zoning restrictions limited African Americans to the Northside after oil was discovered there and as oil refineries began to cluster in the area along the port, in what is now known as "Refinery Row." In the 1930s and 1940s, the Washington Coles neighborhood housed the majority of the City's African American population and until 1944, it was the only place where African Americans could legally reside within Corpus Christi.[34] Originally, the picturesque neighborhood of Hillcrest was for Whites only until about a decade after the first refineries arrived in the Port of Corpus Christi.[35] In 1944, once the refineries had established themselves in the area, the City began to allow African Americans to move to Hillcrest.[36] By 1948, African American residents were legally permitted to buy homes in Hillcrest.[37] White flight from the community accelerated in the 1950s, when Anglo residents of Hillcrest moved into newer neighborhoods like Oak Park.[38] The following decades saw that trend continue, with a marked shift from predominantly White to predominantly African American and Hispanic populations in the Hillcrest neighborhood.[39]

Since desegregation and White flight changed the demographic landscape of the community, Hillcrest has been continually sequestered by a sea of pollution sources that now include refineries, the ship channel to its north, Highway I-37 to its south, and the lengthy ongoing construction of the new Harbor Bridge to its east. Interstate Highway I-37 was built during the 1960s, further entrenching the racial barrier that the City had cultivated between Hillcrest and the City's White population. In a contentious process that would unfortunately be familiar to Hillcrest residents today, City officials

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[33] *See* ATSDR, Corpus Christi Refinery Row Brochure (Aug. 2016), https://www.atsdr.cdc.gov/HAC/pha/CorpusChristi/Brochure_Fact_Sheet_508.pdf.

[34] *See* **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 6; TxDOT, Northside History Project Report, at 98, 102 (2017), https://texashistory.unt.edu/ark:/67531/metapth1310487/m2/1/high_res_d/Northside_History_Project_Report.pdf.

[35] FHWA, US 181 Harbor Bridge Project Final Environmental Impact Statement, at 3-64 (Nov. 2014) (hereinafter "Harbor Bridge FEIS"), https://ccharborbridgeproject.files.wordpress.com/2012/02/eis-document-_us-181-harbor-bridge-final-eis-section-3-0-affected-environment1.pdf.

[36] *Id.*

[37] *Id.*

[38] *Id.*

[39] *Id.*

made statements showing that they viewed the Hillcrest community as little more than an opportunity for industrial growth. One City official stated that the "route would swing to the north adjacent to oil tank farms and would be a natural divider between industrial areas and Westside residences."[40] While the City chose to avoid other residential areas, many homes in Hillcrest were demolished to make way for I-37, isolating the neighborhood from the commercial and residential corridor to its south.[41] A report commissioned by TxDOT indicated that the construction of I-37 "in the early 1960s displaced some Northside residences as well as the businesses (many operated by African Americans)[.]"[42] The encroachment from I-37 also divided parts of the existing community, creating a barrier between the south side of the neighborhood, cutting it off from the remainder of the community which was barricaded between the new interstate and the port/industrial corridor.[43]

The African American population in Hillcrest increased from less than a quarter in 1960, to three quarters by 1970. From 1985 to 1998, nearby refineries focused buy-out efforts in the community, purchasing at least 500 homes.[44] In the 1980s, Hillcrest residents brought a lawsuit against nearby refineries, seeking to address ground water and air contamination, decreasing property values, and health concerns. The landowners and refineries eventually arrived at a settlement. As a result, about 100 homes were demolished in 1998, clearing the way to create an L-shaped buffer zone, adding a few blocks of separation between the neighborhood and the growing industrial corridor now known as Refinery Row.[45]

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[40] Cliff Hawthorne, *Year's Delay Seen if 37 is Rerouted,* Corpus Christi Caller Times, Nov. 18, 1958, at 1, 18, attached as **Exhibit 4**.

[41] Harbor Bridge FEIS, at 3-64, 65.

[42] TxDOT, Northside History Project Report, at 20 (2017), https://texashistory.unt.edu/ark:/67531/metapth1310487/m2/1/high_res_d/Northside_History_Project_Report.pdf.

[43] Jessica Savage, *Corpus Christi library director hopes to rebuild trust in historic Northside neighborhoods*, CORPUS CHRISTI CALLER TIMES, May 6, 2012 ("The neighborhood changed when the [1-37] highway construction began .... 'That changed the neighborhood really forever. It was almost destined to be industrial.' ... Homes in the interstate's path were moved and demolished as the state highway department bought between 500 and 600 parcels of property."), available at http://www.caller.com/news/corpus-christi-library-director-hopes-to-rebuild.

[44] Harbor Bridge FEIS, at 3-65.

[45] *Id*.

B. Increased Industrialization in Hillcrest

The City's land use decisions have resulted in the increased encroachment of industry into the Hillcrest community, as illustrated by examples like the City's siting of sewage facilities, including the Broadway wastewater plant in the adjacent Washington-Coles neighborhood. In the 1930s, with miles of vacant land surrounding Corpus Christi, the City chose to construct its sewage plant in Washington Coles.[46] As early as the 1950s, "a storage tank facility owned by General American Tank Transportation Corporation was sited between Hillcrest and Washington-Coles," further increasing the industrialization of the community.[47]

In 1981, the City further cemented the industrialization of Hillcrest when it established the first industrial district agreement for the area.[48] By 1995, the Broadway Sewage Treatment Plant, was the source of virtually unmitigated foul odors and ongoing violations of environmental standards.[49] In response to complaints from residents, the City commissioned a study, which concluded that the City could save thousands of dollars and reduce the overall number of sewage treatment facilities by closing the Broadway plant and diverting that waste to another treatment facility.[50]

In 1997, after the City Council voted to shut down the plant and to follow the diversion plan recommended by the study, the City promised Hillcrest residents it would close the aging treatment plant by 2001.[51] The City later reversed course and decided, without any community involvement or notice, to maintain operation of the Broadway plant in Washington-Coles and to move ahead with plans for a new sewage plant located in the Hillcrest neighborhood.[52] Before announcing its decisions to keep the old plant open in the adjacent neighborhood and to site a new plant in Hillcrest, the City demolished 200 units of housing that had been provided by the U.S. Department of Housing and Urban Development (HUD), and it also closed all schools in the area.[53] As a result, the Northside, which used to be the densest residential neighborhoods in Corpus Christi, suffered a 30 percent population decrease by 2007.[54]

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[46] **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 6.
[47] **Exhibit 3**, Beeler, at 30.
[48] *Id*. at 33.
[49] **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 7.
[50] *Id*.
[51] *Id*. at 7-8.
[52] *Id*. at 8-9.
[53] *Id*. at 2.
[54] *Id*.

The City's plan to site a new sewage treatment plant in the neighborhood was only thwarted by concerted community efforts, during which the HRA filed an administrative complaint under Title VI of the Civil Rights Act against the City for discrimination in the siting of the sewage treatment facility "in the context of a long history of racist land use decisions affecting African Americans and the Northside and Hillcrest neighborhoods."[55]

In 2007, a federal judge found that the nearby Citgo refinery violated the Clean Air Act by illegally operating two uncovered tanks that contained oil and toxic chemicals including benzene. Benzene is a potent carcinogen, and one of the most dangerous pollutants released by refineries and petrochemical plants.[56] That same refinery was the subject of a then-recent study, which found that it was among 13 facilities that exceeded the EPA's "action level" in 2020 for average annual benzene emissions.[57]

The continued encroachment of the industrial corridor into the community has meant that Hillcrest residents have endured a litany of environmental assaults over the years, including explosions, releases of toxic chemicals, fires, flaring, and violations of environmental law that were so flagrant they resulted in the criminal prosecution by the U.S. government of companies, such as the Citgo example cited above.[58] Over the years, these refinery accidents have become common occurrences that residents refuse to accept. Nor do residents acquiesce to the daily impacts of living near the industrial corridor. These impacts include loud noises and sirens, bright lights around the clock, including light from industrial flaring and vibrations that shake their homes.[59] In 2017, just blocks away from the Hillcrest community, a chemical leak resulted in potential contamination of the City's water supply, with residents unable to use water for days.[60]

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[55] **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 4.; *see* Section IV.D. *infra*.

[56] Environmental Integrity Project, *Environmental Justice and Refinery Pollution*, at 9 (Apr. 2021), https://environmentalintegrity.org/wp-content/uploads/2021/04/Benzene-report-4.28.21.pdf

[57] *Id.* at 5.

[58] **Exhibit 2**, Hillcrest Residents v. TxDOT Title VI Complaint, at 4-5.

[59] *Id*. at 5.

[60] David Switzer & Manuel Teodoro, The Color of Drinking Water: Class, Race, Ethnicity, and Safe Drinking Water Act Compliance, 109:9 Journal AWWA 40, 41 (2017), available at https://mannyteodoro.com/wp-content/uploads/2014/03/SwitzerTeodoro-JAWWA-2017-Color-of-Drinking-Water.pdf; Derek Hawkins, *Corpus Christi's tap water off limits after chemical leak. Schools, restaurants close.*, THE WASHINGTON POST, Dec. 16, 2016, available at https://www.washingtonpost.com/news/morning-mix/wp/2016/12/16/corpus-christi-residents-told-to-avoid-tap-water-after-chemical-leak/.

This was not an isolated incident, as the City has been responsible for several violations of the Safe Drinking Water Act.[61]

C. City Plans in Hillcrest: False Promises & Disinvestment

Concerted land use planning efforts and failures to follow through with promised reinvestments by the City have caused and contributed to the increased industrialization in Hillcrest. In 1999, as part of a planning effort, the City released policy statements focused on creating a buffer zone around the neighborhood where only light industrial activity would be allowed.[62] The City later revised the plan, moving instead to rezone the area as commercial with a two-block strip to the north and west of the neighborhood, but this plan was not adopted either.[63] In 2003, another amendment to the plan for the area encouraged a transition from residential housing to a research and technology park.[64] That plan also called for the relocation of the Broadway wastewater treatment plant, which had caused violations of environmental standards and blanketed the community with foul odors.[65]

In 2008, the City prepared the second phase of a redevelopment plan for the Northside, which included a series of improvements in Hillcrest.[66] Many residents of the community engaged with the process by attending a series of workshop sessions, where they shared their visions of redevelopment for Hillcrest.[67] This redevelopment plan first acknowledged that "[t]he area has been in a slow state of decline, cut off from the rest of the city by freeways, and encroachment of industrial uses from the north and west."[68] The plan also acknowledged that "Hillcrest is an isolated neighborhood, and it has been easy for the rest of the city to ignore it."[69] The plan went on to summarize input from the Hillcrest community, which expressed that "[r]evitalizing the Hillcrest neighborhood was an almost universal goal. This involved obvious tasks of improving the existing housing stock and infilling vacant lots with compatible new units, improving parks, and cemeteries, and re-occupying the school."[70] Despite years of

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[61] Switzer & Teodoro, *supra* note 60, at 41.
[62] Harbor Bridge FEIS, at 3-65.
[63] *Id.* at 3-65, 66.
[64] *Id.* at 3-66.
[65] *Id.*; *see also* **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 8.
[66] City of Corpus Christi, Hillcrest and Washington Coles Areas Redevelopment Plan, at 1 (Nov. 15, 2008), attached as **Exhibit 5**.
[67] *Id.*
[68] *Id*.
[69] *Id*. at 3.
[70] *Id*. at 2.

consulting with the community on these much-needed improvements, the City abandoned the plans for redevelopment and revitalization, in a whiplash inducing change-of-course that has become familiar to Hillcrest residents. This familiar pattern reemerged when the City introduced its Central Business Development Plan in 2013, which proposed improvements for Hillcrest, only to abandon those improvements with the 2015 introduction of Plan CC, Comprehensive Plan 2035, as discussed in further detail below.

In May 2013, the City adopted its Central Business Development Plan, which if implemented, could have reinvigorated the Hillcrest neighborhood.[71] Notably though, the City failed to include any representatives from Hillcrest in the list of individuals and organizations that it consulted with to develop the plan.[72] The City's stated purpose in the Plan was to use measurable strategies "reasonable enough to be accomplished within a period of five years from the date of adoption."[73] The plan called for the addition of significant green spaces and parks, increased medium density housing, and commercial development in the area as an added buffer between residents and industrial facilities.[74] Furthermore, the plan called for significant investments in the Hillcrest community that could have changed course from the City's history of targeted industrialization and neglect. This plan included amenities such as "a neighborhood commercial and restaurant establishment corridor to provide more dining opportunities for the Washington-Coles and Hillcrest residential areas," and a community garden program with "[p]riority for establishment of community gardens [] given to the Hillcrest and Washington-Coles neighborhoods."[75] In addition, the plan called for the City to address the issue of blighted and vacant lots, mobilizing a special code enforcement team to actively seek out "developers and builders to develop these areas as affordable housing and senior-living developments."[76]

Despite the bright outlook projected for Hillcrest by the City's Central Business Development Plan, the City again completely reversed course in 2015 when it introduced Plan CC Comprehensive Plan 2035, a guidance document for long-term

[71] City of Corpus Christi, Central Business Development Plan at i (May 21, 2013), attached as **Exhibit 6**.
[72] *Id*. at iii.
[73] *Id.* at 1.
[74] *See id*. at 4, 8 (analysis derived from comparison of Figure 2. Current Land uses, at 4, and Figure 3. Central Business Development Plant – Proposed Future Land Use Map at 8).
[75] *Id*. at 9.
[76] *Id*. at 15.

physical and economic development of the City.[77] The plan targeted Hillcrest as an "I-37 transition district," recommending that residents move out of the area entirely and be replaced by industrial facilities.[78] As initially introduced, Plan CC called for the removal and relocation of Hillcrest residents to an undisclosed location over an undisclosed period of time.[79]

Plan CC cited to the close proximity of "oil refineries and other industrial establishments," before noting that residents "have long been concerned about environmental pollution and contamination and have been losing population."[80] Plan CC used the results of the City's own neglect and its increased industrialization of the Hillcrest community to justify the relocation of Hillcrest residents, stating that all "residential uses should leave this area and the designated land use should become light industrial or a buffer use (offices, supporting uses) within a heavy industrial district."[81] Despite calling for Hillcrest residents' relocation, the City failed to consult with residents of the community before introducing this element of the plan. After intense pushback from residents who showed up at council meetings to voice their concern, the recommended relocation was removed from Plan CC before its final approval. Despite making this concession, the City's actions have continued to create a de facto industrial transition district through ongoing neglect and land use decisions that continue to industrialize the community.

Indicators of the City's disinvestment are impossible for to residents to ignore: vacant and blighted properties remain unkept, sewage is often backed up, abandoned buildings are occupied by the unhoused, historic cemeteries go uncared for, semis and construction trucks swarm through the residential streets, inadequate police patrols and street lighting compromise safety, and streets and storm water drains go unmaintained, leading to flooding problems.[82] The City has acknowledged many of these issues over the years in its various planning documents, yet it has failed to redress the dire concerns

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[77] City of Corpus Christi, Draft Ordinance 15-1111 - Plan CC (2015), attached as **Exhibit 7**, available at https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=2477736&GUID=8C2403EF-4C46-4AE4-A42A-9A3FFB9B19F5 (follow "2. Draft Ordinance - Plan CC" link).
[78] *Id*. at 37.
[79] *Id*.
[80] *Id*.
[81] *Id*.
[82] Hillcrest Residents Association, Hillcrest PowerPoint Presentation (June 17, 2022) (hereinafter "Hillcrest PowerPoint Presentation"), attached as **Exhibit 8**.

from the Hillcrest community.[83] Some of these issues illustrate the inconsistent implementation of City's Code of Ordinances in Hillcrest. For example, residents of Hillcrest seeking to make improvements on their homes and land have had their applications consistently rejected, while the City continues to greenlight industrial development in their community.[84] Hillcrest residents have experienced the effects of decades of neglect and disinvestment from the City, while watching industry expand ever-closer to their homes.

D. History of Title VI Complaints and Violations in Hillcrest

1. The Broadway Sewage Treatment Plant Title VI Complaint

As described above, the City not only broke its promise to close down the existing sewage treatment plant on the Northside, but in 2006, it also planned to site a *new* Broadway sewage treatment plant in Hillcrest. In response, in 2007, HRA filed an administrative complaint under Title VI of the Civil Rights Act against the City for discrimination in the siting of the sewage treatment facility.[85] The complaint detailed how the sewage treatment plans perpetuated a long history of the City's "discriminatory past land uses" and "broken promise[s] to the residents of Hillcrest and Northside."[86]

Only after HRA filed the Title VI complaint with HUD and EPA, and HUD accepted the complaint for investigation, did the City agree in a settlement with HRA to withdraw its plans for this new Broadway sewage treatment facility.[87]

This history is particularly notable here, as the proposed Inner Harbor desalination plant, like the previous Broadway sewage treatment facility, would also be located in the northern part of Hillcrest on land owned by Flint Hills Resources approximately 1,000 feet from HRA President Reverend Henry Williams' home.

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[83] *See* **Exhibit 6**, Central Business Development Plan, at 14-15 (acknowledging the need to develop affordable housing in Hillcrest and Washington-Coles and to address blighted and deteriorating properties).

[84] Conversation with [redacted] founding member, Hillcrest Residents Association, (September 23, 2022).

[85] **Exhibit 1**, Hillcrest Residents Association v. City of Corpus Christi Title VI Complaint, at 1-2.

[86] *Id.* at 2.

[87] Personal communication with HRA Officers; Letter from Karen Higginbotham, Office of Civil Rights Director, EPA, to [redacted] member, Hillcrest Residents Association (Jan. 15 2009), (acknowledging settlement between the City and HRA and accepting the HRA's formal withdrawal of the Title VI complaint), https://www.epa.gov/sites/default/files/2015-02/documents/04r-07-r6_dismissal_redacted.pdf.

2. The Harbor Bridge Title VI Complaint

From 2013-2015, the Texas Department of Transportation ("TxDOT") led the environmental impact analysis and planning process for a new Harbor Bridge in Corpus Christi, including analyzing various alternative routes for the new bridge. Despite repeated objections from Hillcrest residents and civil rights groups, TxDOT ignored residents' input and chose the "Red Route" as its preferred alternative, which would completely isolate Hillcrest on the 4th side in an industrial area and bring additional pollution and noise to the already overburdened neighborhood. TxDOT omitted the entire existence of Hillcrest residents in its planning process for the new Harbor Bridge, making statements in its feasibility study that the Red Route would "serve as a barrier between the newly developed Northside people-oriented area and the Port and industrial facilities located to the west of the red alternative."[88] This ignored the over 400 Hillcrest families who lived to the west of the proposed Red Route.

TxDOT was not alone in ignoring the objections of Hillcrest residents. As early as September 2013, the City passed its own resolution recommending the Red Route as its preferred route for the Harbor Bridge.[89] Errol Summerlin, a retired legal aid attorney and member of the Citizens Alliance for Fairness and Progress working with Hillcrest residents against the Red Route, remembered a City Council presentation about the proposed route of the Harbor Bridge where "[t]he mayor didn't ask a single question, no one in the council asked a single question about how the community residents in the area were going to be affected by it. All they said was build a pretty bridge."[90] This sentiment was reiterated by City spokesperson Kim Womack in June 2015 in response to Hillcrest residents' opposition to the chosen Red Route: "We challenge the [Hillcrest] neighborhood in the area to think about all the possibilities instead of the negatives," Womack said, "because the bridge is going to be beautiful and it's going to allow for so many more things."[91]

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[88] TxDOT, Corpus Christi District, *U.S. 181 (Harbor Bridge) Feasibility Study*, at 8-8 (June 2003), available at https://ccharborbridgeproject.files.wordpress.com/2012/03/harbor-bridge-feasibility-study.pdf.

[89] City of Corpus Christi, File Number 130000775, (Sept. 10, 2013) (follow "1. Agenda Memo - Harbor Bridge" link) (resolution to recommend "Red Route" passed unanimously), https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=1469878&GUID=54209AC1-BAAE-4EDC-8473-CC3C0AEE8920&Options=&Search=.

[90] Aman Azhar, *In Corpus Christi's Hillcrest Neighborhood, Black Residents Feel Like they Are Living in a 'Sacrifice Zone,'* INSIDE CLIMATE NEWS, July 4, 2021,https://insideclimatenews.org/news/04072021/corpus-christi-texas-highway-infrastructure-justice/.

[91] Priscila Mosqueda, *A Neighborhood Apart*, TEXAS OBSERVER, June 1, 2015, https://www.texasobserver.org/txdot-threatens-to-sever-corpus-christi-neighborhood/.

In March 2015, Hillcrest residents filed another administrative complaint under Title VI of the Civil Rights Act, this time against TxDOT for the disparate impacts the Red Route of the new Harbor Bridge would cause to the Hillcrest and Washington Coles communities.[92] After the Federal Highway Administration's ("FHWA") Office of Civil Rights accepted the complaint and put the highway project on hold while it undertook a Title VI investigation, community members organized and advocated for their neighborhood, leading FWHA and TxDOT to enter into a Voluntary Resolution Agreement in December 2015, which allowed the Harbor Bridge project to move forward, but required tens of millions of dollars for community mitigation, including a voluntary relocation program for Hillcrest residents, a community advisory board, and park improvements and historical preservation in Hillcrest and Washington Coles, among other provisions.[93] At the same time, the City, the Port of Corpus Christi, the Corpus Christi Housing Authority, and TxDOT also entered into another agreement, called the "Four Party Agreement," to implement portions of the Voluntary Resolution Agreement.[94]

In January 2017, due to a dispute over the implementation of the Voluntary Resolution Agreement that caused lengthy delays in the voluntary relocation program,[95] FHWA issued a letter of finding concluding that TxDOT's selection of the Red Route for the Harbor Bridge "violates Title VI, because its location has an adverse and disparate impact on the basis of race, … [and] less discriminatory alternatives are available."[96] In February 2017, FHWA and TxDOT resolved this dispute by amending the Voluntary Resolution Agreement.[97]

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[92] **Exhibit 2**, Hillcrest Residents v. TxDOT Title VI Complaint, at 8-11.
[93] Voluntary Resolution Agreement between FHWA and TxDOT (December 2015), available at https://www.fhwa.dot.gov/civilrights/programs/docs/title_vi_compl_dec/VoluntaryResolution_Agreement.pdf.
[94] Four Party Agreement (December 2015), available at https://ccharborbridgerelocation.com/wp-content/uploads/2019/02/Four-Party-Agreement.pdf.
[95] Alexa Ura, *Texas dispute with feds leaves Corpus Christi neighborhood in housing limbo*, TEXAS TRIBUNE, Jan 25, 2017, https://www.texastribune.org/2017/01/25/dispute-over-texas-bridge-leaves-corpus-christi-re/.
[96] Letter from Irene Rico, Associate Administrator for Civil Rights, FHWA, to James Bass, Executive Director, Texas Department of Transportation, *Subject: Letter of Finding (LOF), DOT #2015-0124*, at 36 (January 18, 2017), available at https://www.fhwa.dot.gov/civilrights/programs/docs/title_vi_compl_dec/2015-0124.pdf.
[97] Letter from James M. Bass, Executive Director, Texas Department of Transportation, to Walter Waidelich, Jr., Acting Deputy Administrator, Federal Highway Administration, *Subject: Voluntary Resolution Agreement (VRA) of December 17, 2015 – US 181 Harbor Bridge Replacement Project in Corpus Christi, Texas* (February 1, 2017), https://www.fhwa.dot.gov/civilrights/programs/docs/title_vi_compl_dec/harborbridgeagreement.pdf.

The construction of the new Harbor Bridge along the Red Route is ongoing, and while over 250 households moved out of Hillcrest as part of the relocation program, many people remain in the neighborhood, either by choice or due to legal or technical barriers to participating in the relocation program. Unfortunately, many challenges and unexpected issues have arisen in the implementation of the Harbor Bridge Title VI agreement. [98] In particular, none of the promised parks improvements on the Northside, which the City was supposed to partner with TxDOT to complete, have been completed to date.[99]

While Hillcrest residents have been waiting to see the promised benefits of parks mitigation from the Harbor Bridge Agreement, they have suffered the burdens of increasing isolation from road closures, vacant lots and abandoned buildings, and additional daily health and safety hazards from dust, incessant noise, air pollution, and truck traffic in and around their neighborhood due to the construction of the new Harbor Bridge. The attached presentation by Hillcrest Residents Association officers and members from a meeting with City officials in May 2022 includes descriptions and pictures of these daily hazards and burdens placed on the residents of Hillcrest.[100] As one long-time resident explained, “[t]he first strike against the neighborhood was the refineries moving in next to the residential area and the plan to construct a new harbor bridge drove the last nail in the coffin.”[101]

Additionally, the construction of the new Harbor Bridge has been delayed repeatedly, subjecting Hillcrest residents to many more years of construction impacts

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[98] *See* Citizens Alliance for Fairness and Progress, *The Hillcrest Documentation Project: A Community perspective on the Hillcrest neighborhoods battle for environmental justice* (April 20, 2021), https://storymaps.arcgis.com/stories/2e7558a7cb4c4e36ac5afdc48269eed9; Harold D. Hunt and Clare Losey, *Crossing the Bridge: Lessons Learned from Hillcrest Relocation*, Texas A&M University Texas Real Estate Research Center (Mar. 6, 2020), https://www.recenter.tamu.edu/articles/tierra-grande/Crossing-the-Bridge-2262.

[99] Communications with Citizens Alliance for Fairness and Progress and HRA leaders; *see* (b)(6) Privacy, (b)(7)(C) Enf. Priva [redacted] *Forum: Hillcrest neighborhood continues to fight against erasure*, Corpus Christi Caller Times, May 7, 2021, (b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted] (“[T]hey promised to restore and enhance our parks, including a new park with a mural to preserve our heritage at the site of the now closed Washington Elementary School. But we are still waiting for these promises.”).

[100] **Exhibit 8**, Hillcrest PowerPoint Presentation, at slides 10-40.

[101] Dan Gearino, *Some Black residents of Corpus Christi feel they're living in a 'sacrifice zone',* THE DAILY NEWS, Jul. 11 2021, https://www.galvnews.com/article_e9715cf6-bc15-5c42-a803-934ab2743f99.html

and road closures than what was initially promised.[102] Furthermore, TxDOT recently issued a Notice of Default to the Harbor Bridge contractor for failure to rectify major design flaws and safety deficiencies.[103] Completion of the project is now uncertain, as TxDot has indicated that, "[d]ue to the complexity of the project and the seriousness of the issues, a timeline for resuming construction has not been determined."[104] And, if the new bridge is ever completed, the old one will be torn down, subjecting the community to what will likely be a drawn-out demolition project.[105]

E. Health Disparities and Environmental Justice Indicators in Hillcrest

EPA's Office of Resource Conservation and Recovery has acknowledged that "[t]he Hillcrest community in Corpus Christi, Texas, is an environmental justice community that sits on the fence line of an area known as 'Refinery Row,' which has the densest concentration of refineries in the nation."[106] The City's actions have not only increased industrialization in Hillcrest but have led to dire outcomes for Hillcrest residents.

A 2016 study found that residents of Corpus Christi's Refinery Row, which includes Hillcrest, suffer from disproportionately high incidences of cancers and birth defects.[107] The Study found exposure to maximum levels of benzene, hydrogen sulfide, particulate matter, and sulfur dioxide, detected in Refinery Row air "indicated levels that could potentially result in in respiratory health effects in susceptible populations like people with asthma or other related respiratory illness."[108] While elevated asthma in Refinery Row was not documented, the study noted that "[e]xposure to petroleum refinery emissions has been shown to increase adverse respiratory effects in

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[102] George Kevin Jordan, *Texas DOT halts $803M Harbor Bridge project over safety issues*, CONSTRUCTION DIVE, Aug. 30, 2022, https://www.constructiondive.com/news/texas-dot-halts-harbor-bridge-project-safety-issues/630824/#:~:text=The%20%24802.9%20million%20Harbor%20Bridge,31.

[103] TxDOT, Press release: *Notice of default issued to Harbor Bridge developer* (Aug. 16, 2022), https://www.txdot.gov/about/newsroom/local/corpus-christi/notice-of-default-issued-to-harbor-bridge-developer.html.

[104] *Id*.

[105] Dan Gearino, *Some Black residents of Corpus Christi feel they're living in a 'sacrifice zone'*, THE DAILY NEWS, Jul. 11 2021, https://www.galvnews.com/article_e9715cf6-bc15-5c42-a803-934ab2743f99.html.

[106] EPA Office of Resource Conservation and Recovery, Compendium of Key Community Engagement Practices at RCRA sites (Jan. 4, 2013), available at https://www.epa.gov/sites/default/files/2016-11/documents/cei-comp.pdf.

[107] Agency for Toxic Substances and Disease Registry, Public Health Assessment for Corpus Christi Refineries at 54-55 (Aug. 2016), available at https://www.atsdr.cdc.gov/HAC/pha/CorpusChristi/Corpus_Christi_Refinery_Row_PHA_508.pdf.

[108] *Id*. at 58.

children."[109] It went on to state that Nueces county has higher rates of asthma hospitalizations among children than Texas a as whole.[110] Finally, the study also noted that residents have expressed concerns over cancers, birth defects, respiratory illnesses, brain tumors, abdominal spasms, skin rashes, eye irritation, burning throat, miscarriages, and stress, among other health issues.[111]

The mixture of chemicals detected in Refinery Row air, including benzene, hydrogen sulfide, particulate matter, and sulfur dioxide, can lead to "temporary respiratory effects such as nose and throat irritation and shortness of breath; and neurological effects such as headaches and other effects related to odors in the community"[112] Long term exposure to the mixture of chemicals in the outdoor air of Refinery Row "increases the risk of cancer."[113] Harmful air pollution impacts to Hillcrest residents from refineries and storage tanks are compounded by the impacts of noise pollution, sirens, dust and traffic, light from industrial flares, vibrations, and foul odors.[114]

Another study from 2021 found that residents in Hillcrest have a 15 year lower life expectancy than a high-income neighborhood in Corpus Christi just 10 miles away: "a resident in [Hillcrest,] a predominantly low-income community of color can expect to live to just 70 years, compared to a resident in a predominantly high-income neighborhood who can live to 85 years."[115] The same study found that a "disproportionate burden of COVID-19 disease, death and loss" were in most cases, found in the same communities facing existing "social, economic, environmental, and health-related challenges," in particular in "low-income communities and communities of color in the Northside including Hillcrest and Washington-Coles[.]"[116] Specifically, the study highlighted that "the ZIP codes with the highest prevalence of diabetes, high

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[109] *Id*.
[110] *Id*.
[111] *Id*. at 54-55.
[112] *Id*. at 61; *see also* Agency for Toxic Substances and Disease Registry, Corpus Christi Refinery Row Brochure (Aug. 2016), available at https://www.atsdr.cdc.gov/HAC/pha/CorpusChristi/Brochure_Fact_Sheet_508.pdf.
[113] Agency for Toxic Substances and Disease Registry, Public Health Assessment for Corpus Christi Refineries, at 5 (Aug. 2016), https://www.atsdr.cdc.gov/HAC/pha/CorpusChristi/Corpus_Christi_Refinery_Row_PHA_508.pdf.
[114] *See* **Exhibit 2**, Hillcrest Residents v. TxDOT Title VI Complaint, at 4-6, 10-11.
[115] Texas Health Institute, Advancing Health Equity in Nueces Cty, Amid and Beyond the COVID-19 Pandemic, at 6 (April 2021), https://www.nuecesco.com/home/showpublisheddocument/27938/637592887627930000.
[116] *Id*. at 37.

blood pressure, coronary heart disease and obesity are predominantly Hispanic and Black communities [], impacted by a legacy of discriminatory policies of the past, and at risk for continued disadvantage in the present."[117]

EPA's EJ Screen tool supports these findings of existing disproportionate health and safety burdens in Hillcrest. Hillcrest ranks very high on numerous EJ Indexes, which consider both demographic and environmental health data, including above the 90th percentile in Texas and nationally for Traffic Proximity and Volume, RMP Proximity, Hazardous Waste Proximity and Wastewater Discharge Indicator.[118]

F. Population and Demographics of the Hillcrest Neighborhood

About 75-100 households currently live in the Hillcrest neighborhood.[119] As shown in Table 1, the Hillcrest neighborhood still has a much higher percentage African American population than the City as a whole and a higher percentage total population of people of color than the City as a whole.[120]

Ethnicity and Race	**Hillcrest (Census Tract 5)**	**City of Corpus Christi**
Non-Hispanic White	3.6%	28.8%
Black or African American	35.1%	3.9%

Table 1, Comparison of 2020: ACS 5-year estimate data for Corpus Christi and Census Tract 5.[121]

[117] *Id.* at 18.
[118] *See* EJSCREEN Report for Hillcrest (Sep. 23, 2022), attached as **Exhibit 9**.
[119] Communication with Citizens Alliance for Fairness and Progress and HRA leaders.
[120] *See* U.S. Census, Corpus Christi Tract 5, DP05 2020: ACS 5-yr estimates data profiles, https://data.census.gov/cedsci/table?g=1400000US48355000500&tid=ACSDP5Y2020.DP05 (last visited Oct. 14, 2022); U.S. Census, City of Corpus Christi, DP05 2020: ACS 5-yr estimates data profiles, https://data.census.gov/cedsci/table?q=corpus%20christi%20&tid=ACSDP5Y2020.DP05 (last visited Oct. 14, 2022). These numbers include some residents in neighborhoods just outside of Hillcrest because of the location of the census block groups. Past numbers from ACS 2014-2018 data for Hillcrest are consistent with these numbers (31% African American, 3% non-Hispanic White, 66% Hispanic/Latino). *See* EJSCREEN ACS Summary Report for Hillcrest, attached as **Exhibit 10**.
[121] *Id.*

Households in Hillcrest also have lower median incomes, higher levels of poverty, and a higher percentage of people living without healthcare coverage compared to the City as a whole.

	Hillcrest (Census Tract 5)	**City of Corpus Christi**
Health: Living without healthcare coverage	43.9%	18.6%
Income: Median household income	$41,875	$59,812
Poverty: poverty status in the past 12 months	24.3%	18.2%
Education: Bachelor's degree or higher	3.3%	24.6%

Table 2, Comparison of U.S. Census Profile for Corpus Christi and Census Tract 5.[122]

G. The City's Inner Harbor Desalination Plant

The City has proposed two locations for building and operating desalination plants in the Corpus Christi region – the Inner Harbor and La Quinta Channel.[123] Other entities in the region, such as the Port of Corpus Christi, are also pursuing other locations for desalination plants to produce water for expanding industrial development in the region.[124]

In public comments at a Port of Corpus Christi Commission meeting in May 2022 related to the Port's proposed Harbor Island desalination plant, Nueces County Judge

122 *See* U.S. Census, Corpus Christi Tract 5 U.S. Census profile, https://data.census.gov/cedsci/profile/Census_Tract_5,_Nueces_County,_Texas?g=1400000US48355000500 (last visited Oct. 14, 2022); U.S. Census, City of Corpus Christi U.S. Census profile, https://data.census.gov/cedsci/profile/Corpus_Christi_city,_Texas?g=1600000US4817000 (last visited Oct. 14, 2022).

123 *See* City of Corpus Christi, Applications and Permits, https://www.desal.cctexas.com/applications-permits.

124 *See* Coastal Alliance to Protect our Environment, *Baywater Desalination* (last visited October 22, 2022), https://capetx.com/desalination/; *see also* Coastal Alliance to Protect our Environment, *It's a Fact, Jack –It Ain't For You and Me!* (last visited October 22, 2022), https://capetx.com/its-a-fact-jack-it-aint-for-you-and-me/.

and former Port of Corpus Christi Commissioner Barbara Canales provided this statement about the City's proposed Inner Harbor desalination plant:

> [W]e have been working on water, here at the Port of Corpus Christi, for years. And we believe that science will drive the best decisions, and I can tell you, from my work with the breakwater, with the Harte Institute that ***inside that Inner Harbor is the worst place for a second desal permit.*** Because we already know that the science tells us that there is a lack of water exchange, that hypoxia and anoxia will occur, and how are we going to discuss oysters in the bay if we're going to drive salinity with no water exchange.[125]

While the City initially proposed and applied for permits for two locations, its recent actions indicate that it is now prioritizing and moving forward with the Inner Harbor site ahead of any other site. For example, the City recently moved forward to purchase land in Hillcrest for the Inner Harbor site.[126] In addition, the City has asked TCEQ to prioritize its review of the City's permit application for the Inner Harbor location over the La Quinta application.[127] The City's capital budget for fiscal years 2022-23 also allocated $220,736,326 in funding for seawater desalination for fiscal years 2023 to 2025, specifically for the Inner Harbor site, and only included an unnamed "second desalination facility" in its longer-term plans.[128]

As discussed further in Section VI., below, City council members have stated that despite the two possible desalination locations and other available alternative water

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[125] Judge Canales Comments at the Port of Corpus Christi Authority Meeting, at 15:29, May 24, 2022, https://portofcorpuschristi.granicus.com/player/clip/359?view_id=1&redirect=true&h=754251d9913095edc452804d6cb7c1a1.

[126] City of Corpus Christi, *Motion to authorize preparation of final contract documents for the purchase of approximately 12.5 acres of property and 11 acres of easements from Flint Hills Resources Corpus Christi, LLC and related entities in the vicinity of Nueces Bay Boulevard, Broadway Street, and the Inner Harbor for a seawater desalination plant in an amount of $5,455,000, which will include an option period of 3 years and potential additional option time to allow for permitting and prerequisites related to a development agreement pursuant to Texas Local Government Code Chapter 212, a right to repurchase in the event of termination of the project, and requirements related to insurance, soil management, environmental sampling, and limits on use of the property*, File number 22-0765, Action Details (2022), https://corpuschristi.legistar.com/LegislationDetail.aspx?ID=5561252&GUID=C28B3E7E-FA10-4D73-A7E2-3F16FEC2CE2B.

[127] *See* Email from Brook McGregor, TCEQ, to Esteban Ramos, City of Corpus Christi (Feb. 15, 2022) ("The City would like to request that WRPERM 13676 "Inner Harbor" water rights application be expedited from our other water rights application WRPERM 13675 "La Quinta.") (obtained by public records request), attached as **Exhibit 11**.

[128] City of Corpus Christi, Proposed Capital Budget, at 318, 321, 369 (2022-2023), https://www.cctexas.com/sites/default/files/FY-2022-2023-Proposed-Capital-Budget.pdf.

sources, they really “only ha[d] one option” and that the City had “put all our apples in one basket” – the Inner Harbor desalination location. A City spokesperson also stated that the City chose the Inner Harbor location because it would be in “an industrial area” and thus would not be located in “a neighborhood,” completely erasing the existence of the Hillcrest neighborhood.

V. Legal Background

Title VI of the Civil Rights Act of 1964 provides:

> No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.

HUD and EPA’s implementing regulations state that this prohibition applies to any program or activity receiving HUD or EPA assistance, and then list more specific discriminatory acts that are prohibited.[129] For example, EPA’s regulations prohibit recipients from choosing “a site or location of a facility that has the purpose or effect of excluding individuals from, denying them the benefits of, or subjecting them to discrimination under any program or activity to which this part applies on the grounds of race, color, or national origin or sex.”[130] HUD’s regulations prohibit “subject[ing] a person to segregation or separate treatment in any manner related to his receipt of housing, accommodations, facilities, services, financial aid, or other benefits under the program or activity.”[131]

Both HUD and EPA’s implementing regulations prohibit recipients from making decisions which have the *purpose or effect* of subjecting individuals to discrimination because of their race, color, or national origin.[132] This prohibits both intentional discrimination and disparate impacts.

A. Intentional Discrimination Claims

Intentional discrimination may be proven using direct or circumstantial evidence. Discriminatory intent may be established by direct evidence, where the evidence “if believed, proves the fact [of discriminatory intent] without inference or

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[129] 24 C.F.R. § 1.4(a), (b)(i-v) (HUD); 40 C.F.R. § 7.30, 7.35(a)(1)-(7) (EPA).
[130] 40 C.F.R. § 7.35(c); *see also* 28 C.F.R. § 42.104(b)(3) (DOJ implementing regulations).
[131] 24 C.F.R. § 1.4(b)(iii).
[132] 24 C.F.R. § 1.4(b)(2)(i); 40 C.F.R. § 7.35(c).

presumption."[133] In contrast, circumstantial evidence can include "suspicious timing, inappropriate remarks, and comparative evidence of systematically more favorable treatment toward similarly situated [individuals] not sharing the protected characteristic… ."[134]

Discriminatory purpose need not be the only motive; a violation occurs where the evidence shows that the entity adopted the challenged policy "at least in part 'because of,' not merely 'in spite of,' its adverse effects upon an identifiable group."[135] *Arlington Heights* and its progeny have set forth a non-exhaustive list of factors to apply when "[d]etermining whether invidious discriminatory purpose was a motivating factor" in the recipients challenged action, such as, statistics demonstrating "a clear pattern, unexplainable on grounds other than race;" "[t]he historical background of the decision;" "[t]he specific sequence of events leading up to the challenged decision;" the defendant's departures from "normal procedural sequence" or substantive conclusions, and the "legislative or administrative history."[136]

To demonstrate discriminatory intent using the *Arlington Heights* factors, with either direct or circumstantial evidence, the plaintiff need provide "very little such evidence ... to raise a genuine issue of fact ...; any indication of discriminatory motive ... may suffice to raise a question that can only be resolved by a fact-finder."[137] Finally, under *Arlington Heights*, the court or agency must conduct a cumulative assessment of the direct, circumstantial, and statistical evidence to determine whether the challenged action was motivated in part by invidious discriminatory purpose.[138]

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[133] *Coghlan v. Am. Seafoods Co.*, 413 F.3d 1090, 1095 (9th Cir. 2005) (citation omitted); *see also* DOJ Title VI Legal Manual, Section VI.B.1...

[134] *Loyd v. Phillips Bros., Inc.*, 25 F.3d 518, 522 (7th Cir. 1994); *accord Troupe v. May Dep't Stores Co.*, 20 F.3d 734, 736 (7th Cir. 1994); *see also* DOJ Title VI Legal Manual at Section VI.B.2.

[135] *Pers. Adm'r of Mass. v. Feeney*, 442 U.S. 256, 279 (1979).

[136] *Vill. of Arlington Heights v. Metro. Housing Dev. Corp.*, 429 U.S. 252, 266–68 (1977); *Pac. Shores Props.*, 730 F.3d at 1159 (stating that, "These factors are non-exhaustive."); 429 U.S. at 266-68; *Faith Action for Cmty. Equity v. Hawai'i*, No. Civ. 13-00450 SOM, 2015 WL 751134, at *7 (D. Haw. Feb. 23, 2015) (Title VI case citing *Pac. Shores Props., LLC v. City of Newport Beach*, 730 F.3d 1142, 1158–59 (9th Cir. 2013)); *see also Sylvia Dev. Corp. v. Calvert Cty.*, 48 F.3d 810, 819 (4th Cir. 1995) (adding to the Arlington Heights factors evidence of a "consistent pattern" of actions of decision-makers that have a much greater harm on minorities than on non- minorities).

[137] *Pac. Shores Props.*, 730 F.3d at 1159 (quoting *Schnidrig v. Columbia Mach., Inc.*, 80 F.3d 1406, 1409 (9th Cir.1996)

[138] *See Arlington Heights*, 429 U.S. at 266.

B. Disparate Impact Claims

Courts have developed analytical frameworks for assessing disparate impact claims in litigation that inform agencies Title VI investigative processes.[139] Some agencies have also established their own guidance documents to aid in the analysis for determining compliance in certain types of disparate impact cases. The three-part test established by courts and the DOJ Title VI Manual is as follows:

> First, does the adverse effect of the policy or practice disproportionately affect members of a group identified by race, color, or national origin? Some courts refer to this first inquiry as the "**prima facie" showing**.
>
> If so, can the recipient demonstrate the existence of a **substantial legitimate justification** for the policy or practice? A violation is still established if the record shows the justification offered by the recipient was **pretextual**.
>
> Finally, is there an **alternative** that would achieve the same legitimate objective but **with less of a discriminatory effect**? If such an alternative is available to the recipient, even if the recipient establishes a justification, the policy or practice will still violate disparate impact regulations.[140]

VI. Argument

A. The City's Choice of the Inner Harbor Desalination Plant Site is Intentionally Discriminatory

The City is well aware of the history of segregation and discrimination and disparate health outcomes in the Hillcrest neighborhood, including the two successful Title VI complaints filed against the City and TxDOT in the last 15 years. Remarkably, the exact site where the City plans to locate the Inner Harbor plant was supposed to be a buffer zone to separate homes from refineries and is very close to where the City previously tried (but failed due to a Title VI complaint) to locate the City's new Broadway sewage treatment plant.[141]

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[139] DOJ Title VI Legal Manual, at Section VII.C..

[140] *Id*. (internal citations omitted).

[141] *See* Section IV.D.1. *supra*; *see also* Brendan Gibbons, *On the Texas Gulf Coast, a race to build desalination plants to serve a thirsty oil & gas industry*, OIL AND GAS WATCH (Aug. 23, 2022), https://news.oilandgaswatch.org/post/on-the-texas-coastal-bend-a-race-for-desalination-to-serve-a-thirsty-oil-gas-industry (Pastor Adam Carrington of Brooks AME Worship Center in Hillcrest and co-

Now, the City has intentionally chosen to burden the Hillcrest community yet again by placing a new industrial plant and its associated harms in Hillcrest for the benefit of industry and the City. This historical background of siting industrial facilities in the Hillcrest neighborhood along with the undisputed racial disparities between Hillcrest and the City demonstrates "a clear pattern, unexplainable on grounds other than race."[142]

On March 18, 2021, at a public meeting for a draft water permit for the Inner Harbor facility, in response to a question about what the City considers when evaluating the proposed Inner Harbor facility, a City official explained, "the proposed location for this is an industrial area, and so it's not going to be … downtown or you know along ocean drive, *or in a neighborhood*, it's in an industrial area so that was important in deciding [the Inner Harbor] just because having a plant over there is not going to interrupt people."[143] The City official repeated this rationale later in the public meeting, stating, "Like I said earlier . . . since this an industrial area, that was part of the reason for the siting over here, to get [the desalination plant] … a little more out of the way."[144] These statements continues a long pattern of the complete erasure of the African American and Hispanic people living in the Hillcrest neighborhood by the City and other government entities during city planning, the siting of highways like the Harbor Bridge and I-37, the zoning of industrial facilities like the Broadway wastewater treatment plant, and provision of city services, as documented in Section IV, above.

Long-time Hillcrest resident and HRA officer [redacted] responded during his public comment on the water permit:

> We still live here, there are residents here. Whether there's 1, or 500, whatever the count may be there are people who are living here, and ***we resent that you call us an industrial area***. We were here long before the refineries started refining. The [industrial] area that you're speaking of is out of the City limits. The refineries … are out of the city limits, that's why they're allowed to do what they do.

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chair of the Citizens Alliance for Fairness and Progress explained, this "was supposed to be buffer zone…Now they want to put desalination here.")

142 *Arlington Heights,* 429 U.S. at 266.

143 TCEQ, public meeting on the City of Corpus Christi's water use permit application, at 49:30 (March 18, 2021) (emphasis added) (Statements made by Kevin Norton, Water Utilities Director), https://archive.org/details/2021.03.18-pm-informal-13676.

144 *Id.* at 1:02:50 (March 18, 2021) (emphasis added) (Statements made by Kevin Norton, Water Utilities Director).

That doesn't give you the right to come into our neighborhood and do what you want … that area is still residential.[145]

During a later in-person meeting with the City manager and City representative for their district in June 2022, HRA and Alliance officers stated "[w]e now know that the City considers the neighborhood as 'the inner harbor', ***as if we no longer exist***."[146]

The City official's statement at the public meeting also provides comparative evidence that the City provides "systematically more favorable treatment toward similarly situated [individuals] not sharing the protected characteristic."[147] That is, the statement makes it clear that the City would not "interrupt people" in a "neighborhood," especially not a neighborhood along Ocean Drive, by choosing to site a desalination plant near them. According to EJ Screen, in contrast to the historic African American community of Hillcrest, the area surrounding Ocean Drive only 2% African American/Black, 48% Non-Hispanic White, and 87% White.[148]

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[145] TCEQ, public meeting on the City of Corpus Christi's water use permit application, at 42:12 (March 18, 2021) (emphasis added) (Statements made by [redacted] HRA Officer) (follow "Listen to Public Meeting MP3" link), [redacted]

[146] **Exhibit 8**, Hillcrest PowerPoint Presentation, at slide 49.

[147] *Loyd v. Phillips Bros., Inc.*, 25 F.3d 518, 522 (7th Cir. 1994); *accord Troupe v. May Dep't Stores Co.*, 20 F.3d 734, 736 (7th Cir. 1994).

[148] *See* EJSCREEN ACS Summary Report for area along Ocean Drive, attached as **Exhibit 12**.

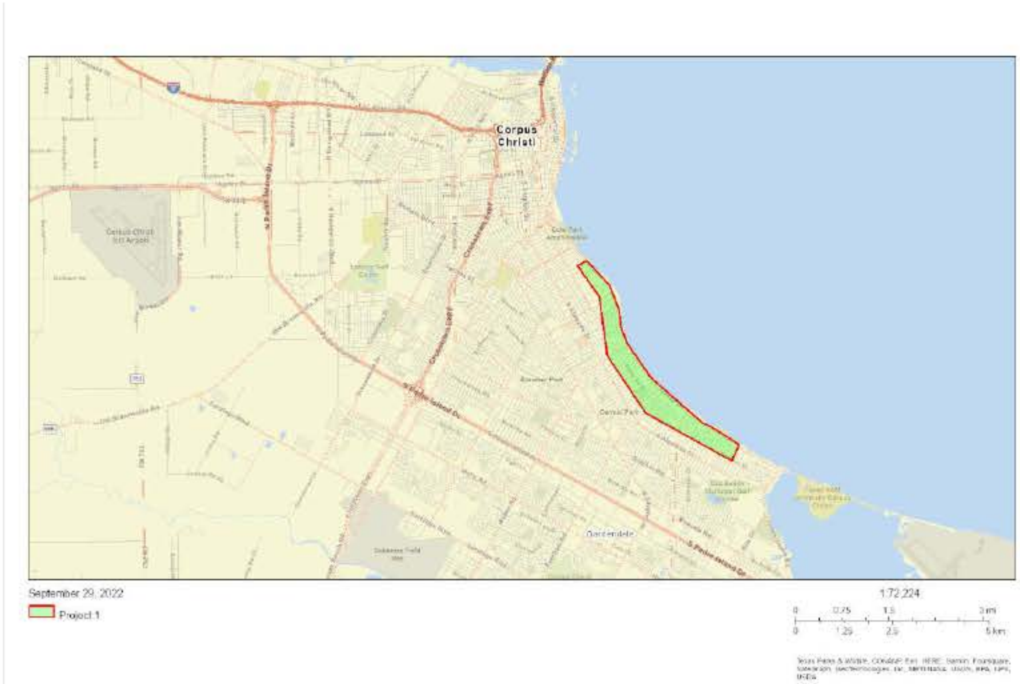

Figure 4, showing neighborhoods along Ocean Drive[149]

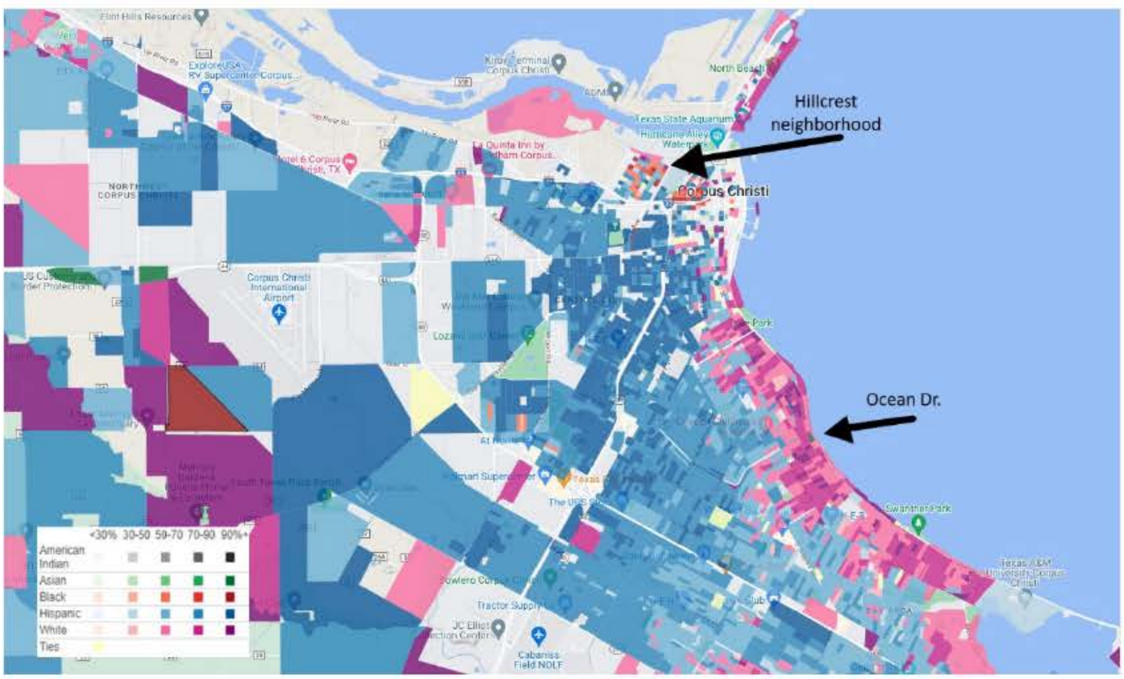

Figure 5, showing Corpus Christi demographic data[150]

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[149] *See* EJSCREEN Report (Version 2.0) for specified area along Ocean Drive, attached as **Exhibit 13**.
[150] Corpus Christi Demographic Map, compiled by Justice Map using census data from the Census Bureau's 2010 Census and the 2020 American Community Survey (5-year summary), http://www.justicemap.org/jtiny=22952.

Not only is Ocean Drive whiter and more affluent than Hillcrest, but its residents do not face the same existing levels of pollution or health risks as Hillcrest residents.

Selected EJ Indexes for:	**Hillcrest: percentile in state**	**Ocean Drive: percentile in state**	**Hillcrest: percentile in U.S.**	**Ocean Drive: percentile in U.S.**
Particulate Matter 2.5	79	42	91	64
Ozone	68	40	83	61
2017 Diesel Particulate Matter	84	41	87	61
2017 Air Toxics Cancer Risk	68	41	83	61
2017 Air Toxics Respiratory HI	74	40	86	61
Traffic Proximity	92	54	94	70
Lead Paint	94	57	94	66
Superfund Proximity	85	47	90	65
RMP Facility Proximity	97	40	99	61
Hazardous Waste Proximity	98	50	95	65
Underground Storage Tanks	93	47	92	66

Table 3, EJScreen Report comparison between Hillcrest and Ocean Drive neighborhoods[151]

Many other Hillcrest residents and officers of HRA and Citizens Alliance spoke at the March 2021 public meeting in opposition to the Inner Harbor desalination plant and HRA submitted written comments raising environmental justice and civil rights concerns.[152] [redacted] submitted supplemental comments after the public meeting stating that the City's comment:

[151] *See* **Exhibit 13,** EJSCREEN Report for specified area along Ocean Drive; **Exhibit 9,** EJSCREEN Report for Hillcrest neighborhood.

[152] *See* TCEQ Commissioners Integrated Database, All Comments on Water Rights Permit No. 13676, https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.detail&item_id=267288782020058&detail=protestants&StartRow=1&EndRow=1&Step=5&requesttimeout=5000; Comments and Hearing

reflects the on-going and historical institutional discrimination exacted upon this neighborhood by the City of Corpus Christi, and their continuing failure to acknowledge the lives, or even the presence, of the residents. This neighborhood will be disparately impacted by the location of this massive facility and that impact must be assessed before any Permit is granted.[153]

Despite these civil rights concerns and clear opposition from the Hillcrest community at the public meeting and numerous City Council meetings since, "the City made no effort to meet with the neighborhood to discuss the City's plans" either while it was examining alternatives for meeting its water needs or for over a year after the public meeting on the Inner Harbor water permit.[154] In fact, the City did not meet directly with Hillcrest community leaders until it had already chosen to move forward with the Inner Harbor location over the other alternative location for desalination.[155]

The City has demonstrated "a clear pattern, unexplainable on grounds other than race," in its targeted industrialization of the historic African American community of Hillcrest.[156] Repeatedly, residents of Hillcrest have demanded improvements for their community. The City has promised investment in the neighborhood, only to encourage industrial expansion while starving the area of much needed resources, resources that the City's own planning documents have identified would bring improvement to the area. As noted above in Section IV.C., the City's 2013 business development plan called for the City to address the issue of blighted and vacant lots through a special

Request regarding Application of City of Corpus Christi for Water Rights Permit No. 13676, submitted by Perales, Allmon & Ice, P.C. and Earthjustice on behalf of the Hillcrest Residents Association (March 18, 2021), available at https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=172689672021077&doc_name=2021%2E03%2E18%20HRA%20Public%20Comment%20and%20Hearing%20Request%2Epdf.

153 Supplemental Comments on Proposed Water Rights Permit No. 13676 by [redacted] to TCEQ (April 1, 2021), https://www14.tceq.texas.gov/epic/eCID/index.cfm?fuseaction=main.download&doc_id=903566792021091&doc_name=1%20%2D%20my%20written%20supplemental%20comments%20to%20TCEQ%2Epdf.

154 **Exhibit 8**, Hillcrest PowerPoint Presentation, slide 48.

155 *See* Section III.C. *supra* (noting that on May 10, 2022, the City Council authorized the City Manager to proceed with the purchase of the property for the Inner Harbor desalination plant, and almost two weeks later on May 23, 2022, the City Manager met with Hillcrest residents and community leaders and confirmed that the City was proceeding with locating the City's desalination facility in Hillcrest instead of the other alternative sites the City had considered.)

156 *Arlington Heights*, 429 U.S. at 266.

enforcement team and for the installation of streetlights for public safety.[157] Furthermore, that plan called for the City to "[i]nventory established residential neighborhoods (priority given to Hillcrest and Washington-Coles neighborhoods) with higher crime rates to determine whether adequate lighting and environmental design techniques are put into place to achieve a higher degree of safety, and establish a Neighborhood Watch program within the Hillcrest neighborhood."[158] However, the City abandoned this plan, never implementing it. Hillcrest residents still have inadequate street lighting, and vacant and blighted properties still crowd the community.[159]

The City also departed from "normal procedural sequence" in selecting the Inner Harbor site without serious consideration of alternative sites.[160] For example, council members made statements that indicate that while other sites were considered, the Inner Harbor site was the only serious contender. As one Council member stated/observed:

> If we're truly only looking at the Inner Harbor, and we really haven't done that much work on La Quinta or any other site, you're only boxing us in to one option . . . we got to have the other information about other true options, with detailed information about costs, viability . . . until we get that information, it's hard to spend 200 million on a project *if we only have one option*.[161]

In June 2021, the same Council member asked for an analysis to "compare apples to apples on a per 1000 gallon basis over a long period of time, not just in the initial costs."[162] However, by December 2021, the information that would have allowed a meaningful side-by-comparison had seemingly never been provided, leading that Council member to abstain from voting to approve the option to purchase the site for the Inner Harbor desalination plant. He went on to state:

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[157] *See* **Exhibit 6,** City of Corpus Christi, Central Business Development Plan.
[158] *Id*. at 21.
[159] **Exhibit 8**, Hillcrest PowerPoint Presentation.
[160] *Arlington Heights*, 429 U.S. at 266.
[161] City Council Meeting, desal update at 1:44:00 by Gil Hernandez (Oct. 19, 2021) (emphasis added), https://corpuschristi.granicus.com/player/clip/1597?view_id=2&redirect=true&h=cca6ee30c92864d60c5f816242937305.
[162] City Council Meeting, desal update at 1:21:06 by Gil Hernandez (June 29, 2021) https://corpuschristi.granicus.com/player/clip/1546?view_id=2&redirect=true&h=38ea2222cc68a3f6937263ec29eb8e26.

> I have asked on numerous occasions about alternatives, in terms of how we go about [desalination] and I have yet to get any response from City staff, it feels like I'm talking to a wall. I don't get any information whatsoever from our water department, from our city manager, from any member of staff. I feel it's disrespectful, it's uncalled for, and it should be provided to me before making a decision of this kind of magnitude. Ultimately, this is going to be a 200 million dollar decision on that we're going to put on the rate payers of our community. Because of that, I will be voting no because I have yet to receive that information. Nothing. Absolutely nothing.[163]

Instead of seeking more comparative information on the alternatives as the council member requested, the City continued solidifying its plans to site the desalination plant at the Inner Harbor location. Without this basic information about alternative options to guide its decision, the City went on to approve the option to purchase the Inner Harbor site. Another council member's statements support this conclusion:

> Everyone knows, I've always made it clear that I'm not a big supporter of the Inner Harbor site. I have some concerns, as staff brought to council's attention that they've done more work on the inner harbor, I understand that, but staff has had plenty of time to be working on both sites, to give us proper information for both sites to be able to compare apples to apples, cost to cost, and yet we've only put all our apples in one basket, which is the Inner Harbor. I think that's inexcusable, staff should've been working on both sites from the beginning, not just one . . . This has been being talked about for years, they've had plenty of time to do the research on both areas. At this point, because the Inner Harbor is in the resolution, I will be voting no.[164]

These statements lead to the inference that the Inner Harbor site was the only option given serious consideration by the City, constituting a serious departure from procedural sequence. The City's choice not to consider alternatives is more confounding

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[163] City Council Meeting, desal update at 2:53:40 by Gil Hernandez (Dec. 14, 2021) https://corpuschristi.granicus.com/player/clip/1611?view_id=2&redirect=true&h=c13679ac03e3a2701280b5905f34fd02.

[164] City Council Meeting, desal update at 2:58:35 by Billy Lerma (Dec. 14, 2021) https://corpuschristi.granicus.com/player/clip/1611?view_id=2&redirect=true&h=c13679ac03e3a2701280b5905f34fd02.

in light of its 2008 settlement of a Title VI complaint brought by HRA for the discriminatory siting of a sewage treatment facility in what would be the footprint of the proposed desalination plant. The City's decision to move forward with siting the facility in this precise location demonstrates a clear pattern of discrimination, "unexplainable on grounds other than race."[165]

B. The City's Inner Harbor Desalination Plant Will Cause Disparate Impacts Based on Race

The City of Corpus Christi has also violated Title VI and its implementing regulations because the siting of the Inner Harbor desalination plant would exacerbate existing disproportionate impacts to the health, safety, and well-being of the predominately African American and Hispanic residents of Hillcrest. In particular, this new plant would further the City's legacy of past policies, enforcement failures, and ongoing land use decisions that have allowed for the industrialization of this historically African American neighborhood.

1. Prima Facie Case

i. The Inner Harbor Desalination Plant Will Cause Adverse Impacts

The City's proposed Inner Harbor Desalination Plant would further industrialize a residential neighborhood, adding to the existing disproportionate health impacts and burdens Hillcrest residents face from decades of segregation, disinvestment, industrial expansion, and highway expansions in their neighborhood.[166] The construction impacts alone of a new major industrial plant in the neighborhood would bring even more truck traffic, noise, and dust in addition to the ongoing construction impacts from the new Harbor Bridge.

The operation of desalination plants also poses several potentially harmful impacts to the surrounding community and environment. Studies on the impacts of desalination on the local environment have found that the high-pressure pumps and turbines used in the reverse osmosis desalination process—the same process to be used in the planned Inner Harbor Desalination Plant—create a level of noise pollution such that desalination plants "should [] be located far away from populated areas or equipped with the appropriate technologies for lowering noise intensities."[167]

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[165] *Arlington Heights,* 429 U.S. at 266.

[166] *See* Section IV, *supra.*

[167] Einav et al., *The footprint of the desalination processes on the environment*, 152 Desalination 141, 145 (2003), attached as **Exhibit 15**; *see also* R. Venkatesan, *Comparison between LTTD and RO process of sea-water*

Furthermore, the City's application for its wastewater discharge permit indicates that the desalination plant will create up to 1.62 million gallons per day of "sludge," which the City intends to truck through Hillcrest to a local landfill.[168]

The Hillcrest neighborhood has already borne substantial noise and truck traffic impacts from the continued industrialization of their community, notably, from ongoing construction of the Harbor Bridge. These noise impacts will continue once construction of the Harbor Bridge is completed and highway traffic begins. Noise can cause populations that live near the source to experience various adverse health effects. While exposure to normal urban levels of noise during the night has been associated with sleep disturbances, acute exposure to noise can increase blood pressure, heart rate, and the release of stress hormones.[169] The added noise and additional truck traffic from construction and operation of the planned desalination plant will increase the burden already experienced by the Hillcrest community.

Next, the proposed desalination plant poses potential harm to groundwater and aquifers in the Hillcrest community, which are already threatened by contamination from other industrial sources.[170] Site selection and method of discharge appear to be the most important factors for determining ecological impacts from desalination.[171] Harmful impacts from desalination exist especially where the pipelines carrying brine are laid above an aquifer, creating potential for leaks and subsequent contamination.[172] Given that the Inner Harbor Desalination Plant is currently proposed to be sited

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desalination: an integrated economic, environmental and ecological framework, 106 Current Science 378, 380 (2014) (noting that desalination plants can cause noise pollution, gaseous emissions, and chemical spills) attached as **Exhibit 16**; Fahad Ameen et al., *The carbon footprint and environmental impact assessment of desalination*, 75 Int'l J. of Envtl. Stud. 45, 50 (2018) (listing potential negative impacts of desalination, including noise pollution, impact to groundwater, land use, impact on marine environment, and energy use), attached as **Exhibit 17**.

[168] City of Corpus Christi, TCEQ Industrial Wastewater Permit Application, Attachment G, available at https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf, *see also* City of Corpus Christi, Desalination Town Hall, at 1:47:08 (Dec. 16, 2021) (statements by Chief Operating Officer for Water Utilities, Michael Murphy, responding to public comments), available at youtube.com/watch?v=De8olbgjD8o.

[169] H. Ising et. al, *Health Effects Caused by Noise: Evidence in the Literature from the Past 25 Years*, NOISE HEALTH 5, 5-13 (2004), attached as **Exhibit 18**.

[170] U.S. EPA, Summary of the Groundwater Flow Directions, Hillcrest Neighborhood, Corpus Christi, Texas, at 3, (Feb. 7, 2012), attached as **Exhibit 14**.

[171] Southern California Coastal Water Research Project, Management of Brine Discharges to Coastal Waters, Recommendations of a Science Advisory Panel (2012), at 13, https://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/docs/dpr051812.pdf.

[172] **Exhibit 15**, Einav et al, *The footprint of the desalination processes on the environment*, at 152.

hundreds of meters away from the intake and discharge points, pipelines will likely be required to transfer seawater and wastewater to and from the plant.[173] These pipelines pose a further risk of contamination to the Hillcrest community's groundwater, which is already endangered by surrounding sources of industrial pollution. A 2012 study noted that groundwater contamination from neighboring industrial properties "ha[d] most likely moved into the Hillcrest neighborhood."[174]

Further, the proposed desalination plant poses a risk to recreational activities that Hillcrest residents enjoy at the closest beaches and fishing areas where the ship channel connects to Corpus Christi Bay. This risk is created by disposal of a hypersaline concentrate, also known as "brine," which is a byproduct of the seawater desalination process.[175] In addition, brine discharge may also contain chemical contaminants from the desalination process.[176] Brine discharge from desalination plants can cause sea desertification and harm the surrounding marine eco-systems. For example, in one locality that was considering implementing desalination technologies, experts estimated that with the projected brine discharge, "the fish catch would decrease by about 30%."[177] Brine discharge has been well-documented as harmful to surrounding marine biotas. The increased salinity from brine discharges may also lead to hypoxia, or depleted levels of oxygen in water, further stressing the marine eco-systems and interrupting the recreational activities that rely on them.[178] In her public comment cited above, Judge Barbara Canales underscored the potential for hypoxia at the Inner Harbor location, stating that the "Inner Harbor is the worst place for a second desal permit.

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[173] City of Corpus Christi, TCEQ Industrial Wastewater Permit Application, Attachment D (Map showing facility site in relation to proposed intake and discharge locations), available at https://www.cctexas.com/sites/default/files/desal-discharge-inner-harbor.pdf.

[174] **Exhibit 14**, EPA, Summary of the Groundwater Flow Directions in Hillcrest, at 3.

[175] NEHA, *The Permitting of Desalination Facilities: A Sustainability Perspective*, 79 J. of Envtl. Health 28, 30 (2016), attached as **Exhibit 19**; **Exhibit 17**, Fahad Ameen et al., *The carbon footprint and environmental impact assessment of desalination*, at 46-7 (describing common desalination processes).

[176] *Id*. at 49-50; *see also* **Exhibit 16**, R. Venkatesan, *Comparison between LTTD and RO process of sea-water desalination: an integrated economic, environmental and ecological framework*, at 380.

[177] *Id*. at 384.

[178] **Exhibit 19**, Brett Koontz et al., *The Permitting of Desalination Facilities: A Sustainability Perspective*, 79 J. of Envtl. Health 28, 30 (2016); *see also* Chrysi Laspidou et al., *Minimizing the Environmental Impact of Sea Brine Disposal by Coupling Desalination Plants with Solar Saltworks: A Case Study for Greece*, 2 Water 75, 83 (2010), attached as **Exhibit 20**.

Because we already know that the science tells us that there is a lack of water exchange, that hypoxia and anoxia will occur[.]"[179]

ii. The Inner Harbor Plant's Adverse Impacts are Disproportionate Based on Race

Census data shows that the Hillcrest neighborhood has a much higher percentage African American population than the City of Corpus Christi (35.1% compared to 3.9%) and a higher percentage total population of people of color than the City as a whole (96.4% compared to 71.3% non-White population).[180]

The adverse impacts of the construction and operation of the Inner Harbor facility discussed above will fall on the Hillcrest community, whereas the purported benefits of increased water supply would extend to all residents and especially to commercial/industrial users of City water.

2. Burden Shifting

The City has no substantial legitimate justification for its decision to choose the Inner Harbor site for its desalination plant, and there are several less discriminatory alternatives available.[181]

i. No Substantial Legitimate Justification

The City has publicly claimed that it needs the water from desalination to meet municipal needs for water, however, statements made by members of City Council undermine these claims that the water is needed for residential uses. One City Council member stated, "we have commitments to industry… And I don't mind saying that it is for industry."[182] He then went on to admit that after two new industrial facilities come online, 80 percent of all the City's water supply will be dedicated to industry.[183] As one

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[179] Judge Canales Comments at the Port of Corpus Christi Authority Meeting, at 15:29, May 24, 2022, https://portofcorpuschristi.granicus.com/player/clip/359?view_id=1&redirect=true&h=754251d9913095edc452804d6cb7c1a1.

[180] *See* Section IV.F. *supra* and notes 120-121.

[181] HRA and the Alliance provide this information for HUD and EPA's benefit at this time and will add any additional responses to justifications or rationales the City provides in response to this Complaint.

[182] City Council Meeting, desal update at 3:06:50 by Councilmen Roland Barrera (August 31, 2021), https://corpuschristi.granicus.com/player/clip/1583?view_id=2&redirect=true&h=c393de21d153430844b3fad6a20ab536.

[183] *Id*; see *also* Brendan Gibbons, On the Texas Gulf Coast, a race to build desalination plants to serve a thirsty oil & gas industry, OIL AND GAS WATCH (Aug. 23 2022), https://news.oilandgaswatch.org/post/on-the-texas-coastal-bend-a-race-for-desalination-to-serve-a-thirsty-oil-gas-industry. The City has cited

City Council member succinctly put it, "I always thought the notion that this water is for everyone and not for industry was somewhat misleading."[184]

In March 2017, the City committed 20 million gallons per day ("MGD") to Exxon-Sabic's new petrochemical facility, and in December of 2018, the City committed 6 MGD to Steel Dynamics.[185] Taken together, the City allotted to industry all of the new water that began flowing from the Mary Rhodes II pipeline in August 2016. As it appears poised to do here with the Inner Harbor desalination plant, the City had claimed that the Mary Rhodes II pipeline water was needed to safeguard against drought.[186]

Even if the City did provide a substantial legitimate justification for the need for an additional water supply, any explanation the City may provide to claim that it carefully considered other desalination locations and had legitimate reasons for selecting the Inner Harbor location is merely pretextual. As detailed above in Section V.A., several statements made by City officials about the site selection process and its failure to meaningfully compare alternatives, support the conclusion that the Inner Harbor site was the only option given serious consideration by the City.

ii. Less Discriminatory Alternatives Are Available to Meet Corpus Christi's Water Needs

The City also failed to meaningfully consider cheaper and less discriminatory alternatives to baywater desalination to meet any additional needs for water, ignoring years of presentations that the City Council received on alternative options. One such option is groundwater from the Evangeline/Laguna segment of the Gulf Coast Aquifer, which could have provided about 25 MGD to the City within 18-24 months, far outstripping the timeline for implementing the City's desalination plans, and at a cheaper cost than desalination.[187] The City now appears to be evaluating the Evangeline Groundwater Project, but City Councilman Gil Hernandez stated in a July 2022 news

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different and conflicting figures for the percentage of the City's water that goes to industry, but all of them are large. For instance, one City official expressed that 55 percent of the City's water goes to industry, while another claimed that the total was less than 50 percent. *Id.*

[184] City Council Meeting, desal update at 3:15:58 by Councilmen Gil Hernandez (August 31, 2021) https://corpuschristi.granicus.com/player/clip/1583?view_id=2&redirect=true&h=c393de21d153430844b3fad6a20ab536.

[185] [redacted] *Fixated on desal in the bay to the detriment of the public*, THE NEWS OF SAN PATRICIO (Aug. 10, 2022), [redacted]

[186] *Id*.

[187] *Id.; see also* Coastal Alliance to Protect our Environment, *Costs of Baywater Desalination* (last visited October 22, 2022), https://capetx.com/costs-of-seawater-desalination/.

article that city staff should have engaged with this alternative water supply option more seriously years ago:

> Evangeline had been providing the information and was asking for meetings to discuss it, but our city staff never called them back," Hernandez said. "They just ignored Evangeline with the ... myopic viewpoint of just desal and the desal in the Inner Harbor.[188]

VII. Conclusion & Relief Requested

For the reasons set forth above, the City of Corpus Christi is violating its duty under Title VI of the Civil Rights Act of 1964. Accordingly, HRA and the Alliance ask HUD and the EPA to thoroughly investigate the City's compliance with Title VI of the Civil Rights Act related to its actions to locate yet another industrial facility – the Inner Harbor Desalination Plant— in the Hillcrest neighborhood.

HRA and the Alliance request that HUD and EPA take all necessary steps to ensure that the City comes into full compliance with Title VI, including putting all further permitting and siting actions by the City in furtherance of the Inner Harbor desalination plant on hold pending a resolution of this investigation and the City's full compliance with Title VI.

Moreover, given the City's long history of discrimination in the Hillcrest neighborhood, we request that HUD and EPA require the City to develop a detailed Title VI compliance and implementation plan with regards to land uses and the City's provision of services to the Hillcrest neighborhood.

We look forward to working with HUD and EPA to ensure that all Corpus Christi residents benefit from equal protection and to prevent further harm in the Hillcrest community.

[signatures on next page]

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[188] Kathryn Cargo, *More than just desalination: City of Corpus Christi considering alternative water sources*, CORPUS CHRISTI CALLER TIMES (July 24, 2022), available at https://www.caller.com/story/news/special-reports/building-our-future/2022/07/24/corpus-christi-considering-alternative-water-sources-as-well-as-desal/65379748007/.

Sincerely,

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Attorneys for Hillcrest Residents Association and Citizens Alliance for Fairness and Progress

INDEX OF EXHIBITS

Exhibit No.	Description
1	Complaint under Title VI of the Civil Rights Act of 1964 by Hillcrest Residents Association vs. City of Corpus Christi (April 2007)
2	Complaint under Title VI of the Civil Rights Act of 1964 by residents of the Hillcrest neighborhood vs. Texas Dept. of Transp. (March 2015)
3	Melissa Beeler, Report on The Effect of Local Planning Actions on Environmental Injustice: Corpus Christi's Refinery Row Neighborhoods (2015)
4	Cliff Hawthorne, Corpus Christi Caller Article: Year's Delay Seen if 37 is Rerouted (Nov. 1958)
5	City of Corpus Christi, Hillcrest and Washington Coles Areas Redevelopment Plan (Nov. 2008)
6	City of Corpus Christi, Central Business Development Plan (2013)
7	City of Corpus Christi, Draft Ordinance 15-1111 - Plan CC (2015)
8	Hillcrest Residents Association, Hillcrest PowerPoint Presentation (2022)
9	EJSCREEN Report for Hillcrest
10	EJSCREEN ACS Summary Report for Hillcrest
11	Email from Brook McGregor, TCEQ, to Esteban Ramos, City of Corpus Christi (Feb. 15, 2022)
12	EJSCREEN ACS Summary Report for area along Ocean Drive
13	EJSCREEN Report for specified area along Ocean Drive
14	U.S. EPA, Summary of the Groundwater Flow Directions, Hillcrest Neighborhood, Corpus Christi, Texas (Feb. 7, 2012)
15	Einav, R., The Footprint of the Desalination Process on the Environment (April 25, 2002)
16	Venkatesan, R., Comparison between LTTD and RO Process of Sea-Water Desalination (Feb. 10, 2014)
17	Ameen, F., The Carbon Footprint and Environmental Impact Assessment of Desalination (2018)
18	Ising, H., Health Effects Caused by Noise: Evidence in the Literature from the Past 25 Years Research Article (Nov. 2003)
19	Koontz, B., The Permitting of Desalination Facilities: A Sustainability Perspective – NEHA Special Report (Nov. 2016)
20	Laspidou, C., Minimizing the Environmental Impact of Sea Brine Disposal by Coupling Desalination Plants with Solar Saltworks: A Case Study for Greece (Feb. 17, 2010)

EXHIBIT 1

CENTER ON RACE, POVERTY & THE ENVIRONMENT

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April 5, 2007

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OFFICE OF THE
EXECUTIVE SECRETARIAT

Steve Johnson
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Director
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To Whom It May Concern:

Enclosed please find a Title VI civil rights complaint filed on behalf of the Hillcrest Residents Association, Corpus Christi, TX.

Sincerely,

Marybelle Nzegwu

Marybelle Nzegwu

CC:

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BEFORE THE

UNITED STATES

ENVIRONMENTAL PROTECTION AGENCY

and the

UNITED STATES

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Hillcrest Residents Association Complainants, v. City of Corpus Christi, Respondents.	**COMPLAINT UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964, 42 U.S.C. § 2000d, 40 C.F.R. Part 7 and 24 C.F.R. Part 1.**

I. INTRODUCTION

This is a civil rights complaint by the Hillcrest Residents Association ("Association"), under Title VI of the Civil Rights Act of 1964 and its implementing regulations, alleging discrimination in the siting of Corpus Christi's proposed new sewage treatment facility. This complaint is against the City of Corpus Christi, which owns and operates the city's sewage treatment plants and chooses the locations of these facilities.

In 1997, Corpus Christi promised Northside residents it would close down the aging Broadway Sewage Treatment Plant by 2001 – the plant is located across the street from residents' homes, a park and a historical cemetery – and divert the sewage flows to the Greenwood Plant across town in a sparsely populated area. The City broke that promise, with discriminatory results. Not only did it not shut down the Broadway plant in 2001 – it operates to this day – in 2006, the City chose to build a *new* sewage plant in the same neighborhood.

The Northside is the City's densest residential neighborhood and is where African Americans were required to live by law under Corpus Christi's earlier segregation laws. Prior to its decision to site a new sewage treatment plant in the Northside, the City demolished 200 units of HUD housing, and closed all the schools in the neighborhood. These actions, in addition to the City's failure to shut down the Broadway plant, have resulted in a thirty-percent population decrease in the area. The discriminatory past land uses continue today in Corpus Christi's broken promise to the residents of Hillcrest and Northside.

This complaint will show all four elements required to make a prima facie case of a violation of Title VI under U.S. Environmental Protection Agency ("EPA") and Department of Housing and Urban Development's ("HUD") implementing regulations: (1) The City's action has an impact; (2) that is discriminatory on the basis of race, color or national origin; (3) caused by a recipient of federal financial assistance;[1] (4) within the statute of limitations period.[2] The City's most recent discriminatory action took place on October 10, 2006 when the City Council voted to acquire property on the Northside for the site of a new sewage treatment facility. This action will result in a substantial adverse effect on the Northside and Hillcrest neighborhoods because it will exacerbate the effects of the many other environmental stressors already operating in or near the Hillcrest and Northside neighborhoods, including the existing sewage plant. The residents will not gain the promised respite from the odor of sewage that already permeates their community. The impact of this new plant will fall primarily on the African American and Hispanic residents of these neighborhoods in violation of EPA and HUD's Title VI regulations.

II. THE COMPLAINANT

The Hillcrest Residents Association is a Texas non-profit corporation. Members are residents of the Northside and Hillcrest neighborhoods located in Corpus Christi Census

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[1] 40 C.F.R. § 7.15.

[2] 40 C.F.R. § 7.120(b)(2).

Tracts 4 and 5, north of Interstate Highway 37. Membership in the Association mirrors the demographics of the Northside and Hillcrest neighborhoods, which are predominantly African American and Hispanic.

The Association's purpose is to 1) expand job and educational opportunities available to the low and moderate income residents of the Hillcrest and Northside neighborhoods; 2) obtain affordable housing by providing decent, safe, and sanitary housing for such residents; 3) engage in activities which serve such residents' needs for community and economic development and community self-help, in order to help such residents achieve self-sufficiency; 4) undertake community economic development, neighborhood revitalization or other activities to combat community deterioration; and 5) provide and engage in other activities and services that are necessary or appropriate to carry out these purposes. The Association works with the Northside Committee, which meets regularly at the Northside Manor Apartments,[3] to help children, families, and adults develop a positive, cohesive and safe community through education, personal enrichment and other activities. The Association also holds tutoring activities, job fairs, family days at the art museum and assists in summer camp enrollment.

Henry J. Williams is the Association's president. He lives in Census Tract 5 across from a memorial park named after [redacted].[4] The proposed Flint Hills sewage plant site is located approximately 1000 feet from his residence. About two blocks from his residence in the other direction is "Refinery Row" where several oil refineries and chemical plants are located. The other officers of the Association are [redacted], Vice President; [redacted], Vice-President; [redacted], Vice President; and [redacted] Secretary.

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[3] The Northside Manor Public Housing Complex is located a mere 150 feet from the existing Broadway Sewage Treatment Plant. The plant's digesters are clearly visible from the resident's homes and the odor of sewage hangs in the air.

[4] [redacted] was instrumental in the Corpus Christi Civil Rights Movement along with [redacted] (for whom the local chapter of the NAACP is named).

III. RIPENESS

Corpus Christi most recently took discriminatory action on October 10, 2006 where the City Council determined it a public necessity to acquire by negotiation or by exercise of eminent domain a tract of land presently owned by Flint Hills Resources, LP, for the public purpose and use as a sewage treatment plant and other related sewage system purposes.[5] This complaint is timely filed under 40 C.F.R. § 7.120(b)(2) and 24 C.F.R. § 1.7(b).

IV. FINANCIAL ASSISTANCE

The City of Corpus Christi must comply with EPA and HUD's Title VI implementing regulations because the City receives substantial federal financial assistance from the EPA through the Texas Clean Water Act State Revolving Fund and from HUD through a Community Development Block Grant.[6]

V. STATEMENT OF FACTS

A. The Northside and Hillcrest Neighborhoods

The City's current action comes in the context of a long history of racist land use decisions affecting African Americans and the Northside and Hillcrest neighborhoods. The Northside and Hillcrest neighborhoods are located in Corpus Christi Census Tracts 4 and 5, north of Interstate Highway 37. These neighborhoods are historically African American. For two generations, all African Americans who lived within Corpus Christi City limits were required by law to live on the Northside. The City Planning and Zoning Commission restrictively zoned African Americans to the area after oil was discovered in the area and oil refineries began to locate in the Northside along the Corpus Christi port. Under this residential segregation by City ordinance, African Americans in Corpus Christi (except those who lived in servants' quarters) were forced to live on the Northside.

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[5] Resolution No. 027021, City of Corpus Christi, Texas, Regular Council Meeting, October 10, 2006.

[6] Corpus Christi's Budget for Fiscal Year 2006 includes a Community Development Block Grant of $771,700 and federal monies through the Clean Water Act State Revolving Fund of $7,132,000. *See* 40 C.F.R. § 7.15; 24 C.F.R. § 1.1.

Segregated HUD housing was built on the Northside. After desegregation, these units remained primarily African American but saw an influx of Hispanics and other people of color. One HUD property with 200 units and approximately 1,200 persons suffered constant flooding problems. Claiming insufficient funds to fix the deteriorating sewer lines, the City of Corpus Christi Housing Authority decided to abandon the HUD units and relocate the residents. In 1998, the 200 HUD units were demolished. This prior HUD land remains vacant and the City of Corpus Christi is the legal owner. Yet, immediately after the HUD units were demolished, the City had sufficient funds to build a new baseball stadium just outside the neighborhood. The displacement of 200 families caused a significant decline in enrollment in the neighborhood schools. Census data shows a thirty percent drop in the population of Census Tracts 4 and 5 – from 4,897 to 3,453 – between 1990 and 2000.

The Northside neighborhood was originally a vibrant community with three schools. All three have been closed. Charles W. Crossley and Booker T. Washington were closed first. The last remaining school, Solomon Coles, was closed in 2005.

The total population of the Northside (counting only the Block Groups north of Interstate 37, which are directly impacted by the City's action) is 3,032. Fifty-one percent of residents are African American, forty-two percent are Hispanic and only five percent are White. City of Corpus Christi Census 2000 population maps indicate that Census Tract 5 (including blocks south of Interstate 37) has the City's second highest population density. Census Tract 4, including the blocks south of Interstate 37, has the City's third highest population density. The Block Group in Census Tract 5 that is closest to the Flint Hills site has a total population of 1,375 with 50.3% African American, 43.9% Hispanic and 4.3% White. Census Tracts 4 and 5 have a higher percentage of minority residents than any other census tracts in Corpus Christi. These tracts also have the highest percentage of people below the poverty level.

Today, at least 16 refineries and other polluting industries are located on "Refinery

Row," the port area immediately adjacent to the Hillcrest neighborhood.[7] Many industries on Refinery Row have repeatedly violated environmental laws by releasing unauthorized emissions.[8] These violators have installed air monitoring networks which have detected high benzene levels (and the presence of other pollutants) along Refinery Row and in the Hillcrest and Northside neighborhoods.[9] Further, the neighborhood is marred by the remaining foundation slabs of the demolished public housing units, and an abandoned Regional Transit Authority maintenance yard (an entire block of solid concrete) that has remained vacant for years because it requires remediation.

B. Siting of Sewage Facilities in Corpus Christi

The Hillcrest neighborhood is located in the Northside, adjacent to the site of the proposed new sewage treatment plant. The existing plant, the Broadway Sewage Treatment Plant is also on the Northside, located adjacent to the Washington Coles neighborhood. The Broadway sewage treatment plant was first constructed in 1936 and became operational in 1938. Today, the plant serves the downtown and North Beach areas of the City. It serves a total area of over 15,000 acres. Broadway was Corpus Christi's first sewage treatment plant. It originally treated all of the City's sewage. Despite miles of vacant land around the small town of Corpus Christi, the City built the sewage plant in Census Tract 4, by law, the only area in the city where African Americans could live under the City's restrictive zoning.

The other plants owned and operated by Corpus Christi are:

<u>Oso Treatment Plant</u>: The largest of the six plants which the City owns, it serves the Southside of the City where over 50% of the population lives. Located near the Texas A&M University Campus, it was completed in 1941.

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[7] Some of these include Valero Refineries East and West, Bill Greehy Refineries East and West, Flint Hills Resources, LP Refinery, Javelina Refinery and CITGO.

[8] Suzie Canales, Citizens for Environmental Justice, *Supplemental Environmental Projects: The Most Affected Communities are not Receiving Satisfactory Benefits* (June 2006) at 3.

[9] *Id.* at 6.

Greenwood Treatment Plant: Located at the intersection of Saratoga Boulevard and Greenwood Drive. The original construction commenced in 1957 and was completed in 1959. This plant serves the International Airport and about 6,000 acres of the City's Westside. The plant sits on 90 acres of land and only 16 are being used. The area is relatively undeveloped and is located very close to the City's landfill where treated waste is presently hauled from the Broadway Plant.

Allison Treatment Plant: Serves the Northwest side of the City and is located close to the Nueces River. The plant became operational in 1966.

Laguna Madre Treatment Plant: This plant serves the Flour Bluff area and was constructed in 1971.

Whitecap Treatment Plant: Serves the North Padre Island area. Constructed in 1974.

In 1995, the Broadway plant was in disrepair and continuously violating environmental standards. There were virtually no odor controls and the stench of sewage constantly enveloped the Northside neighborhood. The aging plant was unable to handle the inflow from deteriorating sewer pipelines. The City ignored complaints by residents until 1995 when the City authorized $237,000 in improvements to the plant.

Then, in 1996 the City commissioned an engineering study to determine if the Broadway plant could be closed and the sewage transferred to another plant. The study determined that diverting to the Greenwood plant was the most feasible plan and would save the city some $900,000 a year in operation and maintenance costs by reducing the number of sewage treatment plants from 6 to 5. The initial projected cost of the diversion was $6 million. The study also considered whether a new plant should be built on the Southside because the area was expected to grow with major commercial activity and upper income residential development. The study again concluded that the City's best option would be to expand the Greenwood plant and divert additional flows there.

On March 18, 1997, the Corpus Christi City Council unanimously adopted a resolution to divert sewage flows from the Broadway plant to the Greenwood plant located in

South/Southwest Corpus Christi, in a sparsely populated area.[10] The Broadway plant would be closed by 2001. City staff were directed to implement the diversion plan without delay. On August 18, 1998, the City passed a motion authorizing the execution of a contract for engineering services for the diversion to Greenwood.

C. The City's Duplicity

In May 2000, without the City Council passing a new resolution or otherwise taking any public action, City staff began considering the option of building a new sewage treatment plant on the Northside. On November 28, 2000 City staff formally sought engineering services to provide a task list for building a new plant on the Northside.[11]

In March 2001, four years after the original Council vote to divert the Broadway sewage to Greenwood and out of the Northside, and the year the Broadway Plant was originally scheduled to be closed, air sampling of the air near the Broadway plant detected (1) mercaptans, (2) sulfur dioxide, and (3) hydrogen sulfide releases exceeding permissible odor thresholds. At that time, city staff were projecting the cost to divert the flows to Greenwood at $22 million. (The cost to build a new plant, regardless of where located, would be at least $37.5 million.) The city used funds originally planned for the diversion project to purchase equipment to disperse a mist of odor-neutralizing chemicals around the Broadway plant to reduce the offensive odors coming from the aerobic digester. The City took immediate action to neutralize odor only because a developer wanted to build an amphitheater in the immediate vicinity of the plant and did not want the smell to cut attendance and thus profits. The City did not shut down the Broadway plant as promised, but moved ahead with plans for the new sewage plant.

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[10] Corpus Christi City Council, March 18, 1997. "Motion approving the Oso/Greenwood Service Areas Sewage Facilities Implementation Plan (1997) and adopting Alternative No. 2, including the diversion of Plant flows to the Greenwood Plant, as the plan of action to provide sufficient and cost-effective treatment facilities through the year 2005."

[11] The City, however, chose *not* to build a new plant on the Southside. It has already built the force mains and lift stations and is in the process of expanding the Greenwood plant for the Southside flows.

Northside residents were not told of the City's new decision to build a new plant in their neighborhood. Council Agenda Items indicated to the public that the City was still actively in the process of considering and implementing the original plan to divert the Broadway flows to the Greenwood plant. Through the use of "Presentation Items" – public comment is not allowed on Presentation Items – that misleadingly indicated that the City was working on the Diversion project, over the course of 2001, City staff presented to the Council their recommendation that a new plant be built on the Northside.[12] The Hillcrest residents never had any indication that the City's plan had changed and were denied the opportunity to comment or participate in the decision-making process. The Council took no formal action on the staff's recommendations, but on January 29, 2002, the Council reached a consensus to allow staff to proceed with the option of constructing a new sewage treatment plant on the Northside.[13] Thus, the Council completely abandoned the diversion to the Greenwood Plant without formally vacating the March 18, 1997 action approving the diversion.

Over the next four years, the City had difficulty locating a suitable site for the new treatment plant on the Northside.

In June 2005, [redacted] President of the Hillcrest Association, was first informed by the City Manager that the City would build a new treatment plant on the Northside. The two sites under consideration were adjacent to the Hillcrest neighborhood: one owned by CITGO and the other by Flint Hills Resources, LP. The residents protested vigorously and the City consented to consider additional sites.

During the City's three-month review of other sites, 11 additional sites were considered. Of the total 13 sites under consideration, eight sites were in the Northside, in

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[12] For example: on May 15, 2001, the posted agenda identified "Presentation Item 16: Status Broadway Wastewater Treatment Plant Diversion." On September 18, 2001, "Presentation Item 25: Broadway Wastewater Treatment Plant Diversion Project." On October 30, 2001, "Consent Item 5: Motion authorizing [execution of] engineering services contracts . . . for the . . . Diversion to Greenwood/Nueces Delta."

[13] January 29, 2002, "Presentation Item 12: Update on Broadway Wastewater Treatment Plant Diversion Project."

densely populated African American and Hispanic neighborhoods. The remaining five sites were located near the Port of Corpus Christi in industrial areas with little to no population. The City did not undertake another review of the diversion to Greenwood. City staff told the Council that the January 2002 action of the Council prohibited the City from diverting the flows to Greenwood. In actuality, no formal action was taken in January 2002 and the Council could have pursued the Greenwood diversion.

The City's decision again came down to the original two sites, CITGO and Flint Hills. Backed into a difficult position, Hillcrest residents took a straw vote. Although they completely opposed a new plant anywhere in the Northside, between the two options presented, they chose the CITGO site, which is slightly farther away from the neighborhood.

Ultimately, the Corpus Christi City Council chose to build its new treatment plant on the Northside at the Flint Hills site, closest to the Hillcrest neighborhood. The October 10, 2006 vote was the next step to effectuate that discriminatory decision. Other than the Broadway sewage plant, when each of the City's five other sewage treatment plants were built, they were sited in sparsely populated areas. They were also built on sufficient land to have a significant buffer zone between the plant and future development. However, the City's decision to build a new plant in the Northside neighborhood will place the sewage plant within two of the most densely populated Census Tracts in Corpus Christi and in the heart of the city's African American neighborhood.

VI. ARGUMENT

Title VI of the Civil Rights Act of 1964 provides:

> No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance.[14]

The City of Corpus Christi, a recipient of federal financial assistance from both EPA and HUD, has violated Title VI as implemented by both EPA and HUD's regulations by its October 10, 2006 decision to site a new sewage treatment plant in the Northside and Hillcrest

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[14] Title VI of the Civil Rights Act of 1964, 42 U.S.C. § 2000d.

neighborhoods.[15] Both EPA and HUD's implementing regulations prohibit recipients from making decisions which have the *effect* of subjecting individuals to discrimination because of their race, color or national origin.[16] Corpus Christi's duty to comply with Title VI is not limited to only those programs that are funded by EPA and HUD. "Program or activity" is defined as "all the operations of" a department, agency, special purpose district or other instrumentality of a State or of a local government.[17] Corpus Christi's City Council is a program or activity under the Act and thus, all City decisions must comply with the requirements of Title VI.

EPA's regulations provide that an EPA aid recipient "shall not use criteria or methods of administering its program which have the effect of subjecting individuals to discrimination because of their race, color, national origin or sex."[18] Further, EPA regulations specifically prohibit a recipient from siting of facilities in a discriminatory manner:

> A recipient shall not choose a site or location of a facility that has the purpose or effect of excluding individuals from, denying them the benefits of, or subjecting them to discrimination under any program to which this part applies on the grounds of race, color, or national origin or sex; or with the purpose or effect of defeating or substantially impairing the accomplishment of the objectives of this part.[19]

Further, the City's October 10, 2006 decision to site a new sewage plant in the Northside violates the City's statutory and regulatory duty to administer all programs and activities related to housing and community development in a manner which affirmatively furthers fair housing.[20] The City's action exacerbates existing adverse environmental and social impacts in

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[15] EPA's regulations can be found at 40 C.F.R. Part 7. HUD's regulations are located at 24 C.F.R. Part 1.

[16] 40 C.F.R. § 7.35(b), 40 C.F.R. § 7.35(c); 24 C.F.R. § 1.4(a), 24 C.F.R. § 1.4(b)(2)(i), 24 C.F.R. § 1.4(b)(5).

[17] 42 U.S.C.§ 2000d-4a (1997).

[18] 40 C.F.R. § 7.35(b).

[19] 40 C.F.R. § 7.35(c).

[20] 42 U.S.C. § 5304 (b)(2); 24 C.F.R. § 570.601.

the Northside neighborhood and creates a substantial adverse impact on the community.

All four elements required to make a prima facie case of a Title VI violations under the implementing regulations are met here: (1) There is an impact (2) that is discriminatory (3) caused by a recipient of federal financial assistance (4) within the statute of limitations. The City's most recent action took place on October 10, 2006 when the City Council voted to acquire a parcel owned by Flint Hills Resources, LP for the site of a new sewage treatment facility. This action has a substantial adverse effect on the Northside and Hillcrest neighborhoods. Siting yet another sewage plant in the Northside will exacerbate the effects of the plants already operating in or near Hillcrest and the Northside. The impact of this new plant will fall on the African American and Hispanic residents of these neighborhoods.

A. The New Plant Will Have Significant Adverse Impacts

1. The Physical and Health Impacts are Significant.

The new plant will not have sufficient odor control. EPA studies indicate that during 34% of the year, winds come from a quadrant that ranges from due east to the northwest, bringing odor directly into the neighborhood. Further, during an additional 3% of the year, the winds are calm. Thus, for an expected 135 days out of a year, the odor of sewage will blow or waft through the Northside neighborhoods.

Sulfur dioxide emissions from the proposed plant will cause increased respiratory irritation and will exacerbate asthma. Sulfur dioxide is also a suspected cardiovascular toxicant, liver toxicant and neurotoxicant. The health impacts of these emissions combined with the existing emissions of particulate matter, benzene, toluene and 1,3 butadiene from nearby refineries will have a significant cumulative impact on the health of Northside residents.

The nearby ship channel to which the effluent will flow is a potentially threatened ecological receptor. The ship channel extends to Corpus Christi Bay. The site of the new plant is a 16.8 acre tract of land currently owned by Flint Hills Resources, LP. The site has been used for above-ground bulk storage of petroleum products since at least 1956. Five existing groundwater monitoring wells are present on the property. They were installed as part of a 1992 Agreed Order with the Texas Commission on Environmental Quality. The site is contaminated. Testing reveals that the groundwater has been impacted by the petroleum hydrocarbon constituent MTBE. At least one organic chemical of concern ("COC") was detected in each of eight soil samples taken in 2005. At least one organic COC was detected in each of six groundwater samples taken in 2005. Lead, arsenic, barium, and mercury may be present as a result of past releases. Construction activities will likely result in additional contamination being unearthed and discovered. The lateral extent of the contamination has not been tested.

The site is located at eight feet above sea level. The 100 year flood plain is at 28.7 feet above sea level. A majority of the site floods in peak weather conditions and at present a large portion of the site is covered by standing flood waters. Storm water runoff from the plant will affect the Northside neighborhoods. Further, construction on the contaminated site may pose health risks to the workers and surrounding community because of exposure to contaminated dust and groundwater. Surface flow of storm water from concrete formations may send contaminated soil into the neighborhoods, especially since the lateral extent of the contamination has not been determined.

2. The Cultural Impacts are Significant

The City's decision to build the new plant in the Northside has a significant cultural impact. Since the Broadway Plant was not shut down in 2001 as promised, the odor continually permeates the neighborhood. This has led to a further decline in population. In 2005, the lone remaining neighborhood school, a historical African American school named after Solomon Coles, the first Black educator in Corpus Christi, was closed. Property values have suffered severely. At one time, 19 predominantly African American churches were located on the Northside. Now, only a few remain but parishioners who moved away still return for Sunday service. Northside and Hillcrest residents cling to their neighborhood because of its history. Buffalo Soldiers are laid to rest here. The Civil Rights struggle was fought here. A memorial park is named after Mr. Williams' (President of the Association) father. To the residents, the City's decision to locate a new sewage plant in their neighborhood indicates that the City is willing to allow the neighborhood to simply die out, and the building of the new plant furthers that goal.

The siting of the new sewage plant is evidence of the City's disdain and neglect of the neighborhood residents' concerns. Fewer and fewer federal, state and local dollars are being spent on the residents while more money is being spent on nearby arenas and ballparks. The Broadway plant is being relocated away from those developments, but it remains in the Northside neighborhood.

B. The New Plant's Impacts are Disproportionate.

Census data shows that the areas immediately surrounding the proposed facility contain a disproportionately high number of people of color. While the total African American population of Corpus Christi is 4.67%, the African American population in the Northside neighborhood is 51.5%. Siting the sewage treatment plant *a mere 700 ft* from residences in the Hillcrest neighborhood has a disproportionate impact on the predominantly African American and Hispanic population of the Northside. The Census Tracts 4 and 5, where the existing plant is located and the new plant is proposed to be located, together comprise 12.5% of the city's African American population. No other two census tracts combined contain more than 3 - 4% of the African American population. Census Tracts 4 and 5 also have poverty rates of over 57%. No other two census tracts combined in Corpus Christi have poverty rates as great.

In addition, the Hillcrest neighborhood already bears the impact of the high number of refineries located in the area known as Refinery Row, which is immediately adjacent to the Hillcrest neighborhood. Corpus Christi was ranked number 1 in Texas for emissions of the carcinogen benzene in 2002 and 2004. The confluence of so many environmental stressors in the Northside neighborhoods increases the disproportionate impact of an additional new sewage treatment plant in the neighborhood.

C. There are Less Discriminatory Alternatives

A comparison of costs between diversion to Greenwood or a new Flint Hills site (based on data provided to the City) reveals that a Broadway diversion to Greenwood would have cost approximately $57,398,000 if constructed in 2002 while a Broadway diversion to Flint Hills today would cost $71,420,471.

Diversion to Greenwood is still feasible today. The City is already in the process of expanding Greenwood to accommodate additional sewage from the Southside. Furthermore, there are other feasible sites for a new sewage plant that are located across the ship channel and between 1 to 2 miles away from the nearest residences.

VII. REMEDIES

Under EPA and HUD regulations, EPA and HUD may use any means authorized by law to obtain compliance with Title VI.[21] EPA regulations require a recipient who has previously discriminated on the basis of race to take affirmative action to provide remedies to those who have been injured by the discrimination.[22] HUD regulations also require any recipient of HUD assistance to take affirmative action to overcome the effects of prior discriminatory conditions.[23]

In order to provide effective remedies for the discrimination set forth in this Complaint, both the EPA and HUD should require as a condition of continuing to provide federal financial assistance to the City of Corpus Christi that the City:

(1) Reverse its October 2006 decision to acquire the property currently owned by Flint Hills for the purpose of constructing a sewage treatment facility, and

(2) Consider less discriminatory alternatives for the site of its new sewage treatment facility. The City could consider alternative sites that are across the ship channel or re-adopt its original plan to divert the Broadway flows to Greenwood.

(3) Require the City to include residents of Hillcrest and the Northside in any decision-making processes that affect their neighborhood.

(4) Sue to compel compliance with the law, to the extent that imposition of the

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[21] 40 C.F.R. § 7.130(a); 24 C.F.R. § 1.8(a).

[22] 40 C.F.R. § 7.35(a)(7).

[23] 24 C.F.R. § 1.4(6)(ii).

foregoing remedies proves in any way to be ineffectual.

(5) Provide complainants with copies of all correspondence to or from Corpus Christi throughout the course of the investigation, deliberation and disposition of this Complaint.

VIII. CONCLUSION

Corpus Christi's decision of October 10, 2006 to acquire the Flint Hills property for use as a sewage treatment facility has a disparate impact on the African American and Hispanic residents of the Northside. This is a violation of EPA and HUD's Title VI regulations. As this Complaint makes clear, residents of Corpus Christi's Northside are being forced to continue to live next door to the sewage treatment plants that serve the entire downtown area.

DATE: April 5, 2007

Respectfully submitted,

HILLCREST RESIDENTS ASSOCIATION

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EXHIBIT 2

LSC

TEXAS RIOGRANDE LEGAL AID, INC.

Austin Office

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Austin, Texas 78751
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March 5, 2015

Federal Highway Administration
Office of Civil Rights
Attention: Title VI Program Coordinator
1200 New Jersey Avenue, SE
8th Floor E81-314
Washington, DC 20590
CivilRights.FHWA@dot.gov

Re: Complaint under Title VI of the Civil Rights Act of 1964

To FHWA Title Vl Program Coordinator:

On behalf of residents of the Hillcrest neighborhood, in Corpus Christi, Texas, we file this complaint under Title VI of the Civil Rights Act of 1964, 49 C.F.R. § 21.5, and the United States Department of Transportation (DOT) and Federal Highway Administration (FHWA) Title VI Handbook (collectively "Title VI").

I. Introduction

For the reasons stated below, we request that FHWA undertakes a Title VI compliance investigation into Texas Department of Transportation (TxDOT)'s compliance with its obligations pursuant to Title VI of the Civil Rights Act. In particular we ask that you review TxDOT's selection of the recommended alternative for the new Corpus Christi Harbor Bridge,[1] public participation procedures during the environmental impact analysis of the bridge, and competitive bidding process for construction of the recommended alternative. We request that FHWA take all appropriate actions to ensure TxDOT's compliance with Title VI.

TxDOT's decisions and procedures violate its duty to administer all programs and activities in a nondiscriminatory manner. These violations include both actions that have caused and will cause significant adverse impact on the basis of race, color, and ethnicity, as well as acts that constitute intentional discrimination based on these protected characteristics, which are prohibited by Title VI.

[1] For a general description of the project and information about the environmental review process, see TxDOT's Corpus Christi Harbor Bridge Project website, http://ccharborbridgeproject.com/.

Specifically, Complainants allege that TxDOT violated Title VI's prohibition on discrimination for three reasons:

1. TxDOT's selection of the recommended alternative for the new Harbor Bridge in the Final EIS and the ongoing bidding process for the design and construction of the route, without adequate consultation with and mitigation for minority residents of these neighborhoods, has had and continues to have discriminatory and significant adverse impacts on African American and Latino/a residents in Hillcrest and Washington Coles.

2. By selecting the recommended alternative without adequate consideration of minority residents' concerns, TxDOT continues to perpetuate past discrimination against African Americans in the historically segregated Hillcrest neighborhood which has already borne disproportionate environmental and health impacts through the siting of a previous highway in the neighborhood and the growth of the surrounding industrial district, including several refineries and the Port of Corpus Christi.

3. TxDOT intentionally discriminated against African American and Latino/a residents of Hillcrest and Washington Coles by implementing discriminatory procedures during the environmental impact process, including site selection and public participation.

II. Complainants

Complainants [redacted] are African American residents of the Hillcrest neighborhood. [redacted] has lived in the neighborhood for [redacted] years and [redacted] grew up in the neighborhood and moved back with her children.

Complainants are very concerned about the health and safety threats posed by the new Harbor Bridge, the further isolation of the Hillcrest neighborhood into an industrial area, and the reduction in their property values. They are also concerned about the exclusion of Hillcrest residents from meaningful participation in the decision-making process about the new Harbor Bridge, and believe TxDOT's actions exacerbate and perpetuate past discrimination against African Americans in the Hillcrest and Washington Coles neighborhoods.

III. TxDOT must comply with Title VI regulations as a recipient of federal funding

TxDOT is a past and current recipient of federal funding, including grants coming directly from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA). TxDOT is a primary recipient of federal funds. *See* 49 C.F.R. § 21.23(d), (f); 28 C.F.R. § 42.102(f)-(g). In particular, TxDOT is leading the environmental planning process for the new Harbor Bridge and has allocated federal transportation funds for the project.[2]

TxDOT is a "program or activity" that is subject to the requirements of Title VI. *See* 42 U.S.C. § 2000d-4a(1)(A)-(B); 49 C.F.R. § 21.23(e)(1). As the agency responsible for transportation solutions within the state, TxDOT plays a direct role in highway planning and construction.

As a recipient of federal funding, TxDOT is required to provide assurances that it is in compliance with Title VI on each of their applications for federal funding. 49 C.F.R. § 21.7. TxDOT is further required to ensure that the City of Corpus Christi's transportation planning process complies with Title VI. 23 C.F.R. § 450.218; 23 C.F.R. § 450.334.

Accordingly, TxDOT's environmental impact analysis, siting decision, public participation process, and mitigation for the new Harbor Bridge Project are all subject to the requirements of Title VI.

IV. Factual and Historical Background

a. Hillcrest and Washington Coles Neighborhoods: A history of segregation and discrimination in the siting of industry and highways

The Hillcrest neighborhood was first platted in 1916 and underwent development along with the Washington-Coles, Dona Park, and Oak Park neighborhoods in the 1930s and '40s, prior to the industrialization of the Corpus Christi Ship Channel. At that time, Washington-Coles was specifically designated as the neighborhood for black residents. In 1944, the City Council allowed black homeowners to move into the Hillcrest neighborhood after being informed that Washington-Coles had no more room for new residents. Over the next two decades, Hillcrest transformed from a predominantly white community to a predominantly black community.

Despite this history of segregation, the Northside neighborhoods have a rich history: well-attended schools, vibrant churches, restaurants, locally owned businesses, and community activism. Ray Charles and B.B. King both played at clubs on the Northside. The first park in the area, T.C. Ayers Park, was established in 1938. In 1964, representatives from the Hillcrest, Ayers, Leathers, and Coles neighborhoods formed HIALCO, an organization that sponsored food banks, vocational education, medical facilities, and voter education projects. The Harlem Theater on North Staples was the only theater with open seating for blacks. The Old Bayview Cemetery, on Waco Street, is

[2] *See, e.g.*, Rick Spruill, *State agrees to funnel $291 million in federal funds for Harbor Bridge replacement*, Corpus Christi Caller Times, April 26, 2012, available at http://www.caller.com/news/local-news/harbor-bridge/state-agrees-to-funnel-291-million-in-federal; Dave Hendricks, *TxDOT may earmark $175 million for Harbor Bridge*, Corpus Christi Caller Times, November 17, 2014, available at http://www.caller.com/news/building-our-future/bridge/txdot-may-earmark-175-million-for-harbor-bridge_36065496.

the city's oldest, with graves dating back to 1845, including those of the City's first mayor and sheriff, pioneer families, and Buffalo Soldiers.

Nevertheless, industrialization, the construction of Interstate 37 and United States Highway 181, and violations of the nation's environmental laws have taken their toll. Over time, the government has allowed industry, new highways, and the Port to encroach on the Northside neighborhoods, perpetuating a history of discrimination against African American residents in Corpus Christi. *See* Exhibit A, Map of Hillcrest and Dona Park Neighborhoods with surrounding sources of toxic releases.

The Port of Corpus Christi opened in 1926 and primarily shipped cotton until the 1930s, when oil was discovered in Nueces and adjacent counties. In 1934, the first industrial plant, Southern Alkali, was built in Northside, off Buddy Lawrence Drive.

In 1958, as industrial growth encroached on Northside neighborhoods from the north, a new freeway was proposed from Corpus Christi to San Antonio. Although objections were raised to the route in Corpus Christi, the highway was not rerouted and construction commenced in 1961 through the Northside neighborhoods. The new I.H. 37 divided existing communities and created a barrier on the south side of the neighborhoods, isolating them from the rest of the community between the interstate and the industrial/port corridor.[3]

Today, Corpus Christi has one of the largest concentrations of major oil refineries next to residents in the United States. The Ship Channel is now home to six refineries, the Port, and numerous petrochemical and energy companies. With the discovery of the Eagle Ford Shale, petrochemical activity in Corpus Christi is only projected to increase in the coming decades.

Due to their proximity to an ever-expanding Port and industrial sector, Northside and Ship Channel neighborhood residents have endured repeated environmental assaults, including explosions, releases of toxic chemicals, fires, and violations of environmental laws so severe that companies have been criminally prosecuted. Just a few examples across several decades include:

- General American Tank Farm Explosion (1952): There was a large explosion at the General American tank farm, just north of the Hillcrest neighborhood. Residents from a 27-block area were evacuated. For 17 hours, firefighters battled to control the fire, and at least a dozen firefighters were injured.

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[3] Jessica Savage, *Corpus Christi library director hopes to rebuild trust in historic Northside neighborhoods*, May 6, 2012, Corpus Christi Caller Times, available at http://www.caller.com/news/corpus-christi-library-director-hopes-to-rebuild ("The neighborhood changed when the [I-37] highway construction began. . . . 'That changed the neighborhood really forever. It was almost destined to be industrial.' . . . Homes in the interstate's path were moved and demolished as the state highway department bought between 500 and 600 parcels of property.")

- Hydrogen Sulfide Leaks (1954): Two years later, Hillcrest residents complained of foul odors, which were eventually identified as hydrogen sulfide from a nearby refinery. Those odors were making their way into the neighborhood through the sewage system. Hydrogen sulfide can poison several different systems in the body, with a toxicity comparable to that of carbon monoxide.
- Southwest Refinery Explosion (1981): More recently, another environmental accident threatened Hillcrest when a gasoline tank exploded at Southwestern Refinery. One worker died and another was injured. The explosion of this tank caused explosions in two other tanks. Hillcrest residents evacuated their homes and sought shelter.
- Southwestern Refinery Emissions (1993): Southwestern Refining emitted a large black cloud of smoke that burned residents' eyes and throats.
- Citgo Refinery (1996–97): Citgo reported a release of hydrogen fluoride (HF). Upon contact with moisture, HF converts immediately to hydrochloric acid, which is highly corrosive and toxic, and requires immediate medical attention following cxposure. Breathing in HF at high levels can cause death from an irregular heartbeat and/or fluid buildup in the lungs.
- Citgo East Refinery (2009): An explosion and fire that lasted several days in the alkylation unit caused a release of HF and critically burned one worker.
- Citgo East Refinery (2009): Another incident at this refinery led to another HF release.

Additionally, two of the companies with refineries adjacent to the Hillcrest neighborhood were indicted for criminally exceeding their benzene limits. In 2000, a grand jury returned an indictment against Koch Industries (now called Flint Hills) for violations of the Clean Air Act, including benzene violations, at the company's West plant. In 2007, Citgo was convicted for environmental crimes, including having uncontrolled benzene emissions, which is a known carcinogen, from open tanks from 1994 through 2003.

The litany of emissions exceedances and refinery accidents has impacted the health and welfare of the residents of the Northside and Ship Channel neighborhoods. The impact of these events is exacerbated by the day-to-day impacts of living next door to heavy industry. These daily impacts include: loud noises and sirens; bright lights at all hours, including lights from industrial flares; vibrations that shake residents' homes; and foul odors. Residents in the Northside neighborhoods also suffer from disproportionately high incidences of cancers; asthma and respiratory problems; and birth defects.

In 1997, state regulators responded to community requests and installed an air monitor on the Northside, which recorded high levels of toxins in the air. From 2002–2005, the monitor registered benzene emissions among the highest in the state of Texas. Problems with industrial pollution, accidents, and environmental justice in the neighborhood persisted.

During the Citgo sentencing, over 800 victims of Citgo's crimes were certified, most current or former residents of the Hillcrest and Washington-Coles neighborhoods.

Ninety of these victims testified at a recent sentencing hearing about the odors and pollution in the neighborhood, the reduction in property values because of the pollution, and the lack of resources available to address neighborhood concerns about the impacts of the pollution.

b. Demographics of the Northside Neighborhoods

TxDOT's recommended alternative (the Red Route) for the new Harbor Bridge will benefit the City of Corpus Christi at the expense of the Hillcrest and Washington Coles neighborhoods, which have a substantially higher percentage of African Americans and overall minority residents than the city as a whole. Corpus Christi is approximately 4.3% African American, whereas Hillcrest and Washington Coles are 38% and 31% African American, respectively.[4]

Even though the Northside neighborhoods have a much higher African American population compared to the rest of the city, the Final EIS fails to consider the unique impacts on Corpus Christi's African American population. Instead, because Corpus Christi is a majority minority city, it considers all proposed routes of the highway to have high environmental justice impact, ignoring the fact that the construction of the Red Route will occur in an area which contains a distinct minority group that has suffered a unique history of discrimination and segregation in the City. TxDOT must address this unique population and its history in its decision-making process for the bridge.

In addition, the total minority population in Hillcrest and Washington Coles is higher than the city and county, demonstrating that both African Americans and Latinos/Hispanics will be disproportionately impacted by harms to these neighborhoods. The City of Corpus Christi and Nueces County have minority populations of 66.7% and 67.1%, respectively, compared with Hillcrest and Washington Coles, which are 93% and 94% minority, respectively.[5]

c. The New Corpus Christi Harbor Bridge Project

TxDOT has led the environmental impact analysis and planning process for the new Harbor Bridge in Corpus Christi pursuant to the National Environmental Policy Act. TxDOT went through a scoping process, released a Draft EIS in December 2013, and a Final EIS in November 2014.[6] In addition, TxDOT is currently seeking requests for proposals for the shortlisted teams for the design and construction of the new bridge.[7] FHWA is expected to sign the Record of Decision approving TxDOT's Final EIS and selection of , likely in April of this year.

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[4] 2010 Census data, *see* Section 3-67 of the Final EIS.
[5] *Id.* at 3-67, 68.
[6] TxDOT, Corpus Christi Harbor Bridge Project, EIS, http://ccharborbridgeproject.com/eis/
[7] US 181 Harbor Bridge Replacement – Request for Proposal, http://www.txdot.gov/business/partnerships/current-cda/harbor-bridge/harbor-bridge-rfp.html

From the very beginning of the planning for the new bridge, TxDOT has demonstrated its intent to prioritize the economic benefits of the bridge for other segments of Corpus Christi at the expense of the Northside neighborhoods. In the Harbor Bridge feasibility study, TxDOT stated that the Red Alternative will "serve as a barrier between the newly developed Northside people-oriented area and the Port and industrial facilities located to the west of the red alternative."[8] This statement completely ignored (or intentionally excluded) the residents of the Hillcrest neighborhood, who would be left on the "industry side" of this new "barrier."

Throughout the planning process for a new Harbor Bridge in Corpus Christi, residents of the Northside neighborhoods and other concerned citizens and advocacy groups have expressed their objections to the disproportionate harm the Red Route would have on these historically African American neighborhoods. *See, e.g.*, Exhibit B, Comments on Draft Coordination Plan and Scoping Presentation; Exhibit C, Comments on Draft EIS; Exhibit D, Letter to TxDOT from Hillcrest Residents; and Exhibit E, Comments on Final EIS filed by concerned civil rights and environmental justice groups. However, Hillcrest residents who attended TxDOT's meetings about the bridge have stated that it was clear from the very beginning that TxDOT intended to choose the Red Route and not offer meaningful mitigation for the Northside neighborhoods, despite residents' concerns. *See,* Exhibit D.

Despite these comments and the history of discrimination and environmental health disparities in the Northside neighborhoods, TxDOT ignored residents' input and selected the Red Route for the reconstruction of the Harbor Bridge as its recommended alternative in the Final EIS. The Red Route will be built between the only two historically African American neighborhoods in Corpus Christi. *See* Exhibit F, Map of Harbor Bridge Reasonable Alternatives.

V. TxDOT's violations of Title VI

Title VI prohibitions apply to TxDOT's decisions related to siting, public participation, and accepting bids for the Harbor Bridge Project. Title VI and DOT's implementing regulations prohibit recipients of federal funding from excluding persons from participation in programs or denying persons the benefit of programs on the basis of race. See 42 U.S.C. § 2000d; 49 C.F.R. § 21.25(a); 28 C.F.R. § 42.104(a). Recipients of federal transportation funding are prohibited from making project site selections that discriminate on the basis of race, 49 C.F.R. § 21.5(3), and from locating or designing a highway in such a manner that requires the relocation of any persons on the basis of race, 49 C.F.R. Pt. 21, App. C (2)(vi). FHWA's guidance document covering Title VI compliance states that consideration should be given to (1) changing highway alignment

[8] US 181 Harbor Bridge Feasibility Study at 8-8, June 2003, available at https://ccharborbridgeproject.files.wordpress.com/2012/03/harbor-bridge-feasibility-study.pdf

so that there are not displacements, or (2) rerouting or shifting a highway segment to reduce displacements.[9]

Moreover, where prior discriminatory practice or usage has tended to subject individuals to discrimination under any program or activity to which Title VI applies, the applicant or recipient "must take affirmative action to remove or overcome the effects of the prior discriminatory practice or usage." 49 C.F.R. § 21.5(7).

TxDOT's recommended route for the new Harbor Bridge will benefit the City of Corpus Christi at the expense of the Hillcrest and Washington Coles neighborhoods, which, as stated in the demographics section above, have both a substantially higher percentage of African Americans and total minority population than the city as a whole.

a. Disparate impacts suffered by the Hillcrest and Washington Coles Neighborhoods

The residents of the Northside neighborhoods will disproportionately suffer from the harmful impacts of the new Harbor Bridge. TxDOT has failed to properly address and mitigate the impacts that the new Harbor Bridge will have on the Northside communities, including increased air and noise pollution, increased isolation, and decreased property values.

i. Increased Air Pollution

Locating the new Harbor Bridge between two historically black neighborhoods ensures that these neighborhoods will receive increased exposure to mobile source air toxics due to the increased traffic flow in these communities. Numerous studies have shown that pollution from highways is very localized. These studies have also shown that those living in close proximity to the highways face significantly elevated exposure to a complex mixture of pollutants including air toxics, diesel particulate matter, and other highway emissions including tire wear, brake wear, resuspended road dust, and various metals.[10]

Living, working, or attending school near major roadways or highways has been associated with negative respiratory effects such as:

- Asthma and bronchitis: exposure to diesel exhaust can induce histamine releases that result in allergic conjunctivitis, rhinosinusitis, pharyngitis, laryngitis, and chronic cough. This exposure can also lead to degradation of lung tissue.[11] Children are especially vulnerable to chronic negative respiratory issues, as living

[9] FED. HIGHWAY ADMIN., COMMUNITY IMPACT ASSESSMENT: A QUICK REFERENCE FOR TRANSPORTATION, 16, *available at* http://www.fhwa.dot.gov/environment/cia/quick_reference/cia_quickref.pdf.
[10] U.S. Environmental Protection Agency, Near-Road Air Quality Monitoring Research (Nov. 3, 2009).
[11] Irina N. Krivoshto et al., *The Toxicity of Diesel Exhaust: Implications for Primary Care*, J. AM. BOARD FAM. MED. 55, 58 (2008).

in close proximity to highway traffic can inhibit lung development during childhood and lead to lifelong weakened lung function.[12]

- Negative cardiovascular effects: long-term exposure to air pollution from high traffic has been show to increase incidences of coronary artery calcification[13] as well as increased coronary heart disease and strokes in women.[14]
- Adverse birth outcomes and developmental effects: living in close proximity to heavy-traffic roadways can cause an increase in term low birth weight and preterm infants. This is especially concerning for African-American women, who already have a higher risk of term low birth weight than white or Latino women.[15]
- Premature mortality: epidemiological surveyors have discovered high acute and chronic respiratory disease morbidity rates from proximity exposure to diesel exhaust, as well as incidences of acute coronary syndrome (heart attacks) and ischemic effects (strokes).[16]
- Increased incidences of cancer: many emissions released by heavy traffic flow, such as diesel exhaust fumes and particulate matter, have carcinogenic properties.[17]

Although TxDOT failed to perform local modeling of air pollution impacts, it contends in the Final EIS that the air quality impacts from the increased traffic will be minor. It does, however, acknowledge that there may be toxic air pollution hot spots and that such impacts would be predominately borne by minority and low-income populations. Given the history of these neighborhoods, their minority make-up, their past exposure to mobile sources air toxics such as benzene, and the high diesel truck fleet mix that will be accessing the Port on the proposed highway, a detailed modeling study of toxic and diesel particulate matter should have been conducted. Such study should allow a comparison of the air pollutant impacts on local populations from the various proposed highway routes. Further, despite the widely-known and well-documented negative health effects associated with long-term exposure to highway emissions, TxDOT's FEIS does not discuss these negative health effects and how they will impact the Northside neighborhoods.

In comments on the Final EIS, the U.S. Environmental Protection Agency (EPA) critiqued TxDOT for failing to analyze the localized increases in air emissions in

[12] W. James Gauderman et al., *Effect of Exposure to Traffic on Lung Development From 10 to 18 Years of Age: A Cohort Study*, THE LANCET 571, 574 (Jan. 26, 2007).
[13] B. Hoffman et al., *Residential Exposure to Traffic is Associated with Coronary Atherosclerosis*, 116 CIRCULATION 489 (2007).
[14] Kristin A. Miller et al., *Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women*, 356 NEW ENG. J. MED. 447, 453-56 (2007).
[15] Michelle Wilhelm & Beate Ritz, *Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996*, 111 ENVTL HEALTH PERSP. 207, 210-11 (2003).
[16] Irina N. Krivoshto et al., *The Toxicity of Diesel Exhaust: Implications for Primary Care*, J. AM. BOARD FAM. MED. 55, 56-59 (2008).
[17] Rachel A. Morello-Frosch, Tracey J. Woodruff, Daniel A. Axelrad, Jane C. Caldwell, Air Toxics and Health Risks in California: The Public Health Implications of Outdoor Concentrations, Risk Analysis, Volume 20 Issue 2, February 2000 (predicting 8600 excess cancer cases).

Hillcrest and Washington Coles: "by primarily analyzing air impacts at the regional level, the FEIS does not give adequate consideration of near-road air emission impacts to minority and low-income populations in the Northside community." *See* Exhibit G, EPA Comments on Final EIS. In addition, EPA noted TxDOT's failure to take into consideration "factors that may amplify near-road emissions (e.g. community asthma rates)," and its failure to address the cumulative effect of new pollutants on already high air emissions. For example, EPA cited studies showing four times the concentration of diesel particular matter in the Northside neighborhoods compared with the county in general.

ii. Increased Noise

TxDOT also concedes that traffic noise impacts will be borne predominately by the low-income and minority populations of the Northside. Though the recommended alternative will include some noise barriers as a form of mitigation, 351 residential receivers will still experience noise impacts—the highest number of any of the alternatives—even after the placement of the noise barriers. The high number of Northside residents that will be affected by these noise impacts further reinforces that the recommended alternative places the new Harbor Bridge in a discriminatory location.

Populations that live in close proximity to noise can suffer various adverse health effects. Acute exposure to noise can cause increased blood pressure, heart rate, and release of stress hormones.[18] Furthermore, exposure to normal urban levels of noise during the night has been associated with sleep disturbances.[19] Residential exposure to road traffic noise is also associated with a risk of stroke, with a 14% higher risk per 10 decibels higher exposure.[20]

The Final EIS, while recognizing that the Hillcrest residents will face increased noise exposure from highway traffic, does not address or mitigate any of these adverse health effects associated with increased exposure to noise. The U.S. Department of Housing and Urban Development (HUD) criticized the Final EIS for not adequately addressing "the incessant drone of traffic noise with which properties in the immediate vicinity of highways must cope." *See* Exhibit H, HUD Comments on Final EIS. In particular, HUD noted, TxDOT should have taken into account the sensitive populations in the neighborhood, including low-income and elderly populations.

iii. Increased Isolation and Decreased Property Values

Segregating the Hillcrest neighborhood from the rest of residential Corpus Christi will cause residential property values to diminish, hasten its conversion from residential use, and adversely impact the availability of low-income housing in Corpus Christi.

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[18] H. Ising, B. Kruppa, *Health Effects Caused by Noise: Evidence in the Literature From the Past 25 Years*, NOISE HEALTH 5, 5-13 (2004).

[19] H.M. Miedema, H. Vos, *Associations Between Self-reported Sleep Disturbance and Environmental Noise Based on Reanalyses of Pooled Data From 24 Studies*, BEHAV. SLEEP MED. 1, 1-20 (2007).

[20] Mette Sorensen et al., *Road Traffic Noise and Stroke: A Prospective Cohort Studey*, EUROPEAN HEART JOURNAL 737, 740-41 (Jan. 2011).

Numerous studies have demonstrated that residential properties located near major roadways experience a drop in value. Detached single-family homes experience the greatest drop in property values as compared to commercial properties or condominiums, with a high drop in value for homes both abutting the highway and located in the highway's impact area.[21]

The location of the new Harbor Bridge will also cause property values in the Hillcrest neighborhood to drop due to the increased noise and air pollution. Numerous studies have shown that as levels of noise and air pollution increase, property values decrease in a directly proportional manner.[22] Decreased property values also make it more difficult for the owner to sell their property and relocate.

In the Final EIS, TxDOT fails to analyze the drop in property values that will occur due to highway construction. Though the Final EIS acknowledges that displacement of Northside residents will occur as a result of the project, it does not discuss that these residents will also suffer from a loss of value to already low-income properties.

In comments to TxDOT about its bridge study, HUD also faulted TxDOT for not including in its study adequate mitigation for harms to the Northside neighborhoods, thereby "justify[ing] inaction at the expense of the host community's quality of life and property value appreciation." To remedy the additional harms to these neighborhoods, HUD "recommends that property owners be compensated for the taking of property value by the new highway." *See* Attachment H, HUD Comments on Final EIS.

b. Inadequate Public Participation

FHWA's Title VI Handbook acknowledges that decisions that identify one or more planned improvements over other options "may result from procedures and processes that exclude a group from the process, or from the failure to consider the impacts of various transportation system alternatives and programs or projects on one or more identified groups."[23] Thus, adequate and meaningful public participation is key to complying with the nondiscrimination requirements of Title VI.

In order to comply with Title VI, DOT recommends that the public involvement process be proactive and provide complete information, timely public notice, full public access to key decisions and an opportunity for early and continuing involvement.[24] Moreover, the agency notes that "seeking out and considering the needs of those who are

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[21] Jason Carey, *Impact of Highways on Property Values: Case Study of the Superstition Freeway Corridor*, ARIZONA DEP'T OF TRANSPORTATION (2001) at 69.
[22] Ian Bateman et al., The Effect of Road Traffic on Residential Property Values: A Literature Review and Hedonic Pricing Study (Jan. 2001) at 5-18.
[23] *1 FED. HIGHWAY ADMIN., TITLE VI HANDBOOK,* FHWA Publication No. FHWA-HCR-06-006, 7-2–7-3, *available at http://ftp.dot.state.tx.us/pub/txdot-info/ocr/title_vi/handbook.pdf [hereinafter FHWA TITLE VI HANDBOOK].*
[24] *Id.*

traditionally ignored or underserved" is a key element in the public involvement process.[25]

Inadequate efforts to reach and involve low income or minority populations during the planning process can result in denying these groups the opportunity to participate in decisions directly affecting them.[26] Thus, DOT guidance encourages state and local agencies to consider: making notification processes and documents accessible in minority and diverse language media; contacting minority groups and leaders to identify information needs and planning/programming issues of concern; ensuring the accessibility of technical information; addressing whether persons traditionally underserved are sought out for active and meaningful involvement; and encouraging adequate minority participation.[27] Additionally, states and MPOs are required under both the statewide and MPO planning processes to hold any public meetings at convenient and accessible locations and times "to the maximum extent practicable."[28]

However, simply involving minority groups is not enough. As DOT emphasizes, failure to seriously consider comments by minority groups/persons is discriminatory.[29] FHWA and DOT also require state DOTs to take steps to mitigate adverse environmental effects of highway construction, including increased air and noise pollution and any adverse environmental justice effects.[30]

TxDOT's Northside workshop on January 29, 2015 provided a clear example of how TxDOT has not valued or meaningfully solicited the input of residents living in the neighborhoods most affected by the Harbor Bridge project in creating true mitigation. Despite the stated goal of the workshop to "encourage a meaningful dialogue between community members and agencies on the future of the Northside area," the notice and structure of the January 29 TxDOT workshop failed to create this dialogue.

First, TxDOT did not provide adequate notice to residents in Hillcrest:

- While it was clear that a lot of agency time and resources went into bringing many TxDOT officials and consultants to the meeting, TxDOT did not let most Hillcrest residents know about this workshop intended to solicit *their input* until TxDOT handed out flyers in the neighborhood *the day before* the meeting
- At the meeting, a TxDOT official stated that Texas RioGrande Legal Aid helped correct the "oversight" of not providing notice to the Hillcrest neighborhood

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[25] *Id.*
[26] *Id.* 7-3.
[27] *Id.* at 7-4.
[28] 23 U.S.C. § 134(i)(6)(C); § 135(f)(3)(B)(ii).
[29] *Id.* 7-4.
[30] *See, e.g.*, http://www.fhwa.dot.gov/environment/noise/.

- Organizations such as the NAACP and individual Hillcrest residents who submitted written comments on the Final EIS in early January critiquing the inadequate mitigation for the Northside were given less than three days' notice
- The workshop directly conflicted with a Martin Luther King Jr. civil rights event with [redacted] at Del Mar College that many Hillcrest residents had been planning to attend for weeks

Second, the format of the workshop did not meaningfully solicit input about residents' concerns or answer residents' questions:

- Neighborhood residents were not asked for their input on the format of the meeting, topics discussed, or questions asked at the breakout sessions
- Rather than objectively recording input from residents, facilitators "translated" that input into written notes
- No public questions or comments were allowed, despite requests by attendees for clarification about the Harbor Bridge generally and the timing, funding, and goals of the community sustainability plan in particular
- Answers were not recorded in attendees' own words and TxDOT did not state at the meeting how the feedback would be compiled in an objective manner way
- TxDOT facilitators, none of whom were from the Northside neighborhoods or were persons of color, reported back the input in their own words rather than allowing residents to speak for themselves

TxDOT's proposed mitigation for the Northside neighborhoods ignores residents' input and does not reduce the disproportionate harms the residents will suffer. The proposed mitigation in the Final EIS includes a Livability Summit, a hike and bike trail, a "community sustainability plan" (with no specifics or funding commitments), oral histories, workforce support, and aesthetic enhancements. A city-wide meeting and a hike-and-bike trail that elderly, minority residents have no interest in using in no way mitigate the negative impacts the project will have on the community.

For example, TxDOT's Livability Summit, held on October 15, 2014, is not a proper mitigation measure. This day-long meeting was held on a Wednesday during working hours and had only five community attendees from the city as a whole. TxDOT has not made it clear whether any of these attendees were from the Northside neighborhoods. Thus, any plans produced at the Livability Summit for the Hillcrest neighborhood is not representative of the community's input.

The mitigation measures in the final EIS fail to take into account the desires and needs expressed by Hillcrest residents. Despite the fact that many Hillcrest residents have stated they would not use a hike and bike trail and requested mitigation that includes: funding to move to safer neighborhoods, more affordable housing in Corpus Christi, and a community-led plan for the future of Hillcrest that addresses concerns about health and safety, TxDOT has not included any of these proposals in its mitigation nor explained to residents why they are not feasible. *See* Exhibit D, Hillcrest Residents Letter to TxDOT.

c. Perpetuation of Past Discrimination

Rather than taking "affirmative action to remove or overcome the effects of the prior discriminatory practice or usage" as required under 49 C.F.R. § 21.5(7), TxDOT's selection of the Red Route for the new Harbor Bridge will do the exact opposite – it will perpetuate the government's history of discrimination against the historically black Northside neighborhoods. As described above, the Hillcrest and Washington Coles neighborhoods have already borne the brunt of the impacts from the construction of the Port, the industrial district, and I.H. 37 over the past few decades by being forced to live with frequent refinery accidents, emissions exceedances, and myriad health problems. The original construction of I.H. 37 segregated Corpus' historic African American neighborhoods, leaving the Hillcrest neighborhood bordered on two sides by the Port and petrochemical plants and on one side by the new highway. The proposed Harbor Bridge project would finish that segregation by entirely severing Hillcrest from other residential neighborhoods.

Despite its awareness of disparate and adverse impacts to the historically black Northside communities, TxDOT has not proactively solicited or created proper avoidance and mitigation measures to address these impacts, as described in the previous sections. An recent op-ed during Black History Month by Sociology Professor Isabel Araiza in the *Corpus Christi Caller Times* called attention to the Harbor Bridge's perpetuation of a discriminatory past: "Events related to the new Harbor Bridge proposal reveal a city still steeped in customs/practices that devalue/undervalue black people's lives, especially those on the Northside. Unequivocally, the Northside community is a product of past, overtly racist public policies." *See* Exhibit I, Araiza Op-Ed, *What about neighbors of new bridge?*.

VI. DOT and FHWA should take all necessary steps to correct TxDOT's violations of Title VI

For the reasons set forth above, TxDOT is not in compliance with Title VI of the Civil Rights Act of 1964. Accordingly, FHWA should take all necessary steps to ensure that TxDOT comes into full compliance with the requirements of Title VI pursuant to the FHWA and DOT's powers under 23 C.F.R. § 200.11, 28 C.F.R. § 42.108, and 49 C.F.R. § 21.13. If necessary, such steps should include launching an investigation, discontinuing all present and future federal funding to TxDOT for road projects including the Corpus Christi Harbor Bridge project, requiring TxDOT to take any necessary steps to comply with Title VI into the future, and/or referring the matter to the U.S. Department of Justice for further investigation. *See* 49 C.F.R. § 21.23.

Thank you for your prompt attention to prevent further discrimination related to the proposed Corpus Christi Harbor Bridge. Please let us know if we can provide any additional information to assist FHWA in addressing these serious concerns.

Sincerely,

Erin Gaines KHH

Erin Gaines
Attorney at Law
Texas RioGrande Legal Aid

Robert Doggett KHH

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EXHIBIT 3

The Report Committee for Melissa Morgan Beeler
Certifies that this is the approved version of the following report:

The Effect of Local Planning Actions on Environmental Injustice: Corpus Christi's Refinery Row Neighborhoods

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor: (b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

The Effect of Local Planning Actions on Environmental Injustice: Corpus Christi's Refinery Row Neighborhoods

by

Melissa Morgan Beeler, B.S.

Report

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Community and Regional Planning

The University of Texas at Austin

May 2015

Abstract

The Effect of Local Planning Actions on Environmental Injustice: Corpus Christi's Refinery Row Neighborhoods

Melissa Morgan Beeler, M.S.C.R.P

The University of Texas at Austin, 2015

Supervisor: [redacted]

Public health problems associated with industrial and hazardous waste facilities seriously and disproportionately impact some communities more than others and have been the subject of environmental justice research for decades. This report aims to 1) evaluate whether and how local planning policies have contributed to a concentration of minorities and poverty adjacent to industry in Corpus Christi's north side, and 2) examine actions that planners and city officials could take to successfully mitigate environmental justice problems. City plans, reports and zoning maps relating to the north side were reviewed to understand whether the City has contributed to the neighborhoods' proximity to industrial sites. These documents suggest that city actions have had some role in the minority neighborhoods' proximity to environmental hazards, especially in the early years of planning in Corpus Christi. Lessons learned from these planning documents are discussed, as well as recommendations for future planning efforts in the north side.

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Chapter 1: Introduction

Since the 1980s, studies have documented the increased risk for minority communities resulting from the siting of industrial activities, municipal waste facilities, and large infrastructure projects. Living near hazardous waste sites has been shown to increase risks of birth defects, congenital heart defects, and low birth weight in pregnant mothers (Downey & Willigen, 2005). Living next to highways and other high traffic areas are correlated with increases in strokes and asthma hospitalizations (Gauderman et al., 2005; Hu et al., 2008).

A national environmental justice movement has attempted to address "disparate impact, unequal protection, and environmental discrimination" through "participatory, democratic processes" (Shanklin, 1997) and litigation. Affected residents of hazardous facilities and other locally unwanted land uses have filed lawsuits under the federal Equal Protection Clause of the constitution claiming local siting decisions are discriminatory. However, these lawsuits have been unsuccessful for many communities due to the difficulty of demonstrating intent to discriminate on behalf of the municipality (Shanklin, 1997).

Other legal avenues can be just as difficult for communities as they require evidence of scientific causation to win. The low-income neighborhood of Hillcrest in Corpus Christi, Texas, filed a lawsuit under the Crime Victims' Rights Act, but it proved too difficult to demonstrate that industrial emissions caused the claimed health effects. (United States v. CITGO Petro. Corp, 2014).

Corpus Christi is a medium-sized port city dominated by the lucrative oil and gas industry. The Hillcrest neighborhood is adjacent to an expanding heavy industrial district, Refinery Row, which is home to five of six major refineries deemed frequent violators by the EPA (Toxic Texas Tours, 1999). In 2007, Hillcrest residents were declared potential victims when Citgo Refining and Chemicals Co. was convicted of violating the Clean Air Act for possessing uncovered oil tanks (United States v. CITGO Petro. Corp, 2014). In recent years, Hillcrest residents have experienced troubling health symptoms such "vomiting, dizziness and shortness of breath," measurable benzene in blood samples, as well as higher rates of birth defects and physical and mental disabilities (NPR State Impact, 2011; Texas Commission on Environmental Quality, 2012). The neighborhood documented their health impacts and requested $30 million in restitution from the refinery (United States v. Citgo Petro. Corp., 2014). As the neighborhood awaited the court's decision, they challenged all air permits requested by industry in Refinery Row. Flint Hills Resources ultimately agreed to reduce emissions and buy one home near the plant on the outskirts of the neighborhood (Environmental Integrity Project, 2013; KRISTV, 2013). In early 2014, the courts fined Citgo the maximum $2 million fine but denied Hillcrest any retribution for their health conditions, stating that obtaining the relevant causal evidence would "unduly delay the sentencing process" (Texas Observer, 2014). Because the community could not provide sufficient evidence that their symptoms were caused by CITGO's uncovered oil tanks, they lost their case.

Hillcrest residents have also been struggling with a transportation project that threatens to cut them off from the rest of the city. The Texas Department of Transportation has recently decided to perform extensive street widening and site the new Harbor Bridge between the historic Hillcrest and Washington-Coles neighborhoods. Once the new highway is complete, the organized but aging Hillcrest community will be surrounded by busy highways and heavy industrial activity near the Port. Over the years, community members and partner advocates have worked to protect what is left of the north side neighborhoods and to ensure that the community will experience a better quality of life in the future, either through buyout of homes or community revitalization (Malan, 2010).

Instead of pursuing litigation, which often results in little for disadvantaged communities, some scholars have proposed alternatives to remedy environmental inequity, such as improved land use and zoning policy interventions (Burby & Strong, 1997). Boone and Modarres (1999) argue that analysis of planning and zoning documents assist us in better understanding how the process of industrial siting may have created disparate environmental impacts on minority neighborhoods. Interventions may take the form of proactive zoning that sites industry far from residential uses, or reactive zoning that creates buffers between industry and other uses (Campbell, Kim & Eckerd, 2014). Some studies show that planners have remained unresponsive to resident exposure to pollution, believing the problem to be a federal or state responsibility (Burby & Strong, 1997). In response, Burby and Strong advocate for planners to collaborate with residents experiencing negative externalities from industry. Planning transparently with the community to come to a solution that addresses community needs may also be a good way to diminish resident cynicism and distrust of government.

Understanding how historic land use decisions have affected Corpus Christi's Hillcrest neighborhood and other north side communities could encourage the city to mitigate environmental injustice. This report has two purposes: 1) to evaluate whether and how local planning policies contribute to a concentration of minorities and poverty adjacent to industry in Corpus Christi's north side, and 2) to examine actions that planners and city officials could take to successfully mitigate environmental justice problems. This report is intended primarily to inform future advocacy efforts of local communities and nonprofit organizations. Findings may also assist other planners in avoiding planning pitfalls that have significant impacts on environmental justice in their communities. Lastly, city officials may find this compilation of planning documents to shed light on their city's history and inform future actions and goals with respect to this community.

Chapter 2: Literature Review

Public health problems associated with industrial and hazardous waste facilities seriously and disproportionately impact some communities more than others. Understanding these impacts and the existing environmental justice movement is important for planners and other decision makers. Provided in this section is a discussion of the literature on the theoretical impact of planning policies on environmental justice and planning interventions local governments have made to reduce risks to health and safety for their residents. An overview of the prevalence of environmental injustice on Corpus Christi's north side is also provided to frame a historical planning analysis.

Environmental Inequality in Public Health

Environmental justice literature tends to focus on the question as to whether racial disparities exist in exposure to environmental hazards and access to environmental amenities (Campbell et al., 2014). In 2010, researchers prepared a comprehensive report for the EPA reviewing the literature on public health outcomes from proximity to environmental hazards (Maantay, Chakraborty & Brender, 2010). The report found that much of the literature supports the idea that living near environmental hazards such as hazardous waste sites, high-traffic areas, and industrial facilities pose risk to those living near it (Maantay et al., 2010).

Studies have shown increased risk for central nervous system birth defects, congenital heart defects, chromosomal changes, and low birth weight in pregnant mothers living near hazardous waste sites (Vrijheid, 2000; Downey & Willigen, 2005). Mothers living near highways and high-traffic areas are also at risk for premature births and low birth weight (Genereux et al., 2007; de Medeiros et al., 2009). Heavily trafficked areas are also significantly associated with asthma hospitalizations (Gauderman et al., 2005).

Exposure to air pollution in general increase residents' risk to fatal strokes (Hu et al., 2008; Maheswaran & Elliott, 2003; Aylin et al., 2001). Several studies over the last twenty years have found an increased risk of childhood and adult cancer due to residential proximity to industrial and nuclear plants (Morris & Knorr, 1996; Johnson et al., 2003; Choi et al., 2006). Although there are also studies with conflicting results, Maantay et al. (2010) recommend these potential health outcomes be seriously considered by decision makers when siting industrial facilities and planning land use (Maantay et al, 2010).

Living next to industrial activity can also impact the mental health and wellbeing of local residents. Downey and Van Willigen (2005) found that residential proximity to industrial activity was psychologically harmful to residents by increasing stress levels of residents. The authors show that individuals perceive industrial activity to be threatening to their health and increase feelings of neighborhood disorder, personal powerlessness, and depression. Those who live near industrial activity tend to have worse mental health than those that do not live near industrial activity (Downey & Van Willigen, 2005).

Because industrial sites, hazardous waste facilities and highways are disproportionately located in low-income communities and communities of color, the public health burdens of pollution are unequally placed upon these populations (Pais, Crowder & Downey, 2014; Mohai et al., 2009; Mohai & Saha, 2007; Morello-Frosch et al., 2002; Morello-Frosch, 2002). Minorities tend to live in more polluted areas of cities (Ash & Fetter, 2004), along heavy traffic areas and highways (Gunier et al., 2003), industrial facilities (Mohai et al., 2009) and hazardous waste sites (Mohai & Saha, 2007). Pollutant exposure is also carried indoors, as industrial and traffic pollutants are found in higher concentrations in low-income, minority households than more affluent households (Brody et al., 2009).

Although minority neighborhoods have struggled with the impacts of industry and waste in their communities for decades, it was not until the 1980s seminal report published by the United Church of Christ that race was shown to be the best predictor of the location of hazardous waste facilities in the U.S. (Maantay et al., 2010). The empirical report helped provide legitimacy to the movement whose purpose is to "[address] environmental enforcement, compliance, policy formulation, and decision making…through a participatory, democratic process" (Shanklin, 1997).

The United Church of Christ commissioned another study in 2007 using the most up to date spatial data and methods and found that racial disparities in hazardous waste site distribution were even worse than originally reported (Bullard et al., 2007). Race was found to be a more predictive variable for hazardous waste sites than income, education, or any other socioeconomic factor tested. When comparing demographics of neighborhoods within 1.8 miles of hazardous waste sites (host neighborhoods) against neighborhoods farther away (non-host neighborhoods), researchers found that host neighborhoods were 56% people of color, while non-host neighborhoods were 30% people of color (Bullard et al., 2007). Poverty rates were also 1.5 times greater in the host neighborhoods. Neighborhoods with clustered facilities had even greater concentrations of people of color than neighborhoods without clustered facilities. Bullard et al. (2007) questioned whether current policies protect the poor and communities of color from environmental hazards, and recommended stronger government policies and industry standards.

Local Planning and Zoning Policies and Environmental Justice

A recent study by Campbell et al. (2014) identified at least four models of environmental policy, either intentional or unintentional, that alone or in combination may explain racial disparities in environmental injustice.

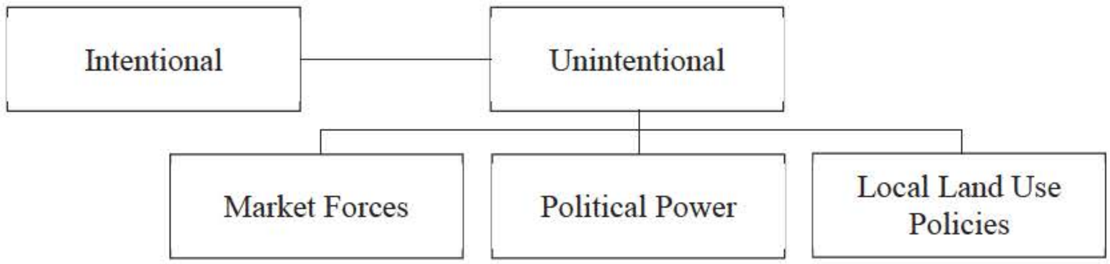

Figure 1. Models of policy's impact on environmental justice.

The intentional model was used by Pulido (2000) to examine the concentration of minorities near industrial areas and white suburbanization. She recommends that EJ literature not only focus on discriminatory or intentional firm siting but also explore less conscious forms of discrimination such as white privilege (Pulido, 2000).

The unintentional models of EJ focus on social processes that did not have the explicit intent to discriminate but may have led to disproportionate outcomes in terms of race and socioeconomic status of affected populations. The market-based view proposes that industrial facilities locate where the land is the least expensive, leading to siting near areas with high poverty (Campbell et al., 2014). In turn, low-income minorities may move closer to industrial facilities for job opportunities or due to decreases in surrounding land values, leading to present-day EJ concerns. Political power is also an important factor to consider, as low-income minorities tend to lack the time, money or collective power that more affluent communities have to influence local policy. The strong political engagement of more affluent communities may lead to more locally unwanted land uses being sited near low-income minority communities.

Less explored in the literature is the effect of local land use policy on environmental injustice. Historical zoning policies help create land use patterns in a city (Boone & Modarres, 1999), and may contribute to the present-day existence of persistent cases of environmental injustice. A case study of New York City found that rezoning of industrial land in more affluent, less minority communities to residential and commercial uses while expanding industrial zones in low-income areas contributed to environmental inequity (Maantay, 2002).

City Planning and Zoning Interventions

Just as local planning actions may contribute to present-day environmental injustice, planning and zoning can be used to mitigate current public health and safety problems in communities near industrial activity. Campbell et al. (2014) modeled the effectiveness of proactive zoning, reactive zoning, and the absence of zoning to mitigate environmental justice. Without a zoning policy, minorities experienced worse environmental quality than non-minorities. Proactive zoning, or zoning that creates specific zones for industry away from residential activity, resulted in less severe environmental justice problems than no zoning. Reactive zoning, or creating buffers around polluters near residential areas, enabled environmental justice problems to occur more quickly but the problems declined over time.

The California Air Resources Board has recommended specific distances to separate sources of pollution (e.g. industrial facilities and freeways) from "sensitive receptors" such as residences, schools, medical facilities, and recreational facilities (Table 1; California Environmental Protection Agency, 2005). Unfortunately, at the time of the study, there had not been substantial air monitoring data to determine a specific buffer distance between refineries and sensitive land uses. Some California cities are looking into updating their buffer requirements around sensitive receptors to remain consistent with new public health research and the impact of polluting facilities (East Yard Communities for Environmental Justice, 2013).

Source	Advisory Recommendations
Freeways and High-Traffic Roads	Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.
Ports	Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the Air Resources Board on the status of pending analyses of health risks.
Refineries	Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.

Table 1. California Air Resources Board recommended distances of separation (California EPA, 2005).

Some industrial communities in California are working to create Green Zones that aim to encourage green energy economies to protect their communities and bring better jobs. The City of Richmond's Planning Commission was persuaded by evidence that cleaner industry could bring more jobs to their community than traditional industry (Communities for a Better Environment, 2012). If the city council approves the land use policy, it would prioritize and incentivize green energy firms and require least-emitting technology for major industrial projects.

While zoning stipulates specific regulations for new development, a comprehensive plan can describe a city's vision for the future and priorities for growth. The State of California provides cities with guidelines for how to address environmental justice in their general plans (Office of Planning and Research, 2003). Commerce City, California, a city with one of the largest concentrations of industrial development in the country, complies with the state guidelines by providing policy statements on environmental justice with regard to each planning element (City of Commerce, 2008). Some of Commerce City's statements include: 1) identifying and addressing adverse impacts of future public facilities, 2) distributing all future industrial benefits and disadvantages regionally rather than concentrating them locally, and 3) participating in regional planning activities to represent the City of Commerce in siting future public facilities (City of Commerce, 2008). Although California's guidelines are not mandatory (Office of Planning and Research, 2003), they help communities address EJ in their plans to acknowledges the problem and think of ways to mitigate the problem, specifically focusing on procedural and geographic inequities.

Cumulative impact screening has also been recommended as a proactive means to reduce industrial siting next to vulnerable communities because it shifts the burden of demonstrating cumulative impacts of exposure from the community to government and industry (Morello-Frosch et al., 2011). Cincinnati requires industrial facilities to demonstrate that they will not cause an adverse cumulative impact on nearby communities in order to receive a permit (Morello-Frosch et al., 2011). Los Angeles performs community impact screenings to inform plans, permits, and enforcement strategies for neighborhoods already affected by industrial activity (Morello-Frosch et al., 2011).

Cities have implemented a variety of policy guidelines to address public health impacts of industrial facilities on residential communities. When reviewing Corpus Christi, plans could address environmental justice problems directly with specific strategies of how to overcome them. Plans could also call for ample buffer zones to protect residents from spills and explosions and zoning documents could codify these buffers.

Environmental Justice In Corpus Christi

Most industrial facilities in Corpus Christi are located in an industrial district infamously named Refinery Row, which runs the length of the north side. Seventeen of the 28 Toxic Release Inventory sites regulated by the EPA are located in or near Refinery Row.

The five sites with the biggest releases or disposal of TRI regulated chemicals are also located within this district. These sites include Flint Hills Resources East and West plants, Valero Refining's East and West plants, and CITGO's East plant (EPA.gov, 2013). Three brownfields, three permitted hazardous waste sites, and one Superfund site on the National Priorities List are also located along the industrial district. Industrial sites may locate and expand here due to their proximity to Interstate 37 and the Port of Corpus Christi. Interestingly, Refinery Row is just outside of the city limits, as shown in Figure 2, meaning they are not subject to city zoning and planning regulations, let alone property taxes. In lieu of taxes, the City signs an agreement with industries in the district every ten years, primarily ensuring district industries that they 1) will not be annexed and 2) sewer and water will be provided by the city in exchange for levying 100% of taxes on land and 60% of taxes on land improvements (Tex. Local Gov't. § 42.044). The agreement ensures that Refinery Row is not subject to zoning. In Texas, zoning is not allowed outside the city limits (Tex. Local Gov't. § 212.003).

In addition to industrial facilities, the north side will also be home to a new highway alignment. TxDOT recently decided to realign Harbor Bridge, a highway currently east of Washington-Coles, through the middle of the historically minority neighborhood (Fig. 2). The transportation agency hired an architectural historian to conduct oral histories and collect community memorabilia of the north side neighborhoods due to the expectation of the project displacing as much as 23% of the population (Ramirez, 2014). TxDOT expects the new Harbor Bridge to change the area "dramatically," expecting their project to adversely affect area residents to the point of displacing them.

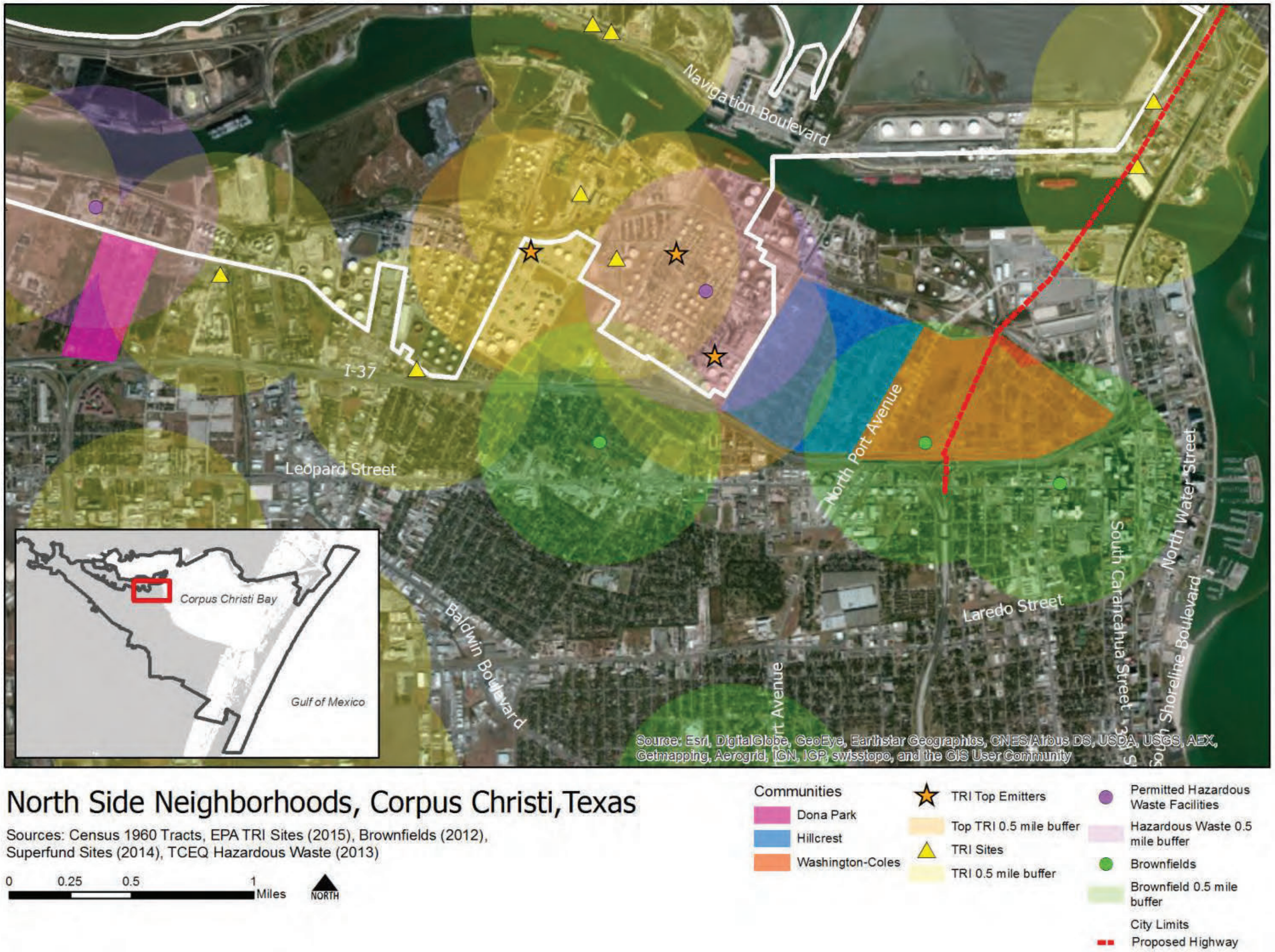

Figure 2. Location of north side communities in Corpus Christi.

Historically significant neighborhoods are present on the north side: Washington-Coles, Hillcrest, and Dona Park (Fig. 2). Washington-Coles was a part of the original city area when incorporated in 1852 has been predominantly been an African American and Mexican American neighborhood. Hillcrest was platted as an exclusive country club community in the early 1900s and annexed in the 1930s (Malan, 2010). Prior to the 1940s, it was primarily a White neighborhood, but when it was opened to African American renters in 1944, it quickly turned into a majority-minority neighborhood (Housing Authority of the City of Corpus Christi, 1944). Dona Park was annexed in the 1950s, also becoming a majority minority community over time (Fig. 3).

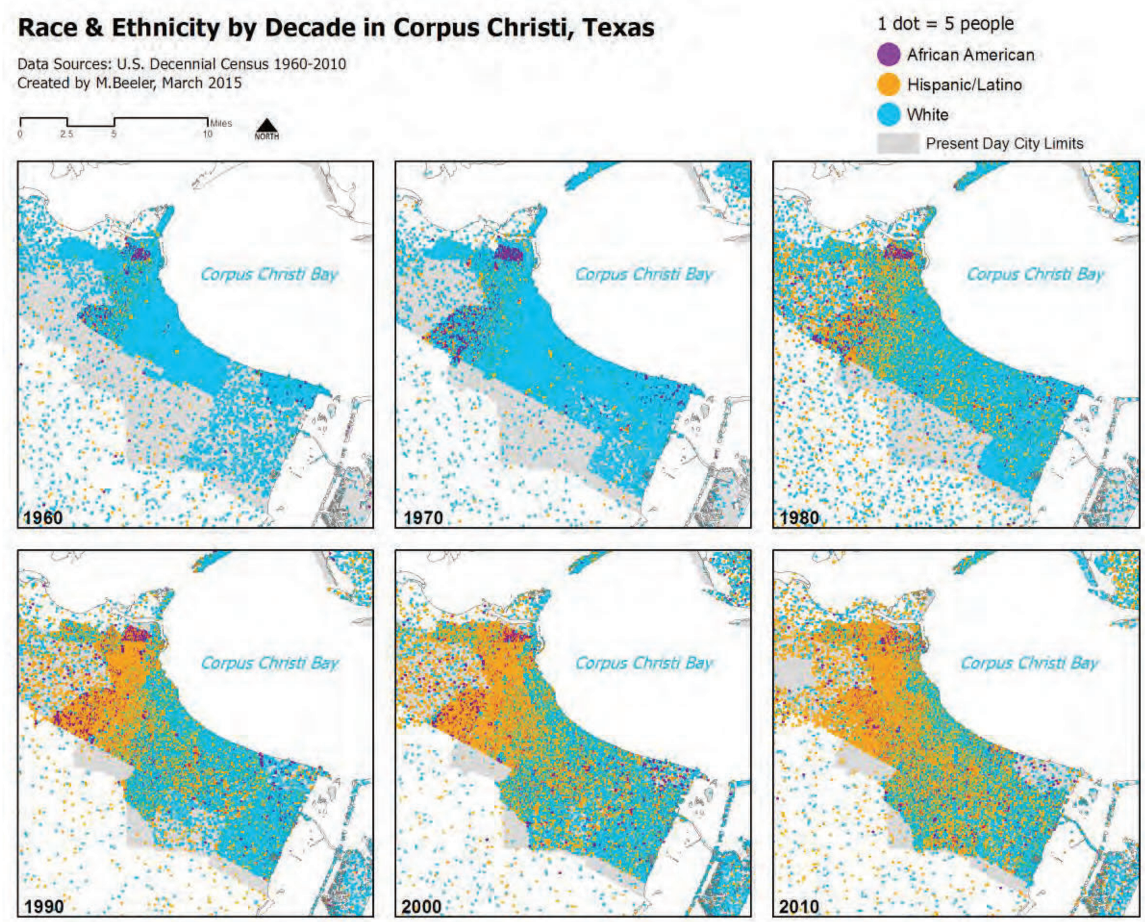

Figure 3. Distribution of race and ethnicity over time in Corpus Christi.

Table 2 compares the demographics of the three north side neighborhoods to the city's demographics in 2010. All three neighborhoods have higher minority concentration and lower median household income levels than the city overall. Hillcrest and Washington-Coles have much higher poverty rates than the city's average. The high poverty level in Washington-Coles may be due to the D.N. Leathers public housing facility being located in the neighborhood. The public housing facility has since been relocated just south of I-37, out of the neighborhood.

	Dona Park (CT 7, BG 1)	Hillcrest (CT 5, BG 1)	Washington-Coles (CT 64, BG 1 & 3)	City of Corpus Christi
White Non-Hispanic (%)	21.2	5.84	9.4	33.3
Hispanic (%)	73.0	57.8	60.2	59.7
African American (%)	4.6	35.8	30.8	4.3
Median Household Income	$25,104	$22,647	$9,686	$47,481
Poverty Rate (%)	13.6	31.3	63.48	18.2

Table 2. Demographic comparison of north side communities at the city (Source: Census 2010 via Social Explorer).

To estimate the characteristics of a population living within a certain distance of an environmental hazard, distance-based analysis has been used frequently in studies (Maantay et al., 2010). Accepted distances have ranged from 100 yards to 3 miles, with most analyses using 0.5- and 1-mile buffers (Maantay et al., 2010). While this method is more advanced than others, it is subject to its own limitations, such as uniform dispersion of emissions in all directions of a facility and equal-sized buffers for all facilities (Maantay et al., 2010).

This study maps half mile buffers around EPA Toxic Release Inventory (TRI) sites, TCEQ permitted hazardous waste sites, and brownfields (see Figure 2). Minority proximity to the top five largest emitters of TRI chemicals were noted to address this limitation of buffer analysis. Although not definitive, data suggest that environmental hazards are sited closer to minority areas and higher poverty areas than non-minority areas and non-poor areas.

Demographics in block groups with the majority of their area within half mile buffers of environmental hazards were calculated and compared to block groups outside of the buffers. The results are shown in Table 3. Block groups within half a mile of an environmental hazard have fewer White non-Hispanics than block groups farther from hazards but still within city limits. Minority concentration is also higher in block groups near hazards than the city averages for both African Americans and Hispanics. The poverty rate is also higher near hazards than the city average.

	City of Corpus Christi	Block Groups over 0.5 miles from a hazard	Block Groups within 0.5 miles of a hazard
White Non-Hispanic	32.6	34.0	20.4
African American	4.1	3.8	6.8
Hispanic	60.2	59.2	70.3
Poverty Rate	18.2	18.4	21.5

Table 3. Demographic proximity to all mapped environmental hazards (ACS 2009-2013).

Minority concentration was most pronounced for block groups within half a mile of top TRI emitters, with only 6% of the population being White non-Hispanic near these sites (Table 4). The poverty level was significantly higher than the city average, with 48% of the population near top TRI emitters earning incomes below the poverty rate. Block groups near brownfields had the second highest minority and poverty concentrations, followed by permitted hazardous waste sites and all TRI sites. Figures 4 and 5 show the distribution of all mapped environmental hazards throughout the city. Note that most are clustered on the north side within the industrial district just outside of the city limits. Another cluster is located just south of the industrial district.

	Within 0.5 miles of Top TRI Sites	Within 0.5 miles of TRI Sites	Within 0.5 miles of Permitted Hazardous Waste Site	Within 0.5 miles of Brownfields
White Non-Hispanic	5.6	27.6	19.6	14.2
African American	26.9	4.5	4.2	6.2
Hispanic	67.5	63.8	74.5	78.7
Poverty Rate	47.7	13.6	2.1	23.8

Table 4. Demographic proximity to specific hazards (ACS, 2009-2013).

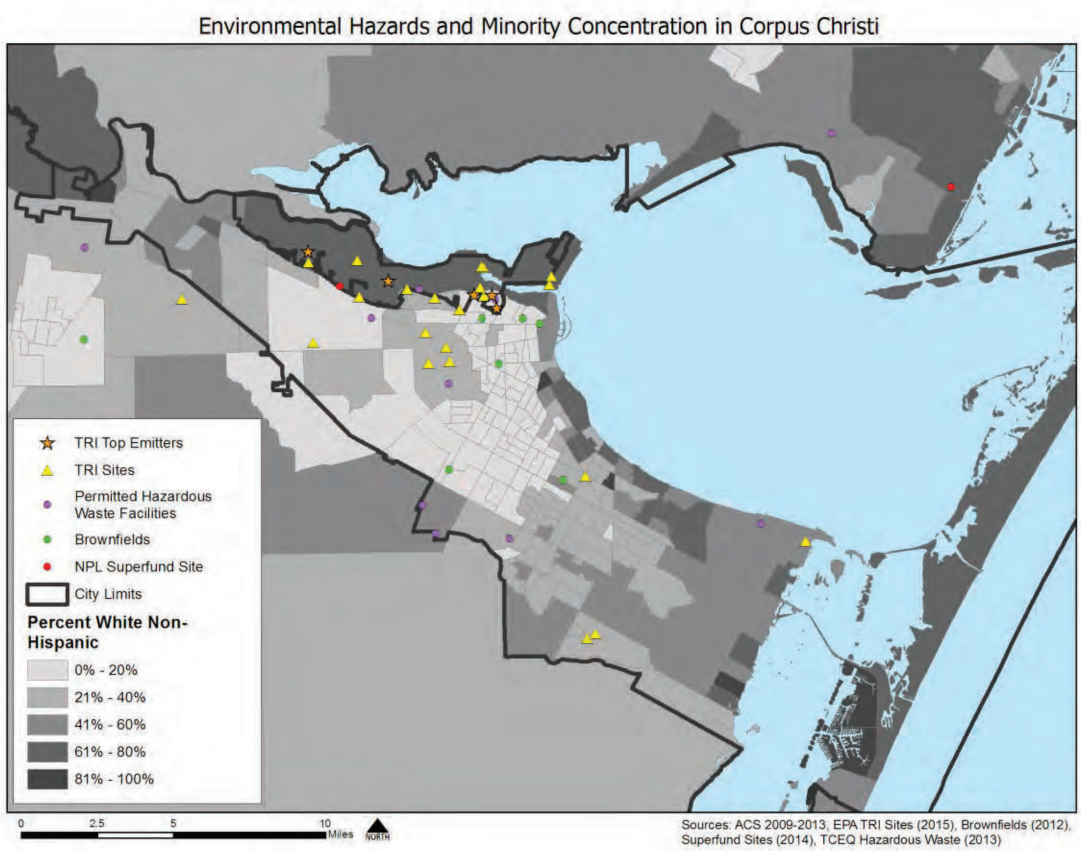

Figure 4. Proximity of environmental hazards in non-minority populations.

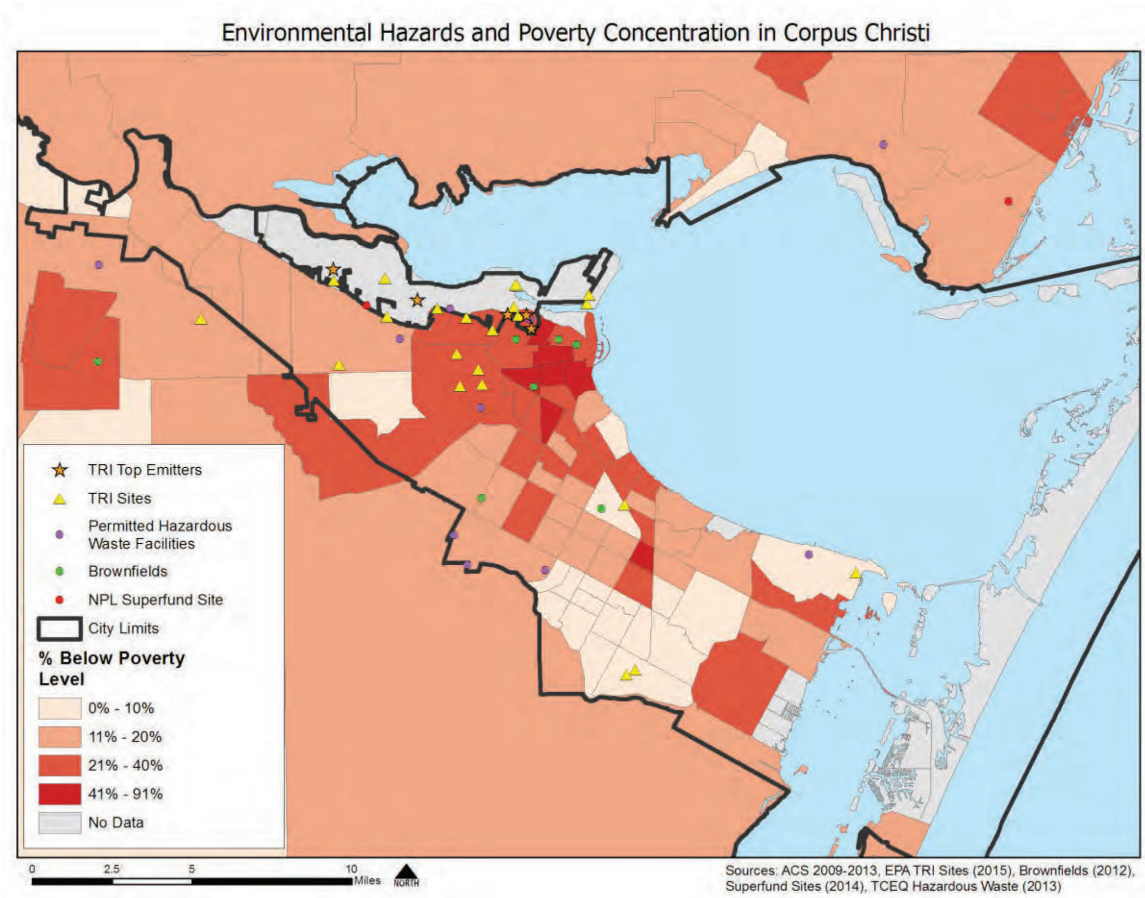

Figure 5. Proximity of environmental hazards to poverty concentrations.

Like communities around the nation, minority residents near Refinery Row have experienced public and mental health impacts due to their proximity to environmental hazards. At least as early as the 1970s, Corpus Christi has had numerous isolated events of explosions and fires at industrial facilities involving a natural gas station, oil refinery, and tank farm, often resulting in nearby residential evacuations (Corpus Christi Caller Times, 1978). Refinery fires, chemical spills, and tank explosions sometimes require dozens of homes to be evacuated (Averyt, 1992; Huff, 1993). Although direct injuries and deaths from industrial accidents have been relegated to workers at the scene (Corpus Christi Caller Times, 1981; Carrico, 1982; Harrill, 1989; Averyt, 1992; Baird, 2008), residents often experience considerable worry and stress, sometimes likening a pipeline explosion to a plane crash or bomb explosion (Meighan, 1992). Some industrial facilities, such as Flint Hills East Plant next to Hillcrest, send automated calls to nearby residents to warn and update them about an accident. However, some residents do not always receive the call (Kelley, 2009).

In recent years, Hillcrest residents have been studied to determine impacts to their health due to their proximity to industrial activity. When CITGO was convicted in 2007 of violating the Clean Air Act by operating tanks without proper emission control devices, the Department of Justice ordered the courts to identify potential victims of the violations (United States v. CITGO Petro. Corp, 2014). Hillcrest organized to collect evidence of their health impacts. A 2008 study conducted by Texas A&M Health Science Center detected benzene in blood samples of Hillcrest residents (Texas Commission on Environmental Quality, 2012). This finding spurred a study by TCEQ in 2010 to test soil and groundwater for harmful chemicals in the neighborhood. However, the study found only pollution below screening levels for human health (Texas Commission on Environmental Quality, 2012). Although hundreds of individuals submitted statements to be declared victims and reported vomiting, dizziness and shortness of breath, the court declared the neighborhood was unable to show a causal connection between their claims and CITGO's offense.

Other neighborhoods have also showed evidence of contamination. In 1996, the Dona Park neighborhood tested positive for cadmium and lead contamination in the soil and residents experienced higher-than-average cancer rates (Center for Public Integrity, 2012). The Housing Authority found a future public housing site contaminated with petroleum hydrocarbons in Washington Coles in 2009 (Meyers, 2011).

The data above show that environmental hazards in Corpus Christi are correlated more with higher poverty and minority status than low poverty and non-minority status. However, previous environmental justice studies urge going beyond present-day demographic analysis to understand how these problems manifested (Boone & Modarres, 1999). The following sections explore whether planning and zoning actions taken by the City of Corpus Christi contributed to present-day environmental justice problems on the north side.

Chapter 3: Methodology

I conducted archival research to understand whether city planning and zoning may have led to present-day environmental injustice by allowing or encouraging the parallel growth of the north side neighborhoods and industrial sites over time. Archived news articles and city maps helped me understand whether industrial or neighborhood land uses came first on the north side, an important component to understanding present-day environmental injustice (Mohai, Pellow & Roberts, 2009). News articles and city reports indirectly related to land use planning helped in tracing the growth and decline of industry and residential neighborhoods. These resources helped contextualize zoning maps and city land use plans to identify when the city may have attempted or failed to address north side resident problems. City plans, reports and zoning maps relating to the north side were reviewed to understand whether the City contributed to the neighborhoods' proximity to industrial sites. Table 5 shows planning documents reviewed for this study. This not an exhaustive list of all planning documents produced or commissioned by the City. The scope and selection of documents reviewed for this report were largely based on availability.

Year	Document
1937	First zoning map and ordinance
1939	Zoning map and ordinance
1948	Zoning map and ordinance
1953	Comprehensive Plan
1957	Zoning map and ordinance
1961	Zoning map and ordinance
1966	Comprehensive Plan
1969	Zoning map and ordinance
1975	Zoning ordinance
1980	Comprehensive Plan
1989	Westside Development Area Plan (Amend. 1995)
1999	Northside Plan
2003	Northside Redevelopment Plan (not adopted)
2008	Northside Renewal Plan (not adopted)
2013	Central Business District Area Plan
2014	Zoning map and ordinance

Table 5. Timeline of plans and zoning ordinances reviewed in this report.

The discussion that follows is not intended to be a systematic review of each planning document in the context of neighborhood growth and decline. Rather, it is a summary of main points in Corpus Christi planning history that have affected industrial or neighborhood growth.

Chapter 4: Findings

To understand how present-day environmental justice problems occurred on the north side, it is important to trace the development of industrial and neighborhood growth to understand which came first. For simplicity, industrial and neighborhood growth are described individually. Figure 6 provides a timeline of highlights in industrial and residential growth alongside city milestones.

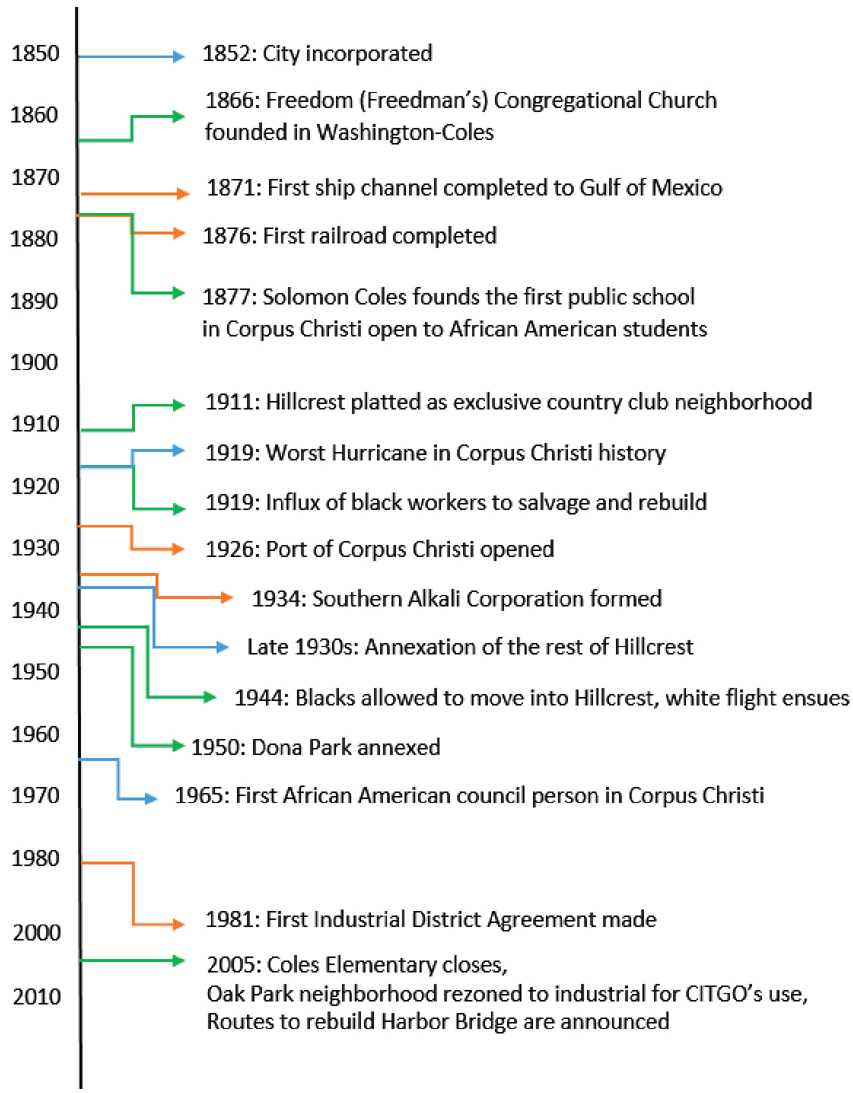

Figure 6. Timeline of industrial (orange), residential (green), and city (blue) growth highlights.

Industrial District Growth

Corpus Christi was not always an oil and gas town. From its incorporation in 1852 until the 1930s, the city's economy was largely agricultural, relying heavily on cotton production and commercial fishing, even upon establishment of several railroad lines and the Port of Corpus Christi (Fig. 7; Miller, 1937). The first major industrial facility in Corpus Christi was established in 1934, following successful gas exploration in the early 1930s and the official opening of the Port of Corpus Christi in 1926 (Miller, 1937; Savage, 2012). Regional oil discovery by 1937 spurred the construction of four pipelines and eight refineries, with more on the way (Miller, 1937). Industrial development catalyzed population growth for the city, doubling population each decade from 1930 to 1950 (Harland Bartholomew and Associates, 1952a). Cost-efficient transportation and labor were cited as reasons for further industrial relocation and expansion in the city (Miller, 1937).

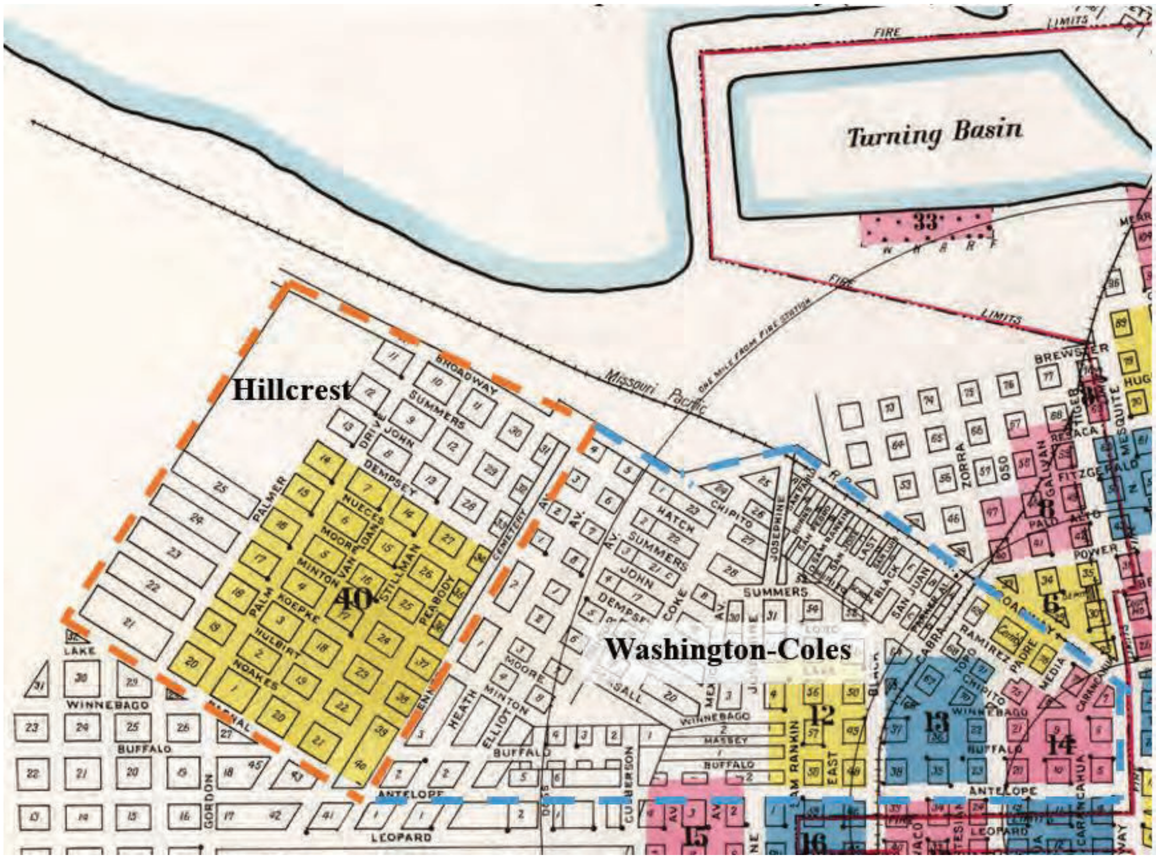

Figure 7. Location of the Port in relation to the north side neighborhoods (Sanborn map, 1927).

Industry located near the Port, mostly likely for transportation efficiency, which quickly surrounded Hillcrest by undesirable land uses. By 1940, nearly all land in the present-day industrial district had been bought by many industrial companies. Hillcrest was hemmed in by Barnsdall to the west, Houston Oil Co. to the north, and General American Transportation tank farm to the east in Washington-Coles (Fig. 8).

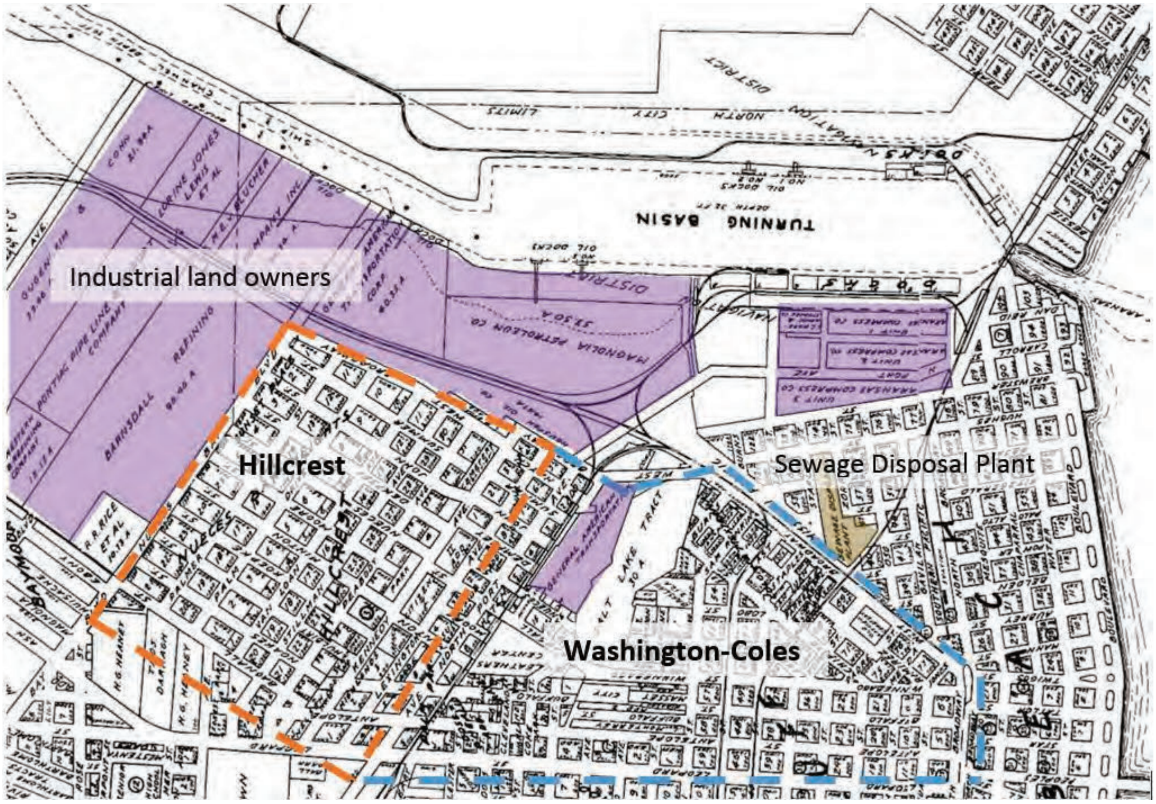

Figure 8. Tract ownership, 1940 (Blutcher, 1940).

More industrial development was actively recruited by Central Power & Light Company (CPL) for continued economic growth. CPL conducted a survey of industrial possibilities in the South Texas area "to determine the proper location of different industries…and then to persuade the industries themselves to locate where their success had been all but assured in advance" (Miller, 1937). In this way, industrial development had not been "haphazard" but "intelligently planned" (Miller, 1937). CPL planned to recruit six major industries to the region: petroleum development, basic chemicals, glassware manufacturing, meat packing, soap manufacturing, and canning. All of these industries were chosen for Corpus due to the availability of raw materials, inexpensive labor, or transportation advantages (Miller, 1937).

By the 1950s, the industrial trend seemed to be expansion of existing refineries rather than relocation of more refineries, as no significant refinery infrastructure had been built since the turn of the century (Harland Bartholomew and Associates, 1952a). A 1952 planning map of employment centers in the city and ETJ showed that three refineries and one chemical plant existed near Hillcrest and other annexed residential neighborhoods in the north (Harland Bartholomew and Associates, 1952a). Industrial facilities were located adjacent to Hillcrest and Washington-Coles by 1950 (Fig. 9).

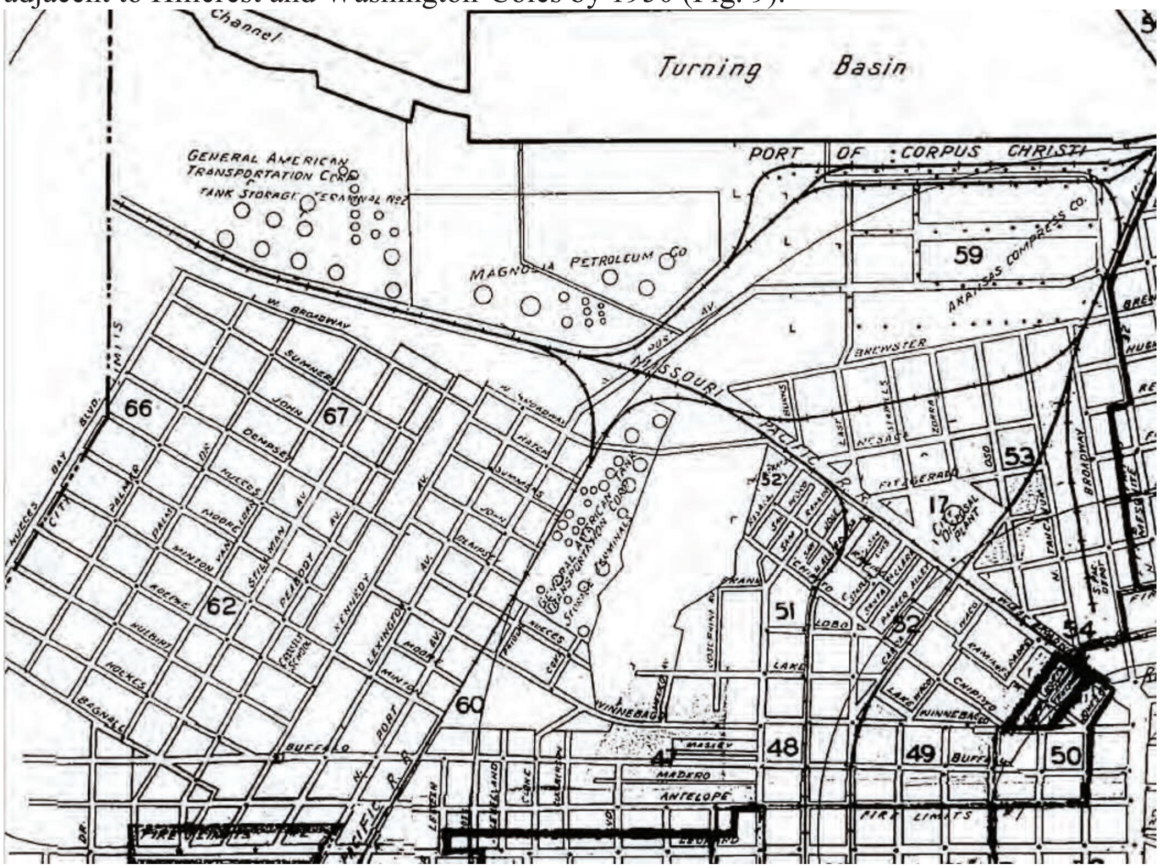

Figure 9. Proximity of industry to Hillcrest and Washington-Coles (Sanborn map, 1950).

Aerial imagery since the 1950s reflects industrial encroachment into each north side neighborhood over time. In 1955, industrial development next to the Port seemed fully built out (Fig. 10a). Tanks can be seen immediately up to the neighborhood boundaries on both the north and west sides of Hillcrest. By 1978, Interstate 37 was fully constructed, while some tanks were removed in the industrial properties west of the neighborhood (Fig. 10b). It is unsure whether these tanks were relocated elsewhere in the north side. Several tanks were still directly across the street from homes. A few decades later, it becomes apparent that the tanks were replaced with refinery facilities and smoke stacks (Fig. 10c). By 2002, a buffer had been created approximately two blocks into the neighborhood, created by a buyout from Flint Hills East Plant (Flint Hills Resources, 2012). These two blocks closest to the western industry were used for office space and parking. A few tanks were also removed north of Hillcrest. Today, the industrial activity to the west of Hillcrest remains fully built out. However, several tanks north of the neighborhood have been removed since 2002 (Fig. 10d).

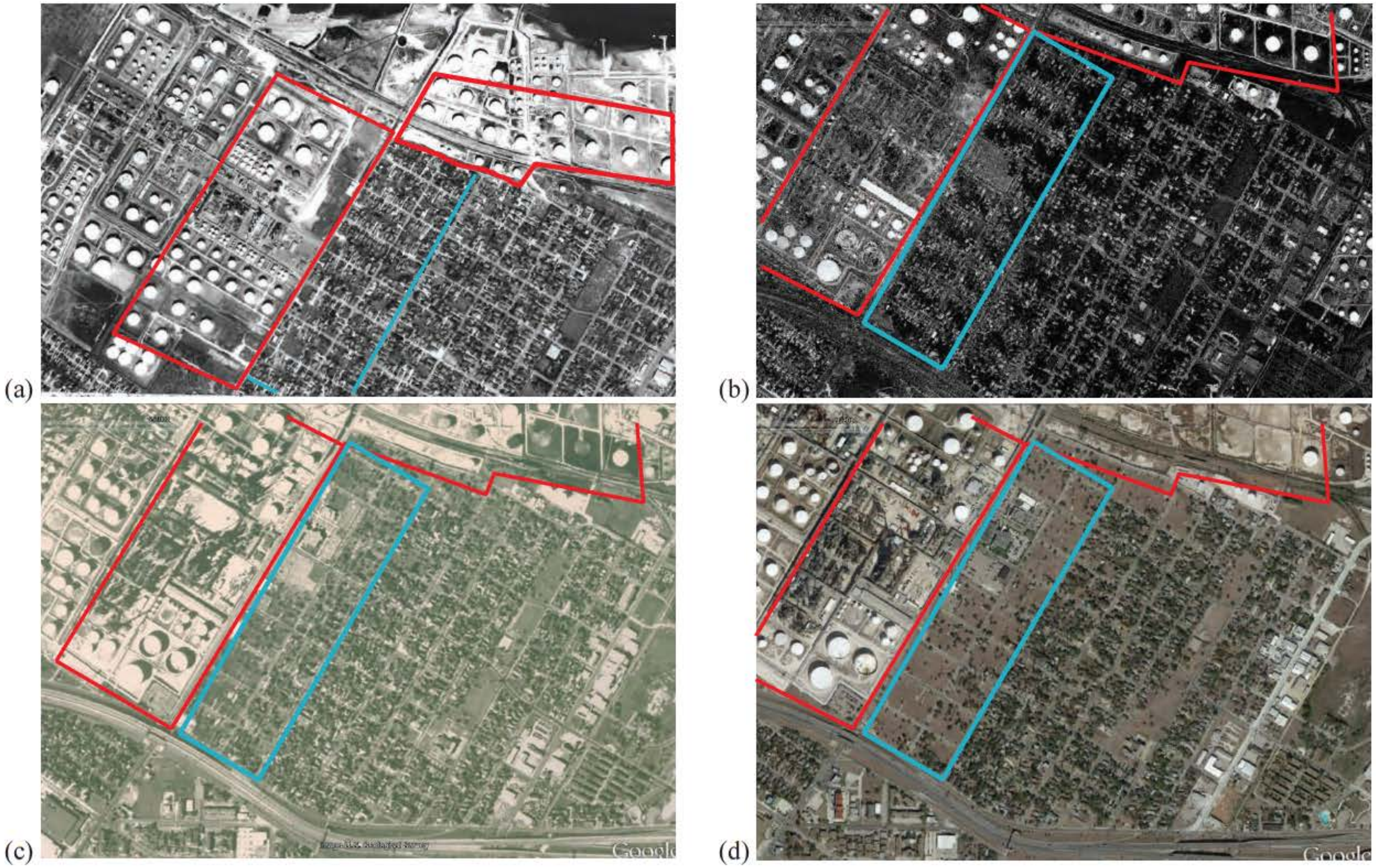

Figure 10. Hillcrest, (a) 1955, (b) 1978, (c) 2002, and (d) 2011 (Texas General Land Office & U.S. Geological Survey via Google Earth).

Though difficult to discern from aerial imagery, Washington-Coles residents also dealt with industrial siting within their neighborhood. As early as the 1950s, a storage tank facility owned by General American Tank Transportation Corporation was sited between Hillcrest and Washington-Coles (Fig. 11a). A wastewater treatment plant was also sited east of the neighborhood, and a couple of industrial facilities were also located along the main highway and railroad tracks east of Washington-Coles (Fig. 11a). The tank farm persisted until 2002 when the tanks were removed and the site remediated (Fig. 11b). The wastewater treatment plant still exists today.

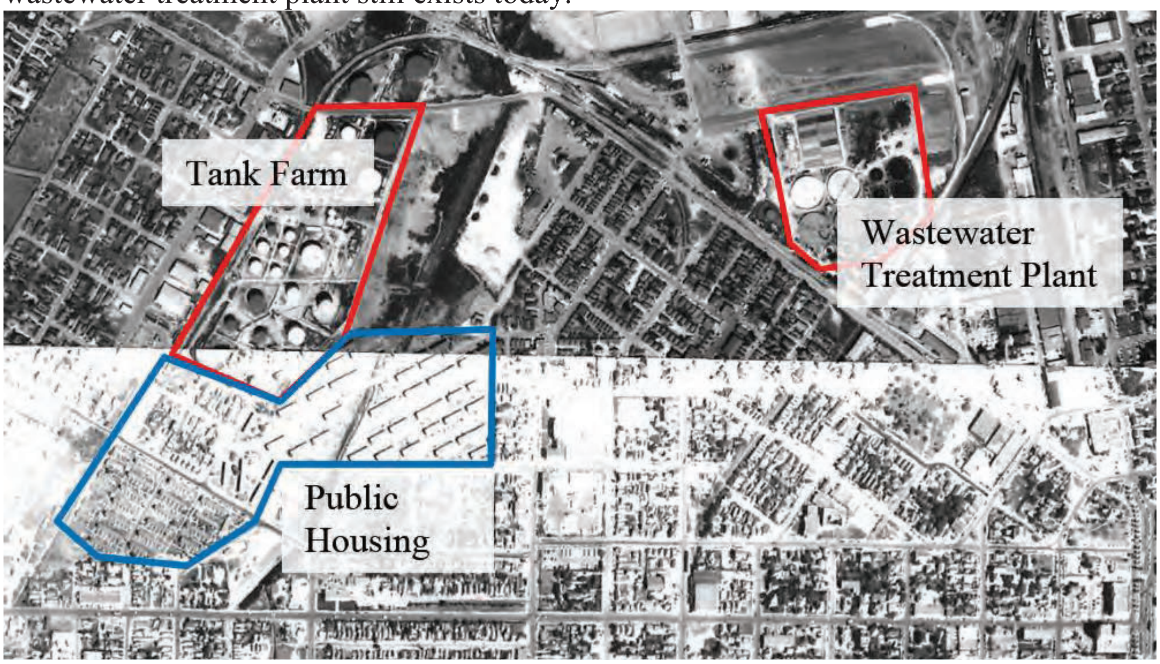

Figure 11a. Washington-Coles, 1955 (Texas General Land Office & U.S. Geological Survey via Google Earth).

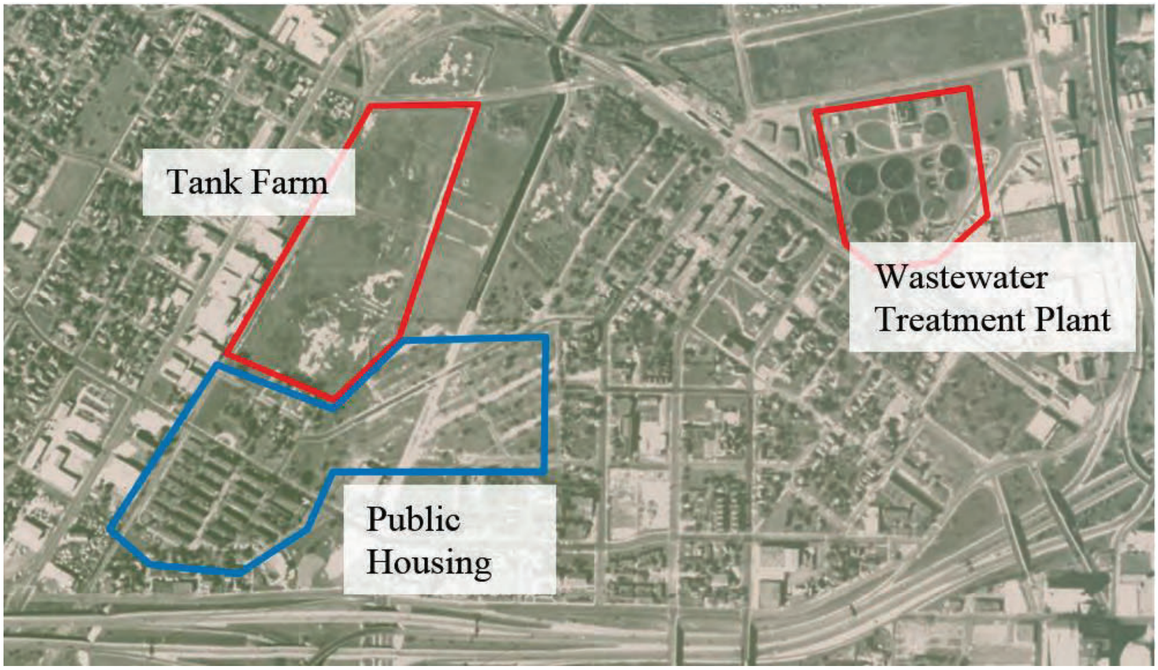

Figure 11b. Washington-Coles, 2002 (Texas General Land Office & U.S. Geological Survey via Google Earth).

When Dona Park was annexed in the 1950s, the subdivision was in close proximity to the industrial district. Storage tanks existed to the east of the community in addition to an ASARCO facility directly to the north (Fig 12a). The zinc smelter facility operated from 1941 to 1985 and in 1988, a waste management facility operated at the ASARCO site (TCEQ, 2013). TCEQ has investigated the possibility of zinc, cadmium, and lead contamination in the neighborhood since 1994, recently finding lead and cadmium contamination in the yards of Dona Park residents (TCEQ, 2013). Nearby tanks adjacent to the neighborhood were removed as of 2004 (Fig. 12b). As of 2011, the ASARCO facility was dismantled (Fig. 12c).

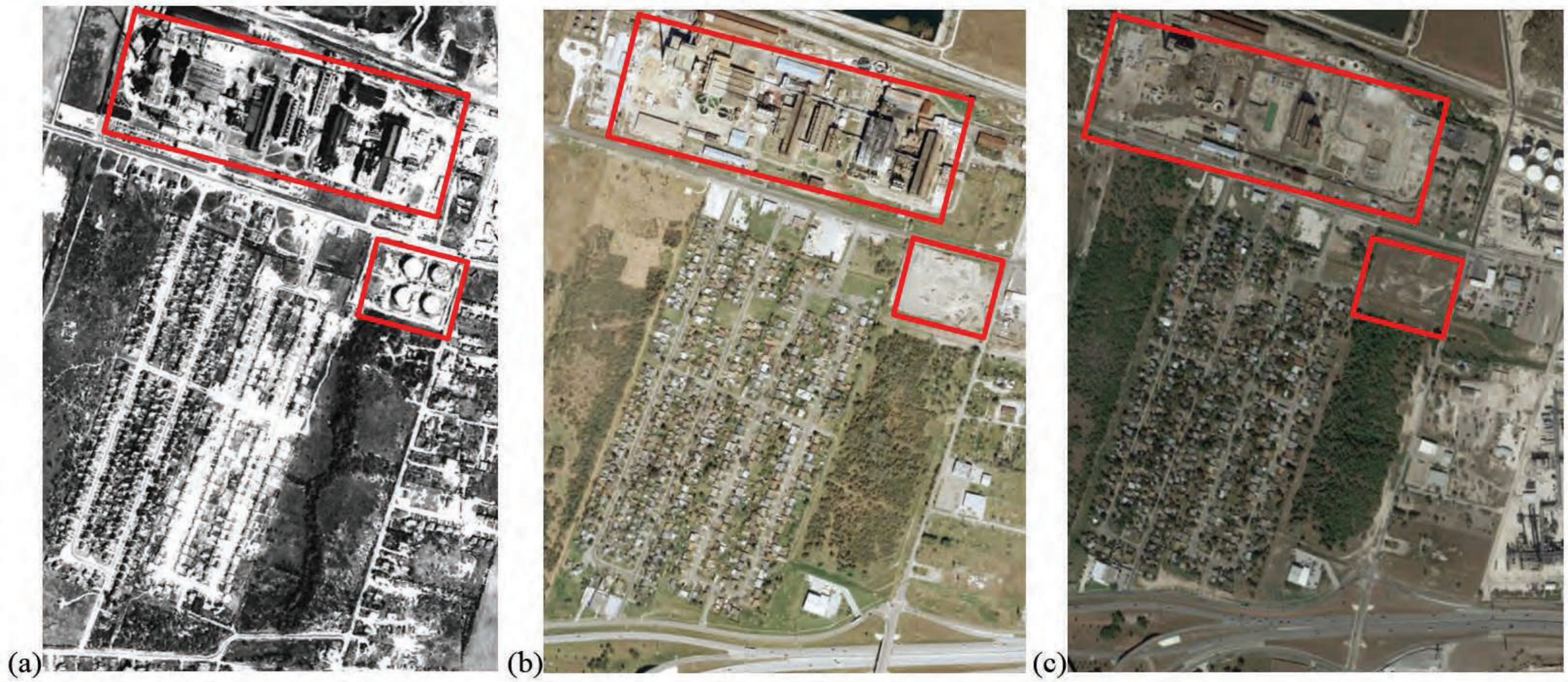

Figure 12. Dona Park, (a) 1955, (b) 2004 and (c) 2011 (Texas General Land Office & U.S. Geological Survey via Google Earth).

The industrial district (AKA Refinery Row) became official in 1981 with the city's first industrial district agreement (CITGO, 2006). Industrial district agreements protect industrial facilities from annexation and thus from permitting and platting requirements. They also provide cities an opportunity to negotiate payment in lieu of property taxes. Industry can also negotiate for fire protection from the city (Corpus Christi Regional Economic Development Corporation, 2007). Agreements have been renegotiated every 7-15 years, each time renewing the clause that protects the industrial district from annexation.

Neighborhood Growth

Long before industrial development moved into the city, Washington-Coles and Hillcrest were home to minority residents. Among the first neighborhoods established in Corpus Christi, it was shared by African Americans and Mexican Americans with segregated churches that can be seen on maps as early as 1887 (Glasrud et al., 2012; Koch, 1887). Railroad lines ran through what is today Washington-Coles, with some factories and other facilities along the railroad closer to downtown, but not in the present-day boundaries (Koch, 1887). The first African American schools in the city were established in the late 1800s in Washington-Coles (Glasrud et al., 2012). Hillcrest was platted in 1911 as an exclusive community for the city's country club that was located farther west (Malan, 2010). In 1919, the destruction caused by the worst hurricane in Corpus Christi history brought an influx of black workers to the city to salvage and rebuild (Glasrud et al., 2012). By the late 1930s, all of present-day Hillcrest was annexed along with other residential communities south of the industrial district, according to city annexation maps. Recall by this time, the Port was established and industrial facilities were locating in the present-day industrial district.

Neighborhood growth on the north side can be largely attributed to segregation and redlining policies. Prior to 1944, African Americans were only allowed to live in Washington-Coles' Census tract, where slum conditions were occurring in dilapidated "shotgun houses," shoddily constructed at a time when there were no construction regulations in the city (Housing Authority of the City of Corpus Christi, 1944). In other areas of the city high concentrations of Hispanics were also living in slum conditions, with poverty and disease. Slum conditions and blight were further exacerbated by the Federal Housing Authority's refusal to insure mortgages due to existing blight or commercial land use (Figure 13). Meanwhile, unscrupulous land speculators were preying on poor African Americans. (Housing Authority of the City of Corpus Christi, 1944).

> Home ownership of the type which is promoted by many operators in this section, whereby well-meaning but improperly informed people 'purchase' land at high prices for small down payments and monthly payment of usually $5.00, should be discourage or controlled. The 'owner' can afford to build only a small dwelling of scrap lumber or an ordinary 'shotgun' house, and often ends up by losing the lot and house to an unscrupulous mortgagor because of default in payments. (Housing Authority of the City of Corpus Christi 1944)

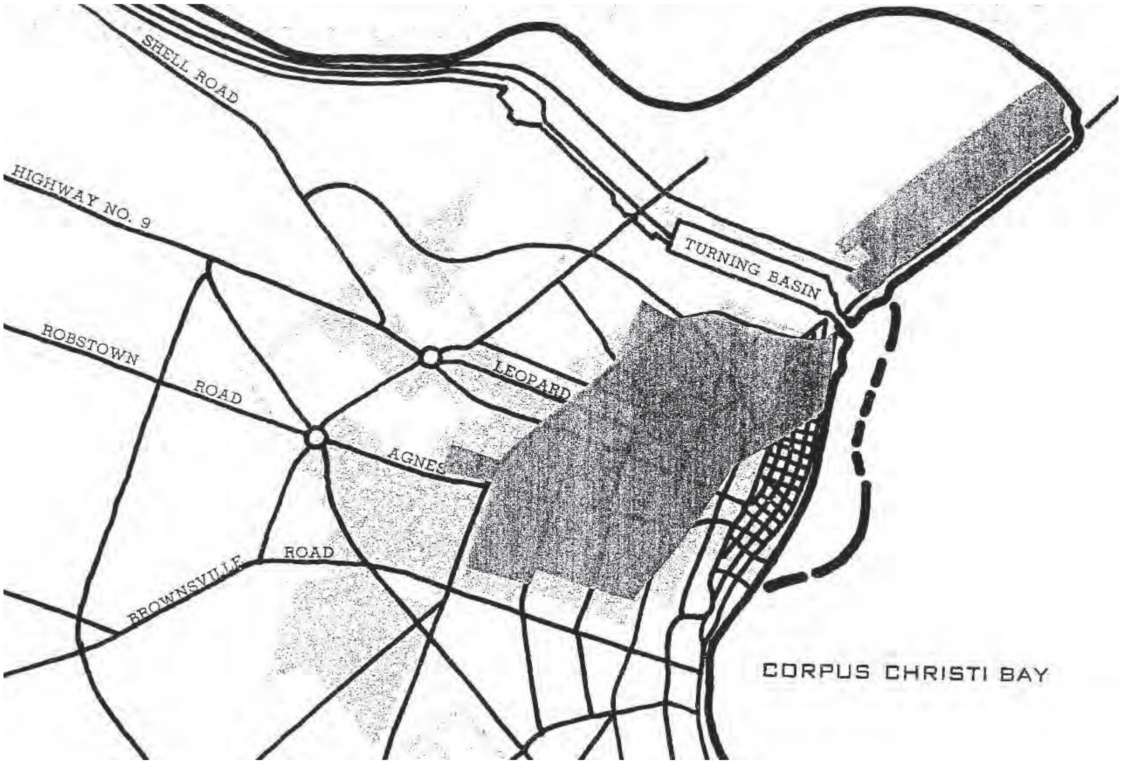

Figure 13. Slums areas designated by Corpus Christi Housing Authority (dark gray) and slum and commercial areas in which the FHA will not insure mortgages due to blight or commercial use (light gray) (Housing Authority of the City of Corpus Christi 1944).

The 1944 Corpus Christi Housing Authority Report "strongly" recommended expanding the overcrowded African American enclave in Washington-Coles into the Hillcrest neighborhood and southwest near the airport. Although the Housing Authority acknowledged that the north side was becoming "overrun" with industry and minorities, instead of relocating public housing, it continued to encourage redevelopment in the same area. The agency valued housing minorities close to centers of employment, stating "it is more economical from every standpoint to keep 'the little man' close to the central section of the city, rather than spread throughout the metropolitan area" (Housing Authority of the City of Corpus Christi, 1944). According to the 1944 report, the Hispanic community had better luck with housing. They tended to be more affluent than African Americans and were able to own homes. However, there was still demand for moderate-income rental housing and homeownership opportunities.

When Census tract 5 was opened to African Americans shortly after the report, white flight from Hillcrest ensued just as the Housing Authority predicted. Despite the poor housing conditions in Washington-Coles, neighborhood commercial thrived in the 1940s and 1950s. The neighborhood provided everything for the African American community including schools, churches, stores, and nightlife (Strasburg, 1998a). Since businesses were segregated, black-owned businesses were concentrated in this area and doing quite well, but when the city became racially integrated, the black population dispersed and businesses suffered. A longtime resident of the north side recalled its heyday:

> During the 1950s and 60s, the northside was known for the top-name entertainment featured in such establishments as the Cotton Club...after integration, some blacks moved to other areas, and the churches and bars went with them...Some businesses relocated, but others died (Cardenas, 1983).

By 1960, only half of the black population in Corpus Christi lived on the north side (Strasburg, 1998a). Those who could move away from the industrial area did so, leaving behind those living in poverty and public housing. Although the black population in the city increased between 1960 and 1970, there was an 8% decline in the black population living in Hillcrest and Washington-Coles over the decade (City of Corpus Christi Long Range Planning, 1974). As the neighborhoods declined, vacancies rose and attracted drugs traffic and other criminal activity.

Witnessing the neighborhoods' decline, former and current residents took action in the 1980s and 90s to preserve and restore the neighborhoods. Many of the projects addressed physical revitalization and major issues such as crime and drug trafficking. The Northside Business Association worked to improve the appearance of businesses and increase security in the neighborhoods (Cardenas, 1983). The Northside Manor Tenants' Association formed a neighborhood watch (Ramsdell, 1984). Residents and local preservationists also worked to salvage the theatre, cemetery, and public housing complexes in Washington-Coles (Strasburg, 1998b). Hillcrest, with many single parent households, invited the mayor to visit their neighborhood park and urged him to help reduce break-ins and revitalize the playground (Cardenas, 1984). In the early 1990s, a former resident of Washington-Coles proposed to repurpose Leathers Drug Store, where much of the drug dealing and loitering in the neighborhood was taking place (Williams, 1992). She envisioned a cultural arts center for the neighborhood and black and Hispanic communities, hosting traveling art exhibits, history libraries, and meeting spaces for community organizations. Area businesses donated to support the project, but the physical renovations may have proved to be too much. There is no Leather Cultural Arts Center on the north side today.

City officials also began to fund cosmetic improvements to revitalize the north side in the 1980s, but seemed to overlook the deep-seeded issues the community was working to solve. City Council adopted programs to renovate north side homes, apartments, and businesses. Funded by Community Development Block Grants, the City offered grants and loans to low-income residents and businesses for exterior paint (Tumiel, 1983). The programs prioritized owners with code violations, vacant properties, and struggling businesses. The city also helped fund yardwork and tree-trimming to establish neighborhood pride (Tumiel, 1983).

Despite some municipal efforts to revitalize the north side, disinvestment and out-migration from the community continued. To reduce crime and blight, the City focused on enforcing building standards and issuing orders to repair or demolish structures (Cardenas, 1983b). Old nightclubs and abandoned homes were demolished in the 1990s, removing places for drug dealers to hide from the police but losing a lot of history in the process (George, 1996). During this time, several residential buyouts also occurred near to industrial facilities in the north side, leaving current communities hoping for the same.

Between 1980 and 2000, industry bought an estimated 750 to 1000 homes on the north side (Foley, 2011). Buyouts created an opportunity for new industrial growth. Oak Park, a subdivision adjacent to the industrial district, was rezoned to industrial use for CITGO's gasoline and diesel treatment facilities (Santos-Garza, 2005). That same year, the population decline in Washington-Coles spurred the closing of Washington-Coles Elementary, indicating further decline and disinvestment for the community. In a third blow to the north side, plans to rebuild Harbor Bridge were announced, with TxDOT's preferred route going directly through Washington-Coles (Santos-Garza, 2005). In the past, residents who remained on the north side hoped for a neighborhood rebound, but felt that the city would simply not invest: "City administration, along with public housing officials and state and federal resources, could come in and redesign the whole Northside. But there's no genuine interest in revitalization" (Averyt & Strasburg, 1998). Today, Hillcrest's Citizens for Environmental Justice organization continues to work for a buyout that will allow residents to purchase safe housing away from pollution (Malan, 2010).

Planning Actions and Impact on the Northside

The city's first zoning ordinance in 1937 neglected to provide north side neighborhoods with a residential distinction, allowing them to remain susceptible to industrial encroachment (Zoning Ordinance, 1937). The zoning ordinance used Euclidean II zoning, which orders traditional classifications such as residential, commercial, and industrial in a nested fashion that allows multiple classifications in a zoning district. For example, the zoning ordinance allowed dwelling districts to have one- and two-family dwellings, churches, schools, and other neighborhood facilities. Apartment districts could have multifamily dwellings as well as all dwelling uses. Retail districts allowed offices, stores, and restaurants as well as uses allowed in Apartment and Dwelling districts. Commercial allowed for larger commercial establishments, plus uses allowed in Retail, Apartment, and Dwelling. Lastly, Manufacturing districts allowed for all of the above plus light and heavy industrial activity.

Nested zoning categories foster mixed use but can provide better health and safety protection for some more than others. With this Euclidean II zoning classification, residents living in single-family zoning districts are the most exclusive zoning category, thus arguably the most protected from commercial and industrial uses. According to the 1937 zoning map, Washington-Coles was zoned entirely in Commercial and Manufacturing districts, even though it is known that residential subdivisions existed in this area. Apartment districts were used as a buffer between Dwelling and Commercial districts. In 1939, new subdivisions annexed west of Hillcrest along the north side were also zoned Dwelling or Apartment (Fig. 14). Dona Park was zoned single family once it was annexed in 1948 (Zoning Ordinance, 1948).

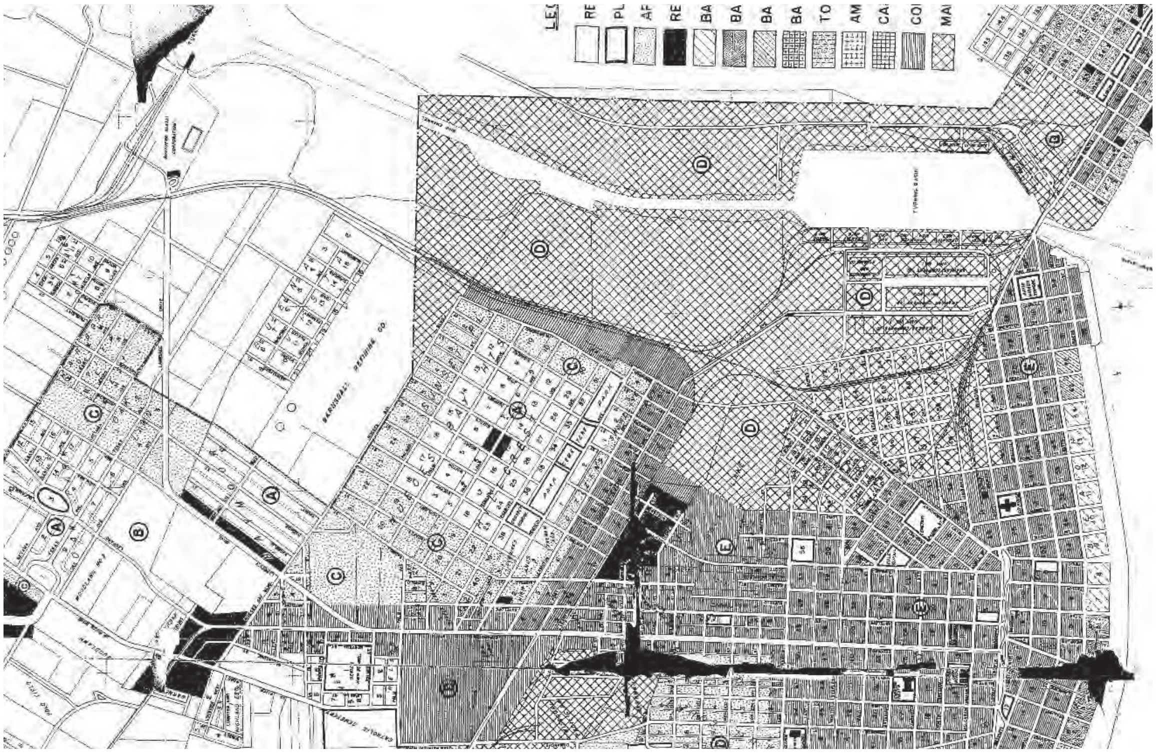

Figure 14. 1939 zoning map (Corpus Christi Zoning Map, 1939).

New zoning changes and public housing investment in the 1940s made it clear that living relatively near industry did not concern decision makers. In fact, as discussed above, the Corpus Christi Housing Authority favored locating housing for industrial workers close to their employment (Housing Authority of the City of Corpus Christi, 1944). The 1940s brought three new public housing projects to Corpus Christi, one of which was D.N. Leathers for the African American population in Washington-Coles (Corpus Christi Caller Times, 1941). With the addition of D.N Leathers, multi-family dwellings, hospitals, and churches were also added to the neighborhood's zoning map, among other uses. Land along Port Avenue was zoned Heavy Industrial, which expressly prohibited housing (Fig. 15). Further in the neighborhood, land was zoned light industrial, which allowed all other uses in previous classifications except Heavy Industrial. The eastern half of the neighborhood was zoned for multi-family dwellings and commercial activity.

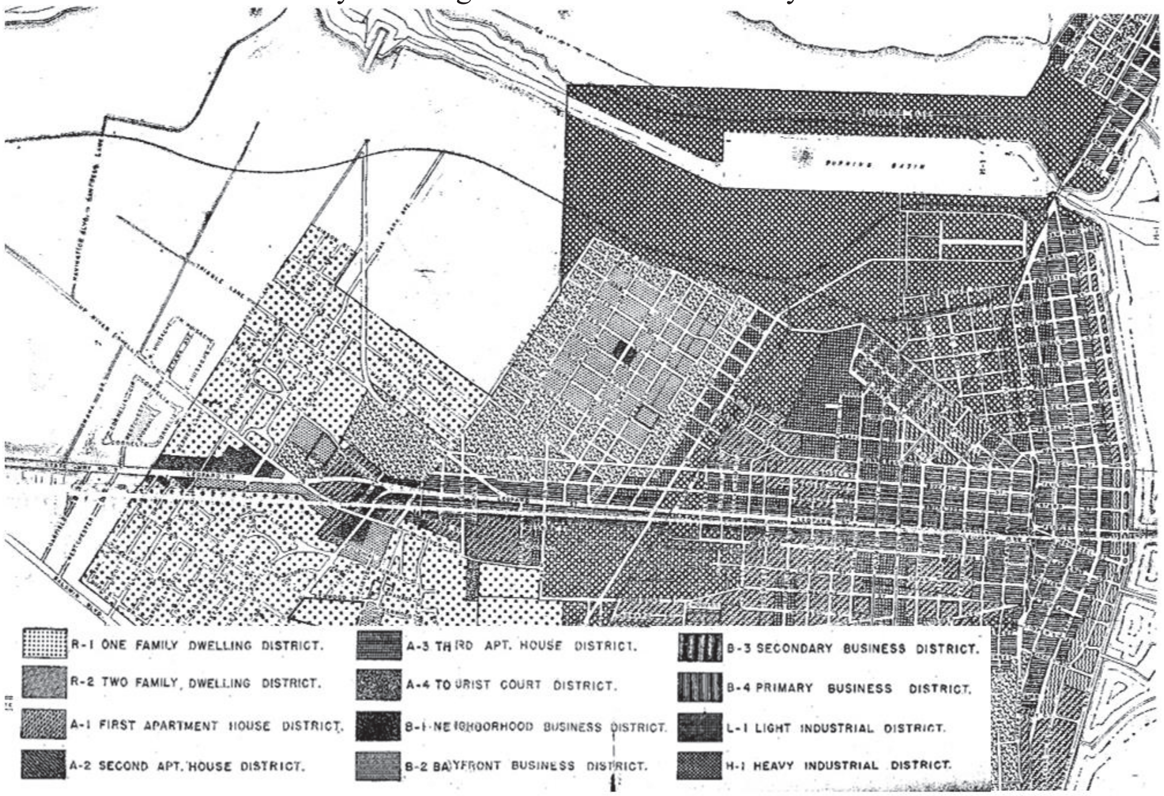

Figure 15. 1948 zoning map (Corpus Christi Zoning Map, 1948).

Although slum clearance was a component of the public housing projects in the 1940s, plans for Urban Renewal in Corpus Christi occurred primarily in the 1950s. A planner from the National Resources Planning Board was funded by the most powerful people in the city (including the mayor, bank president, head of Southern Alkali Corporation, real estate board members, and oil and gas representatives) to create a plan to demonstrate the effectiveness of the federal urban redevelopment program (Weiss, 1980). The city encouraged a citizen group to be formed by those who donated to the study in order to ensure the plan would not be shelved after completion (Corpus Christi Caller

Times, 1950). Yet, NRPB was notorious for neglecting to solicit participation from minority and low-income residents, especially groups who would be impacted by their plans (Weiss, 1980).

Expressway plans announced in the 1940s spurred more planning for slum clearance. In 1955, the city sought federal funding to plan the redevelopment in Washington-Coles that would impact 1,500 households (Corpus Christi Caller Times, 1955). The next year, federal funding for the redevelopment plan was approved, making Corpus Christ was the first city in Texas to obtain federal urban renewal funding (Corpus Christi Caller Times, 1956). FHA loans would be offered to residents displaced by the development, while a "trailblazing" project from the National Association of Home Builders built an undetermined number of "low-cost" homes (Lakeland Ledger, 1956). The 1957 zoning map showed the extent of highway construction and displacement, but no major differences in zoning classifications for north side neighborhoods (Fig. 16; Corpus Christi Zoning Map, 1957).

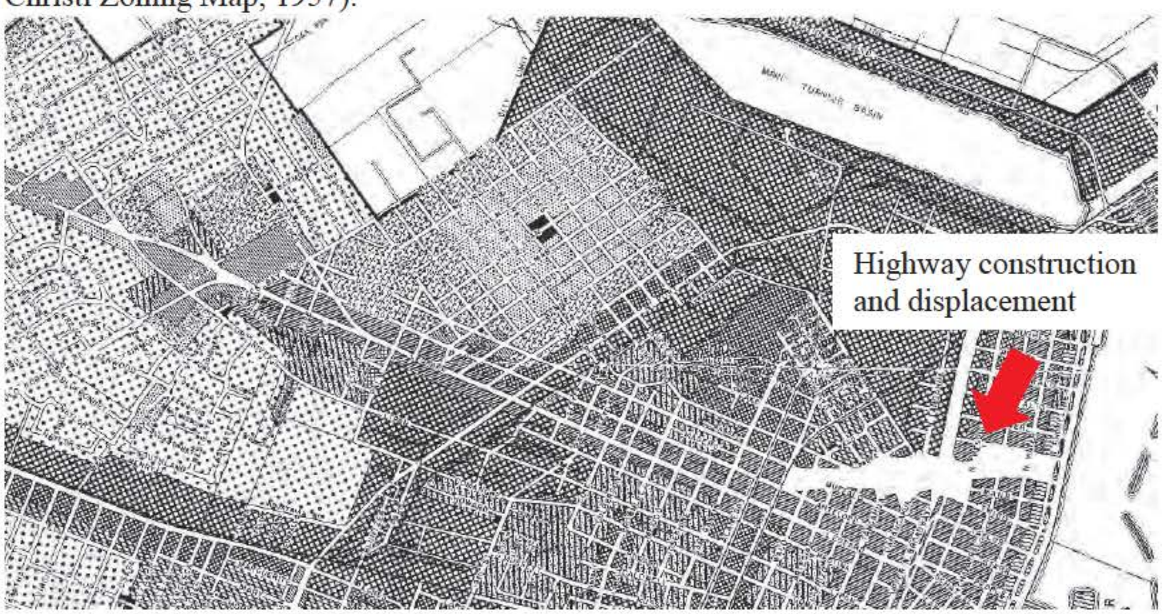

Figure 16. 1957 zoning map (Corpus Christi Zoning Map, 1957).

In 1953, the first comprehensive plan adopted by the City of Corpus Christi provided concrete strategies to rehabilitate the north side, but these strategies were not codified in the zoning ordinance that followed (Harland Bartholomew and Associates, 1953). Among other strategies, the plan recommended creating an amortization scheme to eliminate scattered commercial and industrial buildings in neighborhoods, protect neighborhoods through more restrictive zoning, and redevelop areas that cannot be rehabilitated (Harland Bartholomew and Associates, 1953). The zoning map, however, expanded I-2 Light Industrial district further east into the Washington-Coles neighborhood. I-2 districts allowed for all nested uses as well, including residential uses, which resulted in the same mix of commercial and light industrial uses among low-density residential uses, the exact problem the comprehensive plan sought to eliminate. Only after the 1975 zoning ordinance were dwellings and permanent or temporary housing of people finally excluded in light industrial zones (Zoning Ordinance, 1975). The zoning ordinance also required objectionable uses in I-3 Heavy Industrial districts, such as petroleum refining, to attend a board hearing before expansion. However, facilities in the large, established I-3 district located immediately north of the north side neighborhoods were exempt from this process (Zoning Ordinance, 1961).

In an effort to reenergize the economy during a growth plateau in the 1960s, the City created another comprehensive plan, which recommended the expansion of heavy industrial facilities in the north side (Lessoff, 2008). The downtown element of the plan designated the area immediately east of Washington-Coles for heavy industrial use due to proximity to the freeway and existing industrial facilities. However, only 1-2 blocks were currently used by industrial facilities in that area (Harland Bartholomew and Associates, 1966). The land use element of the comprehensive plan recommended expanding the industrial district west and south of Dona Park (Harland Bartholomew and Associates, 1966). At a neighborhood level on the north side, single-family housing was allowed to persist south of the industrial district and multifamily housing was emphasized for Washington-Coles. Parks were expanded or added for every neighborhood in the city.

The housing element of the plan shifted the burden of improving slum-like conditions to communities, recommending they establish neighborhood improvement associations to support redevelopment. Washington-Coles had been an "obsolete area requiring redevelopment" since before 1950 while Hillcrest had only become blighted by 1960 (Harland Bartholomew and Associates, 1966). Urban renewal principles of displacement and redevelopment were still largely recommendations in the new comprehensive plan, but neighborhood associations were emphasized as vehicles for the protection of existing neighborhoods from further decline in property values. Code enforcement was suggested for blighted areas such as Hillcrest. There was also considerable emphasis on community involvement through informing and involving neighborhoods in the process. However, the consultants note that recommendations in the plan are only the beginning of the program and will not have a major impact on slum areas.

The 1980 comprehensive plan was the first to explicitly require buffers and screening when industrial and commercial facilities were near residential areas. When areas were converted from residential to industrial activity (as was often the case after a buyout), the plan recommended "actions" be taken to protect the remaining residents on the north side, but no specific actions were identified. The plan noted that developing industrial areas were not suitable for long-term housing, thus making a judgement that housing should eventually be removed from the north side. However, there was no mention of how this would be accomplished. The plan acknowledged that the cumulative nature of zoning classifications in Corpus Christi was not preventing low-density residential and intensive commercial/industrial uses from being placed near each other. Therefore, the plan called for a phasing out of the cumulative zoning ordinance and its replacement with more exclusive zoning classifications.

In 1989, the Westside Area Development Plan grouped Hillcrest and Washington-Coles with the industrial westside rather than the neighboring central business district. The plan called for buffers between industrial land use and residential land use, as well as screening, landscaping, and industrial property layout strategies to reduce adverse impacts for residential areas. The plan also identified Hillcrest and Washington-Coles as a priority area for a Targeted Code Enforcement Program to be initiated by a citizen/staff task force that would identify structures in need of code enforcement, as well as non-conforming uses and areas needing street clean-up (City of Corpus Christi, 1989).

In 1998, city planners proposed the first redevelopment plan conducted by the City's planners to provide concrete recommendations in a spatial format to address industrial impacts on the community. However, it was not adopted by City Council. First, the plan recommended three transitional buffer zones, shown in Figure 17 as A, B, and C. Areas A and C were to be used for commercial use, while Area B was offered by industrial firms as an area for outdoor storage. Other recommendations included rezoning parcels immediately north of Hillcrest from heavy industrial to light industrial (the current use at that time). Apartments north of Hillcrest were to be rezoned light industrial to remove residents from this transitional area. The plan also offered visual screening around most of the perimeter of Hillcrest. Rezones along Port Avenue were also recommended, changing zoning designations from heavy industrial to business and light industrial uses. Although this plan was not adopted, by 2000 some of these changes occurred, including the two-block wide buffer proposed by Koch Industries. However, the recommended rezonings were never implemented.

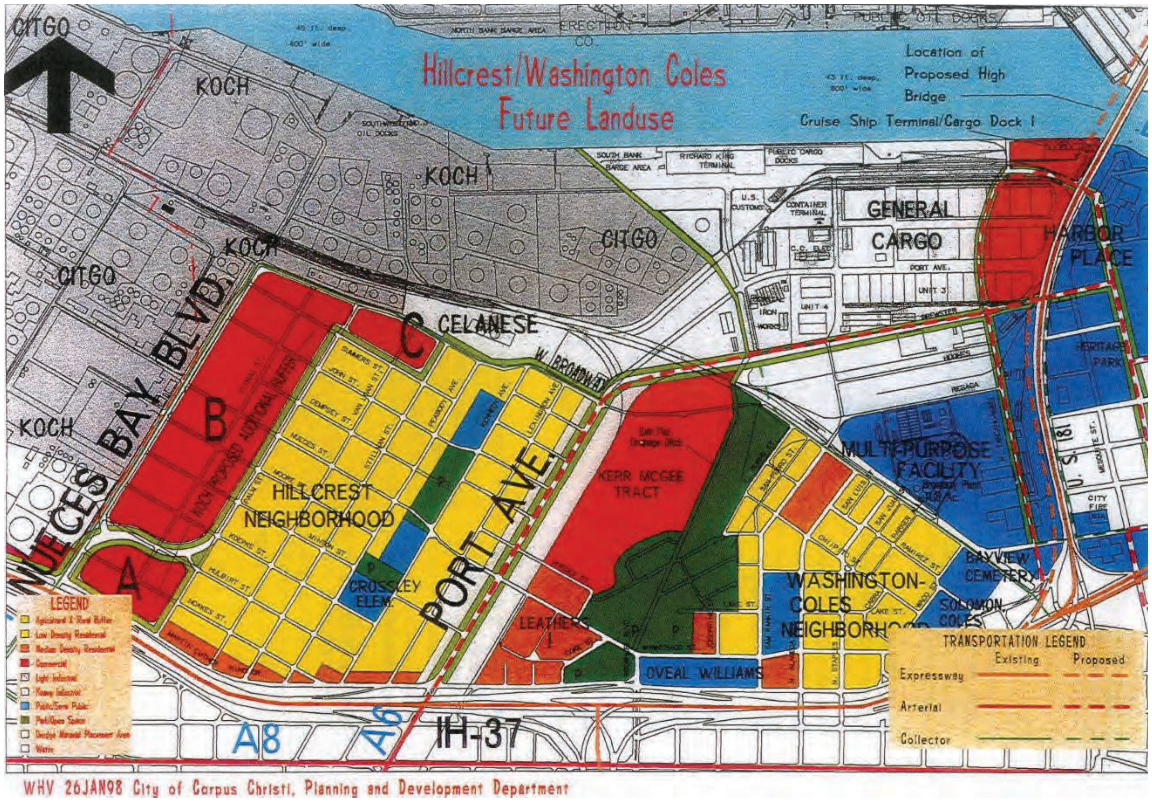

Figure 17. Future land use map (City of Corpus Christi, 1998).

For Washington-Coles, the redevelopment plan recommended a massive park along the old salt lake tract that has only been suitable for drainage. The plan noted that if the tank farm (Kerr McGee tract) could have its groundwater contamination remediated, portions of the site could be used for open space and business incubators (City of Corpus Christi, 1998). East of the neighborhood, the City's wastewater treatment plant was scheduled for closure by 2004. The planners recommended a multi-purpose facility or outdoor recreation center for the site to help connect the neighborhoods to the successful recreation and tourism sites downtown, such as Heritage Park and festival areas. Further tourism and visitor uses were recommended between downtown and Washington-Coles.

In 2003, city planners worked with business, religious and civic leaders on the north side to create another redevelopment plan that would rezone residential property to light industrial, by creating a research and technology park (Ross, 2003). Washington-Coles would be rezoned for neighborhood business, allowing a mix of commercial uses (Fig. 18).

Since the land was valued higher as a commercial or industrial use, rezoning residential areas could raise property values for residents and provide them with higher buyout offers. Figure 18 shows the future land use map from the plan, the dashed black lines indicating proposed routes for the new Harbor Bridge. The plan was never implemented, possibly due to a glaring omission in the city's participatory process. No residents physically living in the neighborhood were engaged in the plan. Planners believed the residents were only going to be satisfied if a buyout was proposed (Ross, 2003). Moreover, the plan lacked the political support and leadership needed to be implemented.

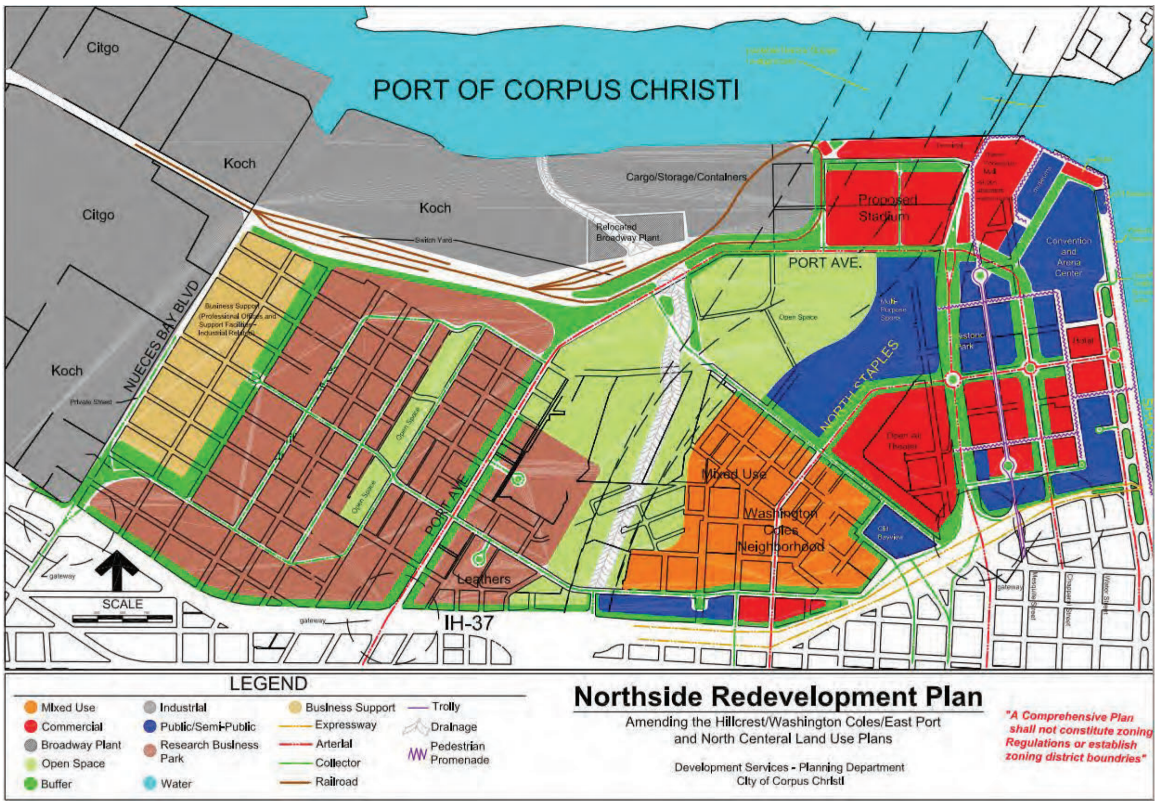

Figure 18. Unadopted future land use map, 2003.

In 2008, the city hired a consultant to do yet another redevelopment plan for the north side neighborhoods. The plan was not adopted and instead criticized because it relied heavily on private investment to spur growth (Wilson, 2008). However, the plan did have some interesting elements. It recommended increasing the buffer zone between the refineries and Hillcrest, as well as consolidating and relocating certain occupied homes to a core area within the neighborhood. Additional homes could be built with the help of Habitat for Humanity. The plan also recommended a different route for the Harbor Bridge, putting the highway between Hillcrest and the industrial sites to the west, which would provide for an addition barrier between the neighborhood and industry.

An adopted future land use map created in 2010 show little impact of city planning efforts in the north side neighborhoods. Some aspects in Figure 19, eliminate existing buffers created by industry, such as the two-blocks of vacant land that Koch bought in 2000. Current zoning for the buffer is still for single family and multi-family uses.

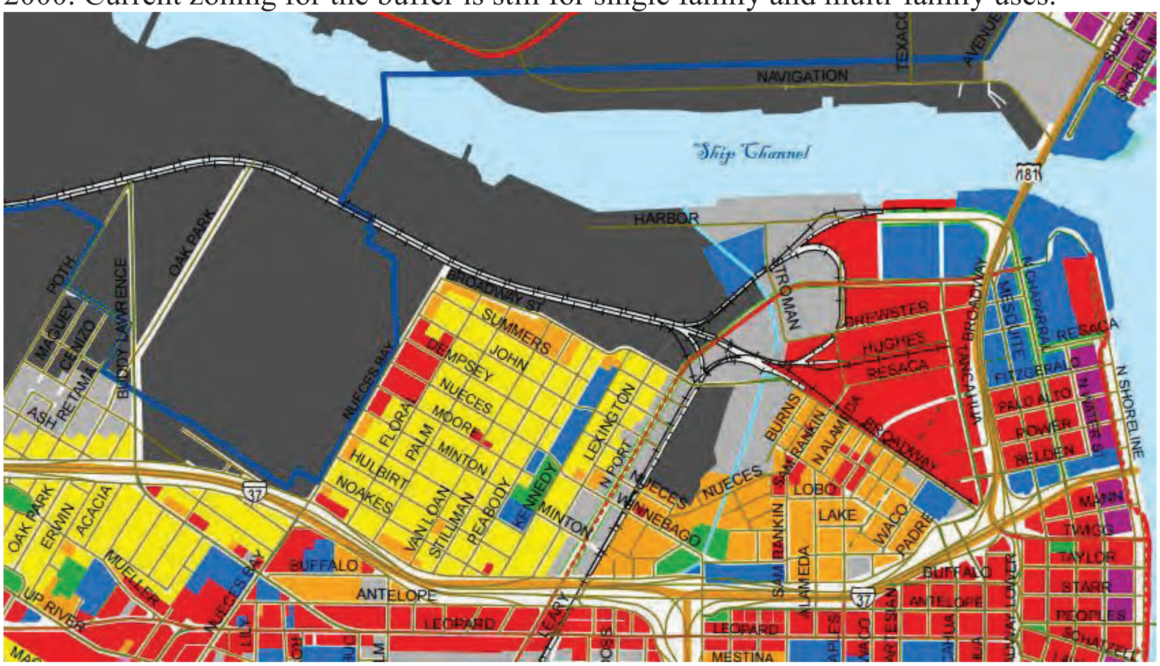

Figure 19. Adopted future Land Use Map (City of Corpus Christi, 2010).

Another Central Business District Area Plan was created and adopted in 2013, this time including Hillcrest and Washington-Coles as part of the CBD planning area, which seems to illustrate a new vision for these neighborhoods when compared to previous plans. The future land use map primarily emphasized mixed use and higher density residential. In

Washington-Coles, the plan called for non-residential mixed use and office in parcels closer to downtown. A large park was called for within the neighborhood as well. In Hillcrest, medium-density residential was added, as well as several parcels of non-residential mixed use and office space (Fig. 20). Additional parks are recommended in the northwest corner of the neighborhood. However, the existing open space buffers would be commercial, light industrial, and office uses. The plan also allows one large parcel north of Hillcrest to remain heavy industrial (dark gray).

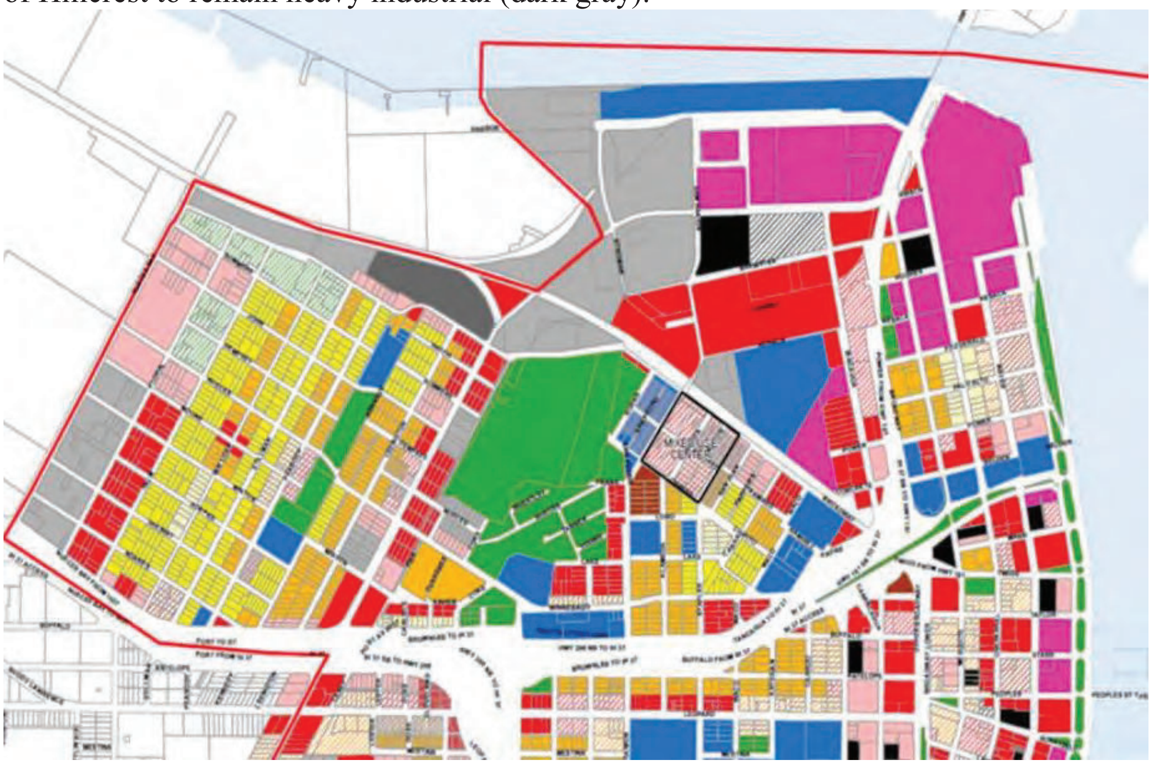

Figure 20. Future land use in the Central Business District (City of Corpus Christi, 2013).

The City of Corpus Christi transitioned to a unified development code in 2011, replacing all previous zoning ordinances with one code (City of Corpus Christi, 2011). Corpus Christi's zoning classifications today are more specific and still provide for a variety of uses and building types. However, little has changed when applied to the north side neighborhoods. In Hillcrest, the west buffer created by industry is zoned single family, general commercial (limited), and office (Fig. 21). Parcels immediately to the north of the neighborhood are still zoned heavy industrial, as are parcels on the east side of Port Avenue and the Kerr McGee tract. The vast majority of Washington-Coles is zoned for various types of multifamily residential with some individual parcels designated neighborhood commercial. Light industrial still exists in both of these communities, but it is relegated to major arterials around the community or along Port Avenue.

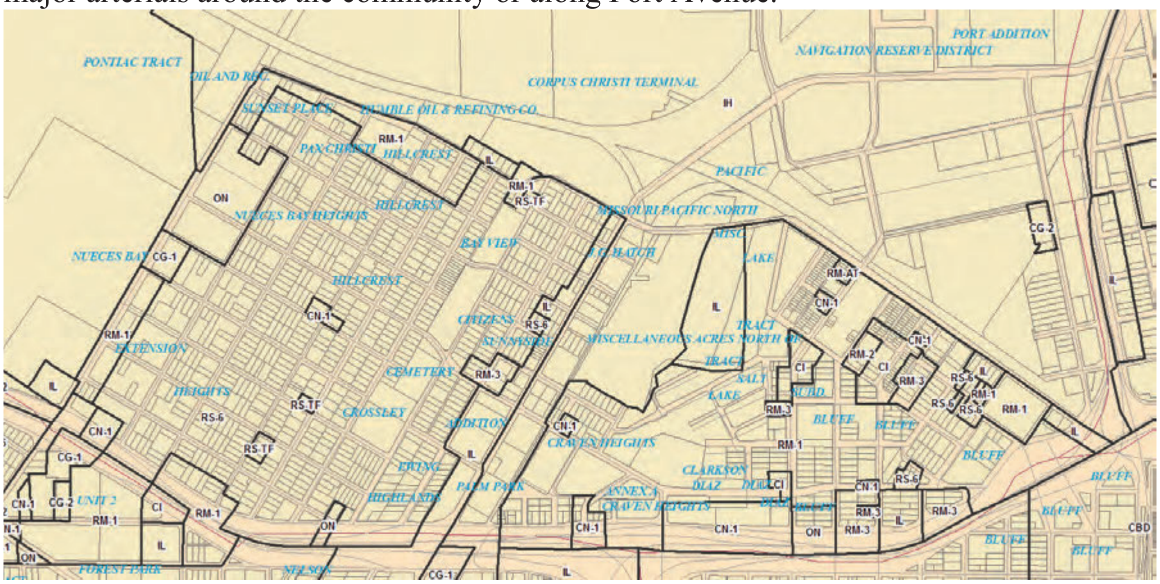

Figure 21. Current zoning (City of Corpus Christi, 2014).

Maintaining a stable planning department has been a challenge for the City and has had implications for north side communities throughout history. In 1945, the planning engineer and planning department assistants quit when the mayor unexpectedly (and illegally) replaced all members of the city's planning commission (Bynum, 1945). The department left a lot of work behind, including a plan to address the problem of manufacturing and industrial use in the "negro residential sections, which are converging upon each other to the saturation point." It took over a year to reinstate the planning department (Caller Times, 1945). In the recent past, history seems to have repeated itself. In 2013, City Manager Ron Olson was concerned with completing a new comprehensive plan as fast as possible. Olson contracted a consulting firm to lead the planning process and, in turn, laid off nine planners. The planning department was absorbed by other municipal departments (Dietrichson, 2013). Planning in Corpus Christi continues to be absent at times when some communities need it the most.

Chapter 5: Conclusion

City planning and zoning actions have had some role in the minority neighborhood's proximity to environmental hazards and the current situation of environmental injustice. Early zoning encouraged industrial growth on the north side, particularly in Washington-Coles, which contained established Mexican-American and African American neighborhoods before the industrial boom. During Jim Crow era housing segregation, African Americans were only allowed to live in undesirable areas, such as near industrial uses and the airport. The City displaced blocks of residents to make way for the Interstate highway in the 1950s and 60s. Comprehensive plans up until the 1980s implied that the north side was more suitable for industrial uses than existing residential uses. Industrial growth followed and expanded into the city from the industrial district, further encroaching on residential homes.

As industrial growth crept into the neighborhoods, the city took neither a proactive nor reactive zoning approach to relocate or restrict housing growth on the north side and protect minority neighborhood home values, as well as general public health and safety. No buffer zones were attempted on behalf of the city even though they were recommended in adopted general plans and unapproved area plans. Buffers that have been established in the north side were created through residential buyouts by industrial facilities. Industrial districts agreements have prevented the city from annexing the industrial facilities, making the city incapable of any zoning and planning interventions around the neighborhoods. The neighborhoods have been left by the city to determine their own fate, as they have been for decades, since plans to fully revitalize or relocate the neighborhoods have never received the political support needed to reach implementation.

Recommendations

Despite the bleak past and present of the north side, there are still some opportunities for change. The City of Corpus Christi could adopt progressive policies to reduce the burden on residential communities near the industrial district. As mentioned in the literature review, cumulative impact screening could be used to shift the burden of demonstrating cumulative effects of pollution from the communities to local government or industry by requiring new industrial expansion or relocation to demonstrate they will not cause an adverse cumulative impact to receive a permit (Morello-Frosch et al., 2011).

The Industrial District Agreement is another opportunity for the community. Since Texas cities do not have zoning power in their ETJs, the agreement could be used to negotiate with industries in the district to devote some of the funds they pay to the city instead to adjacent residential communities to either revitalize the area or move out. The City should work with the residents of the north side to decide how to spend the funds. Examples might include renovations, buyouts, economic development, or additional screening and landscaping for the community. Although the agreement has already been renewed this year, the fund may not explicitly need to be addressed in the industrial district agreement. The City could instead channel a portion of the taxes from the industrial district to fund revitalization in neighboring communities.

Perhaps a more idealistic recommendation is to develop and adopt a comprehensive community plan to address environmental injustice, public health problems, crime, and blight in the north side. With TxDOT's recent decision to realign the Harbor Bridge through Washington-Coles, the City is already thinking of ways to redevelop and reconnect the eastern portion of the neighborhood to downtown. Now is an ideal time to create a plan informed by the history of the north side and ensure that any redevelopment will benefit those who live there. Reviewing previous plans illustrated several lessons learned by city planners and city officials regarding planmaking:

≠ Community relocation and revitalization. For public health reasons, Hillcrest should not remain where it is. It will also only become more isolated after the new Harbor Bridge is built. Since the city will be reinvesting in the portion of Washington-Coles nearest to downtown (east of the proposed bridge), existing north side residents should be relocated there in a planned community.

≠ The planning process must provide deep and meaningful participation for residents who will be affected by the plan.

≠ There must also be a willingness on behalf of decision makers to adopt a plan backed by residents. With these lessons in mind, a community plan could be created to direct investment to the community in an equitable way.

A community plan should include several components:

≠ Historic preservation and designation. The African American population is shrinking in many Texas cities, but that does not mean their history should be forgotten and destroyed. More needs to be done to preserve the memories of long-time residents and the work that leaders of these communities have done to preserve what is left of these communities.

≠ Mixed use and neighborhood commercial, similar to what existed in Washington-Coles' heyday. A walkable, vibrant historic community near downtown would be an attraction in and of itself.

≠ Mixed-income and subsidized affordable housing. Future development should ensure the existing community will have the ability to stay if they wish to retain the character and cultural identity of the community. Nonprofit developers could aid in this endeavor. Low-income housing tax credits projects could also be considered if the area is considered a community revitalization area.

≠ Community development to provide youth development activities, crime watch, and neighborhood beautification developed by the community and supported in part by the city. The City tried to do this in the 1990s by suggesting extensive rezoning, but the community engagement process was severely lacking and there was still a lack of political will to implement the plan.

There is still a question of who should initiate the plan. Industry is unlikely to have a reason to initiate a community plan, as they have said they do not have interests in expanding or buying out any more properties (Wilson, 2008). The city could initiate the planning process but the process should resemble a partnership with the community. The community, with the most to lose, is likely the best to initiate this planning process. North side communities can increase their capacity by starting a non-profit to gain access to grants and donations. Capacity could also be increased by partnering with community organizers, a planning consulting firm and/or the city planning department to create a plan of action for the community. No matter who initiates the plan, city decision makers should be incorporated into the planning process to help ensure the plan will not be undermined in the future and will be an adopted plan recognized by City Council.

North side community leaders and organizations should look for inspiration in communities who have organized for better neighborhood conditions after being marginalized for decades:

≠ Colony Park is a neighborhood in Austin suffering from concentrated poverty, failing schools, and a lack of jobs and neighborhood amenities such as grocery stores, parks and public transportation (Beeler, Kim & Peris, 2014). When the City of Austin received a HUD Sustainable Communities planning grant, the community partnered with the city and urban design firm Farr Associates to create a master plan (City of Austin, 2013). The plan was adopted in late 2014 by City Council. Since then, Colony Park has started a community development corporation to continue to give an organized voice to their community. They also worked with the City to create an implementation plan to ensure future community input in the implementation of the master plan (City of Austin, 2014).

≠ The Dudley Street Neighborhood Initiative grew out of the Roxbury/North Dorchester neighborhoods in Boston to address arson, dumping, and disinvestment in their community (DSNI, n.d.). The community organized around persistent issues in the community, at first focusing on small, winnable goals such as cleaning up vacant lots and working with the city to ensure lots stay clean. DSNI has since developed affordable housing on vacant lots in their community and created dozens of partnerships with other nonprofits, businesses, religious organizations, and government agencies to revitalize their community and retain its character (DSNI, n.d.).

FUTURE RESEARCH

Other researchers who have conducted similar historical analyses of city documents and their contribution to environmental inequity, such as Boone and Modarres (1999), recognize that industrial siting has more components than the city's zoning and land use policies. In addition to land use and zoning, researchers recommend a thorough examination of historical economic development incentives and activities. Future research could document economic development activities undertaken by the City and Chamber of Commerce to better understand how the city may have had marketed and incentivized industrial uses in and near minority communities.

Future reports could also focus on a participatory strategy for the north side neighborhoods. A researcher could design an effective engagement strategy to create a plan for the north side and build relationships between the community and the city in the process. Mediation between the communities, planners, decision makers, and industrial representatives may also be valuable to reduce tensions and move toward an agreed solution for the north side.

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EXHIBIT 4

Corpus Christi Caller

Record-Breaking Storm Blasts at Midcontinent

Twisters, Hard Cold Hit State

7 Dead In Winds, Traffic

Year's Delay Seen If 37 Is Rerouted

CofC Unit Endorses State Plan

ONLY SMALL SEGMENT INVOLVED

3 Groups Favor Alternate

Reds Reaffirm Plan To Force Western Forces From Berlin

NEWS REVIEW

Hale-Aikin Unit Urges More Pay

Baby Dies After Head Hits Table

Politically Mixed Group Quietly Seizes Sudan

High of 58-61 Expected Today

SEPARATE TREATIES

Reds Offer New Nuclear Gambit

THREE-YEAR MORATORIUM IS URGED

AF Fires Atlas ICBM At 3,000-Mile Target

Johnson Tells U. N. Space Plan Bipartisan

DELAY

PAY

COMMITTEE TO PROTEST 37 ROUTE

STORM

SUDAN

Installation For Kiwanis

NUCLEAR

BERLIN

WEATHER

SCHOOLS

Boston Man, 93, Charged With Assault

ATLAS

Fun Night Slated By Nav-Y Club

Radio Insult to Nasser Brings 15-Year Term

Man Fined, Jailed

Burglary Charged

EXHIBIT 5

N VEMBER 15, 2008

Hillcrest and Washington Coles Areas Redevelopment Plan
Corpus Christi, Texas

Background

Civic design Associates was engaged by the City of Corpus Christi in early 2008 to prepare a redevelopment plan for the Northside area, defined as the area between I-37 and Broadway, east of Nueces Bay Boulevard. The area contains approximately 460 acres and encompasses the Hillcrest neignborhood on the west and the Washington Coles area on the east.

The area has been in a slow state of decline, cut off from the rest of the city by freeways, and with encroachment of industrial uses from the north and west.

The first phase of work was completed earlier this year and the results presented to City Council on 17 June 2008. The second phase of the work involved engaging the community in a series of workshop sessions to develop a redevelopment concept plan. This report will serve to summarize the results of these community meetings, held during July through September. This report and presentation serves as an interim milestone prior to the third and final phase of the project, which is to develop implementation strategies, a specific action plan, and a final report.

Planning Phase Report and Presentation

The planning phase centered on a series of public workshops held in July of 2008 at the Oveal Williams Senior Center. The series of three meetings, held over the course of a week, is known collectively as a charrette. All residents and property owners of the area were invited to these meetings. Several follow up meetings were held during August and September with the community Steering Committee to discuss and refine several aspects of the recommendations.

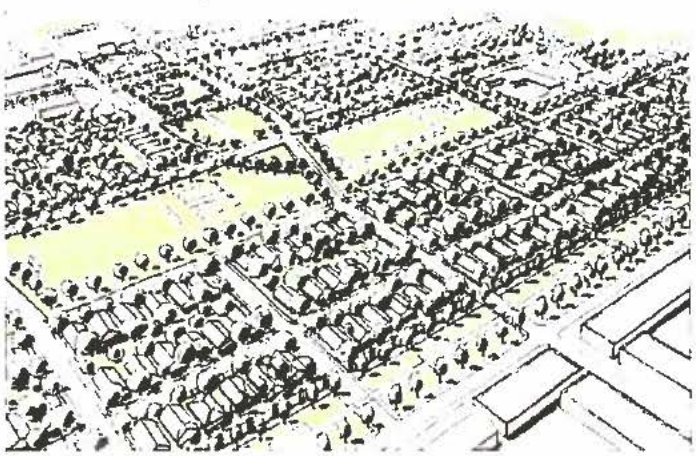
A summary of the events of the charrette week is as follows:

The first public meeting was held on Friday, 25 July, from 6:00 to 8:00 pm. This meeting was primarily an orientation session, designed to present background information and the results of the first phase research and evaluation. A community image survey was also conducted, where the participants were shown a series of images of different urban development situations, both good and bad, and asked to rate each image on a scale indicating their relative like or dislike of the image.

The second meeting is the public design workshop, the centerpiece of the public process. The participants are arranged in groups of 6-8 around a series of tables supplied with maps and aerial photographs of the study area. Each group spends time discussing the advantages and disadvantages of the area and brainstorming ideas for its positive transformation. The participants are encouraged to range freely and not be overly constrained with practical limitations; it is the consultant's task to take the resulting vision and align it with what is possible.

While many diverse ideas were presented, several broad, recurring themes did emerge:

- Revitalizing the Hillcrest neighborhood was an almost universal goal. This involved the obvious tasks of improving the existing housing stock and infilling vacant lots with compatible new units, improving the parks and cemeteries, and re-occupying the school. While these tasks are concerned with the core of the neighborhood, it had to be supported with complementary redevelopment at the edges of Hillcrest. These items are presented as separate items, following.



- Transitioning Port Avenue from predominantly industrial uses to a more diverse mix that includes community serving retail and commercial, and possibly even some higher density housing. As a primary access route to the ballpark and to the Bayfront Arts and Sciences Park, this would be an amenity for the city as well as the immediate neighborhoods.

- Putting the buffer zone between the neighborhood and the refineries to better use. There were two divergent lines of thought about that however: some felt that the area should be open park and recreation space, while others thought it could be used as a business park.

- The Washington Coles area should capitalize on its proximity to downtown, the Bayfront Arts and Sciences Park, and the ballpark. It should accommodate a lively mix of business and housing, offering an eclectic walkable, urban lifestyle.

- The eventual realignment of the harbor bridge approach offers an opportunity to re-connect the Coles area to downtown, and to change the character of the I-37 downtown approach to more of a boulevard.

- Although it is not in the immediate study area, the area around the ballpark should be intensified and redeveloped as an eclectic, arts oriented neighborhood of a character similar to the Washington Coles. This implies the relocation of several industrial and port related activities, possibly to open land north of Broadway and west of Port Avenue.

The vision articulated by the public is bold and transformational, but it must be seen in a long range context as a process that will unfold over a 15 to 20 year time horizon. Certain parts of it do involve a long term shift in use from industrial to a more urban mix of denser commercial and residential uses. While this will take time, there is an overall desire to revitalize the downtown that will eventually lead to positive spillover into the Washington Coles area.

The area that is expected to change the least is the Hillcrest neighborhood, yet it is probably the most immediate priority. Stabilizing the slow deterioration and turning it around with the addition of infill residential development and commercial businesses to serve the community is critical to changing the perceptions of the area. The vision for this area is essentially to return it to its former status as a stable, viable neighborhood. It will require a large number of small steps, but not a radical transformation. Nevertheless, it is no small task.

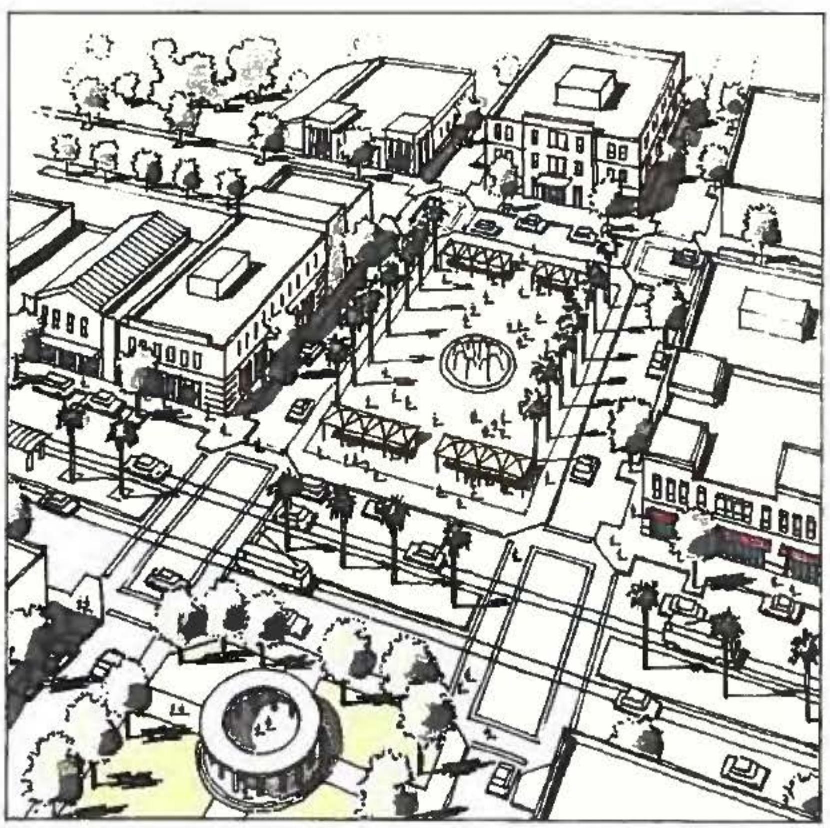
At present, Hillcrest is an isolated neighborhood, and it has been easy for the rest of the city to ignore it. It is cut off by highways and surrounded by industrial uses. The major street connecting it with the rest of the City is Port Avenue, and it must be reclaimed and converted to a more urban mix of uses in order for it serve as the commercial core of

Hillcrest. This will also make it a greater amenity for the entire city, since, as previously mentioned, it serves as an important connector to the ballpark and the Bayfront.

Obviously, this means that many of the industrial businesses currently occupying the area along Port Avenue will need to be relocated. While there are a few newer structures, notably Scott Electric, most of the current building stock is older and nearing the end of its useful life. Some of the businesses are quite successful, but their opportunities for expansion of their current facilities are limited. While a long term shift in uses here will pose some logistical challenges, many of these businesses are facing some difficult decisions in any case, and addressing these growth opportunities as part of a coordinated redevelopment effort will be beneficial to them.

One possibility that was advanced as a transitional strategy was to relocate some of the Port Avenue businesses to the open land comprising the buffer zone. This has the advantage of putting this land in productive use, with the attendant benefit of generating some new taxable value that could be dedicated to other revitalization activities in the neighborhood. However, this approach is not favored by all in the community; one contingent feels strongly that the buffer zone should remain as open space.

In any case, the proposed reclamation of Port Avenue as an urban boulevard acting as a commercial focus for the area enjoyed broad support. Port Avenue is directly contiguous to Hillcrest, but it would also serve the Washington Coles area. It should contain commercial uses that provide neighborhood services, such as groceries, cleaners, dry goods, etc., as well as restaurants, which would enjoy a broader market appeal due to the proximity to the ballpark.



From a design perspective, these uses should be accommodated in a more traditional urban setting, with buildings placed close to the sidewalk and parking de-emphasized by placing it behind the buildings. This is typical of the older development in and near downtown, and is a form that encourages walking and an active, diverse street life. It also provides opportunities for housing and small professional offices, which could be located on the upper stories of the buildings. There is even talk of some kind on transit service (possibly rail) to link the neighborhood, the ballpark, and other parts of the city; Port Avenue would be an ideal alignment for this.

As a neighborhood commercial and mixed use center, there ought to be some sort of civic focal point, such as a central plaza that concentrates activity, acts as an orienting device, and serves as the principal gateway into Hillcrest. The most logical location for this would be along Nueces Street, as this is one of the few streets that also connect eastward into Washington Coles. This does not need to be a large space, perhaps a city block or so, and can be primarily hardscape, in the manner of a Latin American plaza.

The existing Williams Park, located at the center of Hillcrest, provides more of the traditional passive green space activity. Ideally, it would be linked to the plaza on Port Avenue by an additional green space that acts to unify and connect the single-family core of Hillcrest with its activity center along Port Avenue.

The residential core of Hillcrest also needs attention, but this can be more incremental in nature. The existing housing stock needs to be renovated and improved and there are numerous vacant lots available for new development that should be done in a compatible fashion. Hillcrest was once a thriving neighborhood, and its traditional housing stock with its generous front porches is an appropriate model for new development. Front porches bring home life outside and engage it with the neighborhood, and also provide the enhanced safety of "eyes on the street" that keep undesirable activity away.

Enhancing visibility throughout the neighborhood will also enhance safety and discourage illegal activity. Filling in the vacant areas with additional housing, with an outward orientation will help. Adding sidewalks with adequate street lighting will also be beneficial. There are also some simple adjustments, such as removing the oleander hedge that lines part of the park and the cemeteries that will enhance visibility and contribute to neighborhood safety.

The area between Port Avenue and the core of Hillcrest, as it is reclaimed from industrial uses, will provide some opportunities for transitional uses, something between single-family homes and the three to four story mixed use buildings that are envisioned along Port Avenue. This would be an appropriate area for townhomes and smaller multi-family buildings. This will also help to diversify the housing stock and bring in a wider range of residents.

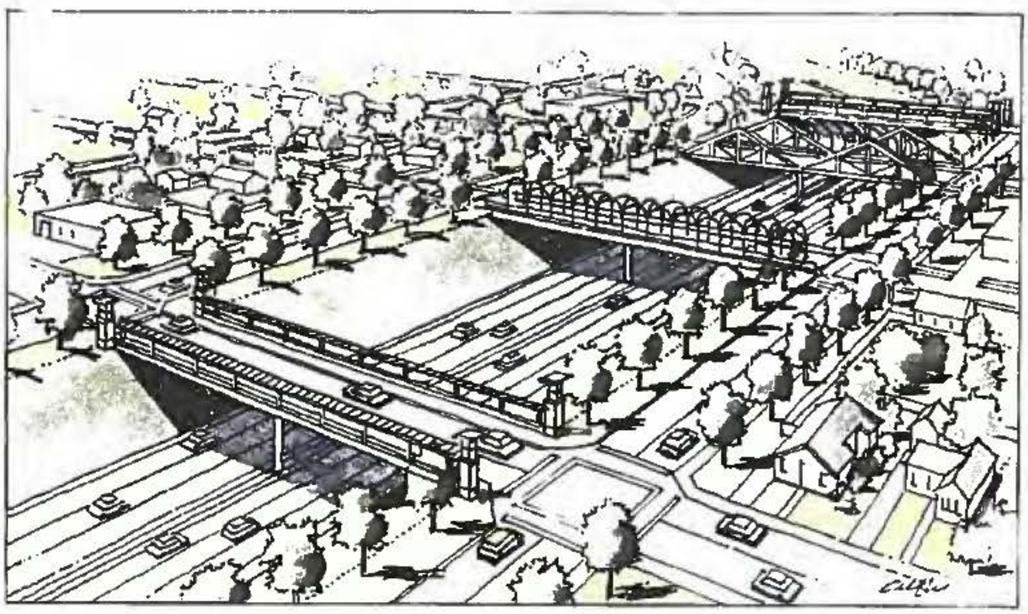
The short-term strategy, meaning the next five years or so, is to focus on the stabilization and turnaround of Hillcrest. Most of the effort in the early years will be within the neighborhood itself, as it will take time to gradually assemble enough property along Port Avenue to make a meaningful difference. Quite a bit of near term redevelopment activity is also possible in the Washington Coles area. This area offers several advantages over Hillcrest from a redevelopment perspective: it is closer to downtown and the bayfront, and conversely farther from the refineries that cast a figurative shadow over Hillcrest. Also, there is a larger concentration of multi-family rental property here, which is generally easier to assemble for redevelopment. Indeed, even a good portion of the single-family rental property is in the hands of a relative few owners. There are also several City owned parcels here, some of which can be easily made available for development.

The character envisioned for this area is as an eclectic, mixed use urban neighborhood that would accommodate a range of businesses and denser residential buildings. The proximity to the bayfront Arts complex suggests that the area could have a certain artistic, even bohemian flavor to it. The principal focus of the commercial uses should be along Staples Street, which is consistent with its historic nature. Indeed, some of the original commercial buildings are still in existence along Staples, and could be renovated as part of the redevelopment activity.

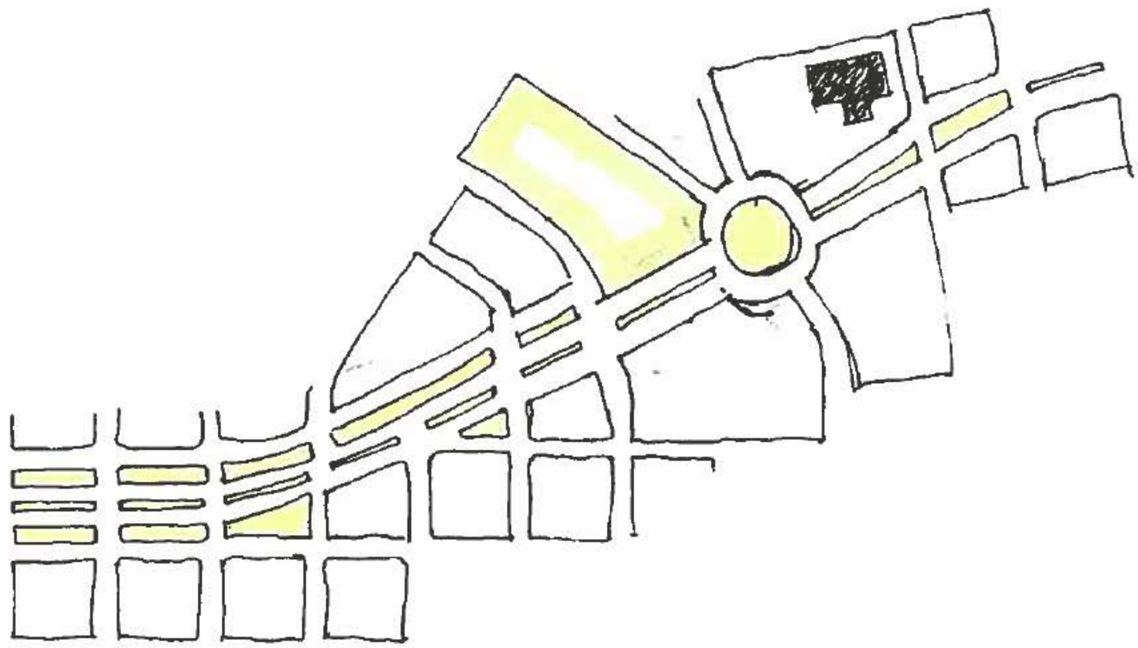
The Washington Coles area also contains several historic and cultural resources that should be taken better advantage of. ~~Washington~~ Coles High School and the Bayview cemetery should be focal points as well as neighborhood amenities. The old railroad depot should also be preserved and revitalized, perhaps even returned to its original purpose as a terminal for rail service to San Antonio and beyond.

While much redevelopment could occur in the Coles area in the near term, it will be the re-alignment of Highway 181 and the harbor bridge that will truly offer the opportunity to reconnect it to downtown. This project is currently on hold due to funding constraints, and could be as much as 15 years away. Yet, it offers tremendous potential to re-unite the Coles area with the bayfront and downtown. Much of the street grid that was severed by the intervention of the highway can be stitched back together.

The other potential offered by the bridge reconstruction is a re-assessment of the nature of the downtown leg of I-37. The preferred re-alignment of Highway 181 is to extend the current alignment of the Crosstown Expressway northward, carrying it over the low-lying salt flats that are between Hillcrest and Washington Coles. This eliminates the jog in the north-south route of Crosstown/181 and makes the intersection a fairly straightforward four-way intersection. Although the current design under study is a four-way interchange, it should be noted that the eastern leg of the crossing only continues for a few more blocks before it comes to a traffic signal near the bayfront. The added expense of dedicated ramps and turn lanes serving this leg do not accomplish much, in fact, they remove an opportunity to reconsider the treatment of this downtown leg. The main lanes of I-37 can be allowed to continue through below grade to their current endpoint, but any traffic coming from the north-south direction should revert to the surface service roads, which are, in effect, the old alignments of Antelope and Buffalo Streets. This allows the old street grid to be reconnected between Washington Coles and the Leopard Street area, making for a strong connection to the south as well.



This idea could be carried even a step further, transforming the I-37 main lanes east of the interchange to an at-grade boulevard, forming a grand entrance into downtown Corpus Christi. Besides allowing for a stronger connection between the northside and the downtown, this would also provide the opportunity to feature certain landmarks like the old Nueces County courthouse in a prominent civic setting.



Together, these concepts represent an ambitious agenda for the revitalization of a neglected, but strategically important part of the city. If Corpus Christi is to have a viable plan for a sustainable quality of life in the future, it will have to have a bold, but achievable vision for its future. Several positive trends are already in place. The city is actively looking to revitalize its downtown area, and the near downtown neighborhoods should provide complementary support for this effort. These areas offer convenient proximity to downtown and plenty of redevelopment opportunities.

The third phase of this redevelopment plan will explore these concepts in greater detail and, more importantly, begin to address the financial feasibility of the plan. Some market research has been done in this and surrounding areas, and while the growth trends are not strong as yet, they are nevertheless positive. Corpus Christi as a whole is exploring strategic growth opportunities, and the Hillcrest and Washington Coles areas should be a key part of this growth. A preliminary analysis of the city-wide growth trends indicates that if the study area could capture between three and five percent of the development activity within the city for the next 15 to 20 years, the aggregate amount of residential units, commercial space, and accompanying amenities would be enough to transform this area into a dense, divers, and vibrant neighborhood.

Three to five percent of the city's development activity may seem like an ambitious goal, considering that the area is currently attracting virtually no development, but it does align favorably with several broad trends in current urban development practice. Consider:

- The study area contains about 1% of the total area in the city. While the growth suggested is disproportionate, large parts of the city are stable and virtually built-out. Growth happens primarily at the edges.

- The proximity to downtown and the BASP will add momentum as redevelopment accelerates in those areas.

- The study area should be treated as a targeted redevelopment incentive zone, with specific programs and project intended to foster growth in the area.

- Most mature American cities are experiencing a new interest in their near-downtown areas as commutes get longer and gasoline gets more expensive. The evolution of a mature downtown life also provides a city with an alternative to the suburban lifestyle, which is proving to be increasingly attractive to many segments of the population.

The challenges are certainly considerable. On the other hand, this simply magnifies the extent of the opportunity for the Hillcrest and Washington Coles neighborhoods.

EXHIBIT 6

CENTRAL BUSINESS DEVELOPMENT PLAN

An Element of the Comprehensive Plan
Adopted May 21, 2013

CITY OF CORPUS CHRISTI CITY COUNCIL 2013

Mayor Nelda Martinez

David Loeb
At Large

Lillian Riojas
At Large

Mark Scott
At Large

Kelley Allen
District 1

Chad Magill
District 2

Priscilla Leal
District 3

Colleen McIntyre
District 4

Rudy Garza Jr.
District 5

Ron Olson
City Manager

CITY OF CORPUS CHRISTI PLANNING COMMISSION 2013

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Philip Ramirez
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Fred Braselton

Gabriel Guerra

Chris Hamilton

Marco Castillo

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Curtis Rock

CITY PLANNING & ENVIRONMENTAL SERVICES DEPARTMENT 2013

Oscar Martinez
Assistant City Manager

Pete Anaya, P.E.
Director

Faryce Goode-Macon
Assistant Director

CENTRAL BUSINESS PLANNING COMMITTEE MEMBERS

A special thank-you goes out to members of the Central Business Development Plan Planning Committee for giving their expertise, time, and hard work in the development of the Central Business Development Plan:

Bart Braselton: Residential Builder

Bryan Johnson: Real Estate Broker

Carl Weckenmann: Dir. of Planning, Regional Transit Authority

Chad Magill: Former Chair, Downtown Management District

Darlene Gregory: Chair, Uptown Neighborhood Initiative

Don Zimmermann: Liaison Officer, CC Naval Air Station Plans

George Clower: Commercial Realtor

Dr. Gilda Ramirez: Director of the Antonio E. Garcia Arts & Ed. Ctr., Westside Rep.

Hope Malkan: Business Owner

Jeff Pollack: HDR/City Integrated Community Sustainability Plan Coordinator

JJ Hart: Destination Bayfront Representative

John Bell: Commodore, CC Yacht Club

John Michael: Engineer/Consultant

John Tamez: City Planning Commissioner

John Vidaurri: Executive Director, Downtown Management District

Judy Lapointe: Six-Points Area Rep.

Tom Niskala: Dir. of Transportation Planning, Metropolitan Planning Org. Rep.

City Staff Committee Members

Peter Davidson: Superintendent, CC Marina

Dan Biles: Dir. of Engineering

Stacie Talbert: Asst. Dir. of Park & Recreation

Michelle Barrera: ACM Exec. Assist. / Special Projects, Business Support Services

Annika Gunning: Zoning Administrator, Business Support Services

Julio Dimas: Project Management, Business Support Services

Elena Buentello: Planning Technician, Comprehensive Planning

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Lisa Wargo: Senior City Planner, Comprehensive Planning

Mike Newberry: GIS Mapping Specialist

Jeremy Mecom: GIS Mapping Support

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APPLICATION

The Goal, Objectives, Policies, and Measurable Strategies of this plan supersedes the South Central Area Development Plan and all previous City plans for this area except for the Reinvestment Zone No. 1 Project Plan which shall remain in force until State law provides for the termination of Reinvestment Zone. In addition, this plan is an update to the original South Central Area Development Plan adopted May 21, 1991 and later updated in February 28, 1995 **and February 17, 2004.**

PURPOSE

The purpose of the Central Business Development Plan (CBDP) is to facilitate the development and redevelopment of the Central Business area by providing policies and measurable development standard strategies for the Central Business area, and the Central Business Future Land Use, Multi-Modal Transportation, and Urban Design Maps. The City's departments shall focus on those policies and standards throughout the planning, development review, building, and Planning Commission and City Council approval processes to ensure a balance of mixed residential, nonresidential, civic, tourist, cultural, educational, and recreational uses. Measurable Strategies provided should be reasonable enough to be accomplished within a period of 5 years from the date of adoption.

CURRENT CONDITIONS

2010 Census Data. The South Central area has experienced a significant decline in population over the last 40 years. In addition, the area has experienced a major exodus of retail businesses since the 1970s. The 2010 Census data for the Central Business Development Plan Area are outlined in the following tables:

Population of the City of Corpus Christi				
Total City Population	2000	2010	Change	% Change
	277,454	302,375	+24,921	9.00%

Central Business Plan Area Population				
Total Plan Area Population	2000	2010	Change	% Change
	13,238	12,406	-832	-6.28%

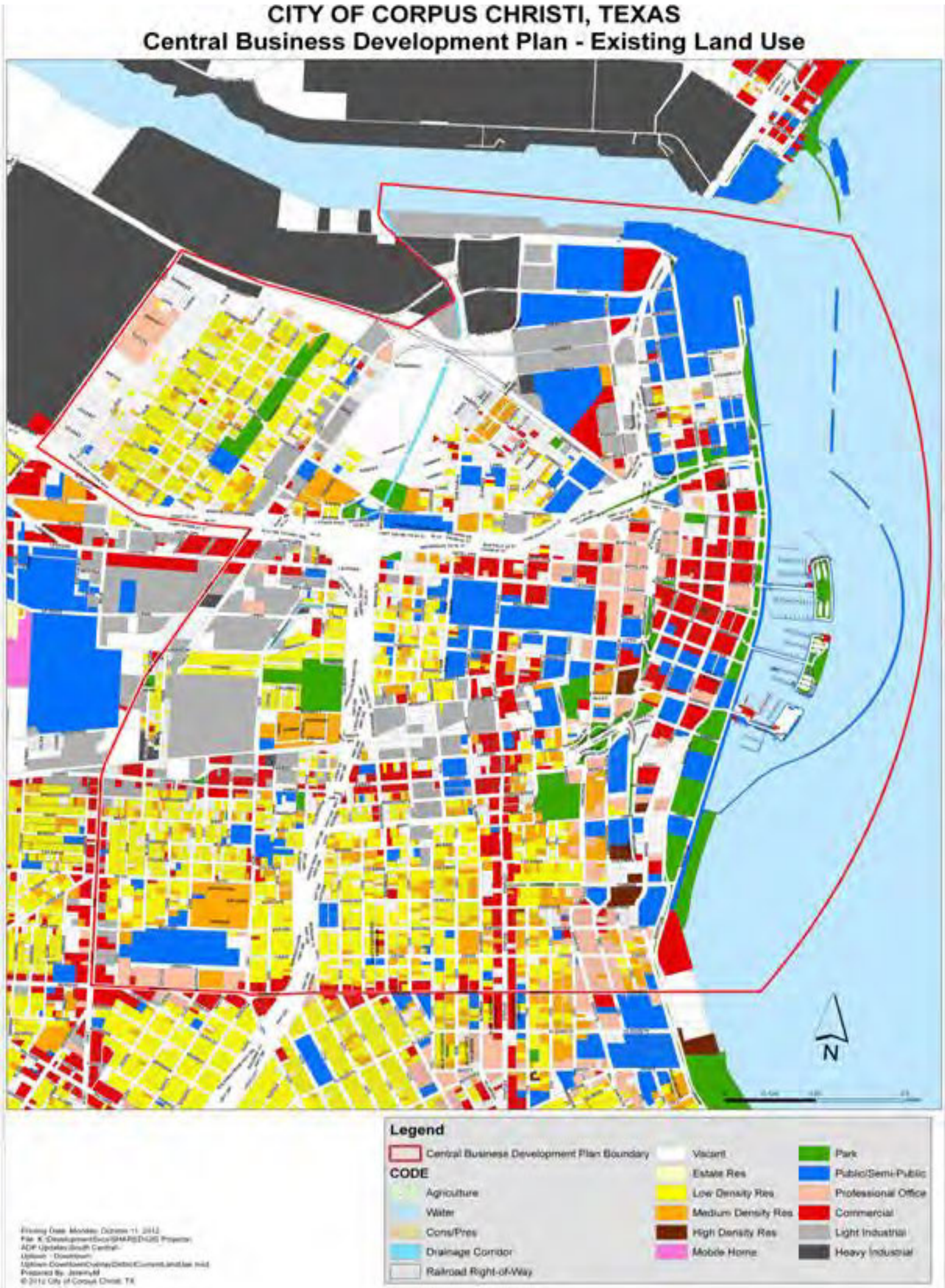
Central Business Plan Area Demographics				
Population By Gender	**2000**	**2010**	**Change**	**% Change**
Males	6,513	6,067	-446	-6.84%
Females	6,725	6,339	-386	-5.73%
Population By Race	**2000**	**2010**	**Change**	**% Change**
White alone	6,910	6,302	-608	-8.79%
Black alone	1,946	1,613	-333	-17.11%
American Indian alone	119	124	5	4.20%
Asian or Pacific Islander alone	53	50	-3	-5.66%
Hispanic (any race)	9,346	9,367	21	0.22%
Other Race	3,746	3,846	100	2.67%
Two or More Races	477	484	7	1.47%
Age Distribution	**2000**	**2010**	**Change**	**% Change**
24 years or younger	5,242	4,763	-479	-9.13%
25-34	1,747	1,625	-122	-6.98%
35-44	1,880	1,489	-391	-20.79%
45-54	1,496	1,551	55	3.67%
55-64	993	1,228	235	23.67%
65-84	1,509	1,352	-157	-10.40%
85+	357	409	52	14.56%
Educational Status (25 + yrs.)	**2000**	**2010**	**Change**	**% Change**
< 9th Grade	2,035	1,849	-186	-9.14%
9th - 12th Grade (no diploma)	1,257	1,559	302	24.03%
High School Graduate	1,495	2,346	851	56.92%
Some College (no degree)	861	1,100	239	27.75%
Associate Degree	205	313	108	52.68%
Bachelor Degree	221	267	46	20.81%
Masters or PHD	132	206	74	56.06%
Housing	**2000**	**2010**	**Change**	**% Change**
Total Housing Units	5,360	5,594	234	4.37%
Owner Occupied	1,211	1,124	-87	-7.18%
Renter Occupied	3,398	3,228	-170	-5.00%
Average Household Income	$23,523	$29,103	$5,580	23.72%
Median Household Income	$15,193	$18,701	$3,508	23.09%

Plan Boundaries. The Central Business Development Plan area consists of 4.64 square miles of area bounded by the City's Ship Channel to the north, the Corpus Christi bay to the east, Morgan Avenue to the south, and Port and Nueces Bay Avenues to the west. This area is depicted in Figure 1.

Figure 1. Central Business Plan Area Boundary

Current Land Use. The following map depicts the current land uses found within the Central Business Development Plan boundaries:

Figure 2. Current Land Uses.



GOAL

Promote the Central Business area as a thriving 24-hour, aesthetically pleasing mixed-use and pedestrian-oriented environment in which to live, work, play, conduct business, and promote the area as an active tourist destination.

OBJECTIVES, POLICES, AND MEASURABLE STRATEGIES

(LU) LAND USE

LAND USE CLASSIFICATIONS

The intent of the Central Business Future Land Use Plan is to demonstrate to potential purchasers or developers the City's long range view of how particular properties should be reconfigured and used should it become feasible to do so. In some cases the recommended future land use is the same as the existing land use. However, in certain locations throughout the planning area, the Central Business Future Land Use Map and special area or neighborhood plans contain parcels with existing uses that are proposed for a change in land use, or for redevelopment as part of a larger site.

Several Land Use definitions are provided to express future land uses for every parcel within the planning area to clearly state future expectations for development. Some classifications are very specific with regard to the type of uses and densities that are expected. Other classifications identify general categories of uses that will allow for varying degrees of flexibility for future development or adaptive reuse of existing structures. These classifications are used in locations that have been identified as appropriate for mixed use development or to promote co-location of compatible uses. The size and location of individual development sites may result in different mixtures of uses and densities. For many parts of the City that remain undeveloped or for which redevelopment is expected, Special Area (Neighborhood) Development Plans have been created to provide an additional level of detail for planning and design recommendations, including descriptions of planned mixed use areas.

RESIDENTIAL CLASSIFICATIONS

Rural Residential (0.5 – 1.0 du/ac)

Homes under this land use designation may consist of single-family structures on larger lots ranging from .5 or more acres, or in developments that preserve open space and natural features by concentrating development in open areas.

Suburban Residential – Low Density (1.0 – 5 du/ac)

Residences are primarily composed of single-family dwellings on lot sizes that commonly average 0.25-acre, including attached or detached traditional single-family homes, T-court homes, or cottage homes.

Suburban / Urban Residential – Medium Density (6– 15 du/ac)

Housing types are generally urban single-family units, primarily attached or detached brownstones and townhomes, rowhomes, and detached cluster housing, T-court homes, patio/courtyard homes and where density incentives are met, cottage homes.

Urban Residential – High Density (15+ du/ac)

Housing types are typified by multi-family units such as apartments, condominiums, courtyard apartments, and lofts.

MIXED-USE CLASSIFICATIONS

Mixed Land Uses integrate a broad range of housing within neighborhoods that allow for greater housing choices particularly for younger and older age groups. This classification is intended to provide market flexibility to allow for a wider range of housing choices, while providing basic daily and necessary commercial and office services to the residents of the neighborhood or community within walking (pedestrian-oriented) distance and/or transit service. Smaller sites may include a single housing type, appropriately scaled to the surrounding development context, and consistent with Future Land Use Plan recommendations where applicable. Larger sites are expected to incorporate a mix of housing types and to be designed to look, feel and function as a cohesive neighborhood. Uses are integrated in both a horizontal (side-by-side) and vertical (one use located above another) basis. This classification is further defined as follows:

Neighborhood Mixed Residential Use– Low Density

This land use is intended to provide a mix of housing options and transition from existing single-family neighborhoods at a typical density of 1.0 - 4 du/ac. Neighborhood Mixed Uses are intended to provide daily retail uses and personal services for the convenience of neighborhoods in which they are located, within a reasonably short distance. Building heights generally range from one to two stories, consistent with surrounding residential development. All neighborhood mixed use projects must be planned and built in accordance with Section 7.11 of the Unified Development Code.

Mixed Residential – Medium Density

This land use includes areas developed with greater walkability and pedestrian orientation attributes, at a typical density of 5.0 - 15 du/ac. Building heights generally range from one to two stories, consistent with surrounding residential development and are often placed closer to the street to form a street edge with residential appearance.

Mixed Residential - High Density

Mixed residential land use areas applicable to more urbanized areas at a density of 15+ du/ac. High density mixed residential development is intended for integration with Town Center and/or Urban Core developments, where appropriate, to create very walkable and active pedestrian zones and housing options close to employment and transit.

Live-Work Units

Live-Work units shall be a permitted use within any designated Mixed-Residential Land Use area or within any designated mixed use district. All proposed Live-Work units must be planned and built in accordance with Section 6.14.7 of the Unified Development Code.

Non Residential Mixed Use

Non-residential mixed use land areas refer to mixed uses within a building or several buildings that do not incorporate residential uses and are located near arterials or major collectors that are intended to provide daily retail, major grocers and other conveniences to serve the local community. Non-residential mixed uses include strip mall centers.

OBJECTIVE LU 1 Plan land uses appropriately for current and future populations and support future development by making a variety of land uses available, while working to ensure compatibility between existing and future land uses, existing and planned infrastructure, and existing natural resources.

POLICY LU 1.1 The City Council hereby adopts the Central Business Future Land Use Plan map (see Figure 3) and the accompanying text as a guide for future land use decisions and development within the Central Business area boundaries. The plan provides guidance for future land use planning, including rezoning, platting, fiscal management, and capital improvement planning, and all development should be consistent with the Central Business area future land use classifications.

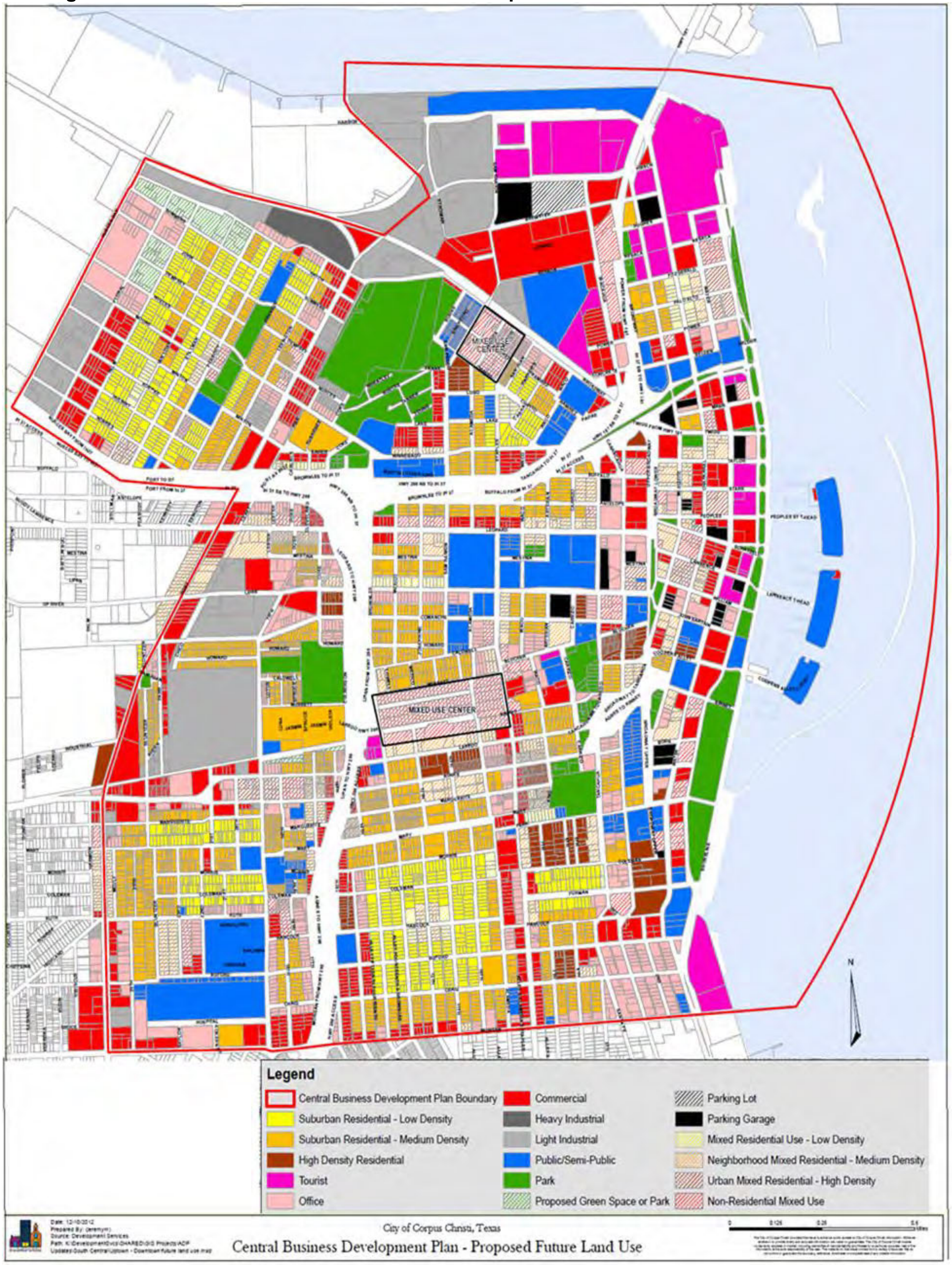
POLICY LU 1.2 Mixed-use districts are being actively encouraged, and locations for new mixed-use centers are being identified, providing live-work-shop opportunities that minimize travel needs. The properties located along Shoreline Boulevard have been identified as areas that shall be considered for tourist-related and residential mixed uses, with limited office or non-tourism related business uses.

POLICY LU 1.3 In order to ensure that development and redevelopment within the Central Business area will eliminate blighting influences of outmoded and inefficient development patterns, the following land use techniques shall be required for all development:

- ❖ Create a walkable, pedestrian-oriented and transit-supportive urban environment.
- ❖ Conserve land, energy, and natural resources through reduced automobile usage and advanced techniques such as onsite low-impact stormwater design techniques where practicable, and concentrate intensive land uses around existing public and private infrastructure so as to take advantage of the value of such investment.
- ❖ Promote a mix of tourist, retail, entertainment, residential, and civic uses in the Central Business area and provide an aggregation of commercial uses in centers; avoid the use of any additional new strip-commercial development along right-of-ways.

POLICY LU 1.4 With exception to the industrial use areas permitted and depicted on the Central Business Future Land Use map, new industrial uses and outside storage uses shall be discouraged within the Plan Boundary, and existing industrial zoning or land use changes to another or expanded industrial use shall be discouraged.

Figure 3. Central Business Future Land Use Map



POLICY LU 1.5 ***Measurable Strategies.*** Priority shall be given to the following land use projects in the following order within the Central Business area boundaries:

1) Promote the construction of a large (minimum 2-story) grocery, entertainment, tourist, office, or residential mixed-use pedestrian center with pedestrian plazas in the area located west of Staples Street and south of Mussett Street, east of the Crosstown Expressway (see examples below).




2) Consider and plan for an additional mixed-use grocery neighborhood center on the northside of I-37 within the Washington-Coles neighborhood. Utilize the Port Avenue corridor north of I-37 as a neighborhood commercial and restaurant establishment corridor to provide more dining opportunities for the Washington-Coles and Hillcrest residential areas and the SEA District tourist areas.

3) Establish a community garden program and utilize undeveloped or underdeveloped properties and underutilized City parks to provide food for local residents, low-income areas, or shelters and food banks; Priority for establishment of community gardens should be given to the Hillcrest and Washington-Coles neighborhoods.

4) Create a Parking Master Plan that includes the locations of potential parking garages within the Central Business area and promote the construction of multi-level garages versus open lot parking facilities.

(UD) URBAN DESIGN

OBJECTIVE UD 1 Plan and provide for a functional 24-hour Central Business area with residential and non-residential mixed use centers, containing areas of different densities, architectural styles, and land uses. Emphasize conflict-free, ADA-accessible, pedestrian-oriented planning techniques to enhance connections between Downtown and Uptown and promote a uniquely attractive atmosphere for small and large-scale tourist attractions and local businesses.

POLICY UD 1.1 The City Council adopts Figures 4 & 5 "Central Business Urban Design Improvement & Urban Living Maps" as the guide for future Urban Design decisions in the Central Business area. The urban design map provided under this Plan constitutes additional planning and implementation measures for the Central Business area.

Figure 4. Central Business Urban Design Improvement Plan (click on the map for interactive layers)

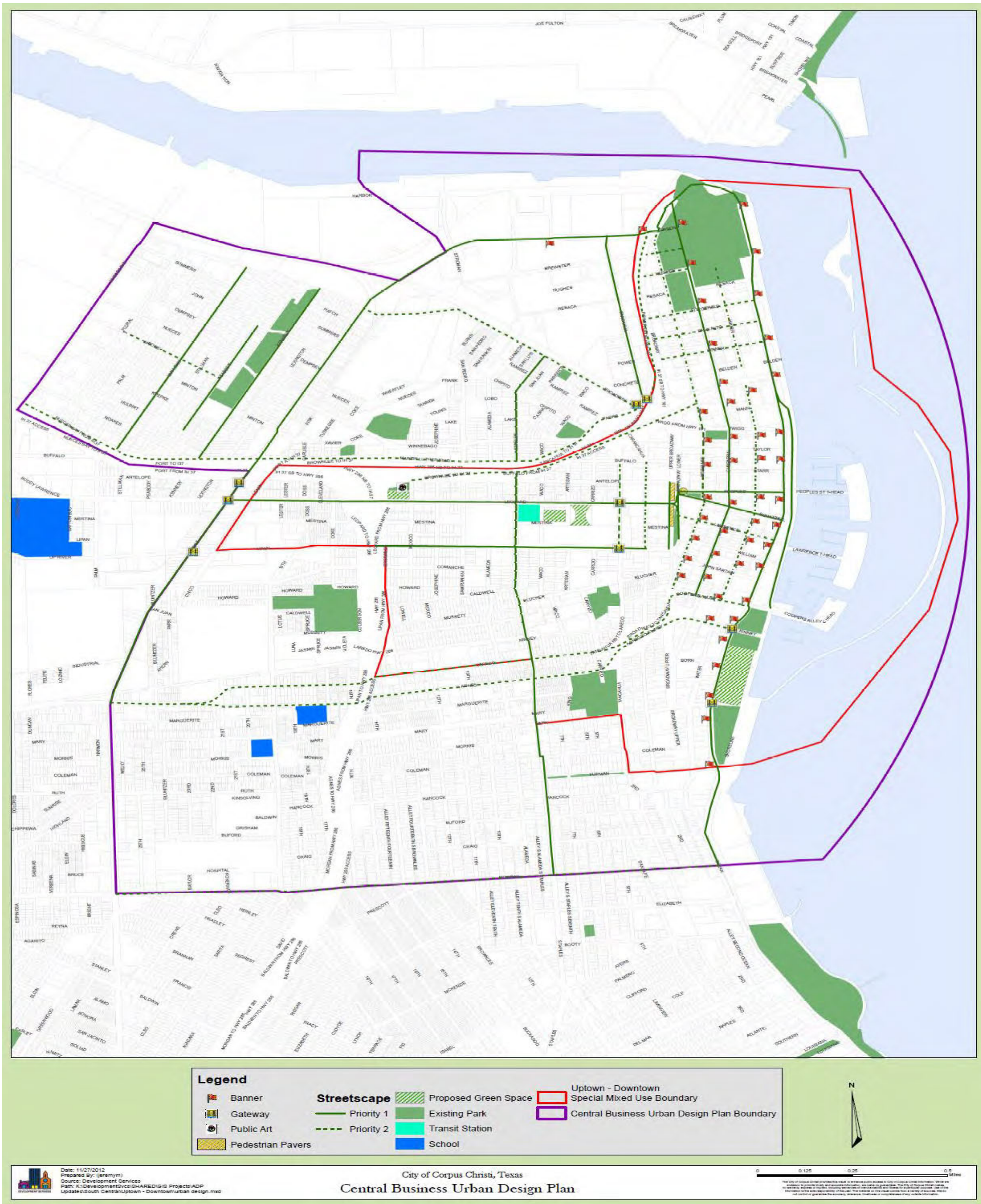


Figure 5. Central Business Urban Living Options Map

This map provides examples of living arrangements and urban design styles recommended by the City's Planning Department in planning these areas; however, the styles shown are not mandated by the city's code, provided the proposed design of a project does not conflict with the design requirements adopted under an overlay, special overlay district, or other adopted City code standards. (Click on map photos to view larger versions)

POLICY UD 1.2 Provide adequate, safe lighting, landscaping, street furniture, and signage to help visually and functionally integrate public and private development projects. Signs shall be required to be oriented and scaled for pedestrian traffic. Consideration should be given to minimizing the number and size of allowable signs and allowing limited-sized monument-type signs within the required setbacks. Billboards are prohibited within the Uptown-Downtown Special Mixed Use Overlay boundaries.

POLICY UD 1.3 Provide diversity, not homogeneity, with a variety of building types in an attractive urban environment utilizing form, color, materials, building orientation, variation in building height, placement, and siting, and by arranging buildings in a regular patterns that are unbroken by parking lots and locating parking behind all uses for new development. Where parking garages are developed, the first floor of any parking garage must be constructed to ultimately provide mixed commercial/office uses on the first floor street level.

POLICY UD 1.4 Pursue the development of a comprehensive “Complete Streets” program and design within the Central Business area boundaries. Pedestrian corridors should provide a strong, pedestrian-oriented environment for people of all ages and diverse forms of mobility.

POLICY UD 1.5 Shading, through the use of storefront awnings, marquees, alcoves, street trees and landscaping shall be designed as a critical component of all roadway projects (particularly on Arterial and Collector right-of-ways) and gateways to and within the Central Business area, and leading to Memorial Park. Improvements shall be constructed and maintained through public and private methods and incentive programs. Collector streets shall be supplied with benches and pedestrian-style post lighting for resting and safety.

POLICY UD 1.6 ***Measurable Strategies.*** Priority shall be given to the following urban design projects in the following order within the Central Business area boundaries:

1) Streetscape Zones (in accordance with the Streetscape Zone standards) shall be provided for the following streets within the Central Business Development Plan with priority given to the following streets:

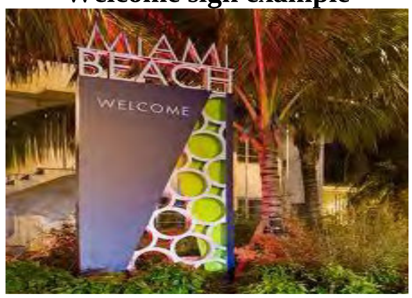
Area	Street Name	Priority
Uptown	Leopard	1
	Lipan	1
	Staples	1
	Upper Broadway	1
Downtown	Lower Broadway	1
	Schatzel	1
	Peoples	1
	Chaparral Street (including SEA District)	1
	Shoreline Blvd.	1
	Water Street	2
	Mesquite Street	2
	Kinney Street	2
	Coopers Alley	2
	Lawerence	2

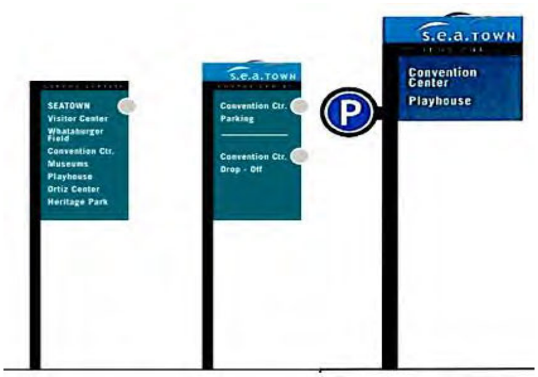
Area	Street Name	Priority
West Side & South Central	Staples	1
	Port Avenue	1
	Agnes	2
	Laredo	2
	Morgan	2
Northside	Port Avenue	1
	Tancahua	1
	Peabody	1
	Van Loan	1
	Kennedy	1
	Staples	1
	Morris	2
	Broadway	2
	Martin Luther King	2

2) Develop the area within a ½ mile radius of the Staples and Leopard Street CCRTA station as a Transportation-Oriented Development with pedestrian-oriented features.

3) Define the physical boundaries of each district through the use of gateways, pole banners, and signs that are compatible with, but distinguish each area from one another; locate a new Welcome Center along the I-37 corridor within the Central Business area, preferably near Shoreline Drive.

Welcome sign example





4) Create an Urban Design Manual for the Central Business Development Plan area that includes different architectural styles for different neighborhood and entertainment areas of the Central Business area, and consistent urban design standards for new development, and develop a program to further incentivize the use of the standards.

5) Require new and redeveloped parking lots to be located behind all structures, or below or above structures.

6) Include additional options for the construction of single-family homes by promoting the development of (attached or unattached) brownstones, townhomes, live-work units, vacation cottages, and medium and high-density mixed residential structures throughout the Central Business Development Area.

7) Establish a street bench dedication program providing street benches throughout the Central Business area utilizing the talents of local artists.


(ED) ECONOMIC DEVELOPMENT

OBJECTIVE ED 1 Promote expansions of local businesses and target innovative and entrepreneurial businesses for relocation, and attract high-wage jobs in fields such as tourism, science, technology, and green or clean industries that create a vibrant economy.

POLICY ED 1.1 Address the barriers to feasible development and redevelopment of blighted areas which retard the growth of housing accommodations in the area, and incentivize and promote the adaptive reuse of existing structures. Promote short-term leasing of vacant properties in key locations.

POLICY ED 1.2 *Measurable Strategies.* Priority shall be given to the following economic development projects in the following order within the Central Business area boundaries:

1) Create a new "Blighted Property" Code Enforcement Team and allow the City Team members to designate a property as being blighted by inspecting blighted buildings and charging the owner for any maintenance performed by the City to bring a building up to the required building code as an initial step in condemnation proceedings. Boarding of ground floor windows of vacant buildings shall be prohibited within the Plan boundaries, and new construction shall include minimum window frontage to create a more attractive and pedestrian-friendly appearance.

2) Streamline the street vendor process and update the vendor regulations and processes to expedite permitting, reduce costs, and regulate (potentially through lottery) the number of vendors permitted in an area, with exception of special events.

3) Establish a semi-permanent or permanent fish market downtown with shading or shade structures for customers.


4) Promote and provide more professional office opportunities surrounding Memorial Hospital and affordable housing options for employees and seniors near the hospital.

5) Inventory and promote the adoption and updating of existing neighborhood centers/plazas to create a pedestrian-style neighborhood gathering place that supports businesses and neighborhood communities.

(HD) HOUSING DEVELOPMENT

OBJECTIVE HD 1 Reduce traffic congestion by providing affordable housing for workers and students within the Central Business Development Plan boundaries and providing an expanded resident population base to support new businesses and improve inner city mass transportation options.

POLICY HD 1.1 Utilize alternative housing types and smaller lot development to promote the development of single-family residential living uses through live-work, townhome, and brownstone units within the Central Business Development Plan boundaries.

POLICY HD 1.2 Promote accessible and affordable living accommodations for the elderly to provide housing options for seniors (close to transit stations and transit stops) close to community centers, to continue living independently in their own community.

POLICY HD 1.3 ***Measurable Strategies.*** Priority shall be given to the following housing development projects in the following order within the Central Business area boundaries:

1) Pursue housing development and transit grants for more affordable and accessible housing for Seniors, students, smaller families, and single adults and provide a variety of housing types and update the City's Future Land Use and Zoning Maps and allow for more mixed-uses within the Central Business area boundaries.

2) Adopt a Transit-Oriented Development overlay over the Staples and Leopard Street transit center to promote higher residential housing densities in proximity to the transit center.

3) Conduct an inventory of vacant parcels (and vacant buildings) within the Hillcrest Washington-Coles neighborhoods, the Spohn Memorial Hospital neighborhood (near the Antonio Garcia Community Center), and other blighted or deteriorating neighborhoods located within the Plan boundaries for designation as potential future affordable housing development locations; actively recruit and assist potential developers and builders to develop these areas as affordable housing and senior-living developments through the use of incentives provided through HUD and other Federal, State, or City incentives available.

4) Create new incentives for the construction of LEED-Certified or Green building standards.

5) Update the City's Unified Development Code and Building Code to further incentivize the construction of Live-Work units within areas of the Central Business Development Plan boundaries.

(CNE) CONSERVATION AND NATURAL ENVIRONMENT

OBJECTIVE CNE 1 Promote sustainable development techniques and protect the limited natural and financial resources through techniques such as Green Building standards, Best Management Land Practices, xeric and native landscaping, low-impact stormwater development techniques, roof-top green gardens and community gardens.

POLICY CNE 1.1 Encourage energy conservation through land use and design, by incorporating mixed uses, clustered developments, development of complete neighborhoods and complete street designs.

POLICY CNE 1.2 Promote the installation of solar and wind energy techniques and reduced impervious surfaces during the planning and construction phases.

POLICY CNE 1.3 Pollution prevention devices shall be researched for incorporation into stormwater outfalls to capture floating debris, sediments and other pollutants before entering the Bay system, particularly along the bayfront where large volumes of floating debris and other urban pollutants along the seawall, beaches and shoreline areas are deposited.

POLICY CNE 1.4 ***Measurable Strategies.*** Priority shall be given to the following conservation and natural environment projects in the following order within the Central Business area boundaries:

1) Construct demonstration projects utilizing techniques for rainwater capture (rain barrels, rain gardens), stormwater reuse (grey water irrigation), directional flow, and pervious materials.
2) Provide more trash receptacles throughout the Central Business area to reduce litter.
3) Establish a solid & toxic waste amnesty period program to incentivize the adaptive reuse, reconstruction, or demolition of existing vacant buildings.

(PR) PARKS AND RECREATION

OBJECTIVE PR 1 Seek the means to develop and support a system of urban parks and open space that link neighborhoods within and outside the Central Business area to growth and employment centers, as well as to other park, recreation, and community facilities within the City that are accessible to all citizens, regardless of race, ethnicity, gender, age, income, sexual orientation, or physical ability.

POLICY PR 1.1 Support the development and redevelopment of viable and lively civic spaces, parks, square, plazas, and other public gathering places, tied to transit and accessible by multiple modes of transportation for residents of existing and new neighborhoods. Promote multiple uses and activities for the City’s existing parks.

POLICY PR 1.2 Continue developing a system consisting of bikeways, footpaths, canoe/kayak launching access points, and/or nature trails, linking parks and recreation areas, schools, beaches, residential areas and barrier islands to the Central Business area from areas outside the Plan area.

POLICY PR 1.3 ***Measurable Strategies.*** Priority shall be given to the following parks and recreational projects in the following order within the Central Business area boundaries:

1) Update Artesian, Retama, and Lovenskold Parks by providing pedestrian plazas, park furniture, public art, and special events (through the Landmark Commission where required); provide a pedestrian and visual connection between Blucher and South Bluff Parks.

2) Support the establishment and all phases of Destination Bayfront on the public property located from Furman Avenue to the Arts Center along Shoreline Boulevard.

3) Conduct additional Walkability Audits within the Central Business Plan boundaries to pinpoint areas needing improvement to serve pedestrians, provide connection to basic services and employment, and promote alternate modes of transportation.

(TD) TRANSPORTATION DEVELOPMENT

Access. The principal accesses to the urban core of the Central Business area are as follows:

1. Interstate Highway 37/US 181 corridor, which, in its current form, runs from west to east/northeast, and bisects adjacent neighborhoods and creates a barrier between the main sections of the downtown district.
2. Port and Nueces Bay Avenues form the western boundary of the CBDP; Shoreline Drive runs along the eastern boundary of the CBDP and Staples Street runs through the center of the CBDP; all of three of which run north and south in the CBDP.
3. Leopard Street and Morgan Avenue run east/west and Morgan Avenue traverses the southern boundary of the CBDP.

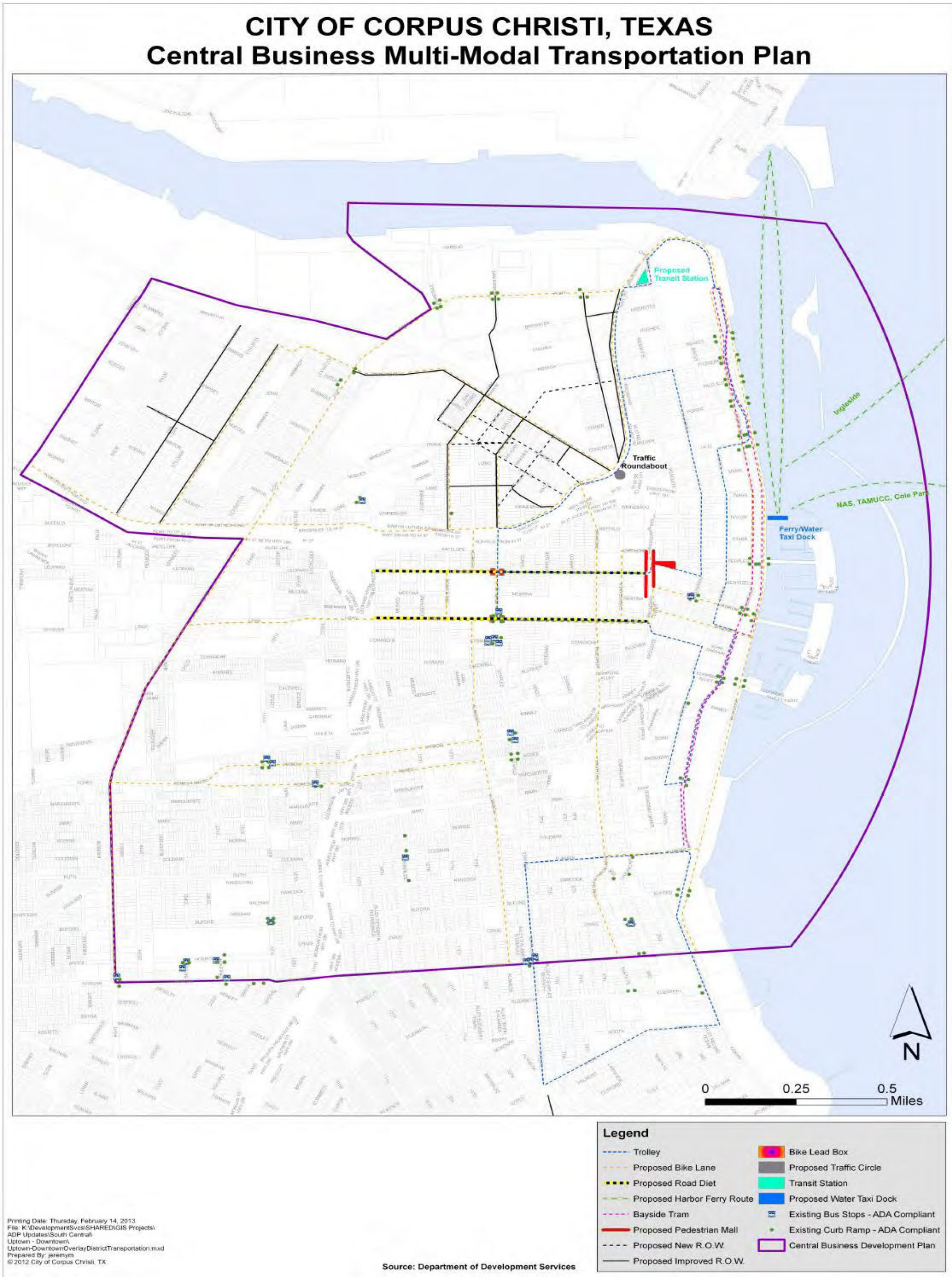
Traffic volumes are as follows for the listed right-of-ways:

Main Street	Classification	No. of Lanes	Traffic Volumes		
			Between These Streets		Trips/Day
Port	A2 Secondary Arterial	4	IH 37	Morgan	14,292
Morgan	A1 Minor Arterial	4	Port	Ocean / Shoreline	39,114
Ocean / Shoreline	A2 Secondary Arterial	4	Morgan	Art Museum	NA
IH 37	F1 Freeway / Expressway	4-10	Port	Ocean / Shoreline	NA
Leopard	A1 Minor Arterial	4	Port	Ocean / Shoreline	24,450
Staples	A1 Minor Arterial	4	Morgan	Leopard	NA

OBJECTIVE TD 1 Utilize transit-oriented development concepts and guidelines in construction to help guide new development and redevelopment.

POLICY TD 1.1 The City Council adopts Figure 6 "Central Business Multi-Modal Transportation Map" as the guide for future multi-modal transportation decisions in the Central Business area. The transportation network of this Plan constitutes additional planning and implementation measures for the Central Business area in addition to those outlined under the City's adopted Urban Transportation Plan.

Figure 6. Central Business Multi-modal Transportation Map (click map for interactive layers)



POLICY TD 1.2 Implement multi-modal land use planning techniques to ensure that new developments and existing neighborhoods maximize the potential of non-automotive access to a broad range of land uses and encourage inter-neighborhood connections.

POLICY TD 1.3 New development plans shall attempt to provide connection to planned or existing pedestrian and bikeway networks by incorporating such connections into the site plan. Where existing right-of-ways are updated, or new right-of-ways are constructed, right-of-way designs shall include pedestrian and bicycle connectivity and access.

POLICY TD 1.4 ***Measurable Strategies.*** Priority shall be given to the following transportation projects in the following order within the Central Business area boundaries:

1) Coordinate with Regional Transportation Authority to conduct a feasibility study for waterborne taxi and ferry transit and, ultimately, to locate a water taxi hub within the Destination Bayfront/Marina Plan area.
2) Ensure that all phases of the Chaparral Street reconstruction are completed, and any existing missing pavers are replaced.
3) Provide and connect new bike lanes with existing bike lanes and provide bike racks at strategic sight-seeing and transit use locations within the Central Business area.
4) Construct new bike lanes and provide trolley access within the southwest (Memorial Hospital) neighborhoods that provide access to downtown sights and services and the bay.

(MD) MARINA DEVELOPMENT

OBJECTIVE MD 1 Enhance capital investment in the city, and continue to improve the appearance, safety and utility of the marina through needed improvements, regular maintenance and appropriate repairs.

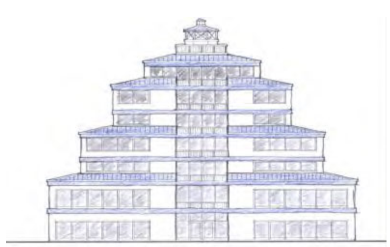
POLICY MD 1.1 Provide more public access and transportation connection from the plan area along the bay and marina, including providing bicycles to transient dock users for transportation along the waterfront and uptown and downtown areas.

POLICY MD 1.2 Promote more water-dependent uses, rentals, and floating structures along the marina, McGee Beach, and the waterfront, including fish markets, kayak launches, day cruises, and bay-area wide water taxi services.

POLICY MD 1.3 Explore expansion of the number of marina slips once occupancy rates of existing slips reach 85% occupancy.

POLICY MD 1.4 ***Measurable Strategies.*** Priority shall be given to the following marina projects in the following order within the Central Business area boundaries:

1) Promote and help fund a new mixed-use Marina Lighthouse Tourist and Office space building on the Lawrence Street T-head (see proposed sketch).



2) Provide new directional signs and landscaping along Shoreline Drive and the T-heads, and sight-seeing scopes for wildlife viewing and birding and fish identification signs.

3) Provide state-of-the-art commercial docking facilities for sight-seeing boats, the Harbor Ferry, and potential water-taxi docking to service Port Aransas, Ingleside, Padre Island, TAMU, NAS, Cole Park, and Corpus Christi North Beach.

4) Establish a circular public tram route servicing the waterfront from the proposed Destination Bayfront Park and the SEA District amenities.

(CI) CAPITAL IMPROVEMENTS

OBJECTIVE CI 1 The City shall provide and maintain, in a timely and efficient manner, adequate public facilities for both existing and future populations, consistent with available financial resources, and planned for the purpose of maintaining or improving future Levels of Service, in accordance with the adopted Capital Improvements Program.

POLICY CI 1.1 The City shall continue to pursue development options not listed within the CIP through the use of Federal, State, and public and private grants and donations.

POLICY CI 1.2 The Capital Improvements Element shall include improvements that are typically large scale and high in cost, and to the greatest extent possible, not recurring in nature. For purposes of this Development Plan, consideration of proposed capital improvement projects with a life expectancy of five years or less shall be given priority.

POLICY CI 1.3 ***Measurable Strategies.*** Priority shall be given to the following capital improvement projects in the following order within the Central Business area boundaries:

1) Develop a “road diet” to narrow Leopard and Lipan Street Corridors from 4 lanes to 3 lanes (including a center turn lane or center turn/median lane); provide a streetscape zone with sidewalks, street furniture, tree planting, bike lanes, and awnings for businesses. Provide sidewalks down the bank of the bluff for pedestrian passage and safety, and consider redesign of the bluff stairs leading to Retama Park through widening the steps to provide for a visually aesthetic gateway leading to a pedestrian piazza joining the adjacent Retama Park.

2) Resolve the increased traffic levels and traffic flow problems in the SEA District during multiple events; resolve the lack of connection between Shoreline Boulevard and Chaparral Street by providing a transit, pedestrian, and bicycle route connecting Shoreline Boulevard to Chaparral Street; plan for the addition of parking garages and a potential transit station in the SEA District.

(PSNI) PUBLIC SAFETY AND NEIGHBORHOOD IMPROVEMENT

OBJECTIVE PSNI 1 Improve the Safety and Livability of Neighborhoods through the use of community planning and provide support to resident led neighborhood revitalization initiatives to cultivate and maintain strong, safe, and thriving neighborhoods.

POLICY PSNI 1.1 Expand local law enforcement agency partnerships and collaborate with community groups to increase awareness and solutions to safety issues and institute and neighborhood Crime Watch program to foster safer neighborhoods.

POLICY PSNI 1.2 Increase natural surveillance and "eyes on the street" using "Crime Prevention Through Environmental Design (CPTED)" strategies such as building doors/entrances and windows to look out on to streets and parking areas; pedestrian-friendly sidewalks and streets; front porches; and adequate nighttime lighting.

POLICY PSNI 1.3 Facilitate the organization of block parties to promote interactions and relationship building between neighborhoods, which may help lead to collaborative clean-up or improvement projects.

POLICY PSNI 1.4 Organize and set up "Better Block Rapid Revitalization Demonstration" projects within specific neighborhoods (including designated destination nodes) to temporarily create attractive and active destination nodes based on multi-modal and pedestrian-friendly techniques and events, promote relationships between community business owners and residents, and provide a vision for future redevelopment of an area.

POLICY PSNI 1.5 Measurable Strategies. Priority shall be given to the following public safety and neighborhood improvement projects in the following order within the Central Business area boundaries:

1) Create a committee to address the issues and needs of the homeless in the City; plan and work towards the placement of all the homeless, unemployment services, and additional social needs and services in one building, in one area.

2) Inventory established residential neighborhoods (priority given to Hillcrest and Washington-Coles neighborhoods) with higher crime rates to determine whether adequate lighting and environmental design techniques are put into place to achieve a higher degree of safety, and establish a Neighborhood Watch program within the Hillcrest neighborhood.

3) Organize a "Safe Routes (Ways) to School program", organized and piloted at one school within the Central Business Development Plan boundary each year.

4) Plan a Better Block Revitalization Demonstration Project event for the following areas:

   a) Leopard Street
   b) Upper Broadway and Retama Park area
   c) Hillcrest Neighborhood
   d) Chaparral Street

(PI) PLAN IMPLEMENTATION

OBJECTIVE PI 1 It cannot be presumed that the Central Business Development Plan shall be implemented by city resources alone; the city's goal is leveraging and supporting private and public sector resources to accomplish the desired results through the use of city funds, grants, loans, tax increment financing, and other financing and development incentives and techniques. Plan implementation should also be seen as an investment strategy, and not just for spending public funds.

POLICY PI 1.1 The Central Business Development Plan shall be implemented through various City Departments, including the Comprehensive Planning, Project Management, Platting and Zoning, and Building Departments, through daily site plan review and utilizing the Central Business Development Plan Future Land Use, Multi-Modal Transportation, and Urban Design Maps as a guide in making land use decisions and determinations within the Central Business Development Plan boundaries.

POLICY PI 1.2 The Central Business Development Plan Planning Committee shall continue to work together with the City and community action groups to plan the uptown and downtown areas as a "cohesive whole", and promote the Objectives, Policies, and Measurable Strategies of the Future Land Use Map and accessory maps included under the Central Business Development Plan. The Central Business Development Plan Planning Committee members shall meet on a predetermined regular basis to plan for and promote the implementation of the Objectives, Policies, and Measurable Strategies of this plan.

EXHIBIT 7

Ordinance adopting a new comprehensive plan for the City of Corpus Christi titled "Plan CC Comprehensive Plan 2035" and providing for a repealer clause and publication.

WHEREAS, the City of Corpus Christi, Texas ("City"), engaged in a two-year process of developing a twenty-first century comprehensive plan, titled Plan CC Comprehensive Plan 2035 ("Plan CC"), which includes policies to guide the physical and economic growth of the City and its extra-territorial jurisdiction through 2035 and replaces policies adopted in 1987;

WHEREAS, the City invited the public to workshops to give input and help develop a vision for Corpus Christi in 2035; and where the City used this input to develop the vision and principles element of Plan CC;

WHEREAS, City Staff provided guidance and assistance throughout the process and coordinated with various community agencies;

WHEREAS, the City invited community members representing a variety of interests to participate in a Citizens' Advisory Committee to provide early input on the development of Plan CC and to review the draft document;

WHEREAS, numerous citizens and community organizations have studied Plan CC and presented their written or verbal recommendations for consideration;

WHEREAS, the Planning Commission, from time to time, may recommend amendments to Plan CC and the City Council may approve amendments consistent with the requirements of the City Charter;

WHEREAS, the Planning Commission has forwarded to the City Council its final report and recommendations regarding Plan CC;

WHEREAS, with proper notice to the public, public hearings on Plan CC were held on Wednesday, August 12, 2015, during a meeting of the Planning Commission, and on Tuesday, October 13, 2015, during a meeting of the City Council, during which all interested persons were allowed to appear and be heard; and

WHEREAS, the City Council has determined that Plan CC would promote sound development of the City and promote the public health, safety, and welfare of its citizens.

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF CORPUS CHRISTI, TEXAS:

SECTION 1. It is the public interest to adopt Plan CC Comprehensive Plan 2035 ("Plan CC"), a new 20-year comprehensive plan, as a guide for the physical and economic growth of the City and its extra-territorial jurisdiction, said document being attached hereto and labeled Exhibit A.

SECTION 2. The City shall use Plan CC as a guideline to facilitate Area Development Plans, service Master Plans and other plans that the City considers necessary for systematic growth and development.

SECTION 3. The City shall use Plan CC to establish codes and ordinances, as the City deems necessary, to promote the sound development of the City and to provide for public health, safety, and welfare of its citizens.

SECTION 4. City Staff, Planning Commission, and City Council shall review and amend Plan CC, if necessary, at least every five years.

SECTION 5. All ordinances or parts of ordinances that are in conflict with this ordinance are hereby expressly repealed and the document titled "City of Corpus Christi Policy Statements: An Element of the Comprehensive Plan," an element of the comprehensive plan adopted by Ordinance 19865 in 1987, is repealed.

SECTION 6. Publication shall be made in the City's official publication as required by the City's Charter.

DRAFT ORDINANCE

The foregoing ordinance was read for the first time and passed to its second reading on this the ______ day of ____________________, 20___, by the following vote:

Nelda Martinez	___________	Brian Rosas	___________
Rudy Garza	___________	Lucy Rubio	___________
Chad Magill	___________	Mark Scott	___________
Colleen McIntyre	___________	Carolyn Vaughn	___________
Lillian Riojas	___________		

The foregoing ordinance was read for the second time and passed finally on this the ______ day of ____________________, 20___, by the following vote:

Nelda Martinez	___________	Brian Rosas	___________
Rudy Garza	___________	Lucy Rubio	___________
Chad Magill	___________	Mark Scott	___________
Colleen McIntyre	___________	Carolyn Vaughn	___________
Lillian Riojas	___________		

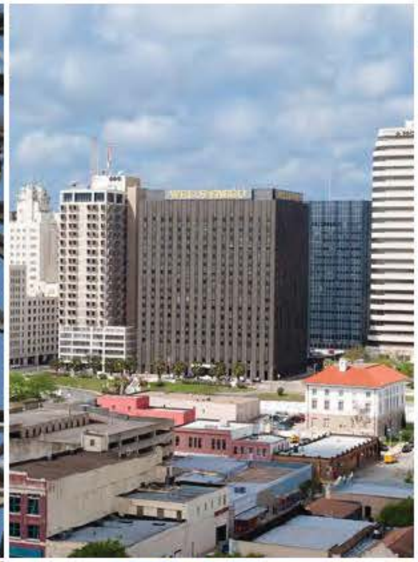
PASSED AND APPROVED this the ______ day of ____________________, 20____.

ATTEST:

_________________________________	___________________________
Rebecca Huerta City Secretary	Nelda Martinez Mayor

DRAFT
JULY 2015

Plan CC
Comprehensive Plan 2035



PLAN CC
COMPREHENSIVE PLAN 2035

CITY OF CORPUS CHRISTI, TEXAS | JULY 2015

EXHIBIT A

Plan CC
Comprehensive Plan 2035

PLAN CC
COMPREHENSIVE PLAN 2035

CITY OF CORPUS CHRISTI, TEXAS | ADOPTED XXXX 2015

EXHIBIT A

Acknowledgements

- **Corpus Christi City Council, 2014-2015**
- **Plan CC Citizens Advisory Committee**
- **Mayor Nelda Martinez**
- **City Manager Ron Olson**
- **City staff members**

THANK YOU to the residents, neighborhood and business leaders, community advocates, and stakeholders who participated in creating this Comprehensive Plan by attending public meetings and engaging with one another, by sharing your experience and knowledge of Corpus Christi in interviews and meetings with the planning team, and by expressing your commitment to Corpus Christi's future. Everyone can be part of putting this plan into action!

PLAN CC TEAM

> Goody Clancy, *prime consultant*
> Stantec Urban Group, *technical lead*
> Peter Kwass Consulting, *economic development*
> W-ZHA, *commercial market analysis*
> Zimmerman /Volk Associates, *housing market potential*
> TischlerBise, *cost-of-services analysis*
> Kailo Communications Studio, *public outreach*

EXHIBIT A

DRAFT
JULY 2015

ORDINANCE WILL APPEAR HERE AND ON THE NEXT PAGE.
PAGES WILL BE ADDED AND LAYOUT ADJUSTED AS NEEDED.

EXHIBIT A

DRAFT
JULY 2015

ORDINANCE CONTINUES HERE

IF NEEDED.

EXHIBIT A

DRAFT
JULY 2015

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JULY 2015

ELEMENT

1

A Vision and Guiding Principles for Corpus Christi's Future

Plan CC is a new kind of comprehensive plan for Corpus Christi. It has a 20-year time horizon and includes a vision for the future and goals and policies for an integrated series of elements that affect decision making about the physical development of the city. The plan provides direction for the city as a whole and will be followed by area development plans that provide more detailed direction for specific parts of the city while reflecting the overall vision and goals of the citywide plan.

This comprehensive plan for the next 20 years is not a **prediction** of what will happen by 2035, nor is it a 20-year **projection** into the future. It is a **plan**. It is designed to guide the city to take advantage of opportunities, invest in the future, and make choices that result in higher quality of life and a more diversified economy.

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Corpus Christi stands poised for a once-in-a-generation opportunity for transformative growth. The city has long experience with the booms and busts characteristic of the energy economy. Since 2011, the city has enjoyed the benefits of the Eagle Ford Shale boom, but this time Corpus Christians want to use the boom to establish long-term, sustainable economic growth and enhance quality of life for everyone.

Developing a vision statement is an essential early step in creating a comprehensive plan. Vision statements and accompanying principles focus attention on a community's values, sense of identity, and aspirations. The **vision** statement tells a story and paints a picture of an ideal future in 2035. The **principles** are based on precepts that are important for guiding the comprehensive plan itself and its implementation. In public meetings around the city, interviews, and website commentary, citizens articulated their desires and hopes for an ideal future. The experience of creating the Plan CC vision and principles showed that citizens from different parts of the city and from all walks of life share many values and hopes about the kind of future they want for Corpus Christi.

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Our Vision

In 2035... Corpus Christi is a thriving community with a strong, diversified economy, a high quality of life for individuals and families throughout the city, and a well-protected environment of natural beauty. Our unique combination of Gulf Coast bay and beach attractions, vibrant cultural life, economic opportunity, and a variety of housing choices supports long-established families and makes Corpus Christi a magnet for young professionals, entrepreneurs, retirees and visitors to the most distinctive destination on the Texas Gulf Coast.

> ***Our broadly diversified economy provides opportunity for all.***
While the port, the oil and gas industry, the military bases, and tourism continue as important mainstays of our economy, new sectors are thriving through entrepreneurial start-ups, technology spin-offs from university research, and expanded ecotourism. Our skilled workforce results from a commitment to a strong culture of educational achievement, from pre-school to grad school. Graduates of TAMU-CC and Del Mar College find jobs in Corpus Christi that allow them to stay, grow, and enjoy urban amenities in a Gulf Coast lifestyle.

> ***Modernized city services and systems support growth and vitality in all parts of the city.***
City services, infrastructure, and utility systems—including streets, drinking water supply, wastewater, and stormwater management—have been modernized over the last 20 years to ensure that the city can support and maintain urban and industrial growth, employing best practices in a cost-efficient manner.

> ***High-quality, safe, connected, and diverse neighborhoods provide a variety of living choices.***
Corpus Christi's growth has revitalized older parts of the city; created new live-work-play neighborhoods and downtown; resulted in compact, mixed-use centers in key commercial districts; and promoted a connected sense of place and neighborhood in new housing development. Mixed-income neighborhoods provide housing affordable at every income level for diverse households, young and old—singles, couples, families with children, empty nesters, and retirees. People can get around the city by multiple modes of transportation—connected networks of good streets and sidewalks, safe bicycle routes, and excellent public transportation.

> ***Stewardship of our natural heritage and green-space networks strengthens our unique character and supports resilience.***
As the major South Texas city on the Gulf of Mexico, our city offers a distinctive combination of an important port, city and island beach attractions and entertainment, greenways and parks, boating and fishing opportunities, and nature experiences. Good stewardship of natural assets reduces our vulnerability to coastal hazards and enhances our resilience. We work to understand and preserve our natural heritage because it is at the foundation of our way of life and our economy.

Corpus Christi in 2035 is a unique place to live, work, study and play—prosperous and full of opportunity, well-run and welcoming, livable and affordable, a lively urban center and a waterside playground—one of the most enterprising and forward-looking cities in Texas.

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The Principles

Be strategic. Strategically integrate public physical, economic, and social investments to leverage private investment and grants in order to create critical mass that supports enhanced choices in housing, transportation, retail and services. This critical mass will then stimulate self-sustaining activities.

Be cost-effective. Establish cost-effective best practices and systems to support ongoing city services and infrastructure.

Act transparently. Promote civic engagement and keep everyone with a stake in the city's future informed about community conditions, options, and opportunities to participate in decision making.

Be accountable. Establish action plans with time lines and responsible parties, as well as systems for regular public review of the implementation of the comprehensive plan.

Pursue goals through partnerships. City government alone cannot implement the comprehensive plan. Collaborative partnerships with regional groups, agencies, businesses, institutions, nonprofits, and citizens are critical to effective implementation.

Be business-friendly. Establish a climate that attracts new industries and supports business growth and entrepreneurship as well as streamlined regulations that also protect environmental resources and quality of life.

Pursue high-quality development. Make public investments a model of excellent design and function and establish high quality design standards for private development. Consistent application of clear standards will make the city more attractive for people who live here now and attract new residents.

Promote good health. Create policies and physical conditions that promote healthy lifestyles in Corpus Christi through easy access to physical activity, healthy food, and medical care.

Prepare students for good jobs by keeping the focus on educational achievement. 21st-century jobs increasingly require a post-secondary education, like associate's or bachelor's degrees or a technical credential. A skilled and well-educated workforce will attract new investment.

Support diversity. Establish policies and strategies that support physical, social and economic diversity in individuals, households, business, and living conditions. These will strengthen the city's ability to attract and retain people throughout the life cycle and across the income range and to create environments that support enterprises of all kinds–from microbusinesses and start-ups to major industries.

EXHIBIT A

ELEMENT

2

Green and Blue: Natural Systems, Parks & Recreation

Natural Systems, Parks & Recreation focuses on the protection and enhancement of natural areas and parks with goals to enhance water quality, preserve natural areas, expand networks of green corridors, improve green infrastructure and expand public access to diverse, high-quality recreation opportunities.

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Plan CC's Vision for Natural Systems, Parks and Recreation

Stewardship of our natural heritage and greenspace networks strengthens our unique character and supports resilience. As the major South Texas city on the Gulf of Mexico, our city offers a distinctive combination of an important port, city and island beach attractions and entertainment, greenways and parks, boating and fishing opportunities, and nature experiences. Good stewardship of natural assets reduces our vulnerability to coastal environmental hazards and enhances our resilience. We work to understand and preserve our natural heritage because it is at the foundation of our way of life and our economy.

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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
Natural Systems	
1. Corpus Christi Bay, the Nueces River, Oso Bay, Oso Creek, and other water resources meet or exceed federal and state quality standards, provide environmentally healthy aquatic and wetland habitat, and are fishable and swimmable.	▪ Support initiatives to ensure that it is always safe to swim at public beaches on the bay and on Padre and Mustang Islands. ▪ Support initiatives to improve water quality so that shellfish beds are open throughout the city and can thrive throughout the Bay. ▪ Support programs to manage the balance of fresh and salt water in the estuary.
2. Wetland areas are protected or effectively replaced so that there is no net loss of wetlands.	▪ Support initiatives to preserve wetlands in the estuary. ▪ Support creation of a wetlands mitigation bank, if feasible.
3. Important natural areas, such as bird breeding sites, are preserved and protected as usable habitat networks with ecological integrity.	▪ Support initiatives for preservation of bird rookeries and similar critical habitat sites. ▪ Continue to support and protect nature preserves. ▪ Promote ecotourism as a way to encourage and fund preservation of the natural environment and wildlife habitat.
4. The city has a network of green corridors including Oso Creek, drainage ways, medians and street trees, parks, and urban wilds to enhance connections for birds and other wildlife.	▪ Give priority to natural, green drainage systems for storm water management. ▪ Give priority to strengthening the green character of existing open spaces. ▪ Secure protection of the Oso Creek corridor through implementation of a linear park along Oso Creek. ▪ Coordinate storm water management with trails and green network projects.
5. Natural barrier-beach environments are protected.	▪ Support continued enforcement of regulations that protect barrier beaches.
Urban Forest	
6. Native and other trees adapted to the environment provide shade along major streets and in parks and other public spaces.	▪ Promote tree preservation and tree planting on public and private property. ▪ Support creation of "adopt a tree" programs. ▪ Give priority to native tree planting along major corridors and other public spaces, with sufficient short-term irrigation to establish trees for long-term, drought-tolerant survival. ▪ Support a full urban forestry program with appropriate staff within the Parks and Recreation Department.

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Open Space, Parks and Recreation	
7. Corpus Christi has a network of attractive, safe, and well-maintained parks that provide shade and other amenities, are well-used by the public, and meet the diverse needs of the population.	▪ Promote strategic implementation of the 2012 ten-year Parks and Recreation Master Plan (PRMP) to support comprehensive plan goals. ▪ Update the PRMP every ten years. ▪ Support cost-effective redesign to ensure that parks are safe and provide sufficient shade.
8. Parks, recreational areas, and other green public spaces are of high quality and are well-maintained.	▪ Provide adequate resources for basic maintenance and operation of all parks, recreational facilities, and other green public spaces, as discussed in the PRMP. ▪ Continue to seek partnerships and sponsorships to support park maintenance. ▪ Incorporate sustainable maintenance practices.
9. Corpus Christi offers residents an array of opportunities for water-based recreation.	▪ Develop a plan for facilities and programs so that every resident has the opportunity to learn how to swim. ▪ Seek partnership options to create community boating programs and education.

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3

Resilience and Resource-Efficiency

Resilience and Resource-Efficiency focuses on the issues of resilience and resource efficiency, particularly energy. Resilience is not only the ability to respond to and recover from hazard events but also the ability to anticipate hazards and reduce overall vulnerability by adapting to changing conditions and promoting multiple lines of defense against hazardous events. The section on resource-efficiency focuses on expanding access to renewable energy sources and promoting efficient resource use through sustainable design. Water conservation is treated in the element *Infrastructure, Facilities, and Services.*

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Plan CC's Vision for
Resilience and Resource-Efficiency

Good stewardship of natural assets reduces our vulnerability to coastal environmental hazards and enhances our resilience.

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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
Resilience	
1. Corpus Christi has a holistic community standard of resilience that adapts to changing conditions such as storm hazards, high winds, and sea level rise.	▪ Support periodic review of resilience planning and implementation to adapt to changing conditions. ▪ Promote public understanding of risk and the responsibilities of individual households, as well as city, state, and federal governments.
2. The City has a multiple lines-of-defense strategy for protection against flooding from coastal storm surges.	▪ Promote implementation of regulations that protect barrier beaches and dunes. ▪ Promote implementation of flood-protection measures throughout the city.
Resource Efficiency	
3. Government operations and buildings are models of resource-efficiency and renewable sources.	▪ Support a greenhouse-gas audit and use of renewable energy sources. ▪ Continue organizational and operational improvements to maximize energy and resource-efficiency and reduce waste. ▪ Give preference to energy-efficient designs, materials and equipment in public facilities and in infrastructure. ▪ Expand the use of renewable energy sources for City operations.
4. Renewable sources of energy, including solar and wind, and other energy-conservation strategies, are available to city households and businesses.	▪ Promote making renewable-energy options available to homes and businesses.
5. Green building techniques are used in new development and retrofits.	▪ Promote green building through awards and nonfinancial incentives.
6. Reinvestment in existing communities conserves resources and sensitive environments.	▪ Support clean-up and adaptive reuse of brownfields. ▪ Encourage the preservation and adaptive reuse of existing structures to reduce construction waste and conserve energy and materials. ▪ Encourage urban farming and community gardens to promote access to local food.

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4

Housing and Neighborhoods

Housing and Neighborhoods focuses on three issues: overall access to a diverse supply of quality housing; investment in the quality of life in established and new neighborhoods; and promoting community identity and sense of place. Housing goals and policies focus on meeting the diverse needs of households at all income levels and all life-cycle stages, reducing chronic homelessness, and ensuring that all housing is code-compliant, in good condition, and resource-efficient. Goals and policies for neighborhood improvement include support for established neighborhoods, mixed-use urban villages, and more connected neighborhoods.

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Plan CC's Vision for *Housing and Neighborhoods*

High-quality, safe, connected and diverse neighborhoods provide a variety of living choices. Corpus Christi's growth has revitalized older parts of the city; created a new live-work-play neighborhood downtown; resulted in compact, mixed-use centers in key commercial districts; and promoted a connected sense of place and neighborhood in new housing development. Mixed-income neighborhoods provide housing affordable across the income scale for diverse households, young and old—singles, couples, families with children, empty nesters, and retirees. People can get around the city by multiple modes of transportation—connected networks of good streets and sidewalks, safe bicycle routes, and excellent public transportation.




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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
Housing	
1. Corpus Christi has a comprehensive housing policy to guide development of quality neighborhoods.	▪ Support a community-based system to develop and implement a citywide housing policy that includes stakeholders from government, the nonprofit sector, and the private sector.
2. Quality housing meets the diverse needs of households at all income levels and all stages of the life cycle.	▪ Support the planning, regulatory and funding initiatives needed to provide a diversity of housing types—rental and ownership, market-rate and assisted—to meet community needs.
3. Chronic homelessness is significantly reduced.	▪ Provide proactive city leadership in planning and implementing homelessness policies.
4. All housing is in good condition and code-compliant.	▪ Support effective, efficient, and sensitive code enforcement that focuses on compliance.
5. New and redeveloped housing is resource-efficient.	▪ Ensure that City-assisted housing, whether new or rehabilitated, is resource-efficient. ▪ Promote resource-efficiency in all new housing through non-financial incentives, such as permit streamlining.
Neighborhoods	
6. Corpus Christi sustains and maintains established neighborhoods.	▪ Support programs to encourage infill development and rehabilitate housing stock in established neighborhoods. ▪ Support enhanced code enforcement and campaigns to address litter issues. ▪ Promote the organization of neighborhood associations and community initiatives to maintain neighborhoods.
7. Neighborhoods are enhanced by investments in "urban villages" to improve quality of life.	▪ Focus public investments—physical, environmental, functional, and social—to support walkable neighborhood commercial and mixed-use districts, including compact centers along major roads. ▪ Locate public facilities, civic, and cultural uses within or adjacent to neighborhood commercial districts to act as anchors where feasible. ▪ Coordinate among city departments and with the Housing Authority, school districts, county, state and federal agencies on the location of new facilities and the disposition of properties.
Community Identify and Sense of Place	
8. The design of new developments promotes a sense of neighborhood rather than creating isolated subdivisions or apartment complexes.	▪ Support regulations and guidelines that promote interconnected development. ▪ Ensure that pedestrian and bicycle facilities are available in new and redeveloped areas. ▪ Encourage unobtrusive parking solutions.

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ELEMENT

5

Diversifying the Economy and Strengthening the Workforce

The Economic Development and Workforce goals focus on diversifying Corpus Christi's economy and supporting well-paying jobs by building on existing industries, promoting innovation, and growing new sectors. Key elements to support diversification include retaining and attracting firms, cultivating an "entrepreneurial ecosystem" that supports small businesses, attracting talented professionals, and ensuring that students and unemployed or underemployed workers are adequately prepared to find and maintain employment. In addition to building on important long-time sectors like oil and gas and tourism, this element stresses the potential of assets such as higher education research and military bases to bring entrepreneurial energy and more 21st-century jobs to Corpus Christi.

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Plan CC's Vision for Economic Development

Our broadly diversified economy provides opportunity for all. While the port, the oil and gas industry, military bases, and tourism continue as important mainstays of our economy, new sectors are thriving through entrepreneurial start-ups, technology spin-offs from university research, and expanded ecotourism. Our skilled workforce results from a commitment to a strong culture of educational achievement, from pre-school to grad school. Graduates of TAMU-CC and Del Mar College find jobs in Corpus Christi that allow them to stay, grow, and enjoy urban amenities in a Gulf Coast lifestyle.

EXHIBIT A

Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
1. Corpus Christi has a diversified economy of well-paying jobs that builds on existing industry strengths and technological innovation.	▪ Leverage the technological strengths of companies in the oil and gas cluster by supporting new product development and expansion into new markets. ▪ Support market diversification by the tourism industry. ▪ Promote expansion of public and private research activity in the region that offers the potential for the development of new products and the emergence of new industries.
2. Corpus Christi is able to attract and retain firms because of its competitive assets and supportive business environment.	▪ Develop and maintain strong lines of communication between local government and businesses to ensure timely response to business needs. ▪ Ensure that business taxes, fees, and regulations are reasonable and equitable. ▪ Make regulatory processes efficient and transparent. ▪ Provide financial incentives judiciously for business investments that offer the potential for strong catalytic impacts, and structure incentives to provide the maximum public benefits. ▪ Increase the availability of technical and financial resources essential to entrepreneurship. ▪ Foster the development of a high-quality workforce across a wide range of occupations and skill levels that meets the current and emerging needs of local businesses and makes workforce a positive factor for business prospects. ▪ Maintain transportation and utility infrastructure in good repair and make additional modernization investments as necessary in a timely manner.
3. Corpus Christi has a robust "entrepreneurial ecosystem" that supports a thriving small business community.	▪ Foster a community culture that recognizes and embraces innovation and entrepreneurship. ▪ Invest in the resources and capacity that support new venture startup and growth. ▪ Encourage youth to develop entrepreneurial talents.

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GOALS	POLICIES FOR DECISION MAKERS
4. Corpus Christi is a community of choice for talented entrepreneurs and professionals.	▪ Foster a community culture that embraces diversity, values new ideas, and welcomes new residents. ▪ Create a strong, positive image for Corpus Christi, both internally and externally. ▪ Strengthen community institutions and amenities that provide a high quality of life. ▪ Provide positive incentives for highly skilled individuals who have other locational choices to settle in Corpus Christi to pursue their careers.
5. Unemployed and underemployed workers have access to training and support services that enable them to improve their employment status and qualify for jobs offered by local employers.	▪ Ensure that career training programs and other workforce development services are aligned with employer needs and responsive to changing employer demand. ▪ Support an easily accessible and seamless service delivery system for jobseekers. ▪ Promote provision of essential support services that enable workers to seek and maintain employment. ▪ Promote a balance between responding to immediate labor force needs and planning for longer-term changes in the labor market.
6. Every student completes his or her education, whether high school or college, with the skills needed to enter a well-paying career.	▪ Make school completion a high civic priority with broad community support and engagement. ▪ Promote partnerships and encourage integrated early childhood services—incorporating cognitive, intellectual and emotional development, health, and family social services—to ensure that children entering school are ready to learn. ▪ Promote provision of a range of age-appropriate career exploration and experience opportunities for children, beginning at the elementary level. ▪ Promote alignment of education, including school boards and workforce development agencies, with the needs of local industry.

EXHIBIT A

ELEMENT

6

Getting From Here to There: Transportation and Mobility

Transportation and Mobility focuses on improving Corpus Christi's transportation infrastructure and systems, including expanding mode choices to encourage biking, walking, and public transportation while maintaining the roadway system for long-term effective use. Integrating land use and transportation planning, along with support for aviation, rail freight and shipping from Corpus Christi, are key goals for the future.

EXHIBIT A

Plan CC's Vision for Transportation and Mobility

People can get around the city by multiple modes of transportation—connected networks of good streets and sidewalks, safe bicycle routes, and excellent public transportation. City services, infrastructure and utility systems—including streets—have been modernized to ensure that the city can support and maintain urban and industrial growth, employing best practices in a cost-efficient manner.





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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
1. Corpus Christi has an efficient and safe transportation network, including bicycles, pedestrians, public transportation, aviation, shipping, trucks and automobiles, that is integrated with land uses and promotes transportation choice, healthy lifestyles, and sustainable development patterns.	▪ Support a multimodal transportation network that is integrated with land uses. ▪ Support compliance with transportation design standards. ▪ Support the development of mode-choice corridors for bicycles, pedestrian and public transportation.
2. Corpus Christi's street system is maintained to standards for long-term effective use.	▪ Support a long-term program to repair existing streets and regularly maintain the system to minimize life-cycle costs. ▪ Support adequate and balanced funding sources for long-term operation and maintenance of the street network. ▪ Integrate transportation planning with utility infrastructure planning.
3. Improve the design and function of neighborhood collector and local streets.	▪ Promote lower vehicular speeds and bicycle/pedestrian use on neighborhood streets. ▪ Consider a reconstruction program for local streets.
4. Corpus Christi has a convenient and efficient public transportation system.	▪ Support continued implementation of the Corpus Christi Regional Transportation Authority Long-Range Strategic Plan to prioritize funding to increase ridership and reduce single-occupancy vehicle use. ▪ Support an operations plan to increase the efficiency and lower the life-cycle costs of the public transportation system. ▪ Support transit-oriented development (TODs) near public transportation stations.
5. Corpus Christi International Airport is the aviation gateway to the Coastal Bend and supports economic development.	▪ Continue to implement the Airport Master Plan.
6. Support and enhance continuing national freight rail service from Corpus Christi.	▪ Support enhancements to rail service essential to the city's economic success. ▪ Minimize delays and improve safety at at-grade railroad crossings.

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7

Community Infrastructure, Facilities and Services

Infrastructure, Facilities, and Services focuses on the improvement of long-term water supplies, water security, waste-water treatment, solid waste disposal and storm water and drainage systems through cost-effective and environmentally sustainable initiatives. Proposed improvements focus especially on long-term planning that integrates management strategies to meet or surpass regional and state goals and standards.

EXHIBIT A

Plan CC's Vision for Infrastructure, Facilities and Services

Modernized city services and systems support growth and vitality in all parts of the city. City services, infrastructure and utility systems—including streets, drinking water supply, wastewater, and storm water management—have been modernized to ensure that the city can support and maintain urban and industrial growth, employing best practices in a cost-efficient manner.

EXHIBIT A

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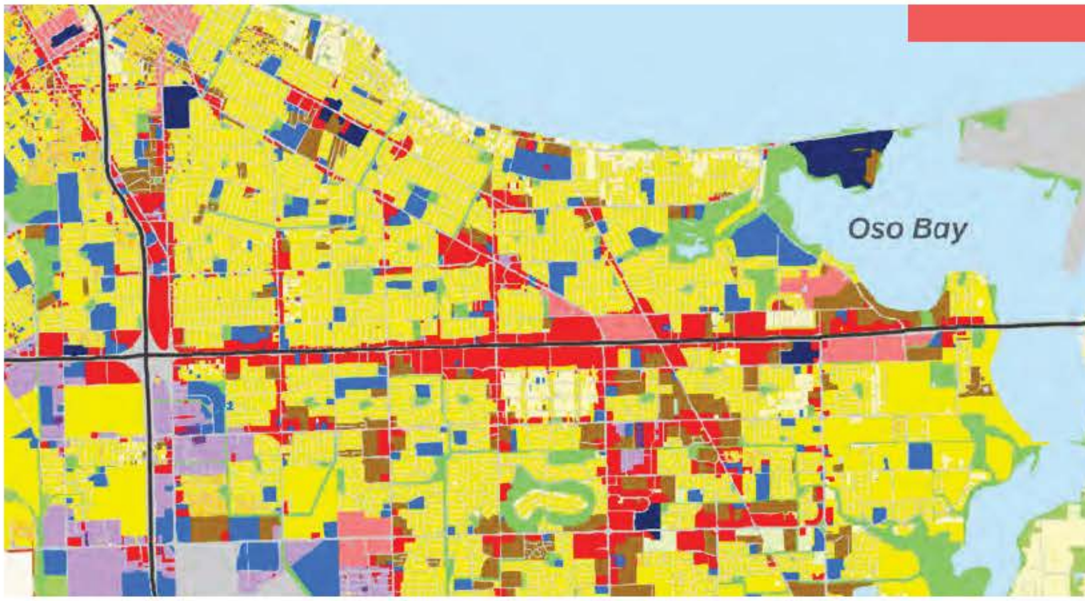
Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
Natural Systems	
1. Corpus Christi has an integrated, sustainable water-resource management program that provides a long-term supply of the right water for the right use–drinking water for residents and processed water for business and irrigation–while ensuring the integrity of environmental systems.	▪ Develop and maintain integrated water-management strategies of surface, reuse, conservation, aquifer storage and recovery and desalination. ▪ Support a water system and management master plan to meet demand through the year 2060. ▪ Continue implementing the city's water-conservation plan. ▪ Support a strategic approach to providing adequate water, wastewater-treatment and storm-drainage infrastructure to support redevelopment and new development in targeted areas.
2. Corpus Christi has long-term water security that exceeds state water quality requirements.	▪ Provide a safe, efficient, and sustainable water supply, treatment, and distribution system in an environmentally sound manner. ▪ Maintain and improve existing water infrastructure, including the incorporation of new technologies where appropriate.
3. Corpus Christi has a cost-effective and environmentally sustainable wastewater-treatment system that supports existing development and accommodates future growth.	▪ Support improvements to meet state and federal standards. ▪ Support an approach that establishes priorities for the replacement and correction of existing facility deficiencies and for meeting future needs.
4. Corpus Christi has a storm water and drainage system that is environmentally and economically sustainable.	▪ Promote natural drainage approaches ("green infrastructure") and other alternative non-structural and structural best practices for managing and treating storm water. ▪ Promote reduction of pollutants in the Bay by reducing storm water discharges. ▪ Promote economic development by reducing potential losses due to flooding and water-quality degradation. ▪ Review the creation of a more equitable billing system for storm water services.
5. All residences and businesses have a dependable, environmentally safe means to dispose of solid waste.	▪ Continue providing city and regional waste-management services. ▪ Continue to maximize landfill capacity by supporting recycling that meets or exceeds state and regional goals.
6. The City maintains all municipal buildings and facilities for long-term use.	▪ Support investment in an asset-management system. ▪ Continue to invest in best practices for long-term, life-cycle energy and resource efficiency in improvements, renovations, or new facilities.
7. Buildings, facilities and open spaces, both public and private, comply with ADA (Americans with Disabilities Act) standards.	▪ Support programs to meet all outstanding ADA deficiencies in public facilities. ▪ Make ADA accessibility information available to the public.
8. Corpus Christi has state-of-the-art broadband and telecommunications services.	▪ Seek provision of high-speed Internet and telecommunications access to all residents and businesses.
9. The city's electric grid is protected and resilient.	▪ Work with electric service providers to upgrade the grid and put it underground.

EXHIBIT A



ELEMENT

8

Future Land Use, Zoning, and Urban Design

Every comprehensive plan contains an element on future land use and a future land use map. The **Future Land Use, Zoning, and Urban Design** element sets forth the policy framework for the physical development of Corpus Christi over the next 20 years. It is the guide for decision makers on the pattern, distribution, density and intensity of land uses that, over time, will help the city achieve the community's vision for the future. The future land use map is not a zoning map but provides the foundation for zoning. It guides land-use decision makers when they are called upon to exercise their discretion in making rulings on rezoning and similar issues.

EXHIBIT A

Plan CC's Vision for Land Use, Zoning & Urban Design

FROM THE VISION:

Corpus Christi's growth has revitalized older parts of the city; created new live-work-play neighborhoods and downtown; resulted in compact, mixed-use centers in key commercial districts; and promoted a connected sense of place and neighborhood in new housing development....

FROM THE PRINCIPLES:

- **Pursue high-quality development.** Make public investments a model of excellent design and function and establish high-quality design standards for private development. Consistent application of clear standards will make the city more attractive for people who live here now and attract new residents.
- **Be strategic.** Strategically integrate public physical, economic, and social investments to leverage private investment and grants in order to create critical mass that supports enhanced choices in housing, transportation, and retail and services. This critical mass will then stimulate self-sustaining activities.

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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
1. Corpus Christi development patterns support efficient and cost-effective use of resources and high quality of life.	▪ Protect and enhance stable residential neighborhoods. ▪ Promote revitalization and redevelopment of older neighborhoods. ▪ Support creation of a City redevelopment authority or similar agency.
2. Downtown and mixed-use urban and neighborhood villages provide walkable environments and new housing options.	▪ Support planning to create urban and neighborhood villages.
3. Public and private developments demonstrate high standards of design.	▪ Adopt design standards and guidelines that result in high-quality built environments.
4. Regulations to protect military and civilian airfield and airport use are in place.	▪ Adopt regulations consistent with the recommendations of the Joint Land Use Study.
5. Transitions from residential enclaves to non-residential uses have occurred in industrial and aviation special districts.	▪ Support city involvement in setting up a fair transition process.
6. Annexation plans provide for orderly growth in the southern ETJ and industrial agreements in the northern ETJ.	▪ Adopt policies and regulations that ensure orderly development in annexed areas.

Plan CC's Land Use Principles

Housing and Neighborhoods

- Preserve and support the character of stable residential neighborhoods.
- Encourage residential infill development on vacant lots within or adjacent to existing neighborhoods.
- Locate multifamily development where there is nearby access to retail, services, and public transportation, such as in mixed-use centers or urban villages.
- Promote interconnected neighborhoods with appropriate transitions between lower-intensity and higher-intensity land uses.
- Avoid locating small areas of residential uses where they will be surrounded by intensive commercial or industrial uses.

Mixed-Use Centers

- Promote residential and mixed-use development downtown.
- Provide for compact and walkable mixed-use urban villages that concentrate retail and services within walking distance of neighborhood residences and where they could support improved public transportation service, such as expected major bus stations and future stops for bus rapid transit, creating "transit-ready" locations.
- Provide for neighborhood villages—smaller mixed-used areas to concentrate neighborhood-serving retail and services along with some residential development.

Efficient Development Patterns

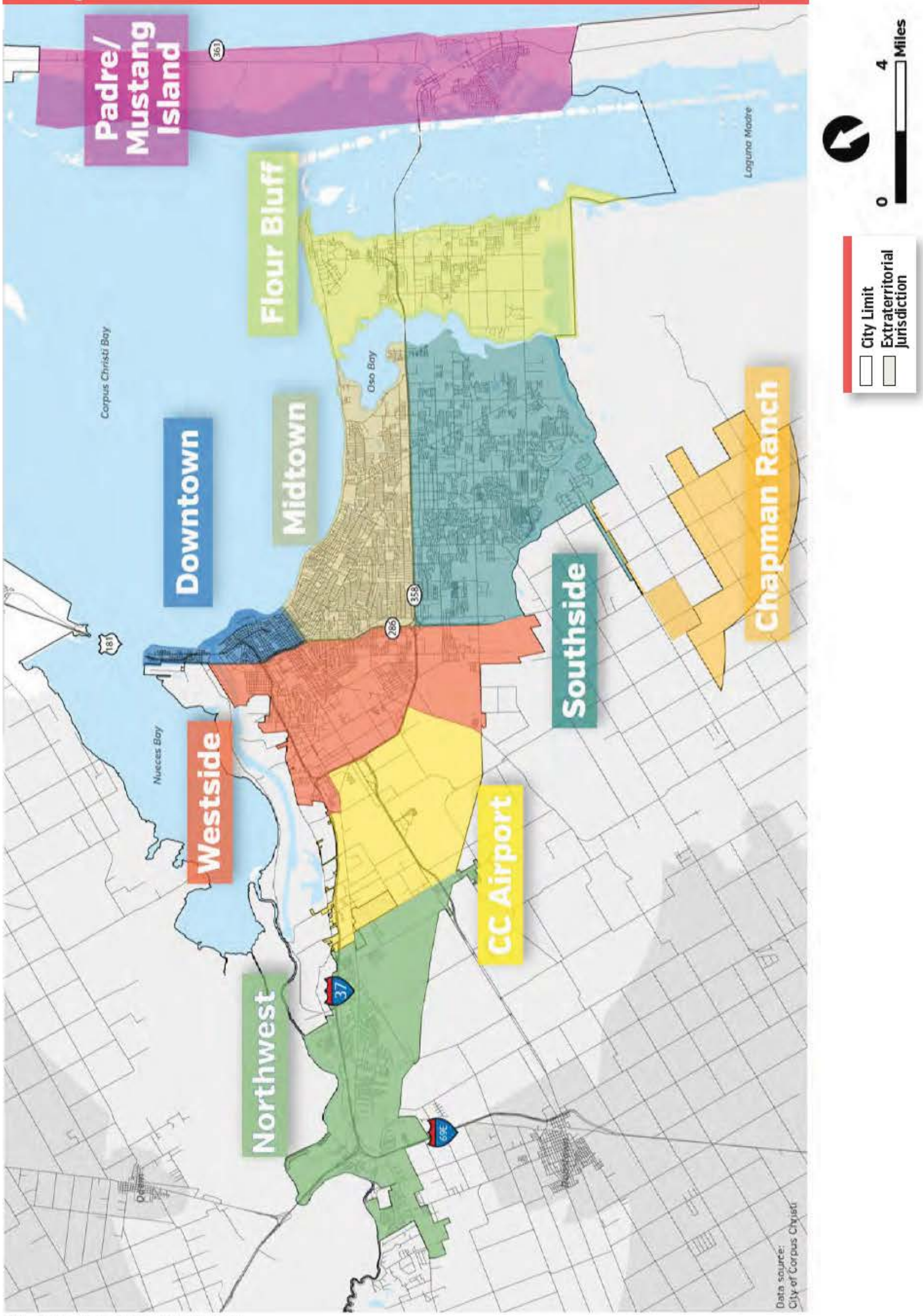
- Locate new residential developments adjacent to and connected to existing development.
- Avoid "leapfrog" development that locates subdivisions far from other residential areas.
- Avoid development that is incompatible with the operation of military airfields and the airport.
- Use annexation powers combined with minimum lot size in zoning and infrastructure policy to promote orderly and efficient development in the ETJ.
- Locate heavy industrial uses close to one another and to services for industrial uses.

Environment and Resilience

- Preserve and protect environmentally sensitive land and water.
- Preserve land around creeks and drainage corridors to achieve a green network of interconnected parks, multi-use paths, passive and active recreational spaces, and conservation land.
- Avoid development without resilience measures and mitigation in areas vulnerable to hazards.

EXHIBIT A

Planning Districts



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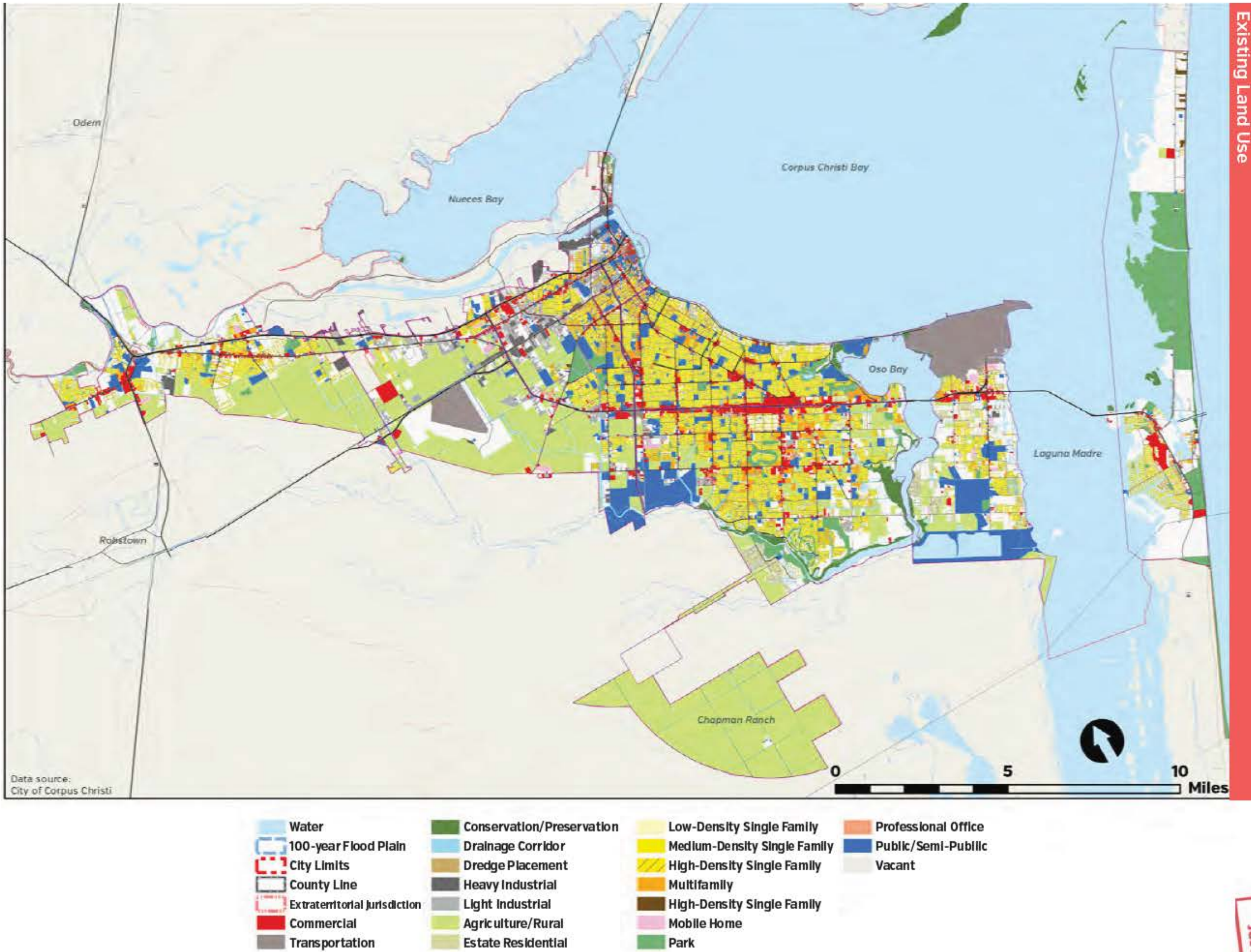

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Future Land Use Definitions

RURAL USES

Agriculture/Rural Enterprise

This category includes farms and other enterprises that serve the rural population, such as convenience retail and gas stations, agricultural suppliers, and so on. Uses include:

- Single-family homes on very large lots or associated with rural enterprise uses
- Agricultural uses
- Vacant land that has not previously been developed
- Small business clusters that serve a rural population

RESIDENTIAL USES

The predominant residential land use in the City of Corpus Christi is the single-family dwelling at a range of densities. Instead of a general residential category, the Future Land Use Map for Plan CC designates three density levels for single-family housing and a separate land use category for multifamily development and for mixed-use development, which can include housing. The purpose of this approach is to show multifamily housing locations. All residential categories also include schools, churches, and neighborhood-serving public uses. Where small enclaves of residential uses are surrounded by existing or planned light-industrial or intensive commercial uses, rezoning should not perpetuate or enlarge these enclaves.

Single-Family

- Low-density single-family: up to 4 units per acre
- Medium-density: 5 to 12 units per acre (including two-family dwellings)
- High-density: more than 12 units per acre

Multifamily

- Multifamily development can range from small apartment buildings with three or four units and townhouse developments to large apartment buildings.
- Smaller buildings of no more than three stories can coexist with neighborhoods of predominantly single-family housing, preferably located at intersections or on collector streets.
- Preferred locations for larger buildings include downtown and downtown-adjacent areas, locations within a walkable distance of urban village cores, and transportation and transit corridors.

COMMERCIAL USES

Commercial land uses include retail and office uses that are typically open to the public at large. Other commercial uses, such as wholesale and distribution businesses, are included in the light industry category because they have similar impacts, such as high volumes of trucking. In Corpus Christi, 60 percent of retail development is located in the SH358/South Padre Island Drive corridor. The concentration of retail and other commercial businesses in this corridor is unlikely to change, particularly because so much of it is located on frontage roads to the highway. The desired change is for redevelopment and transformation of this commercial area into higher-value and more attractive development with higher design standards. Schools, churches, and neighborhood-serving public uses can be included in commercial land use areas.

Zoning can distinguish among different types of commercial development including:

Neighborhood Commercial

- Areas for neighborhood retail and services that meet the day-to-day needs of residents and workers of surrounding neighborhoods (typically within a 3-mile radius) with a range of uses such as smaller grocery stores, banks, restaurants and services such as small professional and health offices, barber/beauty shops, dry cleaners, and so on.
- These areas are accessible by automobile with sufficient parking, but also should be designed to accommodate pedestrian and bicycle access.

General Commercial

- Commercial areas serving a citywide or regional trade area, including shopping and entertainment centers that offer a range of retail and service establishments, including large supermarkets, department stores, movie theaters, big box stores, and supporting retail and professional services.
- Office buildings or office uses on upper stories.
- Leisure and entertainment uses.
- General commercial areas are generally accessed by auto, but these properties should be designed to accommodate pedestrians and bicyclists, provide interior circulation between properties, and use appropriate landscaping to counter heat island and stormwater-management impacts.

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INDUSTRIAL USES

Most of the industrial uses within the city limits of Corpus Christi are light industrial; heavy industry is located in the ETJ industrial districts.

Light Industrial

- Light industrial and office uses, potentially in "business park" settings, and typically near major transportation routes and services including highways, railroads, and airport facilities.
- Light industrial uses typically produce consumer or end-user goods, require limited amounts of raw materials and energy, and are small- to medium-scale in size. Examples include food processing, furniture manufacture, and consumer electronics.
- Small- to medium-sized warehouse and distribution uses.
- Urban agriculture to produce a mixture of foodstuffs for sale
- Supporting uses, such as minor retail and services that support the major uses.

Heavy Industrial

- Heavy manufacturing and large warehousing and distribution facilities.
- Heavy industry is capital-intensive and generally sells to other industries rather than to final consumers.
- Uses that require significant truck traffic and/or rail connections.
- Supporting uses such as minor retail, services, and offices connected to the industrial use or serving an industrial park.
- Certain public uses, such as landfills, that have an industrial character and impact.

TRANSITION DISTRICTS

Special I-37 Transition District

The Special I-37 Transition District covers the residential uses west of the alignment of the new Harbor Bridge and north of I-37, such as Hillcrest and Dona Park. Located close to oil refineries and other industrial establishments, these neighborhoods have long been concerned about environmental pollution and contamination and have been losing population. The construction of I-37 cut them off from neighborhoods to the south. The Transition District designation indicates that over time the residential uses should leave this area and the designated land use should become light industrial or a buffer use (offices, supporting uses) within a heavy industrial district. The existing residential population includes both owner-occupants and tenants, predominantly low-income. The transition should take place over time within a framework that provides fair compensation and assistance to residents in moving to other parts of the city.

Special Aviation Transition District

The Special Aviation Transition District is also a district for transition from residential to non-residential uses, but for a different reason. NAS-CC and the City prepared and adopted a Joint Land Use Study (JLUS) in 2013 that called for land use changes to ensure compatibility with military and civilian aviation. For NAS-CC, this means avoiding residential land uses and other concentrations of people between the military installation and South Padre Island Drive. Implementing this recommendation of the JLUS is particularly important for NAS-CC, one of the most important employers in Corpus Christi. The federal government is expected to begin another evaluation of potential base closings in 2017, and efforts to implement the JLUS will help secure NAS in Corpus Christi.

Like the I-37 Transition District, the Aviation Transition District is home to a low- and moderate-income population of owner-occupants and tenants and the transition process is likely to take many years. A process providing for fair compensation and assistance should be put in place for this area as well and could involve reimbursement programs run by the Federal Aviation Administration.

MIXED-USE AREAS

Mixed-use centers, ranging from vibrant downtown environments to active urban villages, include residential, retail, and office uses. Mixed-use centers are pedestrian-friendly and provide concentrated population and activity centers that can support enhanced transit. The mixture can be vertical, with uses on different floors of a building, and horizontal, with different uses side by side, and include multifamily, townhouse, cottage and small-lot single-family residential, retail and services, offices, hotels and live/work structures. Buildings should be oriented to the street, with active ground-floor uses that provide easy pedestrian access. Parking should be located in the rear of the lot or to the side where

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lots are shallow, or in parking structures. Shared parking districts can make parking more efficient and benefit the entire district. Uses that require large amounts of trucking are not suitable for mixed-use areas. Churches, schools and public uses are included in mixed-use areas.

Plan CC has one mixed-use land use designation that includes three types of mixed-use districts, which can be distinguished through zoning or overlay districts:

- **Downtown:** Downtown is the largest center of pedestrian-oriented, mixed-use activity, with both vertical and horizontal mixture of uses, including housing, offices, ground-floor retail, services, restaurants and entertainment, cultural amenities, and so on. The mixture of uses creates a vibrant 18- to 24-hour, 7-day-a-week live-work-play environment.
- **Urban Village:** Urban Villages are medium-sized walkable centers that cover multiple blocks, include ground-floor stores and restaurants and upper-story offices, and typically have public transportation stops or stations. The types of stores, restaurants, and other amenities serve residents in the surrounding neighborhood and attract people from other parts of the city.
- **Neighborhood Village:** Neighborhood Villages are smaller, walkable, mixed-use villages that can be as small as a few blocks around an intersection. They primarily serve the surrounding neighborhoods with retail and services.
- A **"collegetown"** is a type of Urban Village, with retail, services, entertainment, and (often) housing, that is oriented toward the needs of students and located near a university or college or student-oriented housing.

OTHER

INSTITUTIONAL

Hospitals, colleges, universities, and similar institutions, whether public or private, are designated as separate land uses because of their campus-like character, which requires special attention to edges and relationships with adjacent areas.

GOVERNMENT

Government uses include federal, state, county, regional and municipal government facilities and installations, except for government-owned institutions.

PERMANENT OPEN SPACE

Parks and playgrounds, recreational fields and facilities, greenways, and other green areas managed for public access and recreation

FLOOD PLAIN CONSERVATION

Lands within the 100-year flood plan, preferably preserved for environmental reasons

TRANSPORTATION

Airports, railroads, highway and interstate rights-of-way.

PLANNED DEVELOPMENT AREAS

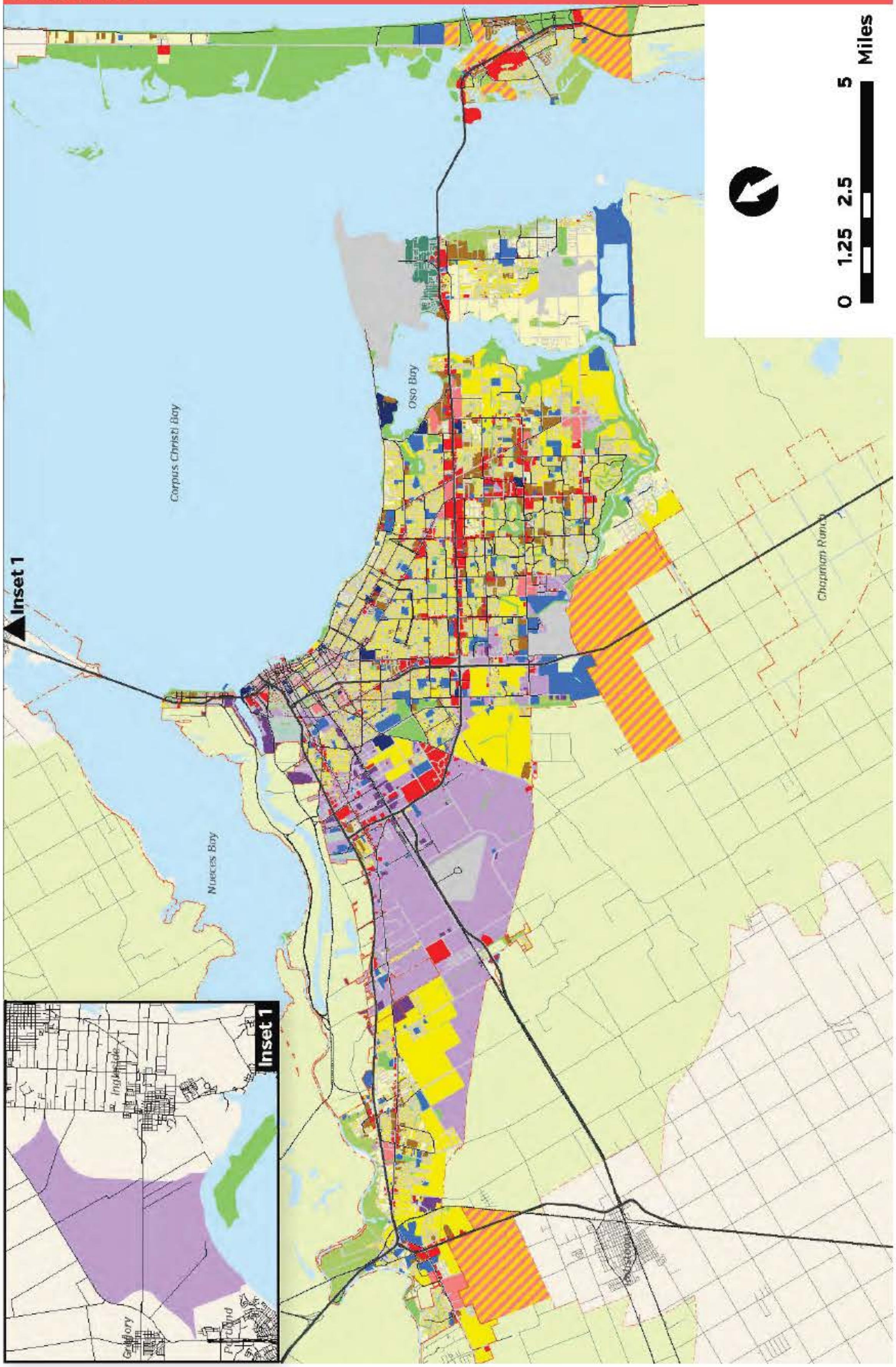
Planned development areas are lands that are currently undeveloped or underutilized but may be suitable in the future for a variety of uses, taking into account environmental and other constraints. Designated on Padre and Mustang islands and in the potential annexation areas, planned development areas are expected to require a rezoning tied to a master planning process or an Area Development Plan process.

Key: Future Land Use Map *(facing page)*

Mixed Use	Medium-Density Single-Family Residential	Flood Plain Conservation
Agriculture/Rural Enterprise	High-Density Single-Family Residential	Water
Commercial	Multifamily Residential	100-Year Flood Plain
Government	Transition Aviation Special District	City Limit
Institutional	Transition Special District	Extraterritorial Jurisdiction
Heavy Industrial	Transportation	Planning District
Light Industrial	Planned Development	Central Business District
Low-Density Single-Family Residential	Permanent Open Space	Proposed Harbor Bridge Alignment

EXHIBIT A

Future Land Use



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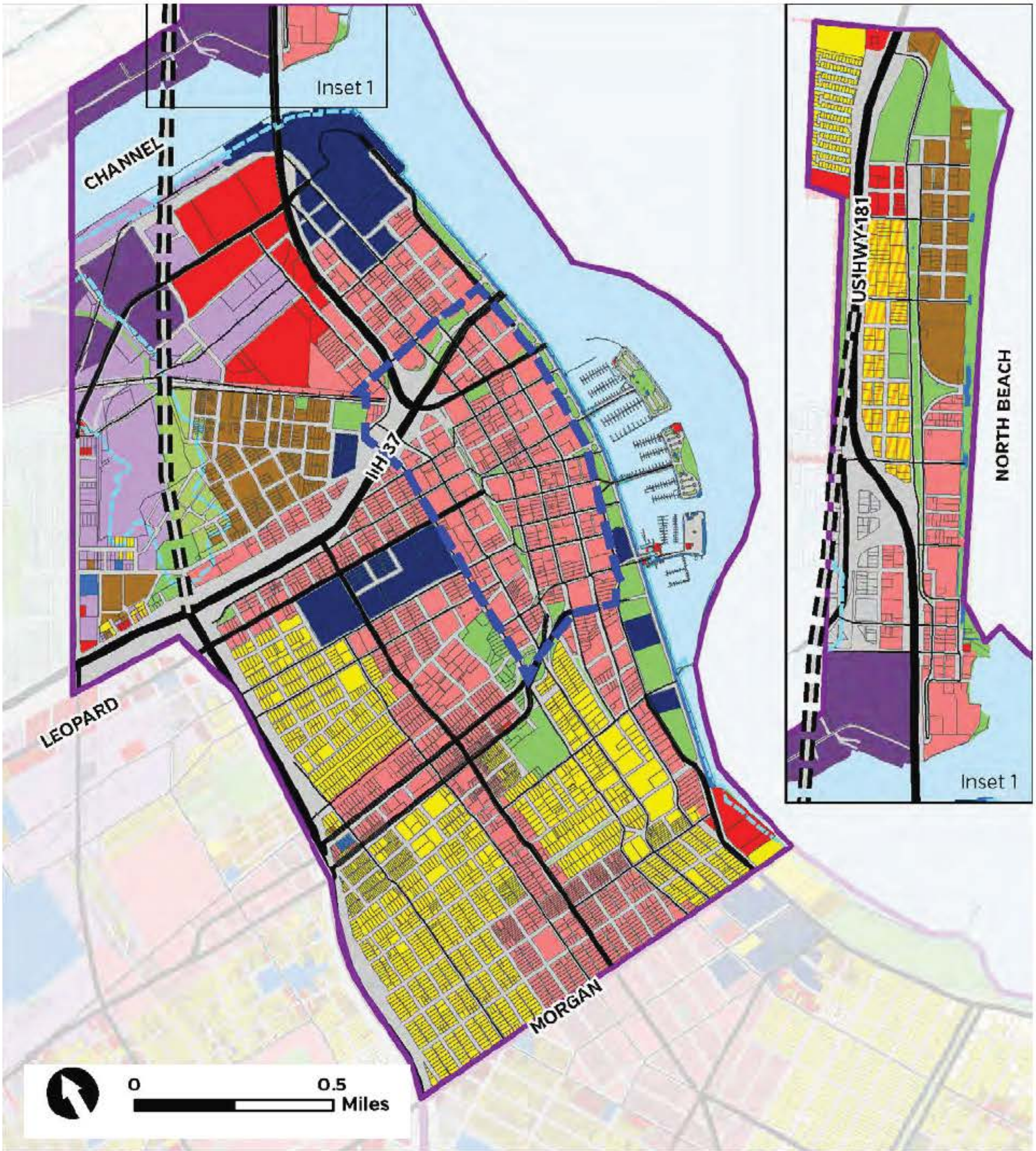
Downtown *Planning District* ***Future Land Use***



FUTURE LAND USE

Downtown
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
- Proposed Harbor Bridge Alignment

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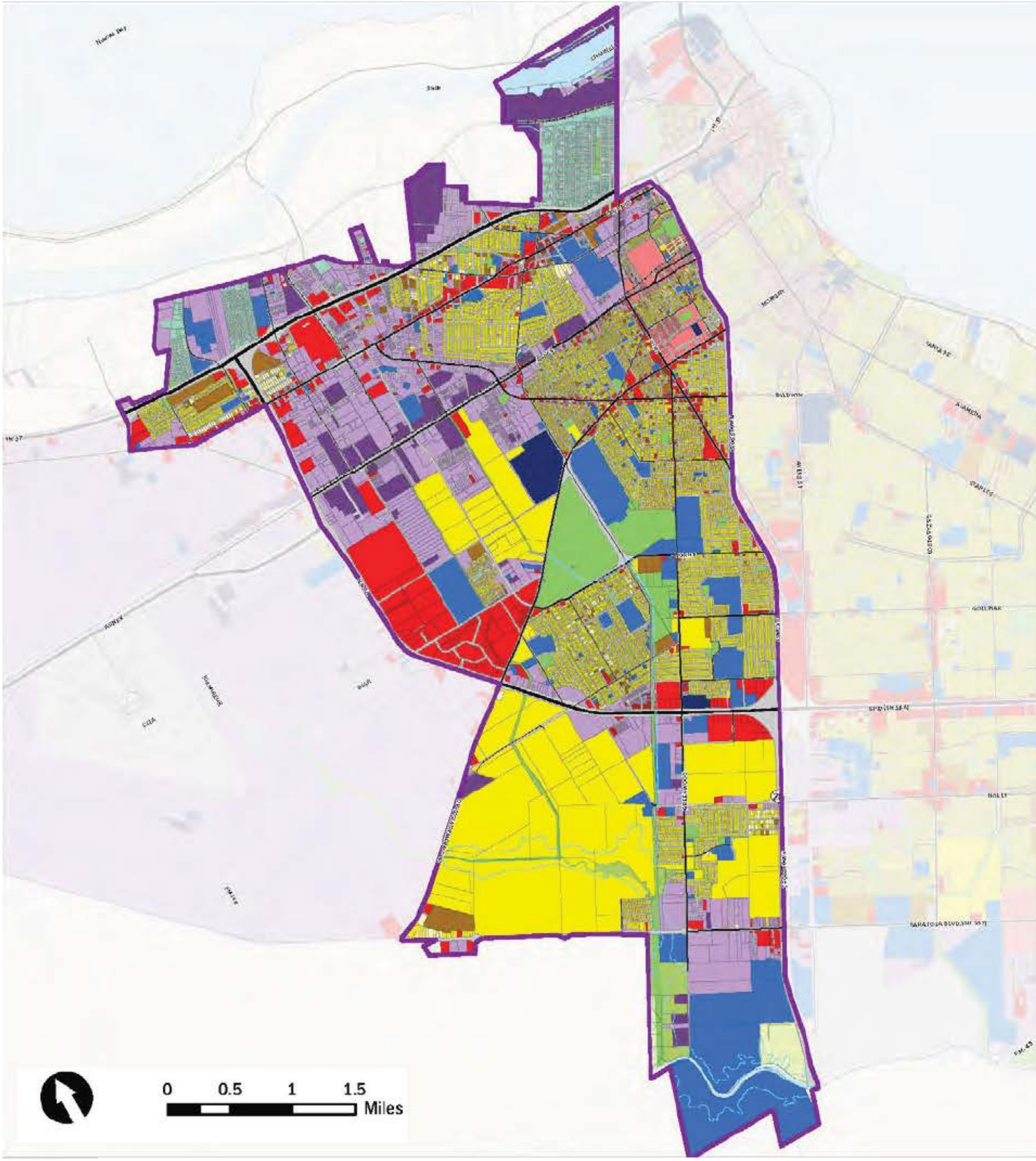
Westside *Planning District* ***Future Land Use***



FUTURE LAND USE
Westside
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
- Proposed Harbor Bridge Alignment

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EXHIBIT A

Midtown Planning District Future Land Use

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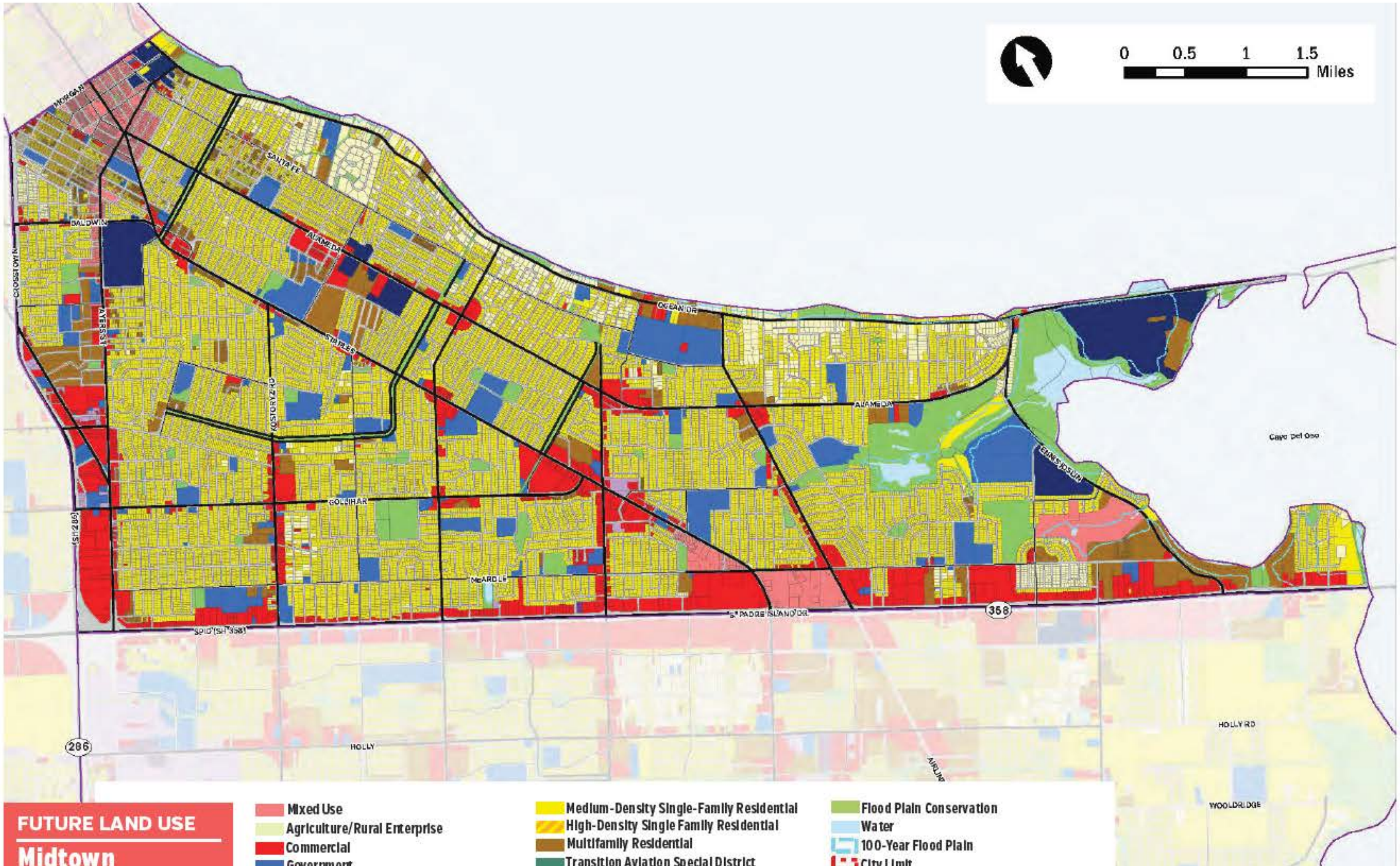

FUTURE LAND USE

Midtown
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
- Proposed Harbor Bridge Alignment

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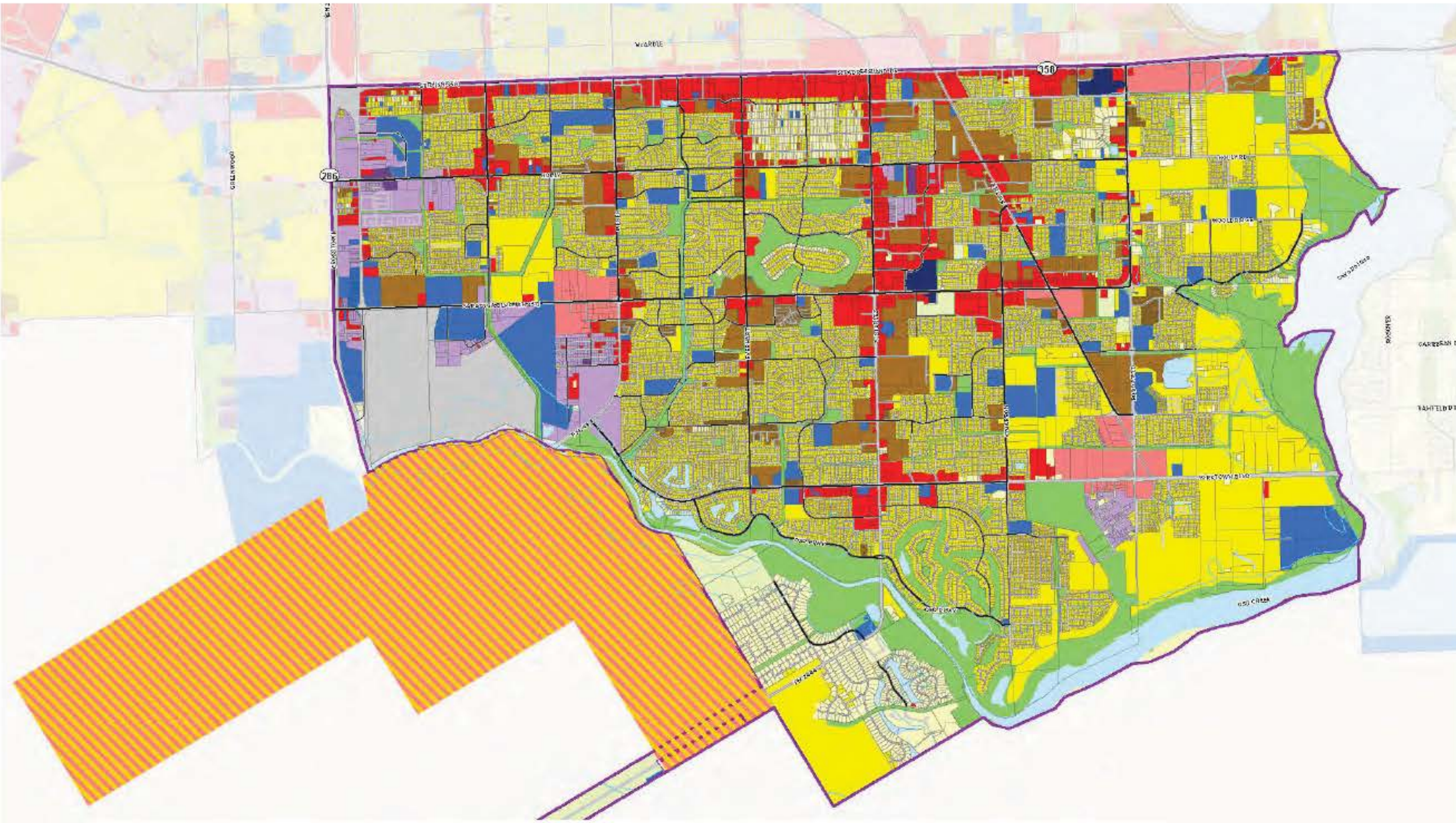
Southside Planning District *Future Land Use*



FUTURE LAND USE

Southside
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
- Proposed Harbor Bridge Alignment

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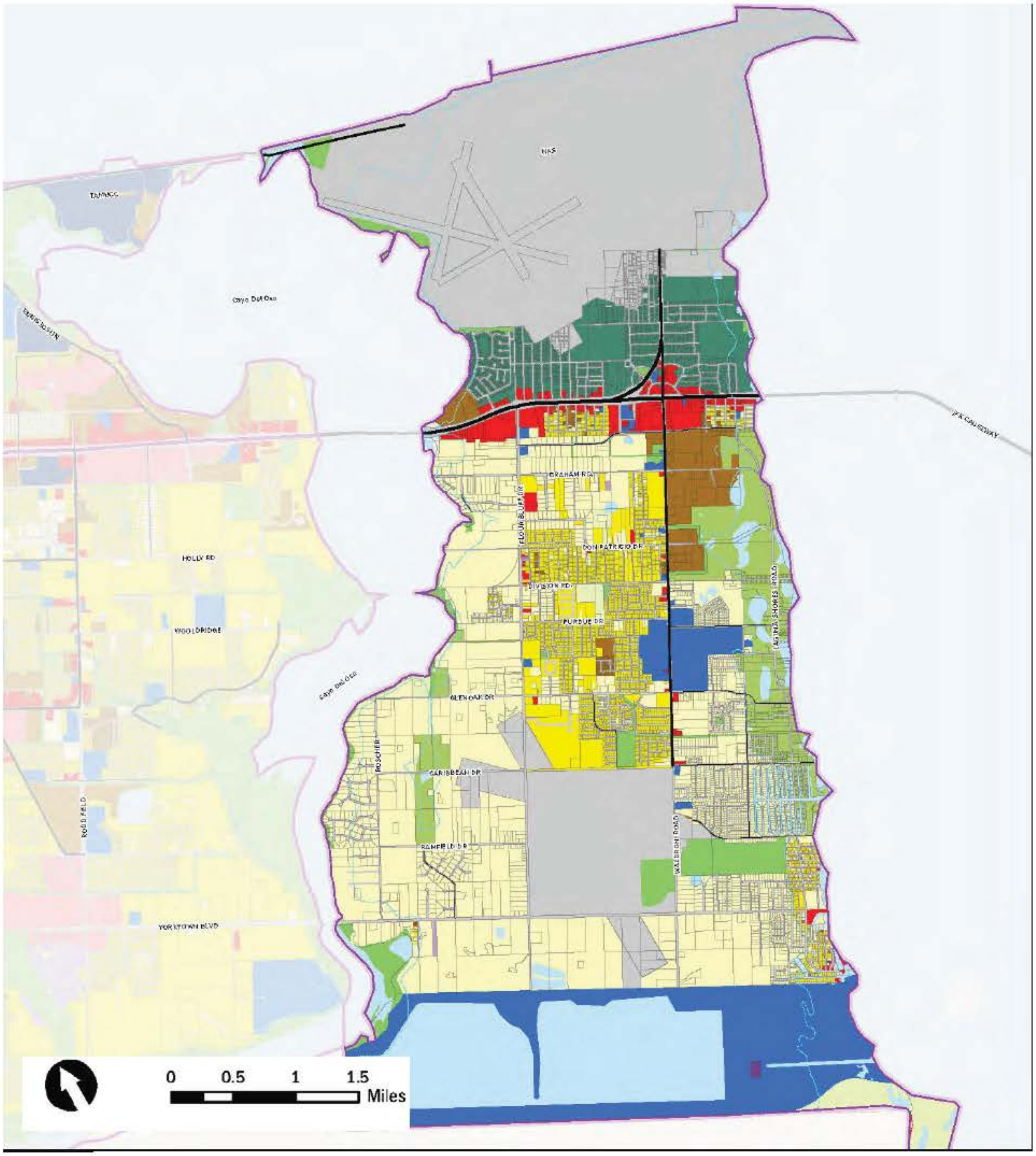
Flour Bluff *Planning District* **Future Land Use**



FUTURE LAND USE
Flour Bluff
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
- Proposed Harbor Bridge Alignment

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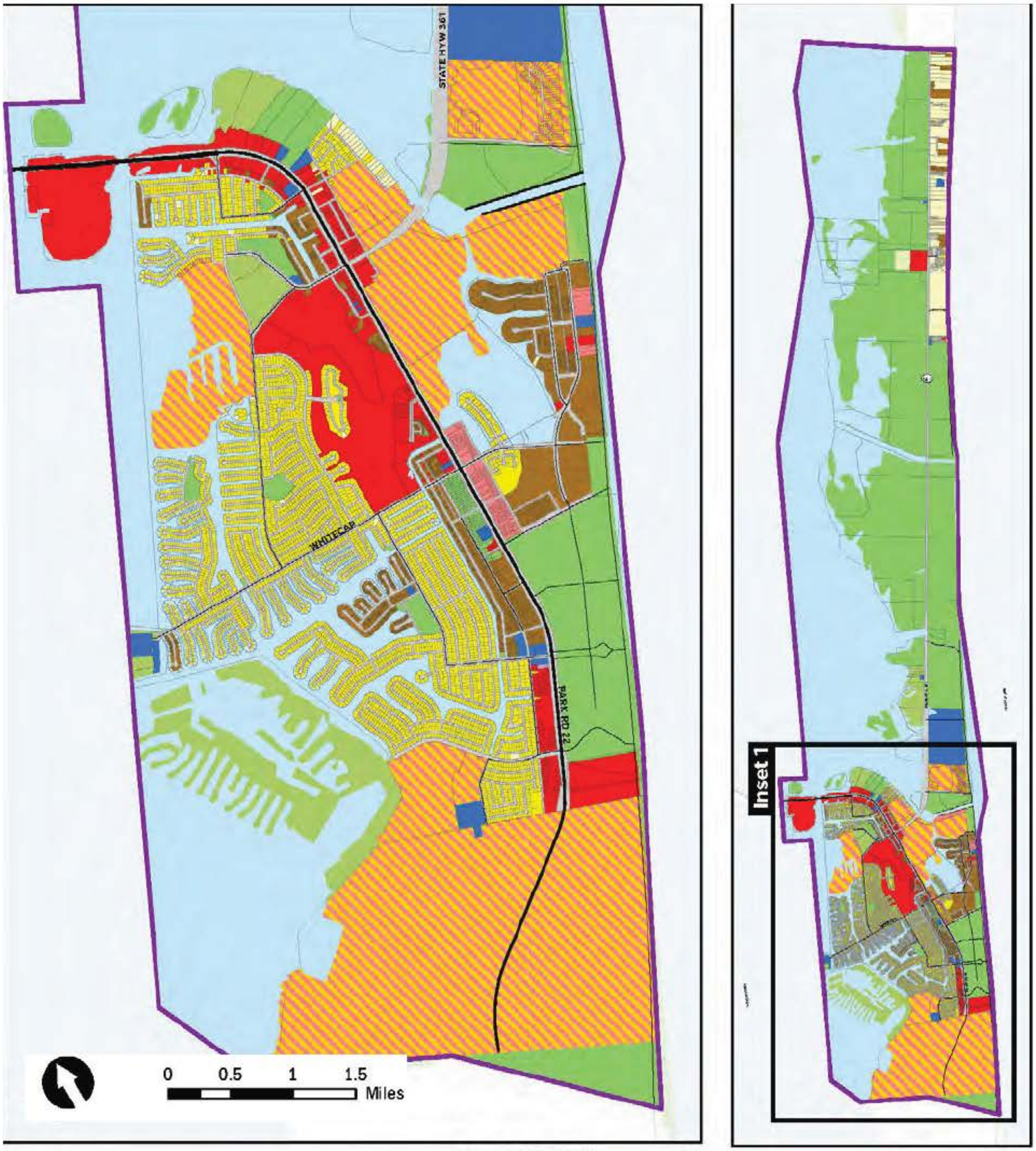
Padre/Mustang Planning District **Future Land Use**



FUTURE LAND USE
Padre Island/ Mustang Island
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
- Multifamily Residential
- Transition Aviation Special District
- Transition Special District
- Transportation
- Planned Development
- Permanent Open Space
- Flood Plain Conservation
- Water
- 100-Year Flood Plain
- City Limit
- Extraterritorial Jurisdiction
- Planning District
- Central Business District
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CC Airport Planning District Future Land Use

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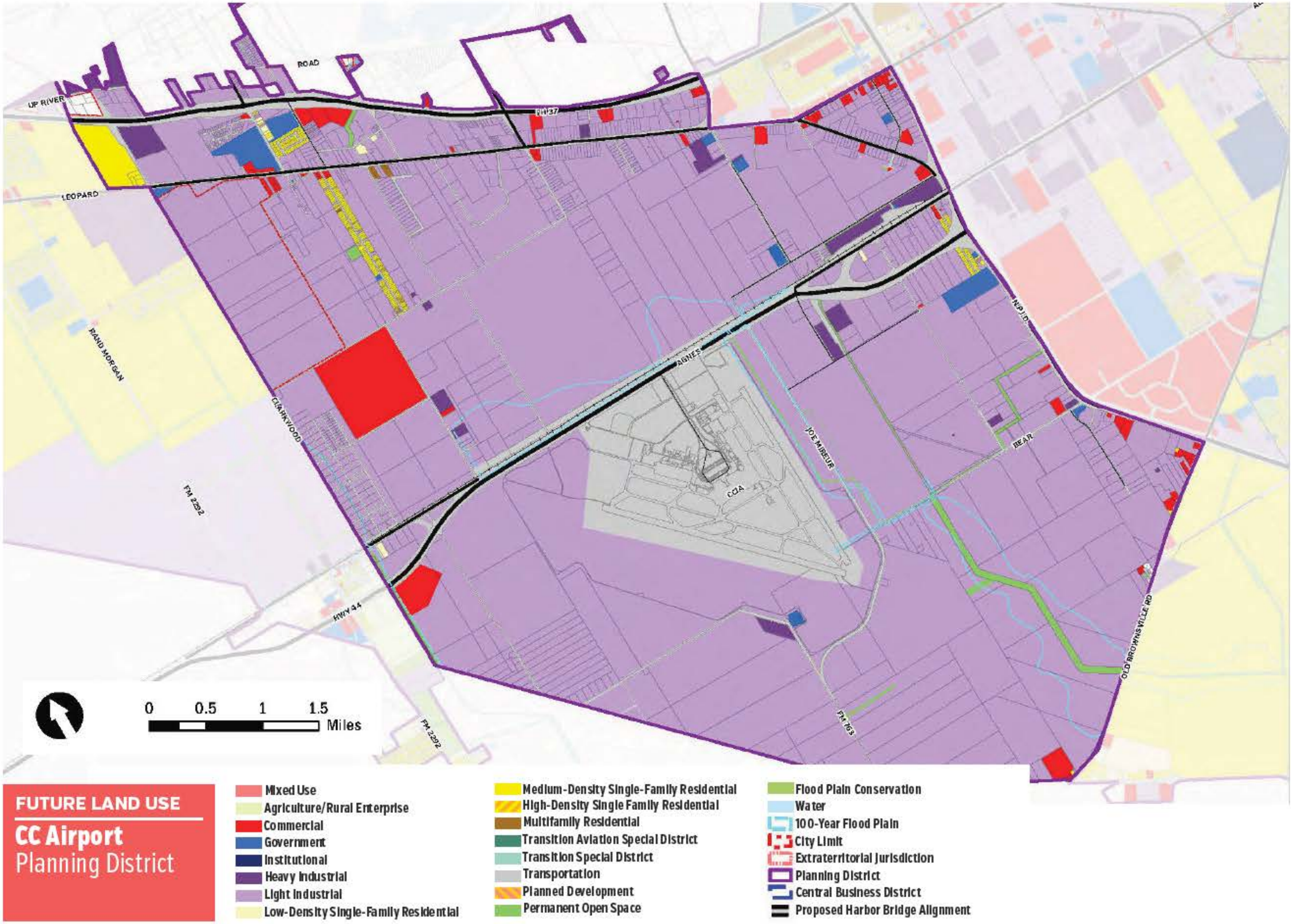

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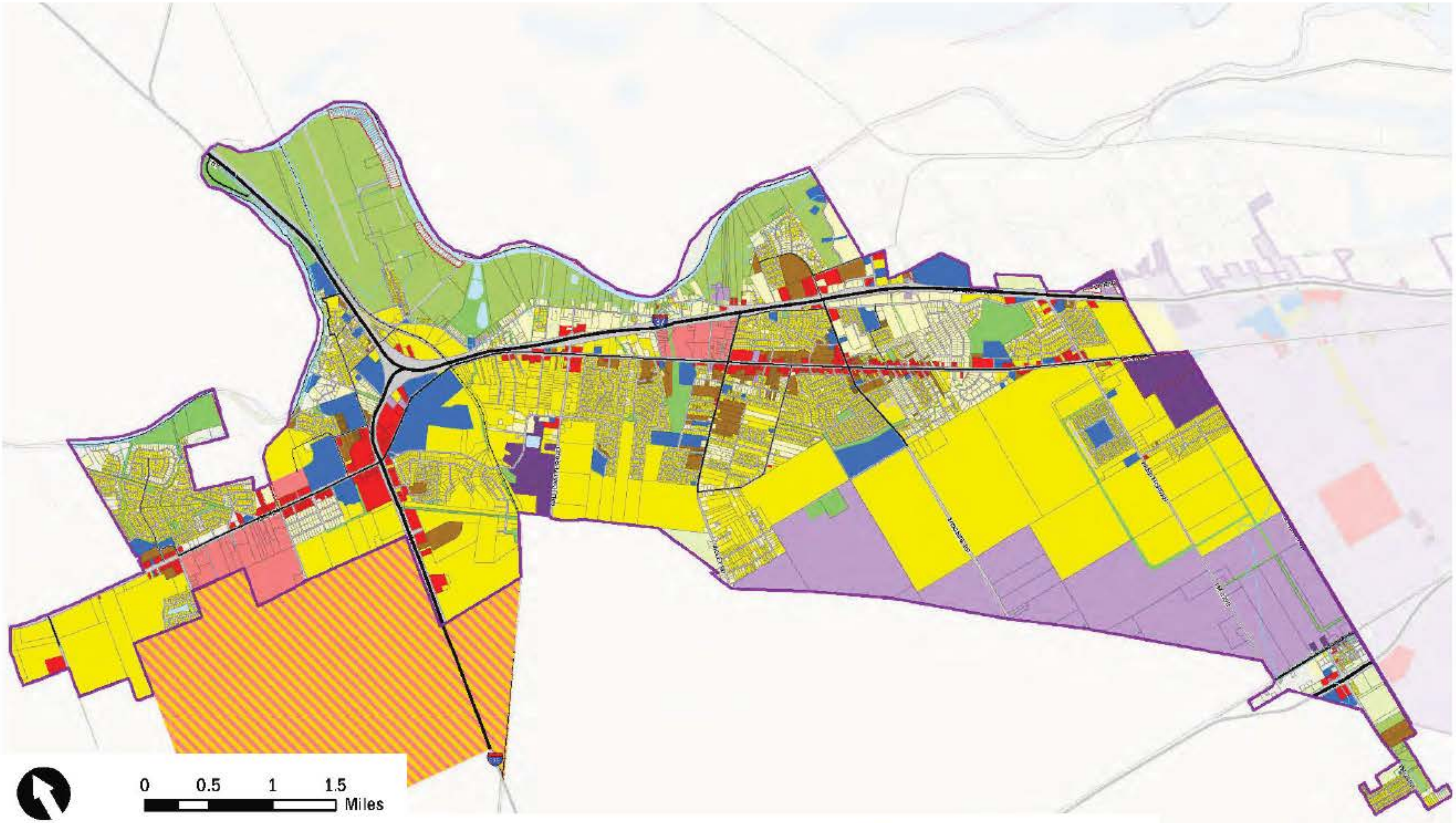
Northwest Planning District Future Land Use



FUTURE LAND USE

Northwest
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
- High-Density Single Family Residential
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- Proposed Harbor Bridge Alignment

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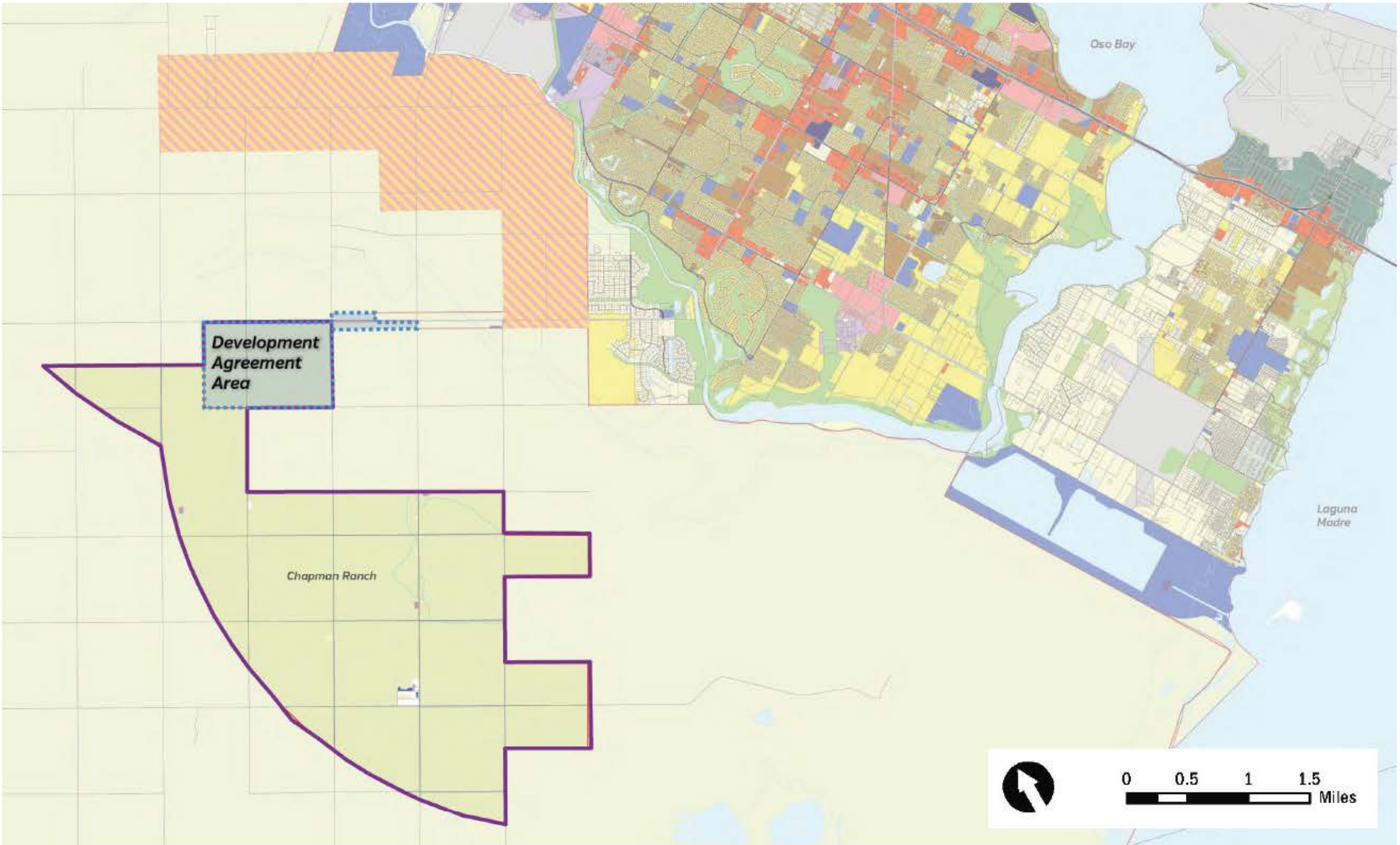
Chapman Ranch Planning District Future Land Use



FUTURE LAND USE

CC Airport
Planning District

- Mixed Use
- Agriculture/Rural Enterprise
- Commercial
- Government
- Institutional
- Heavy Industrial
- Light Industrial
- Low-Density Single-Family Residential
- Medium-Density Single-Family Residential
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ELEMENT

9

Stewardship and Implementation of the Plan

This element focuses on **implementation of the plan** and has two sections. The first focuses on how to make Plan CC a "living" plan that is used, implemented, monitored and regularly updated, including organizational and incentive strategies to advance implementation. The second section provides a matrix of action plans that correspond to each of the plan elements. Although there is more focus on actions that the City of Corpus Christi government can take to implement the plan, many actions will also need the participation of private-sector partners.

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Goals and Policies

GOALS	POLICIES FOR DECISION MAKERS
1. A new, long-range planning system is in place.	▪ Establish a comprehensive plan system based on a twenty-year time horizon. ▪ Require that Area Development Plans and Specific Plans reflect the vision and goals of the overall comprehensive plan. ▪ Amend planning ordinances to reflect the new type of comprehensive planning system.
2. The comprehensive plan is subject to regular public review of progress.	▪ Establish public review of progress in implementing the plan.
3. A new Planning Department is in place.	▪ Give the Planning Department a proactive role in coordinating initiatives to implement comprehensive and other plans.
4. The City has enhanced and new tools to implement the plan.	▪ Make City programs and resources consistent with implementation of Plan CC. ▪ Use incentives strategically to create a critical mass of improvements in designated areas.
5. Implementation of the comprehensive plan is incorporated in decision-making at multiple levels.	▪ Use the plan in preparing and approving other planning and implementation activities by City agencies.
6. The City has expanded funding options to achieve the goals.	▪ Use the funding approach that fits the goal. ▪ Build relationships with government funders and philanthropies.

EXHIBIT A

EXHIBIT A

EXHIBIT A

EXHIBIT 8

HILLCREST

Experiencing Deliberate Environmental Discrimination & Racism

HILLCREST

MEETING AGENDA

Date: 6/17/2022
Time 6:pm
Location: (b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted] **78401)**
Called By: Hillcrest Residents Association
Attendees: H.R.A. Officers and members

Agenda Items:

Welcome
Purpose
Presenters*

(b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

Statement of position on Desalination
Thank you for your time
Meeting Adjourned

(b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

[redacted]

CONCERNS:

Crossley Elementary School – The closing of Crossley Elementary School and its subsequent burning and abandonment.

Vacant Properties - Left unkept and trashed

Abandoned Buildings - Allowing transients

Police - Inadequate Police patrol

Street Lighting - Inadequate Street lighting

Neighborhood - Inadequate care for the historic cemeteries

Upkeep - Grass and weeds uncut

Sewage - Backing Up

Storm Water- drainage

Streets – Poor conditions need repair

Animals – Loose Animals

Note: Vision for the future

- Hillcrest Residents
- Downtown area development plan
- Corpus Christi Planning Division
- Architect – (b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

(b)(6) Privacy, (b)(7)(C) Enf. Privacy

[redacted]

[redacted]

CONCERNS:

Transportation:

Food desert:

Basic Utilities:

Monitoring air/water:

Pollution:

Environmental Justice Presentation

The Untied States Commission on Civil Rights transmitted through President Barack Obama, Vice President , Speaker Paul Ryan, and Senat4 Majority Leader Mitch McConnel, a working definition of Environmental Justice was introduced in Executive Order 12,898

EPA' s EJ definition of environmental justice recognizes environmental justice as a civil right, fair treatment and meaningful involvement of all people regardless of race color, national origin, or income with respect to the development, implementation, nf enforcement of environmental laws, regulations and polices.

Racial minorities and low-income communities are disproportionately affected by the siting of waste disposals facilities ad often lack of political and financial clout to properly bargain with polluters when fighting a decision or seeking redress.

(b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

[redacted]

CONCERNS:

Environmental Racism

Environmental Racism is the disproportionate impact of environmental hazards on people of color. Environmental justice is the movement's response to environmental racism. The Washington Coles / Hillcrest area has been a predominately African American neighborhood for the past 60 years we as a people were relegated to this area of town because of the City of Corpus Christi and to that end, the Port of Corpus Christi wanted a continuous supply of labor and a continuous supply of dock worker in a condense area located strategically near the Port of Corpus Christi who I might add has never had an African American on it Board of I digresses ' thus one of the older Segregated International Long Shoreman Hall in the Country until 10 years ago.

So, for African Americans in Corpus Christi, you were either in Projects (Section 22d3) of the Public Housing code or you had an opportunity to move to Hillcrest where you could live in an affordable home at the time. Unbeknown to the underlying conditions that awaited you, entering Hillcrest because during the 1970s and 1980s our parents were fighting segregation laws, poll tax, segregated schools, and trying to get into neighborhoods such as Hillcrest. We had no idea we were heading for the biggest Health and Environmental catastrophe in American History forced on a people after slavery and after the Tuskegee experiences Still, because of benign neglect, the City of Corpus Christi failed to inform the new residents of Hillcrest that the Port or Corpus Christi was allowing industries into the Port inner harbor that would eventually cause a disproportionate number of carcinogens within the Hillcrest, Oak Park, and Donna Park communities. Thus, a disproportion of bladder cancer, Asthma, and other diseases are found around the inner harbor Dr. Bullard an environmentalist call this part of the Texas Gulf Coast "a toxic soup"

A paper is written by the Greater Good entitled "Water, Industry, and Race" R. Vela, C. Phelan, and I. Araiza depicts the wanton disrespect, disregard, and the marginalization of people of color by the City of Corpus Christi and the Port of Corpus Christi. Who's feet do we the Citizen of the Hillcrest community solicit help from neighbors to our west who pollutes our air daily, a neighbor to our north who allow his constituents to polluter our inner harbor, our neighbor to the east who has neglected its neighbor for 70 years then decided to add injury to insult and pardon a state agency for permission to further harm a race of people with additional environmental injustice.

ENVIRONMENTAL INJUSTICE

- Environmental injustice is **a set of problems created by alienating specific groups and communities, and organizations taking action that hurts the environment around the community**.

ENVIRONMENTAL RACISM

- **Environmental racism** refers to intentional or unintentional targeting of minority communities or the exclusion of minority groups from public and private boards, commissions, and regulatory bodies.

(b)(6) Privacy, (b)(7)(C) Enf. Privacy

[redacted]

CONCERNS:

- **Safety:**
- **Grant:** Denied grants from the city, denied CDBG
- **Code Enforcement laws** – Lack of implementation
- **Drains:**
- **Flooding:**
- **Drainage Fees:**
- **Homelessness:**

ENVIRONMENTAL INJUSTICE UNCONTROLLED DIRT & DUST

ENVIRONMENTAL INJUSTICE - SAFETY

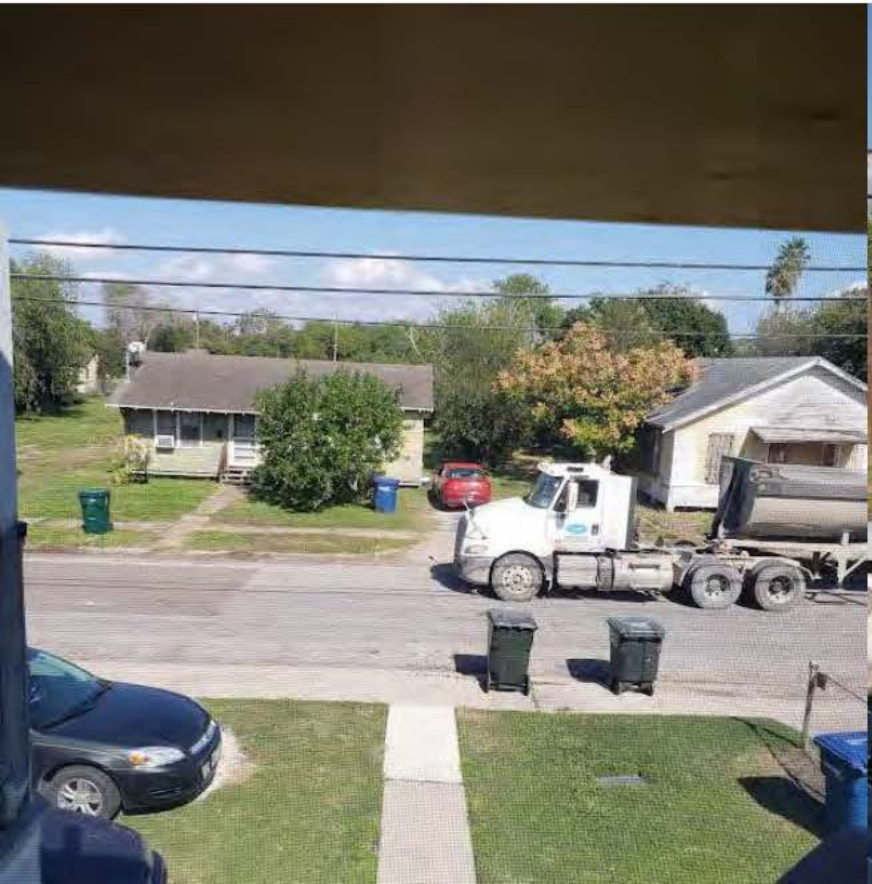
ENVIRONMENTAL INJUSTICE

CONSTRUCTION TRUCKS CUTTING THROUGH NEIGHBORHOOD

ENVIRONMENTAL INJUSTICE

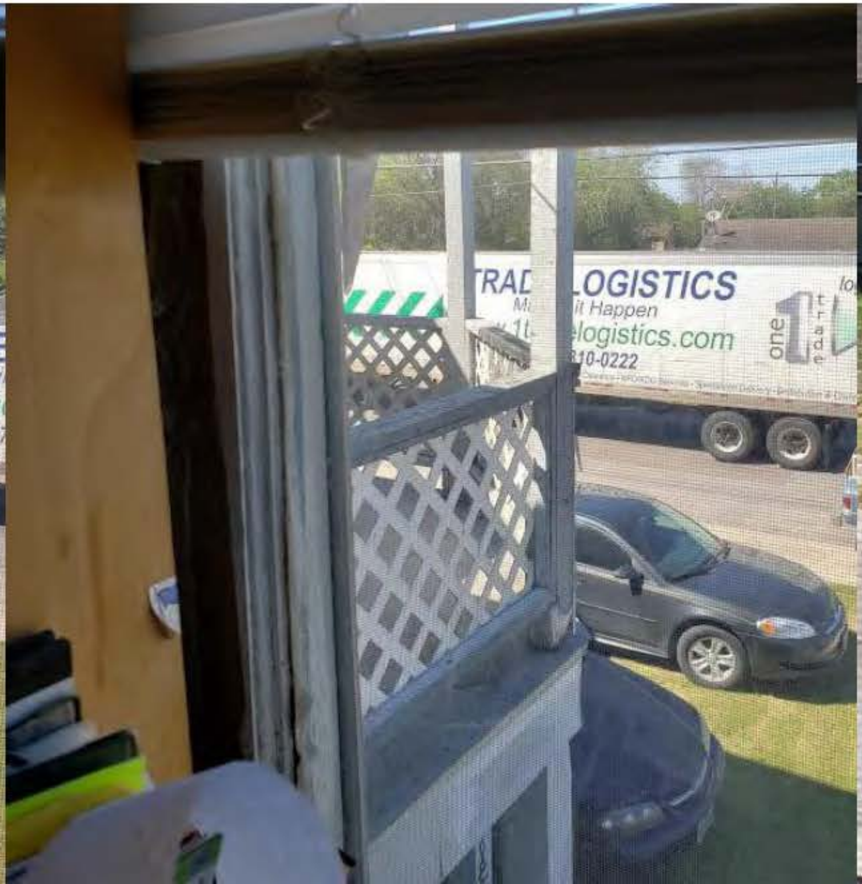
ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE



ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE



ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE

CONSTRUCTION SAFETY

SAFETY


United Rentals
SKYJACK
SKYJACK

SAFETY

SAFETY

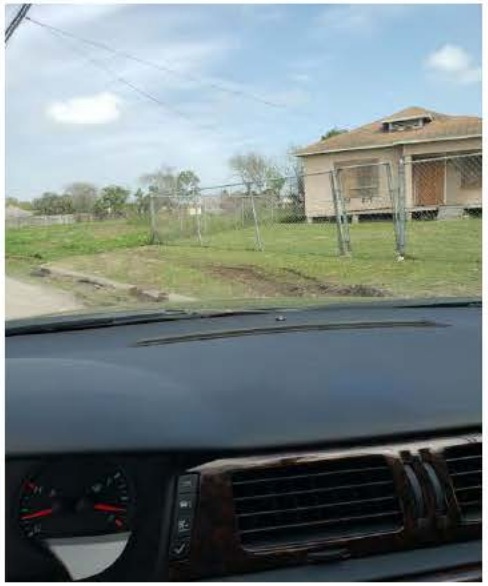
SAFETY

ENVIRONMENTAL INJUSTICE

UNKEPT VACANT AND ABANDON HOMES IN NEIGHBORHOOD

ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE



ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INSJUSTICE

UNKEPT LOTS AND RAGGEDY STREETS IN NEIGHBORHOOD

ENVIRONMENTAL INJUSTICE

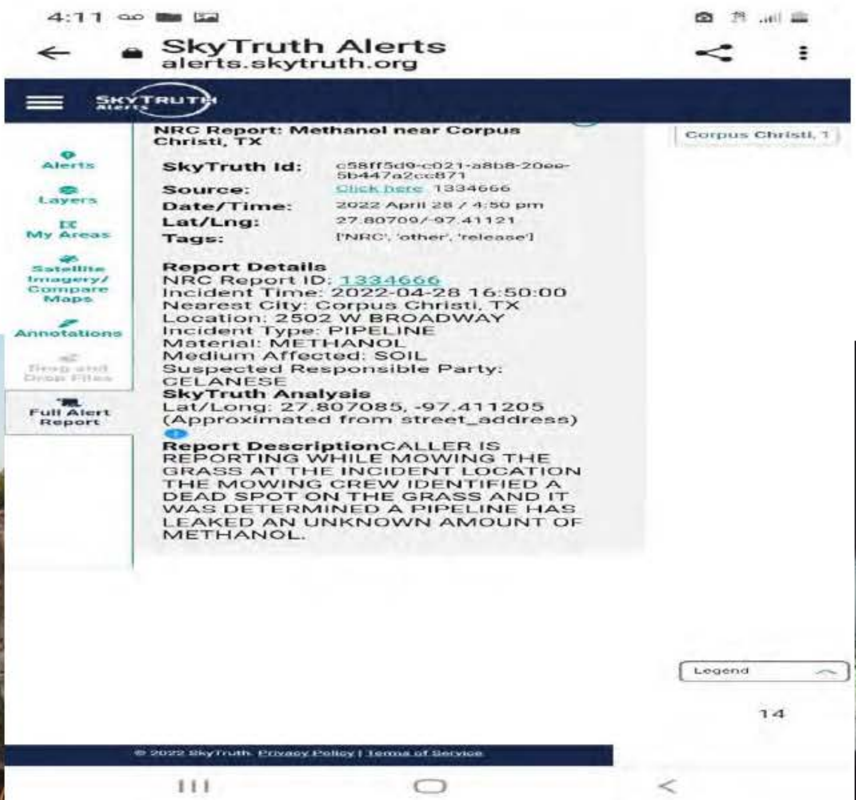
ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL INJUSTICE

ENVIRONMENTAL DISCRINATION

DELIBERATELY NEGLEGTED TO INFORM THE
HILLCREST RESIDENTS OF A TOXIC CHEMICAL LEAK,
METHENOL

ENVIRONMENTAL INJUSTICE



ENVIRONMENTAL DISCRINATION

POOR WATER DRAINAGE AND FLOODING IN NEIGHBORHOOD

ENVIRONMENTAL INJUSTICE

HILLCREST- NOAKES AND PEABODY

(b)(6) Privacy, (b)(7)(C) Enf. Privacy [redacted]

[redacted]

CONCERNS:

Increased Property Taxes - While surrounded by industry and isolated from the City.

City Services - Has there been any discussions about removing or reducing city services since there are fewer homes occupied in the community?

Building - Can current residents build on their own property and or purchase available property in the community?

City Plans - What are your overall plans for the Hilcrest community? Do you plan to use eminent domain and force the remaining residents out of their homes?

Quality of Life for remining Residents - What about the quality of life for the remaining residents, do you care what happens to them?

ENVIRONMENTAL INJUSTICE

PROPOSED PROJECTS

HILCREST COMMUNITY LIVABILITY RECOMMENDATION FOR DR. HJ WILLIAMS MEMORIAL PARK, WASHINGTON ELEMENTARY SCHOOL SITE AND TC AYERS LOCATIONS

DR. HJ Williams Memorial Park

- Resurface the existing Basketball court for multipurpose use. Add a foursquare hopscotch area on the surface.
- Restore and upgrade restroom facility with designated hours of operation
- Upgrade playground equipment to include slides, swings, monkey bars, uneven bars and a see saw. Additionally, incorporate shaded playground equipment with safety play tiles under the playground area. Add other fun equipment as needed.
- Add New walking, biking and dog trail around park.
- Cover the entire Basketball court with lighted pavilion.
- Add pedestrian lighting.
- Add additional trash cans.
- Add additional benches, covered and uncovered picnic tables.
- Add additional shade trees not Palm trees.
- Upgrade park to a historical site with a historical marker.
- Add or restore historical sign that includes picture or image of Dr. HJ Williams

HILCREST COMMUNITY LIVABILITY RECOMMENDATION FOR DR. HJ WILLIAMS MEMORIAL PARK, WASHINGTON ELEMENTARY SCHOOL SITE AND TC AYERS LOCATIONS

WASHINGTON ELEMENTARY SCHOOL SITE

- New community gardens in raised planter beds.
- New backstop for baseball.
- New parking lot.
- New bleachers.
- Maintain Multiuse field.
- New Trail around park.
- Remove existing Washington School structure but use bricks to create some sort of Historical Memorial to capture the Hillcrest History which includes the history banners located at the Oveal Williams Sr Center and the La Retama Central Library. Additionally, the historical memorial should include covered talking library that also includes the Hilcrest History. The talking library should have some additional capacity for additional historical data as needed.

HILCREST COMMUNITY LIVABILITY RECOMMENDATION FOR DR. HJ WILLIAMS MEMORIAL PARK, WASHINGTON ELEMENTARY SCHOOL SITE AND TC AYERS LOCATIONS

TC AYERS AREA

- New trail around park
- Keep Existing Pool but resurface and repair for full service
- New tree planting for screening
- Add Splash Pad – photo included.
- Add full pavilion
  - With nearby BBQ Pits
- Add seating
- Add trash cans

Note: All locations should be ADA accessible.

Note: I will include a copy of the sign in sheet of those person who attended this meeting.

Note: I've included a photo of a Splash Pad

HILCREST COMMUNITY LIVABILITY RECOMMENDATION FOR DR. HJ WILLIAMS MEMORIAL PARK, WASHINGTON ELEMENTARY SCHOOL SITE AND TC AYERS LOCATIONS

ENVIRONMENTAL RACISM

DESALINATION

ENVIRONMENTAL RACISM

- **Environmental racism** refers to intentional or unintentional targeting of minority communities or the exclusion of minority groups from public and private boards, commissions, and regulatory bodies.

WE ARE TOTALLY AGAINST DESALINATION ON THE FLINT HILLS PROPERTY

- On March 18, 2021, the TCEQ conducted a Public Meeting on the City's Water Rights Permit for the Inner Harbor. At that time, City staff were present and heard officers of HRA and Citizens Alliance voice opposition to the Permit. In addition, our attorneys filed written comments in opposition. The City knew over a year ago that we opposed the Inner Harbor site and during all this time, the City made no effort to meet with the neighborhood to discuss the City's plans. There is no excuse for that.

- One inference that can be drawn from that is, had you done so, we might have learned that the facility was not going to be in an industrial area, but was in fact going to be directly in the neighborhood, and you did not want us to know until the details were revealed to us on May 23 of this year. We now know that the City considers the neighborhood as "the inner harbor", as if we no longer exist.

ENVIRONMENTAL INJUSTICE MUST END

EXHIBIT 9

Save as PDF

EJScreen Report (Version 2.0)

the User Specified Area

TEXAS, EPA Region 6

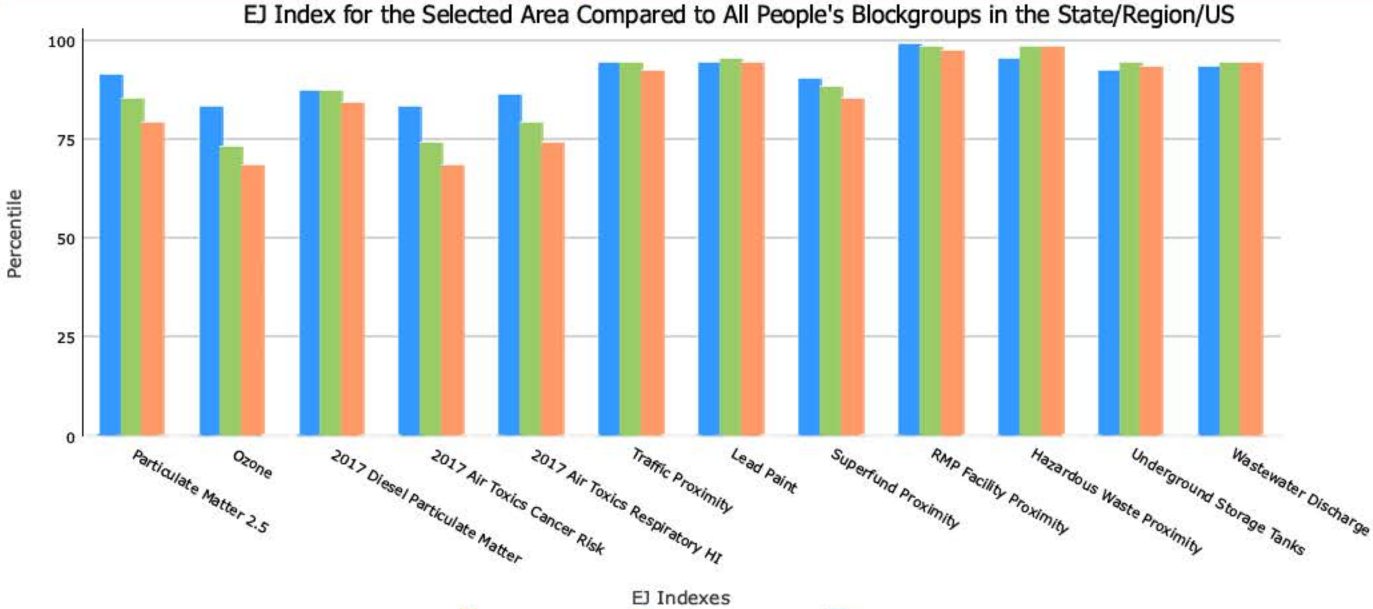
Approximate Population: 1,444

Input Area (sq. miles): 0.40

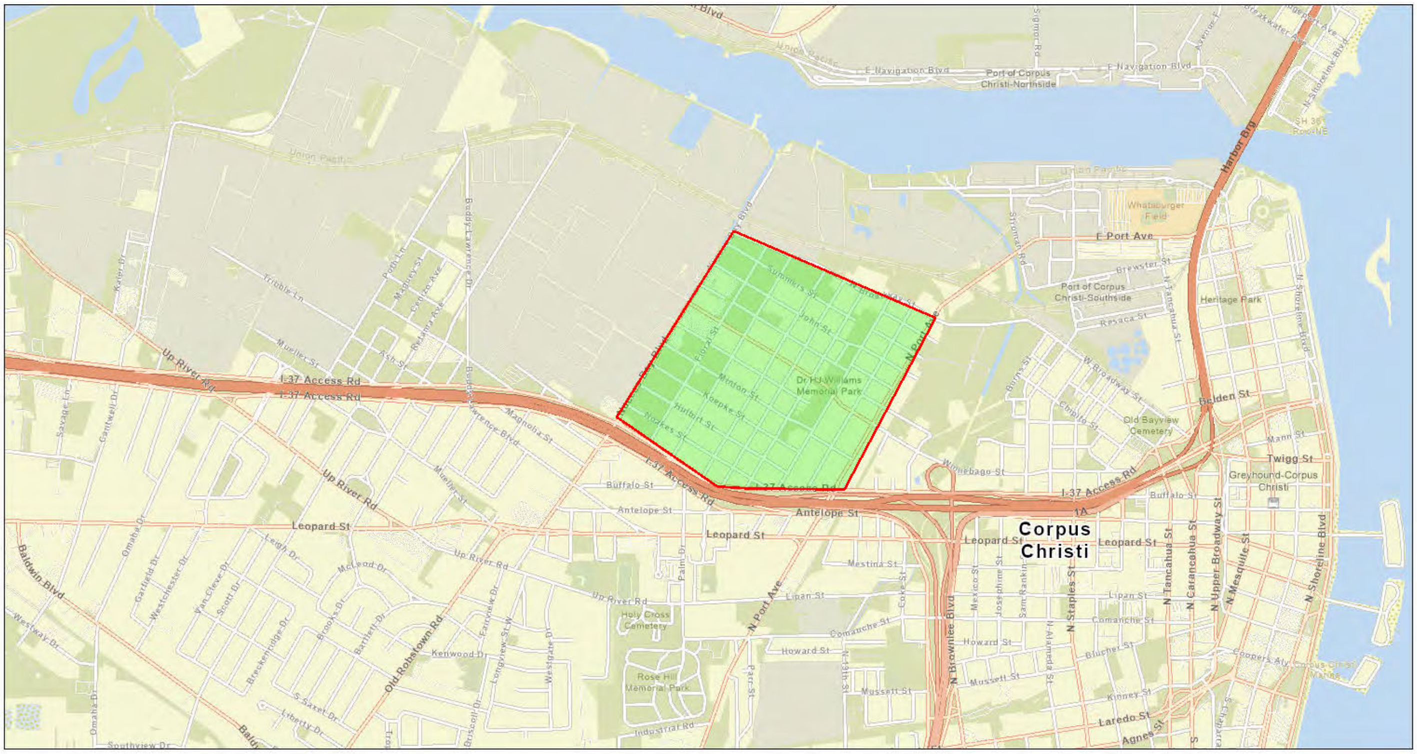
Hillcrest Neighborhood

Selected Variables	Percentile in State	Percentile in EPA Region	Percentile in USA
Environmental Justice Indexes			
EJ Index for Particulate Matter 2.5	79	85	91
EJ Index for Ozone	68	73	83
EJ Index for 2017 Diesel Particulate Matter*	84	87	87
EJ Index for 2017 Air Toxics Cancer Risk*	68	74	83
EJ Index for 2017 Air Toxics Respiratory HI*	74	79	86
EJ Index for Traffic Proximity	92	94	94
EJ Index for Lead Paint	94	95	94
EJ Index for Superfund Proximity	85	88	90
EJ Index for RMP Facility Proximity	97	98	99
EJ Index for Hazardous Waste Proximity	98	98	95
EJ Index for Underground Storage Tanks	93	94	92
EJ Index for Wastewater Discharge	94	94	93

EJ Index for the Selected Area Compared to All People's Blockgroups in the State/Region/US



This report shows the values for environmental and demographic indicators and EJScreen indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJScreen documentation for discussion of these issues before using reports.



September 23, 2022

Hillcrest Neighborhood

1:18,056

0 0.2 0.4 0.8 mi

0 0.3 0.6 1.2 km

Esri Community Maps Contributors, Texas Parks & Wildlife, CONANP, Esri, HERE, Garmin, Foursquare, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0

Selected Variables	Value	State		EPA Region		USA	
		Avg.	%tile	Avg.	%tile	Avg.	%tile
Pollution and Sources							
Particulate Matter 2.5 (μg/m³)	9.75	9.57	52	9.32	59	8.74	79
Ozone (ppb)	25.4	40	1	41.1	0	42.6	0
2017 Diesel Particulate Matter* (μg/m³)	0.265	0.214	69	0.219	60-70th	0.295	50-60th
2017 Air Toxics Cancer Risk* (lifetime risk per million)	20	31	16	32	<50th	29	<50th
2017 Air Toxics Respiratory HI*	0.3	0.36	44	0.37	<50th	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	1400	510	91	470	92	710	88
Lead Paint (% Pre-1960 Housing)	0.5	0.15	90	0.16	90	0.28	77
Superfund Proximity (site count/km distance)	0.11	0.084	79	0.08	81	0.13	69
RMP Facility Proximity (facility count/km distance)	5.1	0.92	98	0.83	98	0.75	98
Hazardous Waste Proximity (facility count/km distance)	4.8	0.72	98	0.8	98	2.2	87
Underground Storage Tanks (count/km²)	6.2	2.2	92	2	92	3.9	82
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.095	0.33	92	0.5	91	12	84
Socioeconomic Indicators							
Demographic Index	78%	46%	90	44%	91	36%	94
People of Color	97%	58%	91	52%	93	40%	94
Low Income	60%	34%	84	36%	84	31%	88
Unemployment Rate	6%	5%	67	5%	66	5%	66
Linguistically Isolated	9%	8%	68	6%	75	5%	81
Less Than High School Education	42%	16%	90	15%	92	12%	96
Under Age 5	12%	7%	88	7%	89	6%	92
Over Age 64	11%	12%	51	13%	43	16%	32

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's 2017 Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update. (https://www.epa.gov/haps/air-toxics-data-update)

For additional information, see: www.epa.gov/environmentaljustice (https://www.epa.gov/environmentaljustice)

EJScreen is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJScreen documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJScreen outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

EXHIBIT 10

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description: Hillcrest Neighborhood

Summary of ACS Estimates	2015 - 2019
Population	1,444
Population Density (per sq. mile)	3,631
People of Color Population	1,397
% People of Color Population	97%
Households	435
Housing Units	651
Housing Units Built Before 1950	224
Per Capita Income	15,021
Land Area (sq. miles) (Source: SF1)	0.40
% Land Area	100%
Water Area (sq. miles) (Source: SF1)	0.00
% Water Area	0%

	2015 - 2019 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	1,444	100%	297
Population Reporting One Race	1,444	100%	526
White	995	69%	290
Black	449	31%	180
American Indian	0	0%	14
Asian	0	0%	14
Pacific Islander	0	0%	14
Some Other Race	0	0%	14
Population Reporting Two or More Races	0	0%	14
Total Hispanic Population	948	66%	279
Total Non-Hispanic Population	496		
White Alone	47	3%	44
Black Alone	449	31%	180
American Indian Alone	0	0%	14
Non-Hispanic Asian Alone	0	0%	14
Pacific Islander Alone	0	0%	14
Other Race Alone	0	0%	14
Two or More Races Alone	0	0%	14
Population by Sex			
Male	816	57%	187
Female	628	43%	137
Population by Age			
Age 0-4	173	12%	86
Age 0-17	375	26%	124
Age 18+	1,069	74%	201
Age 65+	156	11%	109

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
N/A meansnot available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2015 - 2019 .

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description: Hillcrest Neighborhood

	2015 - 2019 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	811	100%	184
Less than 9th Grade	144	18%	89
9th - 12th Grade, No Diploma	194	24%	91
High School Graduate	345	43%	108
Some College, No Degree	85	10%	56
Associate Degree	23	3%	29
Bachelor's Degree or more	19	2%	35
Population Age 5+ Years by Ability to Speak English			
Total	1,272	100%	273
Speak only English	683	54%	194
Non-English at Home[1+2+3+4]	589	46%	204
[1]Speak English "very well"	395	31%	204
[2]Speak English "well"	171	13%	99
[3]Speak English "not well"	22	2%	41
[4]Speak English "not at all"	0	0%	14
[3+4]Speak English "less than well"	22	2%	41
[2+3+4]Speak English "less than very well"	194	15%	106
Linguistically Isolated Households*			
Total	40	100%	63
Speak Spanish	40	100%	61
Speak Other Indo-European Languages	0	0%	14
Speak Asian-Pacific Island Languages	0	0%	14
Speak Other Languages	0	0%	14
Households by Household Income			
Household Income Base	435	100%	91
< $15,000	77	18%	63
$15,000 - $25,000	57	13%	50
$25,000 - $50,000	160	37%	84
$50,000 - $75,000	82	19%	60
$75,000 +	59	14%	56
Occupied Housing Units by Tenure			
Total	435	100%	91
Owner Occupied	108	25%	52
Renter Occupied	327	75%	91
Employed Population Age 16+ Years			
Total	1,107	100%	273
In Labor Force	628	57%	183
Civilian Unemployed in Labor Force	38	3%	51
Not In Labor Force	479	43%	165

Data Note: Datail may not sum to totals due to rounding. Hispanic population can be of anyrace.
N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS)
*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description: Hillcrest Neighborhood

	2015 - 2019 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	1,540	100%	244
English	881	57%	206
Spanish	656	43%	206
French	0	0%	14
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	3	0%	6
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	0	0%	14
Chinese	0	0%	14
Japanese	N/A	N/A	N/A
Korean	0	0%	14
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	0	0%	14
Other Asian	0	0%	14
Tagalog	0	0%	14
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	0	0%	14
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	0	0%	14
Total Non-English	659	43%	319

Data Note: Detail may not sum to totals due to rounding. Hispanic popultion can be of any race.
N/A meansnot available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2015 - 2019.
*Population by Language Spoken at Home is available at the census tract summary level and up.

EXHIBIT 11

From:	Brooke McGregor
To:	[redacted]
Cc:	Kathy Alexander
Subject:	RE: City of Corpus Christi Water Rights Permit Applications
Date:	Tuesday, February 15, 2022 10:51:43 AM
Attachments:	image001.wmz image002.png

Hello Mr. Ramos,

We will finalize processing WRPERM 13676 “Inner Harbor” ahead of WRPERM 13675 “La Quinta”.

Thank you,

Brooke McGregor
Manager
Water Rights Permitting and Availability Section
Water Availability Division
(512) 239-2025

From: Esteban Ramos [redacted]
Sent: Tuesday, February 15, 2022 10:39 AM
To: Brooke McGregor <brooke.mcgregor@tceq.texas.gov>
Subject: City of Corpus Christi Water Rights Permit Applications

Hello Ms. Alexander and Ms. McGregor:

The City of Corpus Christi thanks you both for all the work that you are doing on the applications (WRPERM 13675 and WRPERM 13676). The City would like to request that WRPERM 13676 “Inner Harbor” water rights application be expedited from our other water rights application WRPERM 13675 “La Quinta”. We would also like to offer any assistance that we can to help with the applications. Please let me know if you have any questions

Thank you
Esteban (Steve) Ramos
Water Resource Manager
City of Corpus Christi Water Utilities
[redacted]

EXHIBIT 12

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

Summary of ACS Estimates	2015 - 2019
Population	5,365
Population Density (per sq. mile)	3,930
People of Color Population	2,815
% People of Color Population	52%
Households	2,235
Housing Units	2,629
Housing Units Built Before 1950	319
Per Capita Income	45,973
Land Area (sq. miles) (Source: SF1)	1.37
% Land Area	100%
Water Area (sq. miles) (Source: SF1)	0.00
% Water Area	0%

	2015 - 2019 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	5,365	100%	598
Population Reporting One Race	5,227	97%	1,128
White	4,645	87%	598
Black	116	2%	182
American Indian	13	0%	30
Asian	412	8%	253
Pacific Islander	0	0%	14
Some Other Race	41	1%	51
Population Reporting Two or More Races	138	3%	263
Total Hispanic Population	2,261	42%	524
Total Non-Hispanic Population	3,104		
White Alone	2,550	48%	369
Black Alone	116	2%	182
American Indian Alone	12	0%	26
Non-Hispanic Asian Alone	412	8%	253
Pacific Islander Alone	0	0%	14
Other Race Alone	0	0%	14
Two or More Races Alone	13	0%	120
Population by Sex			
Male	2,797	52%	337
Female	2,568	48%	359
Population by Age			
Age 0-4	425	8%	170
Age 0-17	1,009	19%	218
Age 18+	4,356	81%	374
Age 65+	1,133	21%	143

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2015 - 2019 .

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

	2015 - 2019 **ACS Estimates**	**Percent**	**MOE (±)**
Population 25+ by Educational Attainment			
Total	3,862	100%	407
Less than 9th Grade	120	3%	105
9th - 12th Grade, No Diploma	187	5%	127
High School Graduate	509	13%	169
Some College, No Degree	755	20%	184
Associate Degree	307	8%	122
Bachelor's Degree or more	1,984	51%	224
Population Age 5+ Years by Ability to Speak English			
Total	4,940	100%	468
Speak only English	3,796	77%	359
Non-English at Home[1+2+3+4]	1,144	23%	253
[1]Speak English "very well"	932	19%	252
[2]Speak English "well"	168	3%	113
[3]Speak English "not well"	44	1%	51
[4]Speak English "not at all"	0	0%	14
[3+4]Speak English "less than well"	44	1%	51
[2+3+4]Speak English "less than very well"	212	4%	123
Linguistically Isolated Households*			
Total	22	100%	38
Speak Spanish	22	100%	35
Speak Other Indo-European Languages	0	0%	14
Speak Asian-Pacific Island Languages	0	0%	14
Speak Other Languages	0	0%	14
Households by Household Income			
Household Income Base	2,235	100%	193
< $15,000	194	9%	76
$15,000 - $25,000	117	5%	100
$25,000 - $50,000	535	24%	161
$50,000 - $75,000	266	12%	133
$75,000 +	1,122	50%	153
Occupied Housing Units by Tenure			
Total	2,235	100%	193
Owner Occupied	1,117	50%	136
Renter Occupied	1,117	50%	176
Employed Population Age 16+ Years			
Total	4,433	100%	405
In Labor Force	2,898	65%	354
Civilian Unemployed in Labor Force	38	1%	32
Not In Labor Force	1,535	35%	193

Data Note: Datail may not sum to totals due to rounding. Hispanic population can be of anyrace.
N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS)
*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

	2015 - 2019 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	6,345	100%	679
English	5,033	79%	588
Spanish	1,064	17%	324
French	31	0%	98
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	11	0%	58
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	125	2%	182
Chinese	9	0%	28
Japanese	N/A	N/A	N/A
Korean	0	0%	19
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	2	0%	25
Other Asian	22	0%	40
Tagalog	19	0%	144
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	10	0%	18
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	12	0%	49
Total Non-English	1,312	21%	898

Data Note: Detail may not sum to totals due to rounding. Hispanic popultion can be of any race.
N/A meansnot available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2015 - 2019.
*Population by Language Spoken at Home is available at the census tract summary level and up.

EXHIBIT 13

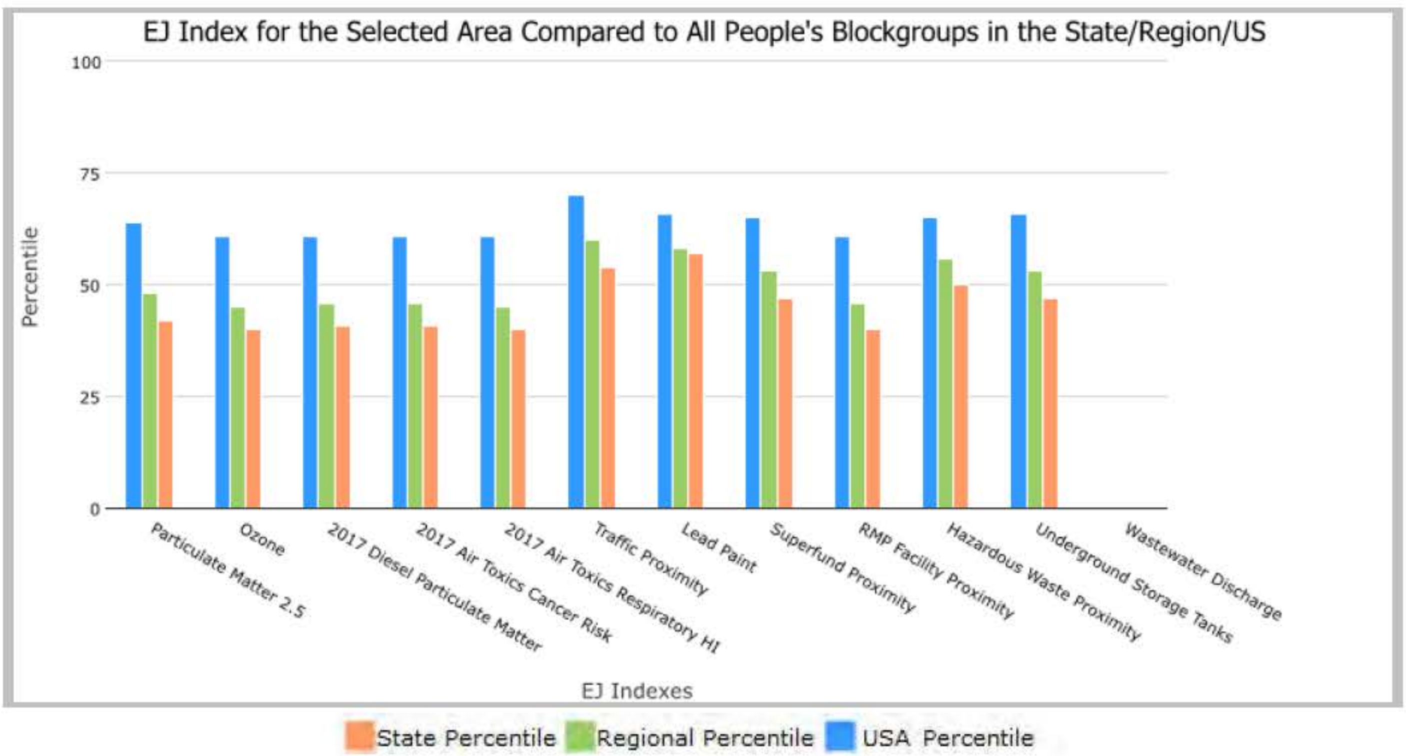
EJScreen Report (Version 2.0)

the User Specified Area, TEXAS, EPA Region 6

Approximate Population: 5,365

Input Area (sq. miles): 1.34

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Environmental Justice Indexes			
EJ Index for Particulate Matter 2.5	42	48	64
EJ Index for Ozone	40	45	61
EJ Index for 2017 Diesel Particulate Matter*	41	46	61
EJ Index for 2017 Air Toxics Cancer Risk*	41	46	61
EJ Index for 2017 Air Toxics Respiratory HI*	40	45	61
EJ Index for Traffic Proximity	54	60	70
EJ Index for Lead Paint	57	58	66
EJ Index for Superfund Proximity	47	53	65
EJ Index for RMP Facility Proximity	40	46	61
EJ Index for Hazardous Waste Proximity	50	56	65
EJ Index for Underground Storage Tanks	47	53	66
EJ Index for Wastewater Discharge	N/A	N/A	N/A



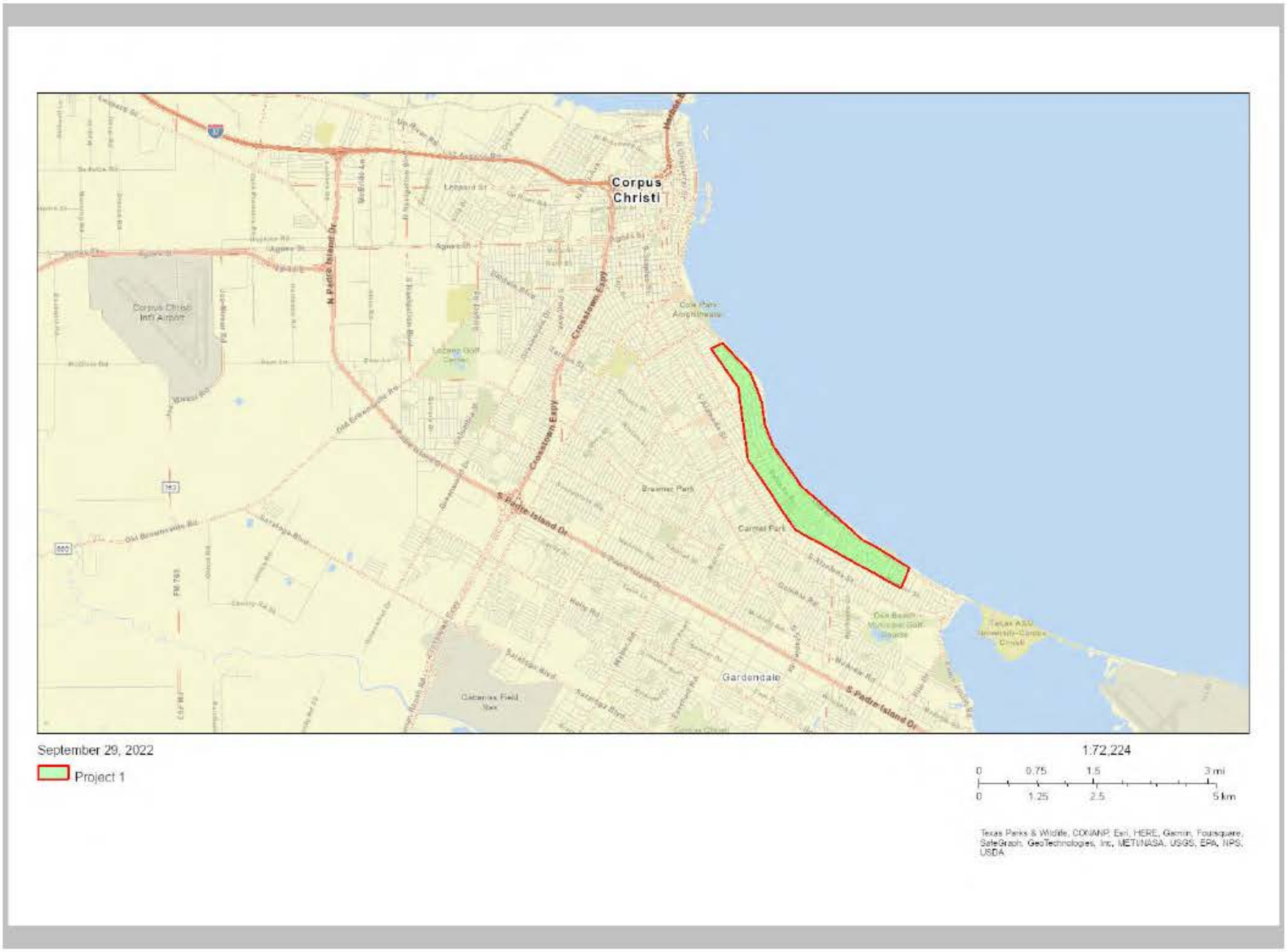
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

EJScreen Report (Version 2.0)

the User Specified Area, TEXAS, EPA Region 6

Approximate Population: 5,365

Input Area (sq. miles): 1.34



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0

United States Environmental Protection Agency

EJScreen Report (Version 2.0)

the User Specified Area, TEXAS, EPA Region 6

Approximate Population: 5,365

Input Area (sq. miles): 1.34

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Pollution and Sources							
Particulate Matter 2.5 ($\mu g/m^3$)	9.83	9.57	59	9.32	65	8.74	80
Ozone (ppb)	25.1	40	0	41.1	0	42.6	0
2017 Diesel Particulate Matter* ($\mu g/m^3$)	0.12	0.214	22	0.219	<50th	0.295	<50th
2017 Air Toxics Cancer Risk* (lifetime risk per million)	20	31	16	32	<50th	29	<50th
2017 Air Toxics Respiratory HI*	0.22	0.36	14	0.37	<50th	0.36	<50th
Traffic Proximity (daily traffic count/distance to road)	630	510	79	470	81	710	73
Lead Paint (% Pre-1960 Housing)	0.31	0.15	82	0.16	81	0.28	64
Superfund Proximity (site count/km distance)	0.063	0.084	62	0.08	65	0.13	50
RMP Facility Proximity (facility count/km distance)	0.15	0.92	17	0.83	23	0.75	26
Hazardous Waste Proximity (facility count/km distance)	0.53	0.72	63	0.8	60	2.2	45
Underground Storage Tanks (count/km^2)	1	2.2	43	2	48	3.9	46
Wastewater Discharge (toxicity-weighted concentration/m distance)	N/A	0.33	N/A	0.5	N/A	12	N/A
Socioeconomic Indicators							
Demographic Index	41%	46%	45	44%	49	36%	64
People of Color	52%	58%	43	52%	52	40%	67
Low Income	29%	34%	45	36%	41	31%	51
Unemployment Rate	1%	5%	18	5%	18	5%	18
Linguistically Isolated	1%	8%	30	6%	40	5%	48
Less Than High School Education	8%	16%	36	15%	35	12%	46
Under Age 5	8%	7%	62	7%	64	6%	72
Over Age 64	21%	12%	87	13%	84	16%	78

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's 2017 Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

For additional information, see: www.epa.gov/environmentaljustice

EXHIBIT 14

SUMMARY OF GROUNDWATER FLOW DIRECTIONS, HILLCREST NEIGHBORHOOD, CORPUS CHRISTI, TEXAS

By: Scott Ellinger, P.G.
February 7, 2012; Addendum August 31, 2012

INTRODUCTION

The purpose of this summary is to describe fundamental aspects about the movement of groundwater and groundwater flow directions at the Hillcrest neighborhood in Corpus Christi, Texas. The Hillcrest neighborhood is located between Interstate 37 and the Corpus Christi industrial canal, and is situated east of petrochemical industries including Flint Hills Resources, L.P. (Flint Hills) and CITGO Refining and Chemicals Company, L.P. (CITGO). Questions about groundwater movement have led the U.S. Environmental Protection Agency (EPA) to review related technical information and prepare this summary and the attachment describing its findings about the directions of groundwater movement beneath the Hillcrest neighborhood.

BACKGROUND

Water occurring beneath the surface of the ground in saturated geologic materials (e.g., soil, sediment, and rock) is called *groundwater*, and when saturated geologic material can produce or transmit useable quantities of water, it is called an *aquifer*. The aquifer described in this summary, for the Hillcrest neighborhood, occurs within clay, silt, sand, and gravel deposited by river and coastal processes. These sediments are distinguished by their geologic characteristics and ages, and occur within a geologic formation called the Deweyville Formation.

Groundwater does not usually remain stationary, but moves or flows underground according to forces acting on the groundwater. At the Hillcrest neighborhood and surrounding area, the main forces affecting groundwater movement are gravity and external pressure. Gravity is related to the natural slope of the sediments making up the shallow aquifer beneath the neighborhood, and external pressure is related to changes in pressure caused by pumping wells which alter natural groundwater flow directions. An important hydraulic feature of the area is the Corpus Christi industrial canal which serves as a boundary where groundwater exits the shallow aquifer and discharges to surface water.

The most direct and accurate method of determining the direction of groundwater movement is by measuring the elevation of groundwater at multiple locations over the aerial extent of an aquifer. Measurements are plotted on a map of the area and lines are drawn to connect points of equal elevation. These lines represent equal pressure between connected points and are called equipotential lines. The equipotential lines and map together are called an equipotential surface map. Groundwater moves along a flowpath perpendicular to equipotential lines and the direction of movement is from lines of higher value to lines of lower value (i.e., higher to lower elevation or pressure). Groundwater flow paths are usually shown by arrows on equipotential surface maps pointing in the direction of groundwater flow.

A number of equipotential surface maps and related data for the Hillcrest neighborhood and surrounding area were reviewed by EPA. These maps and data were from the U.S. Geological Survey, the Texas Bureau of Economic Geology, the Texas Department of Environmental Quality, the Texas Water Development Board, Flint Hills, CITGO, El Paso Corporation, Rosengarten, Smith, and Associates, Inc., Citizens for Environmental Justice, and various other published reports. Detailed information on EPA's findings are discussed in the attachment.

Because there can be changes in the factors influencing groundwater pressure, such as the numbers of wells pumping at any given time and effects from precipitation, groundwater elevations and thus equipotential surfaces and gradients can also change. To examine the relationship between changes in groundwater elevations over time and groundwater flow directions near the Hillcrest Neighborhood, EPA conducted a basic statistical analysis to assess flow directions by using data collected over a multi-year period. Specifically, the analysis used groundwater data to calculate the likelihood of lines of equal pressure existing between sets of groundwater monitoring wells. The calculation utilized 4-years of groundwater elevation data, reported as being collected on the same days during monitoring events from 2005-2009. More detailed information about this analysis is provided in the attachment.

CONCLUSIONS

The objective of this analysis was to determine and summarize the main groundwater flow direction at the Hillcrest Neighborhood in Corpus Christi. The findings are that groundwater flow beneath the Hillcrest neighborhood has usually been towards the Corpus Christi industrial canal, and that groundwater contamination from the Flint Hills Terminal 2 area has most likely moved into the Hillcrest neighborhood. The assessment was made primarily by reviewing existing information and by performing a statistical analysis to evaluate the likelihood of equipotential over a multi-year period. Groundwater in the southern part of the Hillcrest neighborhood will continue to be monitored for the contaminants of interest. Facility areas north of the Terminal 2 area are less likely to impact the Hillcrest neighborhood based on an analysis of groundwater data from 2005-2009.

Attachment

GROUNDWATER FLOW DIRECTIONS
HILLCREST NEIGHBORHOOD

FINDINGS

Based on information reviewed by EPA, the following conclusions were made regarding groundwater flow directions at the Hillcrest neighborhood.

- The main shallow groundwater flow direction beneath the Hillcrest neighborhood is northeast towards the Corpus Christi ship channel[1,2] (Figure 1).

- The main shallow groundwater flow beneath the portion of the Flint Hills and CITGO facilities adjacent Hillcrest neighborhood, is northeast towards the Corpus Christi ship channel[3,4,5,6,7].

- Some groundwater enters the Hillcrest neighborhood from the southern part of the Flint Hills Terminal 2 Area and moves towards the Corpus Christi ship channel[8,9].

- Flint Hills Resources has agreed to continue sampling monitoring wells MW-1 and MW-2 for at least two years. These wells are closest to the facility and during the April 2011 sampling, trichloroethene (TCE) was detected in MW-1 at a concentration of 11.9 µg/L. The screening level for TCE used during that sampling round was 15 µg/L. This level was based upon the potential for vapor intrusion in a residential setting.

- Basic statistical analysis suggests the further one goes to the north along the west boundary of the Hillcrest neighborhood, the less likely it becomes that shallow groundwater will move from the Flint Hills Resources and Citgo facilities towards the Hillcrest neighborhood.

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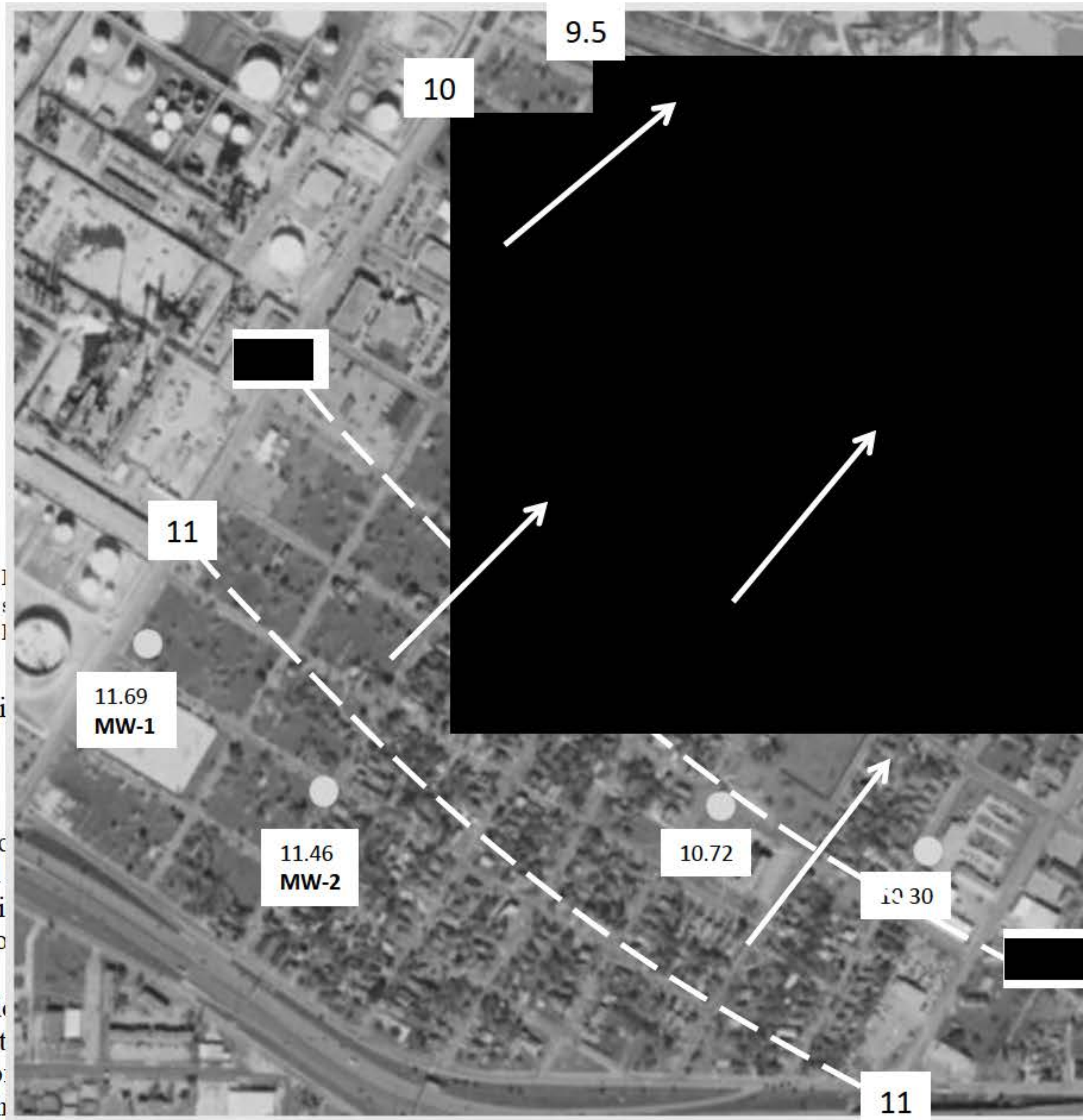
1 Weston Solutions Inc., 2010
2 EPA Equipotential Surface Map, S. Ellinger
3 Flint Hills Resources, July 2009-June 2010
4 Rosengarten, Smith, and Associates, April 2011
5 Rosengarten, Smith, and Associates, October 2010
6 Rosengarten, Smith, and Associates, 2010, Second Half 2009
7 Rosengarten, Smith, and Associates, 2010, Second Half 2008
8 Flint Hills Resources, July 2009-June 2010
9 Weston Solutions Inc., 2010



Statistical Analysi

Method:

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- In this case, the x and y variables represent groundwater levels measured in different monitoring wells over 4-years. The stronger the linear relationship, the greater the likelihood of equal potential between the two groundwater monitoring wells. Thus, groundwater flow would tend to be perpendicular to a line between two wells with an *r* value of 1, -1, or relatively close to either value.

- Three pairs of wells were chosen to indicate equipotential and groundwater flow direction. They are: (i) IH37-11 and MW-51, (ii) IH37-11 and P-103, and (iii) IH37-11

[10] McClave and Dietrich, 1982

and MW-88 (Figure 2). These sets were chosen because they are oriented approximately both perpendicular to, and parallel to, the boundary of the Hillcrest Neighborhood and the industrial canal.

- Wells IH37-11 and MW-51 were used to see whether groundwater from the southern Terminal 2 area has typically moved towards the industrial canal or towards the Hillcrest Neighborhood. Wells IH37-11 and P-103, and IH37-11 and MW-88, were used to see whether groundwater along the eastern boundary of the Flint Hills and Citgo facilities has probably moved from facility areas towards the Hillcrest Neighborhood or the industrial canal.

Analysis:

- For the well set IH37-11 and MW-51, *r* indicates a moderately strong linear relationship (0.80) suggesting groundwater flow in the vicinity of those wells has been generally towards the Corpus Christi Ship Channel. However, facility data near the Hillcrest Neighborhood boundary still indicates a limited groundwater flow gradient towards the neighborhood. Scatter plots for two of the well sets are provided in Figures 3 and 4.

- For the well sets IH37-11 and P-103 (*r* = 0.69), and IH37-11 and MW-88 (*r* = 0.-30), these two *r* values indicate that the further one goes to the north along the west boundary, the less likely it becomes that groundwater has moved from the Flint Hills Resources and Citgo facilities towards the Hillcrest neighborhood. This analysis is meant as a general indication of flow and values for *r* could be different if data from other sets of wells had been used.

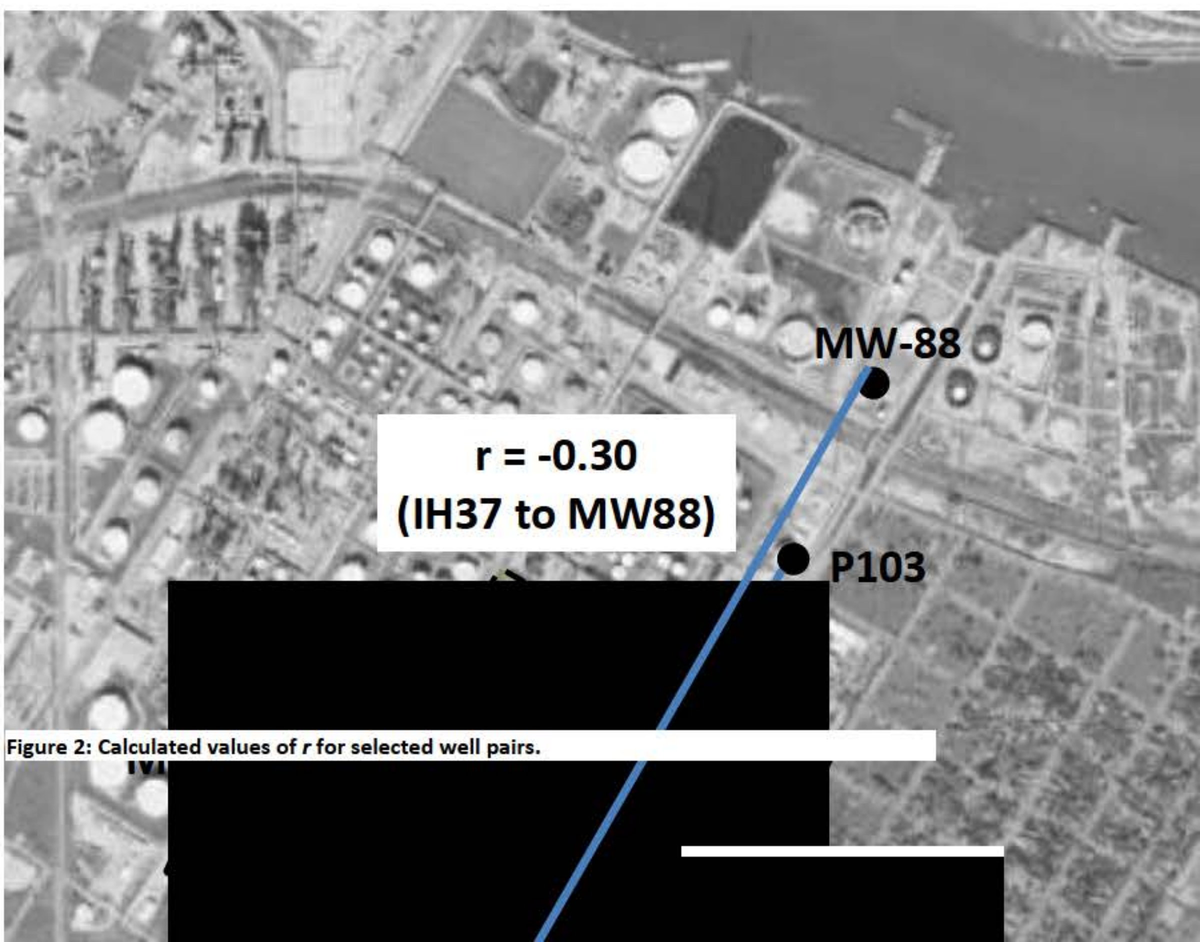

Figure 2: Calculated values of *r* for selected well pairs.

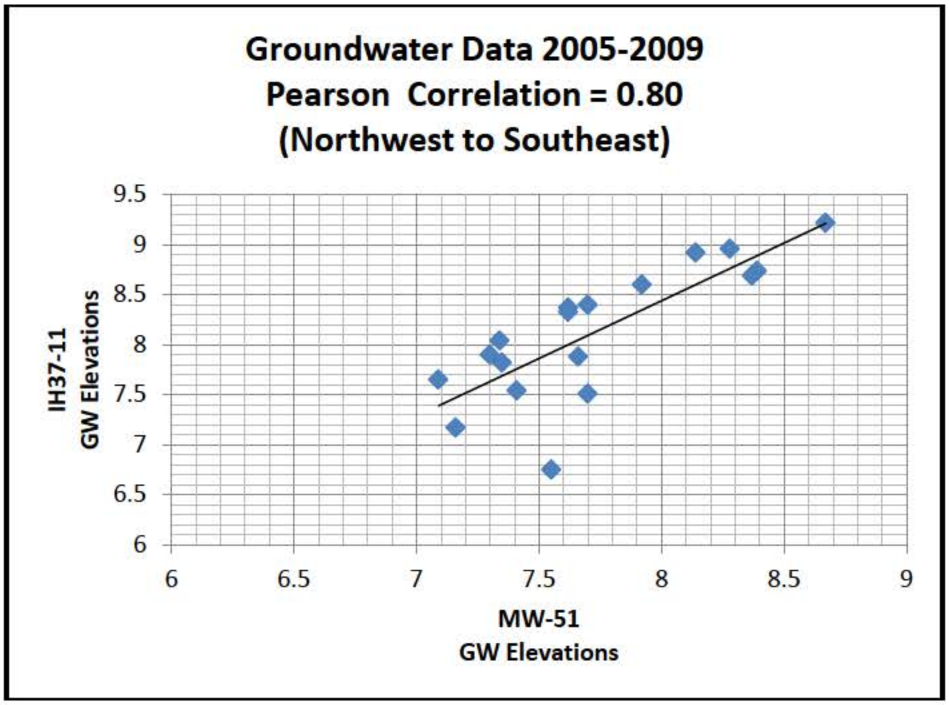

Figure 3

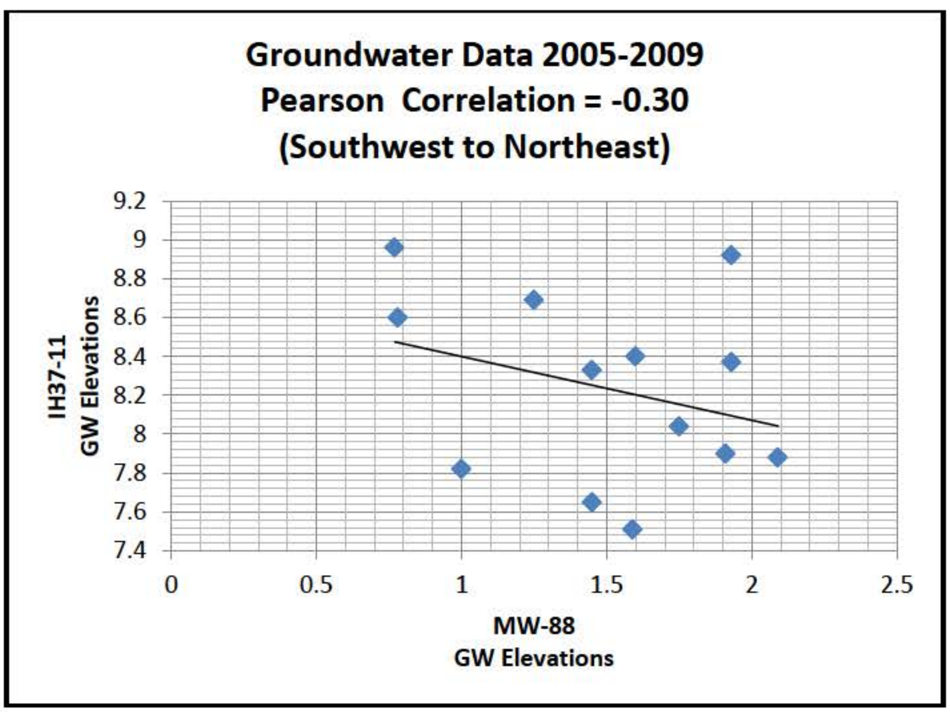

Figure 4

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Weston Solutions Inc., 2010, Groundwater Investigation Report, Buffer Zone, FRH East Refinery

ADDENDUM

The following groundwater flow map was developed by using data from the Hillcrest neighborhood and with data from selected monitoring wells located at adjacent industrial facilities. Groundwater measurements for both the neighborhood and industrial facilities were taken on or about April 2011. The consistency shown between the April 2011 map and the flow map developed for the Feb. 7, 2012 report (above), suggests changes are not needed in the conclusions provided in the Feb. 7 report.

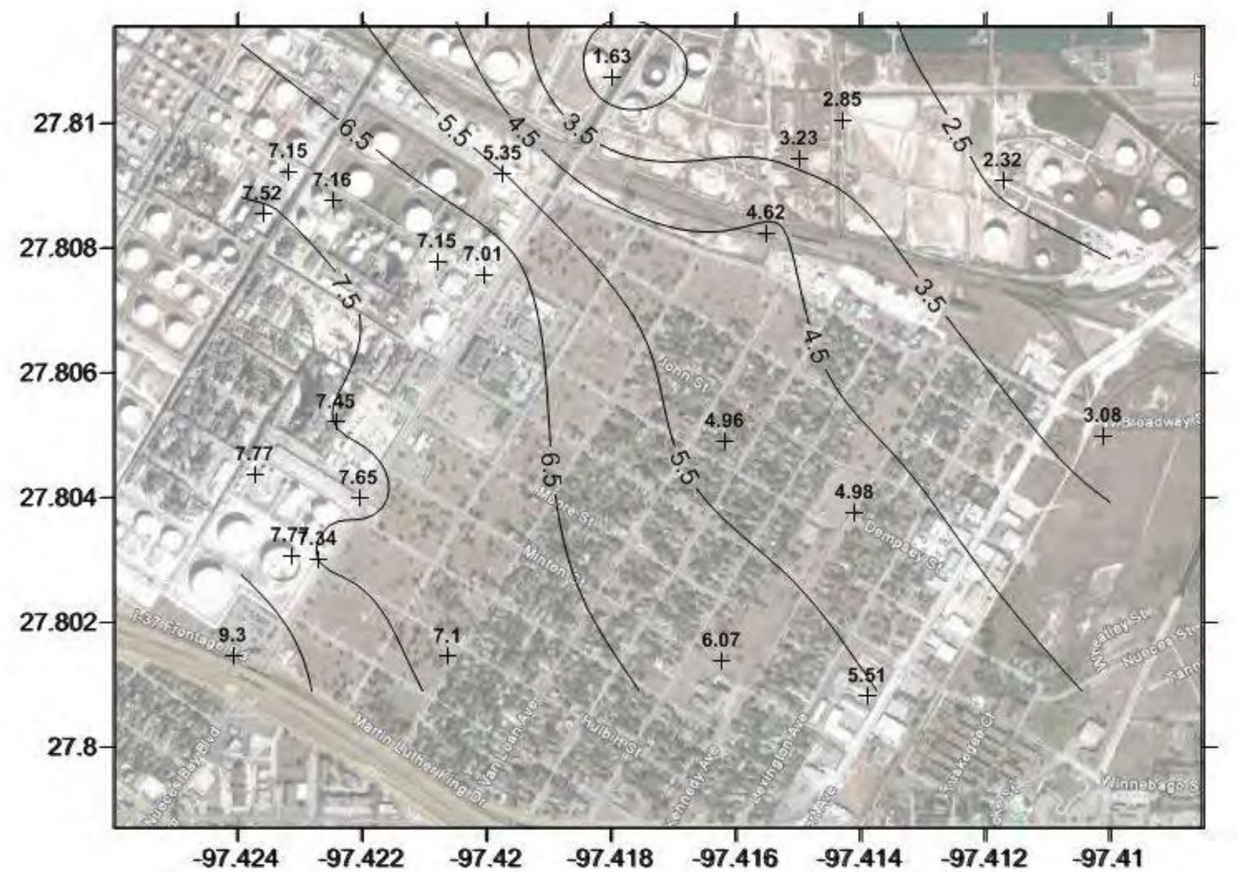

EXHIBIT 15

ELSEVIER

Desalination 152 (2002) 141–154

DESALINATION

www.elsevier.com/locate/desal

The footprint of the desalination processes on the environment

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Abstract

Processes of desalination of seawater are intended to reduce the deficits in potable water both at present and in the future. Water desalination processes offer various environmental benefits (related to sanitation, water softening, quality of sewage effluents), but the process is also accompanied by adverse environmental effects. These effects can be minimized by the appropriate planning. Most of the effects anticipated would then affect the local environment in the vicinity of the desalination plants. Desalination may have an impact on five domains: the use of the land, the groundwater, the marine environment, noise pollution, and finally the intensified use of energy. The impact on land use is caused by the use of the coastal land for the purpose of building factories, thus converting the coastal area into an industrial zone instead of an area of tourism and recreation. The impact on groundwater mainly occurs if pipelines carrying seawater or brine are laid above an aquifer. It also occurs in the case of feed drilling. In such cases the aquifer may be damaged either by infiltration of saline water or by disturbances of the water table. The impact on the marine environment takes place mainly in the vicinity of the concentrated brine discharge pipe. Even though the concentrated brine contains natural marine ingredients, its high specific weight causes it to sink to the sea floor without prior mixing. In addition, chemicals, which are administered to the water in the pre-treatment stages of the desalination process, may harm the marine life in the vicinity of the pipe's outlet. The actual placement of the discharge pipe may also damage sensitive marine communities. Noise pollution: A desalination plant, which is based on reverse osmosis technology, requires high-pressure pumps, which generate noise. Therefore the plant must be located at a suitable distance from population centers. Technological means may be employed in order to minimize noise intensities. A desalination plant may also affect the environment indirectly, such as via the intensified use of energy by the plant. This increased use of energy results in an increased production of electricity by the respective

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power station, which in turn results in increased air pollution, pollution by coal dust, thermal pollution, etc. The severity of these effects differs in different areas according to: a) the hydrogeological nature of the marine body (bathymetry, depth, tides, waves, currents); b) the biological sensitivity of the marine habitat; c) the type of desalination plant, its size, the required secondary structures and infrastructure. Environmental awareness and preliminary planning can minimize the adverse effects of the desalination process on the environment.

Keywords: Marine; Environment; Desalination; Brine; Outlet; Intake

1. Introduction

According to the Bible, the first project of desalination was conducted by Moses at the place of Mei Mara in the Sinai desert, where by introducing a piece of bitter wood into the bitter water Moses has turned the previously bitter fluid into potable water. The first scientific report describing a technology designed for the desalination of seawater was published by Thomas Jefferson, the American Secretary of State, in 1791 [1]. Instructions for operation of the technology were posted on notice boards in every ship, for use in a case of emergency. During the Second World War, hundreds of portable desalination devices were used by the troops of the various armies. In the early fifties, research projects were initiated with the aim of lowering the price of the desalination process. The incorporation of membrane processes resulted in a major improvement to the technique. The increase in the standard of living in the developing countries during the second half of the 20th century resulted in an increased demand for water for daily use as well as for industrial use. At the same time, clear water, regarded in the past as a natural resource, available and cheap, had turned into a precious commodity. A number of reasons may be given to explain this process: growth of the population, wasteful use of water, pollution of available water resources, and climatic changes related to global warming. At the beginning of the third millennium, we are facing a revolution in the desalination process, where reasonable costs and a continuous trend of further lowering the costs, will enable the supply of water of high quality at convenient prices, thus allowing expansion of residential areas as well as an improvement in the quality of life of people all over the world.

The yearly deficit in Israel's water budget, as estimated in 2001, is between 200 and 500 million m^3/y. A desalination plant, such as the one to be constructed in Ashkelon, would be capable of producing 100 million m^3/y of water (320,000 m^3/d), accounting for 20–50% of this deficit. Being the first in a line of plants to be constructed places great responsibility on the planners and on those who approve the plans, to establish proper standards that can meet with environmental demands. The construction of plants for seawater desalination is the preferred environmental option for reducing the water budget deficit, but first the environmental price of such plants should be thoroughly researched and taken into account.

The common technologies for seawater desalination are based on two main processes — evaporation and membrane separation, as shown in Table 1 [2–4]. In general, all processes of evaporation require large amounts of energy and therefore are suitable only to areas that are rich in cheap fuel. The cost of energy is the main production expense in desalination plants (excluding the amortization) and the process of reserve osmosis (RO) is the most efficient desalination process both in terms of energy and costs [5,6]. For this and other reasons reverse osmosis is becoming the established and preferred desalination process all over the world and in particular in Israel, and therefore most of this paper will be dedicated to it.

The process of reverse osmosis is based on the fact that in all salt solutions an osmotic pressure arises whose magni cxctude is proportional to the salt concentration. When a semi-permeable

Table 1
Common desalination technologies [2,3]

Reverse osmosis (RO)	Membrane processes, the most common system in use. A semi-penetrable membrane separates two solutions of different concentrations.
Electrodialysis (ED/EDR)	Membrane processes. A bundle of membranes is placed between two electrodes and an electric field is induced. It is mostly suitable for brackish water and for the remediation of polluted wells.
Multi stage flash (MSF)	Evaporation processes, in combination with power stations. The system includes a series of compartments. The flow of hot water into a compartment in which there is low pressure results in the evaporation of part of the water.
Multi effect distillation (MED)	Evaporation processes, based on the cycle of latent heat when generating steam, usually used in combination with power stations.
Vapor compression distillation (VCD)	Evaporation processes based on the principle of a heat pump. Repeated cycles of condensation and evaporation.

membrane is placed between two solutions of different concentrations and osmotic pressures, the difference in osmotic pressures will result in a flow of solvent (and a tiny part of the solute) through the membrane, from the less concentrated solution to the more concentrated one. In the process of reverse osmosis, the direction of the solvent flow is reversed by exerting external pressure, higher than the difference in osmotic pressures, on the more concentrated solution.

A reverse osmosis plant consists of a bundle of membranes placed in a pressure chamber, a high pressure pump, a turbine for recovering energy from the high concentration brine which is discharged from the plant, and a system for the pretreatment of the feed water and the product water. In this process (see Fig. 1), the seawater enters a pretreatment system, which contains sand filters, micron filters and a system for chemical dosing. The purpose of this pretreatment system is to protect the membranes from fouling by dirt, biological or chemical deposits. The feed pump generates seawater flow at pressures of 55–80 atm. through the membrane system. The desalinated product water, which has passed through the membranes, then receives a final treatment, which includes the adjustment of its reactivity ratio, the reduction of its corrosivity and its disinfection. The discharged brine passes through the turbine, which recovers 30–40% of the energy invested by the process pump and is then returned to the sea. A secondary system used for periodical cleaning of the membranes is installed in each reverse osmosis plant.

There are five aspects to the impact of desalination plants on the environment:

1. Adverse effect on land use. As factories are located near the shoreline, seashores serve as the sites for industrial plants and for pumping stations rather than for recreation and tourism.

2. Impact on the aquifer. If a desalination plant is constructed inland in order to minimize the impact on the beach, there is a need for pipes to transport the seawater and brine. Leakage from the pipes may result in penetration of salt water and therefore presents a danger to the aquifer. The aquifer is further endangered if drilling is initiated in order to draw brackish feed water.

3. Impact on the marine environment as a result of returning the concentrated brine to the sea. Although the brine contains materials, which originated in the sea, its high specific weight and the potential presence of additional chemicals introduced in the pretreatment stage may harm the marine population in the area of the discharge of the brine. The installation of the feed and

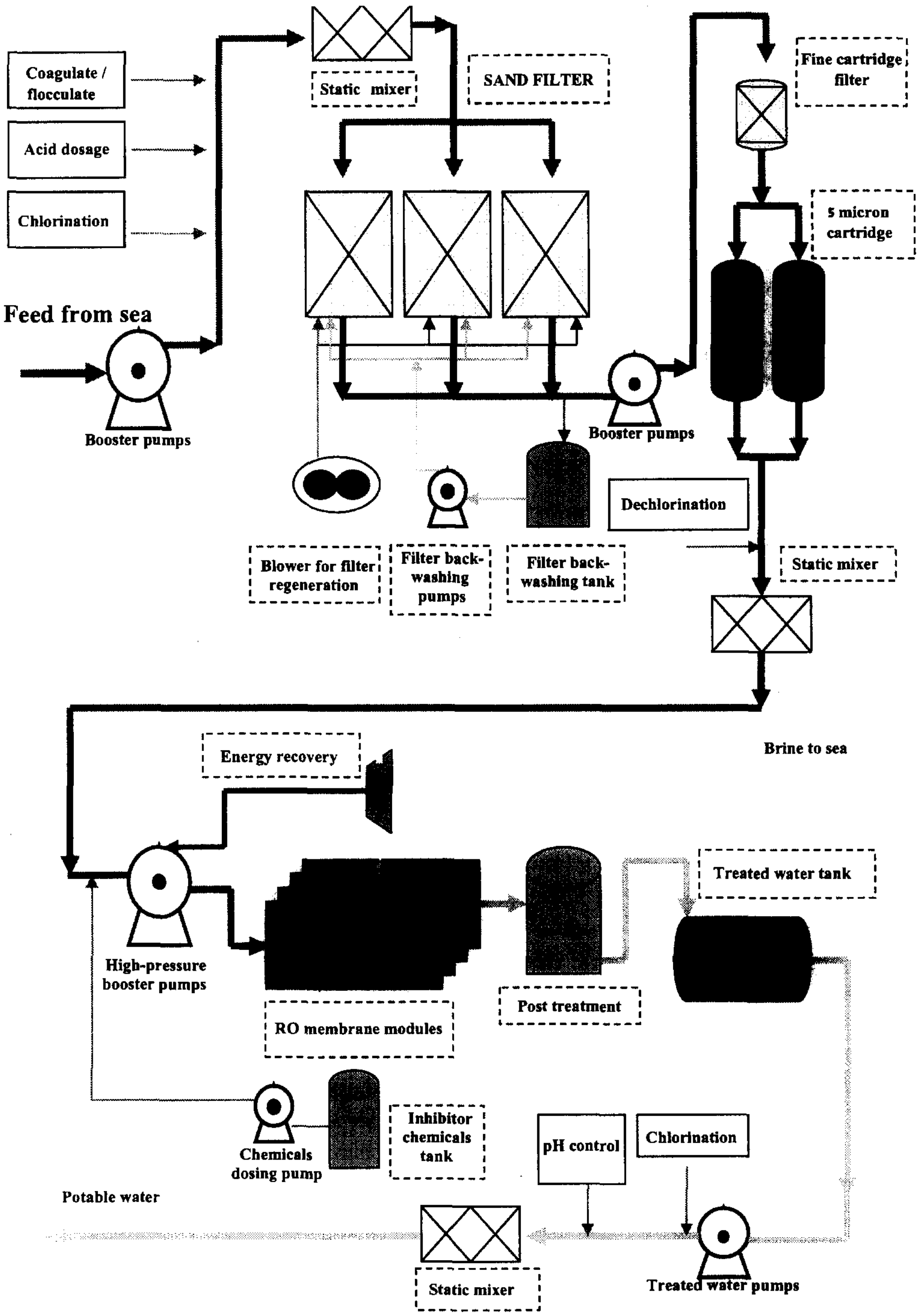

Fig. 1. General layout of a desalination plant employing reverse osmosis technology.

discharge pipes may itself be harmful. Layers of sand and clay may suffer re-suspension during the laying of the pipes and rocky areas and reefs may suffer mechanical blows.

4. Impact of noise. Seawater desalination plants require the use of high-pressure pumps and turbines for recovering energy, which produces noise. They should therefore be located far away from populated areas or equipped with the appropriate technologies for lowering noise intensities.

5. Intensive use of energy. This has an indirect impact on the environment due to the need to increase production of electricity with the well-known related environmental consequences.

2. The use of land

The environmental value placed on the use of land changes from place to place and is dependent on the population density and on the public awareness. In many places this value is negligible, but in places with limited seashores, such as the State of Israel, there is a high value attached to each strip of shoreline, which could be used for internal tourism, external tourism and for conservation of nature. The area required for a seawater desalination plant (including pumps and holding ponds) is about 25 acres for a plant that produces 100 million m^3/y. In an area smaller than a 1000 dunams it is possible to desalinate 1 billion m^3 of water.

The outline scheme for the development of the coasts of Israel designate limited areas only for heavy industry, no building is allowed within 100 m from the shoreline (with a few exceptions).

One of the solutions for minimizing the use of coastal land when building desalination plants is locating the plants farther inland. This introduces the problem of using pipes for transporting large amounts of seawater and brine, with the danger of pollution to the underlying aquifer from potential leakage. Placing the desalination plant adjacent to areas with established and operating infrastructure, in the framework of infrastructure unification, will minimize this impact.

3. Impact on groundwater

Pipes of seawater laid over the aquifer pose a danger to it as these pipes may leak and salt water may penetrate the aquifer. The coastal aquifer of Israel extends to most areas along its Mediterranean shores and thus lies under most of the potential sites for an inland desalination plant. As a result, the laying of pipes carrying seawater and brine necessitates the use of proper sealing techniques and the installation of detectors, which would stop the pumping in case of a malfunction. The preferred site for a plant is an area where the probability of harm to the aquifer is low.

The supply of feed water from feed drilling is a reliable technology. Its main advantage lies in the provision of clean and filtered seawater, the significant reduction in the danger of pollution, and the stable temperature of the feed water. The use of water from feed drilling also allows for savings in the pretreatment stage. The drawbacks of the system are the danger of disturbing the water table and the aquifer. In many cases (for instance in the plant in Ashkelon) this option was ruled out in advance.

4. Impact on the marine environment

Most of the impact on the marine environment is a consequence of the positioning of the feed pipes and the brine discharge pipes. The initial impact during the laying of the pipes is temporary and confined to the location of the works, but even this impact may be significant, especially in rocky habitats and coral reefs. The severity of the impact is a function of the level of disturbance to the environment and of the natural sensitivity, which in turn is dependent on the specific nature of the habitat and on the specific communities.

The main impact is due to the discharge of the concentrated brine to the sea, and its magnitude depends on environmental and hydro geological factors characteristic of the sea: bathymetry, waves, currents, depth of the water column etc. These factors would determine the extent of the mixing of the brines and therefore the geographical range of the impact.

Höpner and Windelberg divide the global marine habitats into 15 categories according to their sensitivities to the effects of desalination plants [7] (Table 2). According to the hierarchy, which they suggest, the sites most suitable for the construction of desalination plants are the shores of the ocean (No. 1), in regions of high-energy oceanic coasts. The most sensitive regions (No. 15) are Mangal, mangrove flats. Because of the diversity of species characteristic to them, coral reefs are rated at 13.

4.1. Composition of discharge brines

In all processes of desalination, discharged brines, the concentration of which is higher than that of the natural seawater, are returned to the sea. The concentrations of the brines are usually found to be double or close to double that of natural seawater [8]. In addition to the high concentration of salts, this discharge water contains various chemicals used in the pretreatment stage of the desalination, including various defouling materials. In the case of evaporation plants, thermal pollution is also produced.

Table 2
Sensitivities of marine habitats to desalination plants [7]

1.	High-energy oceanic coasts, rocky or sandy, with coast-parallel current
2.	Exposed rocky coast
3.	Mature shoreline (sediment mobility)
4.	Coastal upwelling
5.	High-energy soft tidal coast
6.	Estuaries and estuary-similar
7.	Low energy sand-, mud- and beach rocks-flats
8.	Coastal sabkhas
9.	Fjords
10.	Shallow low-energy bay and semi-enclosed lagoon
11.	Algal (cyanobacterial) mats
12.	Seaweed bay and shallows
13.	Coral reefs
14.	Salt marsh
15.	Mangal (mangrove flats)

The types and the amounts of the chemicals used depend on the chosen technology and the required quality of the product water. Chemicals that are likely to be found in the brines include antiscaling materials, surfactants, and acids used for the lowering of pH. The salts returned to the sea are identical to those present in the feed water, but they are now present at a higher concentration. In plants of reverse osmosis, the discharge concentration is 30–70%, or 1.3–1.7 times that of the original seawater. This is a higher concentration than the one found for MSF plants where the return ratio is 1.1–1.5 [9–11].

The chemicals used in the pretreatment of seawater are mainly [12,13]:

- NaOCl or free chlorine, used for chlorination, preventing biological growth (antifouling).
- $FeCl_3$ or $AlCl_3$, used for the flocculation and removal of suspended matter from the water.
- H_2SO_4 or HCl, used for pH adjustment.
- SHMP $(NaPO_3)_6$ and similar materials, prevent scale formation on the pipes and on the membranes.
- $NaHSO_3$, used in order to neutralize any remains of chlorine in the feed water.

All these materials (in concentrations and amounts which are similar to those used in desalination plants) are approved for use by the American EPA and most of them are used in systems for drinking water. Chemicals that dissolve in seawater may contribute ions identical to the ions already present in the seawater. For instance, sulfuric acid increases the concentration of the SO_4 ion from 3020 to 3050 mg/l, an increase of about 1% above the natural concentration of seawater (based on technical information from the Hydranautics company and its rodesign simulation package). Cleaning of the membranes is conducted 3 or 4 times a year, and the chemicals used are mainly weak acids and detergents (citric acid, sodium polyphosphate and EDTA which is used in order to remove carbonate deposits). The rinse water is kept in a titration container and after being treated (titration, neutralization of the cleaning materials), it is disposed off either by transporting it in closed containers to an authorized salt disposal site, or by the continuous flow of small quantities together with the discharged brine back to the sea. The high dilution ratio (about fifty to one million) ensures very low concentration of rinsing materials in the brine returned to the sea. Tables 3–5 show some estimates regarding the materials, which would be returned to the sea in the planned desalination plant in Ashkelon [12].

4.2. Dispersion of the concentrated salts

The major environmental problem associated with a desalination plant is how to get rid of the surplus of concentrated brines. In most cases, these brines cannot remain on land because of the danger they pose to the underlying groundwater and because of other potential and severe environmental impacts. A natural disposal site for these brines is the sea, but an appropriate technology is required in order to insure the proper dispersion of the concentrated solutions and thus minimize their adverse effects on the marine environment. Several alternative techniques are available for this purpose, and the choice between them would depend on the particular conditions in the area, taking into consideration the environmental, engineering and economical aspects. The alternative techniques are:

- Discharging the brines by a long pipe far into the sea.
- Direct discharge of the brines at the coastline.
- Discharging the brines via the outlet of the power station's cooling water
- Directing the brines to a salt production plant.

4.3. Discharging the brines by a long pipe far into the sea

The brines, which would be routinely returned to the sea, would form a plume of highly saline seawater, corresponding to their amount and to the conditions of the sea (depth, bathymetry, currents, etc.). The plume would sink to the sea

Table 3
Flows of seawater and brine

	Feed — seawater	Discharge brine returned to the sea (including rinse water)
Hourly flow, m^3	13,000	6,750
Concentration of salts, mg/l	40,500	77,920
Total amount of salt, t/h	526	526

Table 5
Cleaning and rinsing of the membranes

	Yearly amount, t	Storage volume, m^3
Citric acid	70	30
Sodium tripolyphosphate	50	20
EDTA	30	10

Table 4
List of chemicals and the amounts used in the pretreatment stage

Chemicals	Doses, mg/l	Flow, kg/h	Daily amount, t	Accumulated volume (diluted material), m^3
Sodium hypochlorite	6	80	1.9	120
Sulfuric acid 98%	30	390	9.4	100
SHMP (scale remover)	6	80	1.9	120
Iron chloride — flocculant to treat suspended colloids	4	50	1.2	120
Sodium bisulphate	4	50	1.2	120

floor and its effects would extend over a range of hundreds of meters.

As this presents a continuous and cumulative source of pollution, it would result in a continuous damage to the biota within the plume's vicinity. It is therefore desirable to place the point of brine discharge far away from the beach and from rocky areas which are rich in organisms, as well as far away from areas where large numbers of people are involved in activities such as recreation, touring, fishing etc.

Most of the data in the literature and most of the practical experience regarding the flow of liquids into the sea is related to various forms of sewage discharge, where the effluents float on the seawater because of their lower densities. These forces of buoyancy are important in the dilution process of water jets [14] but do not exist in the case of concentrated brine discharge. The process of brine dilution is a combination of two physical processes: the primary (jet) dilution and the natural dilution.

The rate of the jet dilution process depends on the difference in densities (a function of the concentration of salts and of the temperature) between the concentrated brine and the seawater, as well as on the momentum, the rate of the flow and the velocity at the outlet of the discharge pipe. The jet dilution is further affected by the diameter of the discharge pipe and by the depth of the sea floor. In the case of brine, the water jet descends to the bottom and the effectiveness of this stage is reduced. Appropriate planning of the discharge pipe, such as the incorporation of diffusers directed upwards, may improve the jet dilution process [15,16].

The second phase is the natural dilution (turbulent dilution), which takes place following the jet dilution stage, mainly as a result of processes of diffusion and mixing which are generated by marine currents and waves. It varies according to the marine conditions.

Installation of diffusers on the discharge pipe boosts the turbulent dilution. The diffusers enable the increase in the pressure of the entering solutions and increase the volume of seawater in contact with the brine, therefore improving the mixing. The success of the diffusers operation depends on their number and on the space between them. It is possible to improve the dispersion efficiency by using special diffusers, such as Red Valve diffusers. These boost the brine pressure at the outlet of the discharge pipe and thereby improve the dilution. Another option is the use of diffusers directed at an angle of 30–90° to the sea floor, so that the concentrated brine is pushed in the direction of the surface of the sea.

The main effects on the marine biota would be in the vicinity of the discharge pipe and would be related to the increase in the concentration of salt. This would mostly affect benthic organisms dug in the sandy bottom as well as planctonic organisms. The salinity is expressed in weight of salts per 1‰ and in most seas and oceans its value varies between 32–38‰, which is the range to which most marine creatures have adapted. The eastern part of the Mediterranean is more saline that its western part [17]. In the Red Sea salinities may reach a value of 41‰.

Marine organisms exist in an osmotic balance with their environment and an increase in the concentration of salts in this environment may result in the dehydration of cells, decrease of the turgor pressure and death (mainly of the larvae and young individuals). The biomass in Israel's Mediterranean coasts is composed of species, which have originated from Pacific and Atlantic species. The Atlantic species, found in the Eastern Mediterranean, are at the limit of their tolerance to the water salinity, while species that have originated in the Pacific can cope more easily with an increase in salinity.

The sensitivity to the increase in salinity varies from species to species. To the best of our knowledge, no systematic research has yet been conducted on the tolerance of the various species in our region to variations in salinity. Some of the planktonic algae, and in particular the siliceous ones, can tolerate high salinities (these species appear in coastal salt marshes, such as the Bardawill), but most of the species will not survive. Certain species are able to tolerate higher salinities after a period of acclimatization, but the nature of the discharge flow would not enable the foundation of a population of halophile species at the outlet of the discharge pipe.

The sensitivity of the invertebrates, mainly that of crabs, varies but in general it is found that long abdomen invertebrates are more sensitive to an increase in salinity than short abdomen ones. The larvae of crabs and of other invertebrates, which float in the water, are more sensitive than the adults to changes in salinity [18–21].

Data from systematic monitoring of the dispersion of concentrated brines in marine outlets is scarce, and the only information we have available is from Cyprus and the Canary Islands. Two desalination plants operate in Cyprus: the plant in Dhkelia, which has operated for 4 years and the new plant in Larnaca, which has operated for a few months only [7,22].

4.3.1. The plant in Dhkelia

The length of the discharge pipe is only 250 m. The suction feed pipe is only 200 m away from the outlet of the discharge pipe and extends 150 m into the sea. The Cyprus Department of Fisheries monitors the site. An increase in salinity within a range of 100–200 m from the outlet of the discharge pipe has been reported [23–26]. In a dive performed on March 7, 1999, around the area of the outlet of the discharge pipe, an impact to the life of the littoral fauna and the flora was observed, as witnessed by the disappearance of certain species from the littoral due to the increased salination in that area.

4.3.2. The plant in Larnaca

The plant in Larnaca was built by the IDE and Oceana companies. At present it is owned by IDE, which will remain the owner for the next 10 years, at which point the ownership will be transferred to the government of Cyprus. The plant was completed a few months prior to the writing of this paper. It is intended to produce 54,000 m^3 of water daily and a similar amount of brine. Following the experience in Dhkelia, the Cyprus Department of Fisheries demanded that a discharge pipe of 1 km length at least would be provided, with its outlet at a depth of more than 10 m below sea surface. The existing pipe is 1500 m long and is located 25 m below the surface. The suction feed pipe is 1100 m long and is located more than 2 km away. According to Marina Argiro (Cyprus Department of Fisheries), the first measurements conducted in the site point to good dilution conditions.

An impressive study carried out in the Canary Islands was presented in a conference that took place on the 28–31 of May 2001 in Cyprus. The work included both a survey and the monitoring of the dispersion of concentrated brines past the outlet of the discharge pipe, and the influence on the marine flora [27]. The research was carried out at the plant of Maspalomas II. The plant produces about 17,000 m^3/d (about 10% of the amount expected in the plant of Ashkelon). The discharge pipe is 300 m long, its diameter is 60 cm and the water depth is 7.5 m. It should be noted that the topographic structure of the sea floor in the area is characterized by a shallow shelf extending out a few meters followed by a steep fall off. The sea in the region of the island is often rough, and the tide rises about 2 m. The measurements were conducted by divers under calm conditions of the sea. Even though dilution was satisfactory at the surface of the sea, sinking of concentrated and dense solutions to the bottom was still observed. In measurements that were conducted later in the region of the plume, a concentration of more than 60‰ was detected at a distance of 100 m from the outlet, and as a result other regions within the plume are to be monitored. The plume took an elongated form, resembling a salty underwater river flowing in the direction of the fall line. Impacts on the local marine flora in the vicinity of the outlet were observed.

4.4. Direct discharge of the brines at the coastline

The alternative of discharging concentrated salt solutions directly at the coastline is not recommended by the authors of this paper, although under certain conditions (small plants, insensitive shore) it should be given some consideration because of economical factors. Brine water, which is continuously returned to the sea, will form a plume of high salinity seawater, depending on the marine conditions and other factors. The effect will be noticeable at distances of hundreds of meters from the outlet (depending on the amounts of the brines). Even if the brines would be mostly diluted at a short distance from the outlet, during the many days in which the sea is calm (such as during easterly winds), the secondary dilution would be negligible. On those days the damage to the coastal habitats would be high. This method is not recommended for seas with high sensitivity, or for large desalination plants, or for areas with population of high environmental awareness.

In Malta there is a desalination plant that has been operating for many years. The plant discharges the concentrated brines directly into the sea, but dilution with seawater is fast due to the great depth (27–30 m). To the best of our knowledge, no environmental survey was conducted in the region (personal information, Domovic Darko).

In Saudi Arabia there are several large-scale desalination plants in operation (quoted as producing one billion m^3/d) but the general environmental awareness in the country is very low. The concentrated brines are discharged directly into the sea and contain chemicals from the pretreatment stage as well as membrane cleaning materials. The brines are carried away by the tide and by the marine currents. We estimate that the depth of the sea is greater than that of the Mediterranean, and therefore the dilution is faster (personal information, Nicos P. Isaias and Gerhard L. Schanz).

In Kuwait there are a number of large and energy costly desalination plants that are based mostly on the evaporation processes and are combined with power stations. The concentration of brines at the outlet is lower than the discharge concentrations in plants of reverse osmosis. There is now a tendency there to change to RO plants. The country lacks general environmental awareness and the concentrated brines are discharged into the sea [28].

In Qatar there is a number of large desalination plants in operation, utilizing both reverse osmosis and evaporation technologies (MSF). Large amounts of brine are generated and there is also an associated increase in temperature, but the concentration of salts is relatively low. There is a general lack of awareness as to the environmental effects of the brines. In an essay describing the environmental effects of the plant [9], the marine inlets and outlets are described. The outlets are located near the coastline, and therefore in order to enlarge the plant it became necessary to build a 2 km long feed suction pipe for phase B of the plant.

An interdisciplinary study was conducted in Florida, USA, aimed at checking the effects of the discharge of concentrated brines (and sometimes of hot water) from various outlets [29,30] on the environment. The plants which were studied were small scale ones, the largest plant producing 5500 m^3/d and most of the other plants produced much less. The highest salinity of brine measured was 39 ppt as compared with a background salinity of 35 ppt. The tide in the area varies between values of 1–1.5 m. In most instances the concentrated brines were discharged directly into the sea, but in some cases discharge was accomplished using a short discharge pipe. The population of invertebrates (foraminifera), fish and seaweeds were monitored and so were the salinities along cross sections of 10 m length (in varying directions), both along the sea floor and at sea level. There was no preliminary inspection of the study area and no comparison with a control population. According to the researchers, no significant changes were noted in communities of biota along the sections. Higher concentrations of salt were found in the direction of flow.

4.5. Discharging the brines via the outlet of the power station's cooling water

This option suggests using the hot water discharged from the power station for the dilution of the concentrated brines. The main environmental advantage is the high dilution ratio achieved. An additional advantage lies in the relatively low specific weight of the hot water, which would partially offset the high specific weight of the brines and would therefore reduce their tendency to sink to the bottom.

The combination of a power station and a desalination plant holds many advantages, though most of these are relevant to plants that are based on the various evaporation systems and not to reverse osmosis plants [6,28, 31–33].

Calculations made in Ashkelon and Hadera indicate that the total salinity of the water at the vicinity of the outlet of the discharge pipe would increase by 1 to 5%. According to the available models for dispersion [34,35], the effect of the added brine will disappear at a distance of a few meters from the outlet. In terms of environmental considerations, the preferred mode of operation using this alternative would be to use the existing outlet and monitoring system of the cooling water of the Electricity Company so as to avoid an added impact to the marine environment.

4.6. Directing the concentrated brines to a salt production plant

This option, whereby the salts pumped from the sea are utilized for salt production rather than returned to the sea, presents many environmental and economical advantages. Its only drawback is the small number of salt producing plants found in the vicinity of desalination plants. If using this technology, there would be an advantage to the additional reprocessing of the brines through the membranes, thereby increasing the salinity of the discharged water.

This option is partially employed in Eilat. The Mekorot plant in Eilat (which in the past was based on the Zarchin system) is based nowadays on reverse osmosis and produces almost 12 million m^3 of desalinated water each year. Part of the feed water is brackish water from drilled wells (9 million m^3 in concentrations of 3500–6000 mg chlorides per l) and the rest of the feed is seawater. The concentration of the brines generated from the brackish water is 70% and the brines generated from seawater reach a concentration of 50%. The brines exit the plant at concentrations that are 2.0–2.5 times higher than the concentration of seawater. The brines are then transferred from the plant to the Salt Company ponds and any surplus (the amount of which varies with the varying seasons), is transferred to the Eilat bird watching center. At the grounds of the center the brines are combined with brines from other sources (the fish growing farms, seaweed growing plant), and are then transferred in an open canal to the sea. As the canal passes through an area, which is a highly saline marsh, and as the flow is by a strong current, it seems that there is no penetration of brine water into the groundwater. The canal's outlet is located in the northern beach area and to the best of our knowledge the rate at which the brine disperses in the sea has not been monitored (personal information, Rafi Iphargan).

5. Noise pollution

A seawater desalination reverse osmosis plant is a noisy plant. Most of the noise is produced by the high-pressure pumps and by the turbines used for energy restoration [36,37]. The impact of the noise does not allow for the operation of a large desalination plant in the vicinity of a population center without the use of technological means. Means for decreasing the noise level include the building of canopies over the pumps and the appropriate acoustical planning of the plant.

6. Intensified use of energy

The intensified use of energy by the desalination plant results in indirect environmental impacts, since the energy requirements of the plant increase the production of electricity, the burning of fuels and in turn the boost the process of global warming. The energy required to desalinate a m^3 of water varies from one plant to another and from technology to technology, and the reverse osmosis technology is the most energy efficient.

Based on various publications, it is estimated that the amount of electricity required to produce 1 m^3 of water varies between 3.5–4.5 kWh/m^3. We estimate the optimal value to be 4.5 kWh/m^3. The amount of coal needed to produce one kWh is 353.8 g. The corresponding amount of crude oil (which varies from plant to plant) is approximately 234.9 g for one kWh. (this data provided courtesy of Dr. Michal Perla, Electrical Company). A plant producing 100 million m^3/y water would require an electrical output of 50–60 MW.

7. Conclusions

The processes of desalination as a source for potable water are about to become more widespread. Our duty as citizens and as planners is to be aware of the environmental aspects related to the various processes and in each case to consider the environmental costs as well as the requirements and the financial costs.

In a paper, which deals with the problems caused by processes of desalination, it is also important to address the numerous advantages, both direct and indirect, of adding desalinated water to the existing water system. The main purpose of seawater desalination is to offset present or future deficits in potable water, by producing water of good quality at a reasonable price. However, the amounts and the quality of the produced water highlight several additional environmental advantages. These advantages are dependent on the intended point of use of the desalinated water as well as on the volume and quality ratio between this water and the rest of the water in the water supply system.

The added environmental advantages of the use of desalinated water are:

a. Improvement in quality and sanitation — by adding to the general water supply water that is free of pollutants, carcinogenic materials, organic materials, viruses as well as of offending colors, tastes and scents.

b. Softening of the water — the advantages to the average household from the softening of water include prevention of clogging of water pipes, prevention of scale formation in boilers and kettles, improvements in laundry and dish-washing efficiencies, etc. The advantages to the industry include savings on water softening expenses, economizing the use of anti scaling materials, etc. The softening of water also reduces the need for detergents and this reduced usage would improve the quality of sewage water.

c. Advantages to the agriculture and the environment — the use of treated wastewaters which contain high concentrations of dissolved salts, sodium, chloride and boron, harms agricultural growth and especially harms sensitive crops. This use damages the soil, interferes with proper drainage, causes the accumulation of salts in the substrata, and even damages the underlying groundwater. It has been observed that salination has already damaged the aquifer and a large number of wells have already been shut down. Any damage to the soil, to the crops and to the groundwater brings with it further damage to the environment and to the economy. The Israeli quality requirements of the product water from desalination specify an upper limit of 0.4 mg/l for boron, so that the product water is bound to be low in salinity, and thus the concentrations of chloride and sodium would be 10–100 mg/l. In addition, there is the potential for a decrease in the amount of salts that are now being added to urban sewage due to the softening of industrial and domestic water. Thus desalination is expected to reduce the salinity of treated wastewater, with all the related implications, including the ability to make intensive use of treated wastewater in various agricultural applications and even as potable water. The only way to insure the preservation of natural water systems is by the addition of artificially produced water for domestic and industrial use.

A balanced environmental evaluation of the processes of desalination will take into account the extent to which the population requires the water, the ability to allocate water for agricultural, industrial and nature preservation needs, as well as the need for drinking water.

A balanced environmental evaluation of the processes of desalination will take into account the level of sensitivity of the corresponding environment, both marine and terrestrial, to the environmental impacts of the desalination plant, and the costs of minimizing these impacts.

A balanced environmental evaluation of the desalination processes will take into account the economical and environmental costs of the various technologies for acquiring water, such as (deep) drillings, recycling, use of brackish water, etc. Taking into account the various environmental aspects, there is an apparent advantage to the use of reverse osmosis processes over the use of evaporation processes [9,37–38].

By employing intelligent planning and the appropriate technologies, it is possible to minimize the adverse effects of seawater desalination plants on the environment. The environmental awareness of the planners, the designers, the decision-makers and the public during the early stages of planning and construction, will enable the construction of environmentally friendly plants.

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EXHIBIT 16

Comparison between LTTD and RO process of sea-water desalination: an integrated economic, environmental and ecological framework

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Sea-water desalination has emerged as the key alternative to overcome demand–supply gap of potable water, worldwide. This paper aims to carry out a technology review of sea-water desalination, technologies in an integrated framework of economic, environmental and ecological analyses. The economic analysis here refers to a project/technology development effort analysis in the context of national economy. The cost per unit output from this perspective is the economic cost. In an environmental analysis, the higher specific energy consumption in a process vis-à-vis the best technology option in the project area is measured in terms of certified emission reduction. In ecosystem analysis, the accent is to find out whether the technology disrupts the existing eco-system. Such a disturbance entails a huge ecological cost. The cost quantified per unit output is arrived at as the reduction in GDP in the project affected area due to the direct and indirect effects of adverse ecological effects; these effects are deduced using specifically developed *I–O* tables 'with and without' technology options, for the project area. The choice of technology is the one with the minimum composite cost per unit output. The composite cost in the context is the sum of economic cost, the environmental cost and the ecological cost per unit output. The framework is applied in the technology review of low-temperature thermal desalination process and its impact on project areas of Lakshadweep islands and Thoothukodi district vis-à-vis the alternative RO process of sea-water desalination technology.

Keywords: Economic, environmental and ecological factors, reverse osmosis, sea water, thermal desalination.

FRESHWATER consumption increased by six times between 1900 and 1995, more than double the population growth rate[1]. Nowadays the availability of potable water is a worldwide problem due to the steep increase in demand for water not matched by recharge. Roughly one-third of worldwide population of 6.8 billion lives in water-scarce areas. Analysts estimate that by 2025 two-thirds will be living in water-scarce areas, making this a critical problem equivalent to climate change. Under this global situation, solutions such as water transfer or dam construction are not sufficient; sea-water desalination with an installed capacity of 63 million cubic metre per day has emerged as the key alternative. The major questions being posed with regard to desalination are high environmental cost due to high energy consumption and the environmental impact of large plants dumping their concentrate waste stream into the oceans (ecological cost). This article aims to carry out a technology review of the low-temperature thermal desalination (LTTD) process developed by the National Institute of Ocean Technology (NIOT), Chennai which has a mandate to develop technologies to harness the vast potential of the sea. The review would use an integrated economic (price per litre of desalinated water to yield an internal rate of return (IRR) equivalent to the social discount rate), environmental (specific energy consumption per litre of desalinated water vis-à-vis the best technology option) and ecological (cost due to the disturbance in the ecosystem measured as the change in GDP in the project catchment area per litre of desalinated water due to the introduction of a particular technology) analysis of setting up LTTD plants for sea-water desalination.

The unit of analysis is not technology, but the 'project area'. This implies that we will not evaluate technologies to rank them universally, but evaluate all technology options for each project area in terms of composite cost of economic, environmental and ecological components. The analysis would be carried out here for two domestic locations to illustrate the methodology. To bring out implications, the LTTD composite cost (economic and ecological cost) would be compared with the results for the next best technology option.

Comparison of desalination technologies

The principal desalination technologies can be classified by the separation mechanism into thermal and membrane desalination technologies. Thermal desalination separates salt from water by evaporation and condensation, whereas membrane processes use semi-permeable membranes and driving forces like pressure to separate salt

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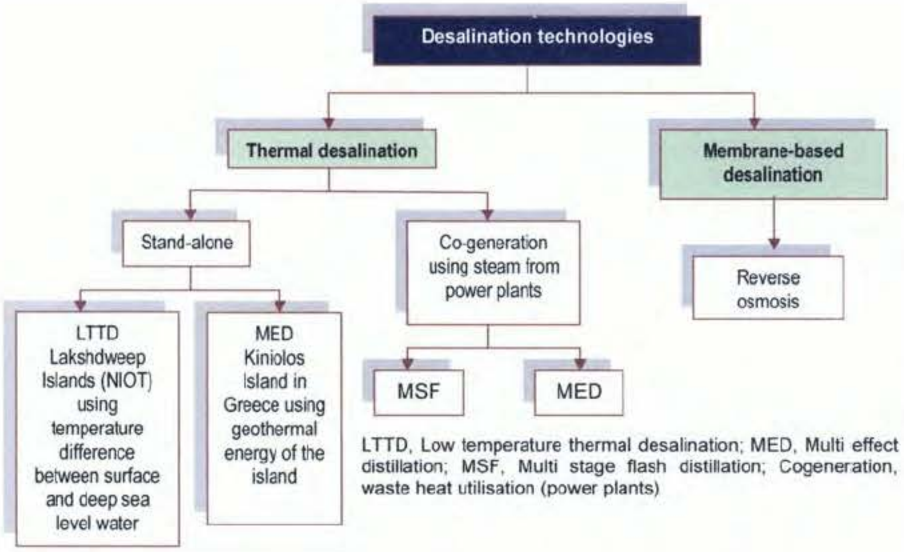

Figure 1. Desalination technologies. Source: Ref. 10.

from water. An overview of the currently available and applied commercial desalination techniques is shown in Figure 1.

Understanding desalination technologies

A comparison of the LTTD process with reverse osmosis (RO) process, multi-stage flash distillation (MSF) and multi effect distillation (MED) in terms of principle of operation, and environmental and ecological effects can help us in understanding the implications of technology choice.

Principles of operation

RO is a membrane process, where water at high pressure is made to pass through a porous membrane having pores of 0.5–1.5 nm size. The dissolved solids are left behind. This is carried out in stages as described below:

Stage 1: First, sea water is pre-treated in order to make it suitable for RO application.

Stage 2: Subsequently, the pre-treated feed water has to be pressurized before entering the polymeric RO thin-film composite membranes.

Stage 3: In the RO membrane unit, salt is separated from water with a rejection of 98–99.5% depending on the membrane in use.

Stage 4: Due to the fact that RO permeate has extremely low levels of dissolved salts, limestone ($CaCO_3$) bed, lime ($Ca(OH)_2$) or caustic soda (NaOH) may be added to increase hardness, alkalinity, pH and to cause the formation of calcium bicarbonate. This reduces corrosion problems in the water distribution system. Moreover, RO permeate contains dissolved carbon dioxide which needs to be removed because it may be transformed in carbonic acid, making water corrosive.

Stage 5: Finally, RO retentate has to be disposed. Several disposal options are available, and the most frequently employed option is discharging into the sea. The discharged brine may damage the existing ecosystem.

LTTD works on the principle of utilizing temperature gradient between two water bodies to evaporate the warmer water at low pressure and condense the resultant vapour with the colder water to obtain freshwater.

MED was the first process used for sea-water desalination. It is based on heat transport from condensing steam to sea water or brine in a series of stages or effects. It is a distillation process where the evaporation of sea water is obtained by the application of heat delivered by compressed vapour inside horizontal tubes.

MSF is an important thermal desalination process. The principle of operation in MSF is based upon a series of flash chambers where stream is generated from sea water at a progressively reduced pressure. In MSF, heated water flashes inside a low-pressure chamber and the steam generated is condensed in a sequence of stages.

A detailed review on the technologies is available in the literature[1–3]. However, the scope of the present article is restricted to a comparison of LTTD technology with the RO process-based desalination.

NIOT developed and installed a commercial LTTD plant at Kavaratti islands, Lakshadweep, in response to the 'dire need' expressed by the residents. They wanted good quality of drinking water and appropriate quality of soft water for other purposes such as cattle rearing, bathing, etc. The households in the islands were not able to use the contaminated groundwater for these purposes. The islanders were particular that if a desalination process is to be adopted to source good quality water, it should not disturb the fragile marine ecosystem of coral islands. The technology so developed had to be maintenance-free or one that could be easily maintained by the unskilled labour skill set available within the islands. Earlier attempts to develop commercially viable RO-based systems had completely failed to operate under the trying conditions and for want of skilled labour in the islands. Besides, the RO-based technology was perceived by the islanders as one that could disturb the marine ecosystem in Lakshadweep. NIOT responded to the aspirations of the islanders and developed the LTTD technology and installed a lakh litre per day desalination plant in the year 2005.

In 2012, the National Council of Applied Economic Research (NCAER) was to elicit the perceptions of the islanders on the utility of such a plant in their day-to-day life. The research institution was also asked to review the technology in terms of economic cost per unit output vis-à-vis other commercially available and competing technologies and to briefly comment on how alternative technologies, including LTTD could affect the marine ecosystem and review whether this parameter is given adequate importance. This article is based on such a review of the LTTD plant at Lakshadweep. It also carries out an analysis for NIOT's proposed LTTD plant for Thoothukodi Thermal Power Station in Tamil Nadu utilizing waste heat recovered from condenser discharge.

Environmental and ecological factors to be considered in shaping technology policy

Adoption of technologies for desalination can have adverse environmental and ecological effects. For instance, adoption of certain technologies can cause considerable damage to ecology and environment in a number of ways including (i) Uncontrolled discharge of concentrated brine that can contaminate water aquifers and damage aquatic ecosystems[4]. The brine discharge may also contain pre-treatment chemicals, corrosion materials, nuclear contaminants (if attached to nuclear power plants), etc. (ii) Desalination plants use the thermal energy from an attached power plant from the waste water discharge of the condenser unit. The electrical energy used in the process of desalination emits carbon dioxide, which results in environmental pollution. Generally, the lesser the energy requirement by desalination technology, the lesser this indirect environmental impact is going to be. (iii) Desalination plants may cause noise pollution, gaseous emissions and chemical spills. In the case of discharged concentrate, total dissolved salts (TDS), temperature and specific weight (density) of the discharge are of critical importance as they result in damage to the aquatic environment. TDS discharge is directly proportional to the recovery ratio of the plant. The increased temperature can also harm the aquatic life. The increased density results in the sinking of the discharge, termed as desertification of seas, causing harm to certain parts of the ecosystem.

Ecological effects and technology options

The most important ecological impact associated with the desalination process arises due to brine discharge into the sea, which causes 'sea desertification' and 'imbalance to the marine eco-system'[5]. Brine discharge may also contain pre-treatment chemicals, corrosion materials, etc. In the case of LTTD, sea desertification is negligible, while the same from an RO plant is very high. RO has very high chemical discharge and causes eco-system disturbance, while the same is negligible in the case of LTTD, MSF and MED. As a result, the adverse impact on fishermen involved in activities such as ornamental fishing is minimal from the LTTD, MSF or MED plant vis-à-vis the RO alternative.

Technology choice – methodology outline

The choice of technology was reviewed on the basis of the composite cost of providing 1 litre of desalinated water. The composite cost was arrived at as the cumulative cost of the following:

(i) Price per litre of desalinated water that would yield a 12% IRR on investments in the desalination plant, assumed as the base cost. The test discount rate of 12% used is the social discount rate (SDR). SDR is often set as the real rate of return in economic prices on the marginal unit of (public sector) investment in its best alternative use[6]. This is the logic in assuming a SDR of 12%. A lower SDR would result in sub-optimal projects being undertaken initially, while the deserving ones are starved for funds which arrive for approval later. While a very high SDR would result in non-utilization of surplus funds.

(ii) Environmental cost per litre of desalinated water is arrived at on the basis of additional energy consumption per litre of desalinated water over the technology option with the least specific energy consumption. In the Indian context, one megawatt hour (MWh) energy consumption is assumed to imply a tonne of carbon dioxide emission. If a process involves reduction of specific energy consumption by one MWh, it is assumed to have earned one certified emission reduction (CER). For further details on this, readers can refer to the Central Electricity Authority, Website, Homepage[7].

(iii) Ecological cost per litre of desalinated water is arrived at as the change in GDP per litre of desalinated water in the 'project catchment area' due to the introduction of a particular technology. The reduction/increase in final output is arrived at by evolving an input–output table for the project catchment area along with both direct and indirect effects of the introduction of technology from the Leontief inverse table.

The composite cost was arrived as the sum of base cost, environmental cost and ecological cost per unit output of desalinated water. Economic interpretation of Leontief inverse table is briefly explained below as an understanding is crucial to estimate the ecological cost per litre of desalinated water. In a simple and refined form an input–output coefficient table, originally designed by Leontief, represents in each of its columns a technique of production.

$$AX + Y = X, \tag{1}$$

Equation (1) is the basic input–output system of equations. Matrix A is called the input–output coefficient matrix, vector X is the vector of output and vector Y is the vector of net final demand.

Mathematically, the vector of output X in the system of eq. (1) can be solved as follows:

$$X - AX = Y, \quad (I - A)X = Y, \quad X = (I - A)^{-1}Y, \tag{2}$$

where I stands for the identity matrix, which is a square matrix where all the diagonal elements are equal to one and all the other elements are equal to zero. $(I - A)^{-1}$ is the Leontief inverse which can be calculated.

The input structures represented by the A-matrix show the type and amount of various inputs each industry requires in order to produce one unit of its output, but tell nothing about indirect effects. For example, the effect of the production of a motor vehicle does not end with the steel, tyres and other components required. It generates a long chain of interactions in the production process since each of the product used as input needs to be produced and will, in turn, require various other inputs. The production of tyres, for instance, requires rubber, steel and cloth, etc. which, in turn, require various products as inputs, including the transport service provided by motor vehicles that necessitates the production of motor vehicles in the first place. One cycle of input requirement requires another cycle of inputs which, in turn, requires another cycle. This chain of interaction goes to infinity. However, the sum of all these chained reactions is determined from the value of the Leontief inverse[8].

Categories of LTTD plants developed by NIOT

NIOT has been working extensively in the field of LTTD and has established plants of various capacities. NIOT started working with LTTD applications in 2004 and established various plants. Some of successful demonstrations of LTTD technology are mentioned below.

(i) Land-based plant in Kavaratti Island, Lakshadweep, with capacity of 100 m^3/day (2005). (ii) Power plant condenser reject water-based LTTD cogeneration plant at NCTPS, Chennai with capacity of 150 m^3/day (2009), and Thoothukodi (proposed). (iii) Barge-mounted experimental plant off Chennai coast, with capacity of 1000 m^3/day (2007; currently dismantled after successful demonstration).

Scope of the present review

Here, we analyse stand-alone Kavaratti Island LTTD plant as well as the proposed Thoothukodi co-generation LTTD plant in terms of the composite cost of base cost of the process of desalination, and environmental as well as ecological cost per unit output of desalination. We also discuss the perceptions of the islanders on the impact of clean water supply to Kavaratti in the last five to six years.

LTTD process – stand-alone and co-generation units

While the ocean with its temperature variation across depth presents a scenario of two water bodies for an island-based stand-alone LTTD plant, a coast-based thermal power plant discharging huge amounts of condenser reject water into the nearby ocean represents an alternative co-generation application of LTTD process. In the technology review the former case of LTTD application, viz. a stand-alone desalination plant in Kavaratti islands was studied (Lakshadweep case study). For the latter, LTTD co-generation thermal desalination unit case study at the proposed Thoothukodi district was studied (Figures 2 and 3). The main components of the LTTD plant are the evaporation chamber, condenser, pumps and pipelines to draw warm and cold water, and a vacuum pump to maintain the plant at sub-atmospheric pressures.

Composite cost of desalinated water

(i) Price per litre of LTTD water that would yield a 12% IRR on investments: The capital cost, excluding interest

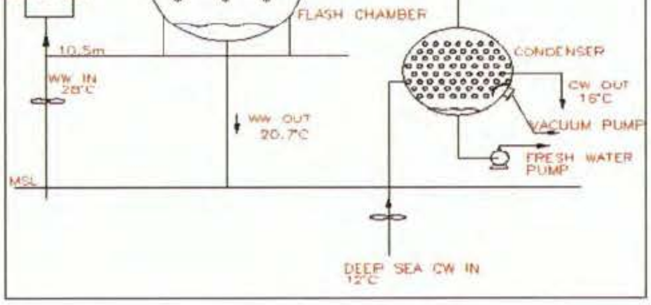

Figure 2. Schematic of LTTD process for Karavatti. WW, Warm water; CW, Cold water. Source: NIOT, Chennai.

Table 1. Price per litre of LTTD water that would yield 12% economic IRR (stand-alone case study)

Particulars	Amount (Rs)
Price per litre of LTTD water that would yield 12% economic IRR	0.75
Impact on ecology	Negligible, hence the interests of fishermen – major stakeholders in the coral islands – are protected.
Environmental impact	Higher energy requirement for operation of the plants means there is an environmental impact. This works out to 0.23 paise per litre

Source: Ref. 10.

Source: NIOT

Figure 3. A view of the installed Kavaratti desalination plant.

during construction incurred in setting up the plant was Rs 1752 lakhs, the annual operating cost, including wages, salaries, electrical energy consumption and repair and maintenance incurred is around Rs 46.83 lakhs[9]. The price per litre of LTTD water that would yield 12% economic IRR on capital investments works out to Rs 0.75 per litre (Table 1).

(ii) Environmental cost per litre of LTTD water over the best technology choice: In terms of incurring the least environmental cost per litre, the RO process stands out as a better option than the LTTD process. In terms of specific energy consumption, the LTTD plant consumes around 10 kWh of electrical energy per cubic metre (1000 l) vis-à-vis is the RO process which claims to consume only around 4.5 kWh per cubic metre. Since a reduction of 1 MWh specific energy consumption per unit output is valued at 1 CER, and as 1 CER is traded at six Euros, we can value the additional environmental cost per litre assuming that the exchange value of unit Euro at around Rs 70. The additional environmental cost works out to a negligible 0.23 paise per litre.

(iii) Ecological cost pet litre of desalinated water: Ecological cost per litre of LTTD desalinated water is negligible as it does not disturb the marine ecosystem. The RO system-based desalination could entail a huge ecological cost, even if it operates successfully as the ornamental fishing activity in coral islands would not have taken off.

Perceptions of islanders

Based on interviews with experts and field visits to desalination plants as part of the study, it was observed that LTTD was perceived as the best technology by residents of Kavaratti islands because of many interconnected factors. RO which was tried earlier was not suitable because of various reasons, such as high brine discharge and the consequent disturbance in the ecosystem affecting the livelihood of fishing households in the islands, corrosion of mechanical parts and requirement of skilled labour. The reasons behind the preference of LTTD can be summarized as follows:

- An LTTD plant uses higher energy for its operation compared to the membrane-based RO technology. In spite of this, LTTD is the preferred technology for coral islands since it is eco-friendly. This is because it does not disturb the marine ecosystem as there is no discharge of brine solution into the sea.
- LTTD does not necessitate storage of chemicals in the islands unlike RO.
- LTTD process does not require skilled labour for its operation.
- LTTD is a stand-alone technology.

Socio-economic impact of using LTTD technology

The study attempted to understand the perception of the people in the island on changes in their lives since the introduction of LTTD process. Most of the study population (93%) confirmed that there has been some change in their day-to-day lives because of using LTTD technology for desalination. The kind of changes reported by the study population range from regular access to good quality water, reduction in the prevalence of low blood pressure, better health conditions, reduction in water-borne diseases such as jaundice and diarrhoea, and reduction in hardness of water.

Standard of living

The study enquired of the people whether introduction of LTTD technology has made a change in their standard of living. More than 60% of the surveyed population also 'strongly agreed' that their standard of living has changed for the better after introduction of LTTD technology. Figure 4 presents the survey findings.

Water-borne diseases

We also attempted to understand if there was prevalence of water-borne diseases in the area before the introduction of the LTTD process. While more than half (53%) of the study population replied in the affirmative, the remaining 47% responded negatively. Dysentery (88%), typhoid (13%), amoebiasis (6%) and cholera (6%) are the common water-borne diseases reported in the survey area before the introduction of LTTD. In contrast, almost a negligible (2%) share of the study population reported that water-borne diseases are prevalent in their area even after the introduction of LTTD. Thus it can be concluded

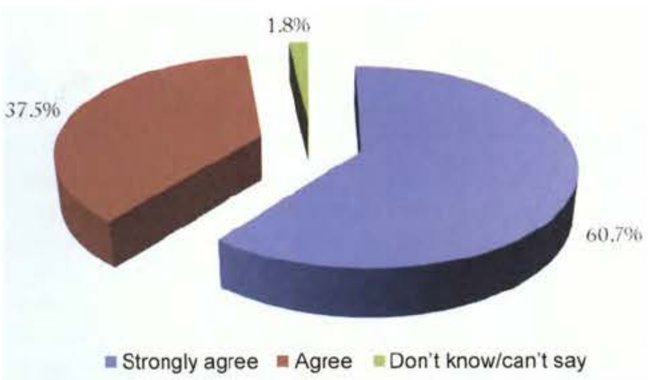

Figure 4. Perception of study population regarding changes in standard of living since introduction of LTTD in Kavaratti Island, Lakshadweep. Source: Primary Field Survey, NCAER, April 2012.

Figure 5. Thoothukodi Thermal Power Station. Source: NIOT.

that the LTTD process for desalination has impacted the people living in the surrounding areas of the desalination plant in a positive way by reducing water-borne diseases.

Healthcare treatment

As part of the survey, an effort was made to look at the availability of options for healthcare and treatment of water-borne diseases in the area before the introduction of LTTD. Most of the study population (98%) reported that the existing number of government healthcare staff was sufficient. They also reported that doctors are generally available at the government healthcare facilities.

NIOT's LTTD unit as a co-generation plant in power plants

North Chennai Thermal Power Station (NCTPS)

It can be seen from LTTD plants that a temperature difference and adequate vacuum levels should be sufficient for generation of freshwater. One aspect of LTTD is that it transfers the available heat from warmer water to colder water while generating freshwater from the warm water. This aspect could, therefore, be aptly used in thermal power plants resulting in the double benefits of cooling the reject water from the condenser and generating freshwater. A small temperature gradient of about 8–10°C, as is the case with most power plants, would be sufficient to utilize the concept. With the idea of demonstrating application of an LTTD plant in a coast-based thermal power plant, with the co-existence of warm power plant condenser rejected water and the nearby surface sea water with a gradient of about 8–10°C, NIOT set up the LTTD plant NCTPS and is in the process of setting up an LTTD co-generation unit in Thoothukodi.

Thoothukodi Thermal Power Station (TTPS)

It is situated near the new port of Thoothukodi on the sea shore of the Bay of Bengal, Tamil Nadu (Figure 5) and spread over an area of 160 ha. The units are all coal-based. Coal is transported by sea through ships from Haldia, Paradeep and Vizag ports to TTPS. Generation and plant load factor (PLF) for the year 2010–11 was 7113.696 MU and 77.33% respectively. TTPS has a total installed capacity of 1050 MW, comprising five units of 210 MW each.

Thoothukodi city is in a water-shadow area and facing severe water shortages, and the water demand is heavily increasing. The plant requires about 1.5 MLD (million litres per day) DM water with quality less than 1 ppm and 4 MLD of 100–200 ppm, in addition to domestic water for the township and plant. The water requirement for the plant is currently met from river sources, which is scarce

Table 2. Base cost of a two MLD plants in Thoothukodi (Rs in lakhs) in constant prices

Year	Capital cost excluding IDC (interest during construction)	Operating cost salaries and wages	Operating cost electricity	Repair and maintenance cost	Travel, insurance and rent	Water output in lakh litres
1	2541.6					
2	635.4	46	241	27	34	3650
Years 3 through 26		46	241	27	34	7300
Present value (Rs)	2,775.82	360.78	1,890.20	211.76	266.67	53,995.99
Price per litre (Rs) to yield 12% IRR	0.051	0.007	0.035	0.004	0.005	0.102

Price to be recovered per litre to yield 12% IRR = 10 paise. Source: Ref. 10.

in summer. Also, other potential power stations are explored for implementation of future plants. The second unit of TTPS and a few private power plants are also getting commissioned. In order to meet the demand for clear desalinated water, NIOT has proposed a desalination plant in TTPS. LTTD has proposed considering the possibility of producing high-quality water utilizing the condenser discharge.

Application of LTTD in mainland (power plant): Cost based on LTTD project in Thoothukodi

Based on the project cost and operating and financial expenses, the estimated price of desalinated water per litre from the project in Thoothukodi to yield 12% IRR is given in Table 2.

In the discounted cash flow (DCF) analyses, inflation is not factored in and the analysis is carried out on base-year prices. The analysis period is restricted to 26 years (including the gestation period) as it represents the useful life of the LTTD plant.

Ecological cost of adopting RO technology in Thoothukodi

The possible impact of the choice of RO technology for desalination on the economy of Thoothukodi district, as a whole has been analysed.

Gross district domestic product

The gross district domestic product (GDDP) for Thoothukodi district has been estimated for the year 2009–10, using the available official data on GDDP for the year 2008–09 and the gross state domestic product (GSDP) of Tamil Nadu for the years 2008–09 and 2009–10, as available from the Directorate of Economics and Statistics, Tamil Nadu.

Input–output tables

In order to assess the linkages between industries and to facilitate impact analysis of induced final demand, input–output (*I–O*) table for 2009–10 has been constructed for Thoothukodi district, based on the above GDDP estimates and the *I–O* coefficients available from the all-India *I–O* transaction tables compiled by CSO. Compilation of *I–O* table requires preparation of supply and use tables of domestic output of Thoothukodi district. Impact analysis has been carried out for the following activities.

Fishing

The total value of output of fishing activity in Thoothukodi district for the year 2009–10 at factor cost has been estimated at Rs 473.67 crores. However, at market prices, the value of output of fishing is Rs 832.24 crores. The difference between the market prices and factor cost of fish output is accounted by trade and transport (Rs 365.90 crores) and net indirect taxes (Rs 7.34 crores).

According to the information provided, if RO technology, which includes the consequent discharge of brine, is used, the fish catch would decrease by about 30% (based on telephonic interviews with experts). This implies that there would be loss of Rs 142.10 crores (30% of Rs 473.67 crores) in fish output at factor cost. Consequently, at market prices, the loss would be Rs 109.77 crores in trade and transport services (30% of Rs 365.90 crores, Rs 58.50 crores in trade activity and Rs 51.28 crores in transport activity). It is assessed that these losses will be in the final consumption of households and exports; thus the entire loss will be in final demand.

Impact on the Thoothukodi district economy if RO technology is adopted

The loss on account of adopting RO technology in Thoothukodi has been assessed at Rs 142.10 crores in fish output, Rs 58.50 crores in trade activity and Rs 51.28 crores in transport activity. This is the direct impact on the economy of Thoothukodi district and is purely on account of brine discharge following the adoption of RO technology. However, decrease in output of the district in fishing, trade and transportation will also indirectly affect

Table 3. Estimates of fall in output in Thoothukodi district due to adoption of RO technology (Rs in lakhs)

Sectors	Present estimates		Loss in output		Per cent decrease	
	Final demand	Gross output	Final demand	Gross output	Direct effect	Direct and indirect effects
Agriculture, livestock and forestry	59,111	231,680	0	–1,253	0.0	–0.5
Fishing	46,039	47,367	–14,210	–14,464	–30.0	–30.5
Mining, manufacturing, electricity, construction	539,796	1,413,453	0	–5,833	0.0	–0.4
Trade, hotels and restaurants	146,571	410,845	–5,850	–7,856	–1.4	–1.9
All other services	709,049	1,059,754	–5,128	–7,831	–0.5	–0.7
Total at factor cost	1,500,565	3,163,099	–25,187	–37,237	–0.8	–1.2

Source: Ref. 10.

Table 4. Cost of LTTD versus RO plant in Thoothukodi

Particulars	Amount (paise per litre) for LTTD	Amount (paise per litre) for RO process
Price per litre to yield 12% IRR on Thoothukodi LTTD plant investments	10	Not available
Environmental cost	0.05	0
Ecological cost	0	43 paise, if 30% catch is affected; 14 paise, if 10% catch is affected

Source: Ref. 10.

other industries due to the inter-industry linkages in the economy.

For estimating the indirect impact, the static Leontief model (based on Leontief inverse) is used. The estimated direct and indirect impacts on account of RO technology in Thoothukodi are shown in Table 3.

For Thoothukodi district as a whole, the fall in output will be 1.2% if direct and indirect effects are taken into account as a result of brine discharge if RO technology is introduced in the district. In absolute terms, the direct loss will be Rs 251.87 crore and indirect loss will be another Rs 120.50 crores, bringing the total loss to Rs 372.37 crores.

The total loss in output in Thoothukodi would be Rs 372 crores, if the traditional crafts' catch are affected due to the desertification of sea. Since traditional crafts contribute to 30% of overall catch, a reduction of catch by 30% maximum entails a staggering ecological cost, if the existing ecosystem is disturbed due to adoption of RO in Thoothukodi power plants; even a 10% reduction in traditional crafts' catch can entail a staggering ecological cost per litre as shown below.

The loss in output translates to GDDP loss of Rs 316 crore. If the district power plants set up around 20 million lpd plants to cater to power plants as well as to meet the drinking water requirements for the townships, the ecological cost per litre works out to 43 paise per litre.

The ecological cost of 14 paise per litre is enormous even if the catch is affected by a very marginal 10 per cent. The 2 million lpd LTTD plant in Thoothukodi is expected to consume around 6 kWh per cubic metre power vis-à-vis the specific consumption rate of 4.5 kWh/cubic metre of RO. This would translate into a very negligible environmental cost of around 0.05–0.06 paise per litre. Details are presented in Table 4.

In the case of Thoothukodi power projects, adoption of RO process for desalination would entail a huge ecological cost (ranging from 140% to 430% of basic processing cost), affecting the livelihood of traditional fishermen. It could range from 14 to 43 paise per litre. Thus LTTD emerges as the best alternative due to the eco-friendly nature of the technology.

Concluding remarks

Water is a unique natural resource as it is life-sustaining. The projected water requirement in India by 2025 is 973–1180 BCM, which exceeds the projected supply. Therefore, desalination of sea water for household consumption and industrial use is gaining importance as a measure to augment India's water resources. In this context, the policy for choice of desalination technology becomes quite relevant. This choice must include considerations of cost, efficiency, as well as environmental and ecological side effects of the technology.

There are two main variants of desalination technology – thermal technology (encompassing LTTD, MED and MSF) and membrane-based RO technology. The analysis reveals that LTTD technology is the way forward in coral islands, in spite of higher energy consumption vis-à-vis RO. Thermal desalination should also be the preferred technology for the coast-based power plants, iron and steel plants, and paper and pulp industry.

In the medium and small-scale category industries, including dyes and chemicals and the leather industry would call for the use of thermal desalinated water in the coastal areas and RO-based desalinated water in the interiors.

Introduction of LTTD has significantly improved the standard of living of the inhabitants of Kavaratti, according to an NCAER survey. An overwhelming 93% of respondents agreed with this assessment. They also reported that there was no discharge of chemicals that had an adverse effect on ornamental fish available as a wild variety in the coral island. Incidence of water-borne diseases has also decreased, according to the results of the same survey. Besides, this involves minimal efforts towards maintenance, often accomplished by unskilled labour. There is a case to incentivize adoption of LTTD or penalize adoption of alternative technologies.

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The carbon footprint and environmental impact assessment of desalination

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ABSTRACT

Desalination is an important means to meet water needs in many countries. The existing process is costly and energy intensive and further strains the environment with brine disposal and greenhouse gas (GHG) emissions. This paper describes several factors that are to be considered in desalination plants, such as the use of the land, the contamination of groundwater and the marine environment, the use of energy, and noise pollution. One major indirect environmental impact is the production of the energy required to run the desalination plants, particularly from burning oil, which increases GHG emissions. The carbon footprints associated with sea water desalination plants in the United Arab Emirates are assessed along with the other factors affecting human and marine life. There is no standard environmental impact assessment method, but the World Health Organization has begun work to produce one.

KEYWORDS

Desalination; pollution; United Arab Emirates; sustainable solution

Introduction

According to the Bible, the first ever desalination project was conducted by Moses at Marah in the Sinai desert. He introduced a piece of wood into bitter water, producing drinkable water. The first ever scientific report describing desalination technology of sea water was published by Thomas Jefferson, the American Secretary of State, in 1791 [1]. The instructions for the operation of technology were posted on notice boards in every ship so that it could be used in the state of emergency [1]. The mechanism was a common pot, with a wooden lid of the usual form, in the centre of which a hole was bored to receive perpendicularly a short wooden tube made with an inch and half auger. Jefferson obtained 2 quarts of fresh water an hour, and observed that the expense of fuel would be very trifling, if the still was contrived to stand on the fire along with the ship's boiler [1]. During the Second World War, hundreds of portable desalination devices were used by the armies of various countries [2]. In the early 1950s, the goal of desalination projects was to lower the price of the technology. The rising standard of living resulted in the increasing demand for water for domestic and industrial purposes, during the second half of the twentieth century [2]. Thus, clean water, a natural resource, became a precious commodity. At the beginning of the third

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millennium, there is a revolution in the desalination process. The trend to lowering the cost of the technology should lead to the supply of water of high quality at reasonable prices [2].

Figure 1 shows the common technologies for seawater desalination. They are mainly divided into thermal techniques and membrane techniques. Thermal techniques are further divided into distillation and crystallization techniques. Thermal desalination processes use energy to evaporate water and then, ultimately, condense it again. Membrane desalination is a separation program in which separation is enabled by means of phase change. A hydrophobic membrane displays the barrier for the liquid phase, allowing the water vapours to pass through the membrane pores during the vapour phase. The crystallization techniques are used to recycle both valuable salts, and pure volatile solvents from binary solution. In the crystallization process, the microporous hydrophobic membranes present at least two functions. (1) As an active interface, they promote heterogeneous nucleation; (2) as a mass transfer interface, they concentrate solution by solvent removal. Uniform crystals result in the feed tank through the fine control of the solution supersaturation and heterogeneous nucleation promotion in the membrane module. The ellipses, in Figure 1, indicate processes that are still in the research and development stage [3–5].

Efficient evaporation requires a large amount of energy and, therefore, this process is suitable only in countries where fuel is cheap. The cost of energy is the major defining factor of desalination processes [6]. The cost of energy is the total cost of installing, and operating a project. Reverse osmosis (RO) requires the least amount of thermal and electrical energy as compared to multi-effect distillation (MED), and multi-stage flash (MSF). In addition, RO has the smallest carbon footprint. For this reason, RO is becoming the preferred desalination process worldwide [6]. Figure 2 shows the general schematic of seawater desalination processes.

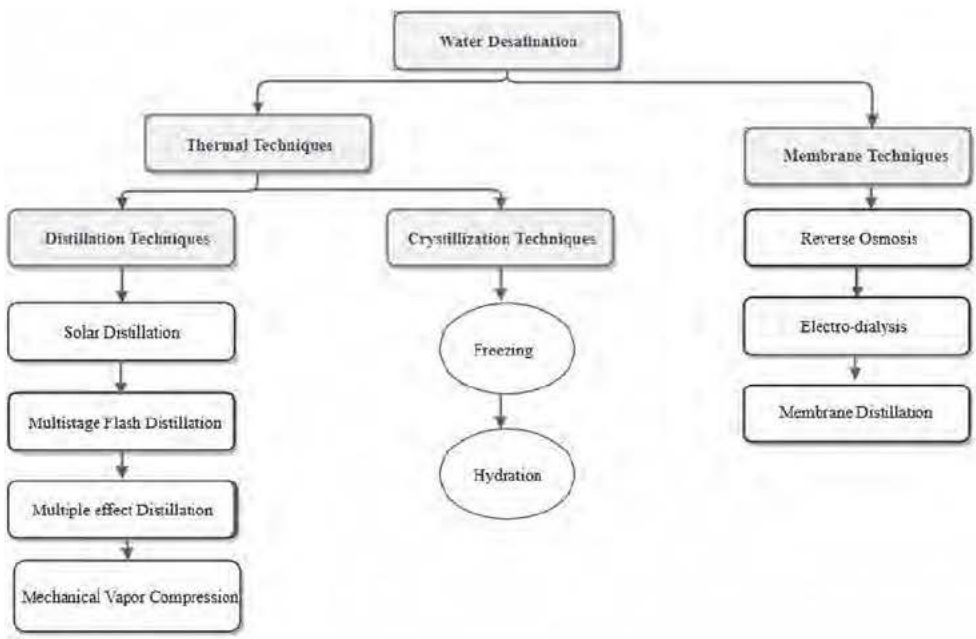

Figure 1. Processes of water desalination [4].

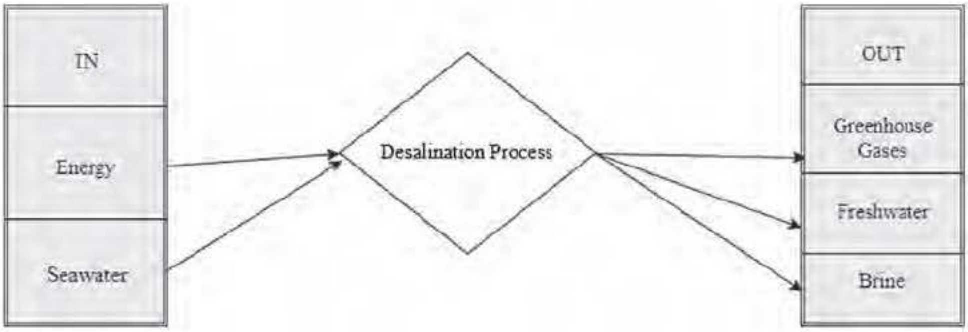

Figure 2. Schematic of seawater desalination [7].

The RO membrane technique is considered most promising for seawater desalination. RO uses dynamic pressure to overcome the osmotic pressure of the salt concentration, causing water to permeate from the saline side of a membrane to the fresh water side. Salts are rejected from the membrane. The RO membranes are semi-permeable polymeric thin layers, adhering to a thick support layer. Membranes are usually made of cellulose acetates, polyamides, and thin film composite membranes [8–12]. Figure 3 shows the schematic of an RO plant. The process takes place at ambient temperature. Electricity is required for the pumping of water to a higher pressure. The use of special turbines can reclaim part of the energy. Operating pressures vary between 10 and 25 bars for brackish water and 50–80 bars for seawater. High pressure is required to allow sufficient permeation at relatively high concentrations of the brine along the membrane axis located in the pressure vessel. Water conversion can go as high as 90–95%, in the case of light brackish water; and there is 35–50% recovery, in the case of seawater. Increased water temperature, up to a membrane limitation, also increases the flux through the membranes. The water quality depends on the membrane rejection properties, proper system design, and recovery system. Some relatively small molecules like carbon dioxide, hydrogen sulphide, boric acid, and silica may penetrate

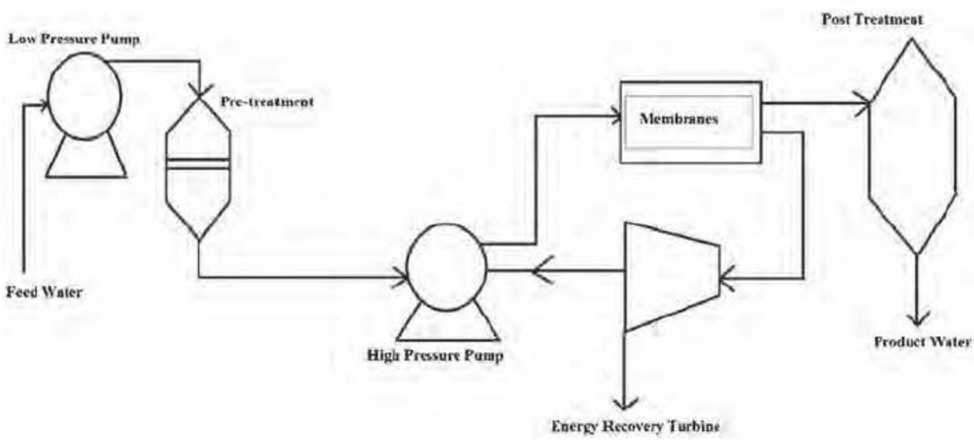

Figure 3. Schematic of reverse osmosis desalination plant [8].

and pollute the water product. These problems can be resolved by using an ion exchanger, aeration, or mixing the water to change the content and dilute concentration [10,13].

Electro-dialysis or reversible electro-dialysis is considered to be a promising technique. It forces ions to pass by means of DC electrical power through semi-permeable membranes into concentrated streams leaving behind dilute salt solutions. This happens because of the insensitivity of the membranes to fouling, and the thermodynamic transfer properties of this technique such as thermal conductivity, specific heat, and solubility [8,9].

Nano-filtration is used to remove some heavy salts from water. Ultra-filtration is the modern solution for removing bacteria and viruses from the water. Micro-filtration membranes, used to remove suspended particles, provide a barrier against Giardia, Cryptosporidium and, other viruses. Electro-dialysis reversal membranes are used to remove the special salts like nitrates from water. Some of these membranes are used for pre-treatment of polluted water before RO desalination [8,9].

In this paper, RO desalination plant will be discussed in detail as it is the most widespread technology. A brief view of adverse impacts of sea water desalination plants on human and marine life will be provided along with a case study on the carbon footprints of desalination plants in the United Arab Emirates.

Regional distribution of desalination capacities

Worldwide, the installed capacity for desalination of seawater is increasing rapidly. About two-thirds of this water is produced by thermal processes and mainly in the Middle East, whereas membrane desalination is the predominant process elsewhere [4]. Figure 4 [4] shows that 14% of all desalination plants are located in the Asia-Pacific region, 18% in the United States of America, 14% in Europe and 54% in the Middle East and North Africa.

The largest number of desalination plants can be found in the Arabian Gulf which accounts for 45% of the worldwide daily production [4]. The distribution is as follows: the United Arab Emirates (26% of the worldwide seawater desalination capacity); Saudi Arabia accounts for 23% of which 9% can be attributed to the Gulf Region and 13% to the Red Sea; Kuwait is less than 7%; the remaining countries account for 3% [4] In the Mediterranean, the total production from seawater is about 17% of the worldwide capacity. Spain has 7% of the worldwide capacity, the largest producer in the region: about 70% of the Spanish

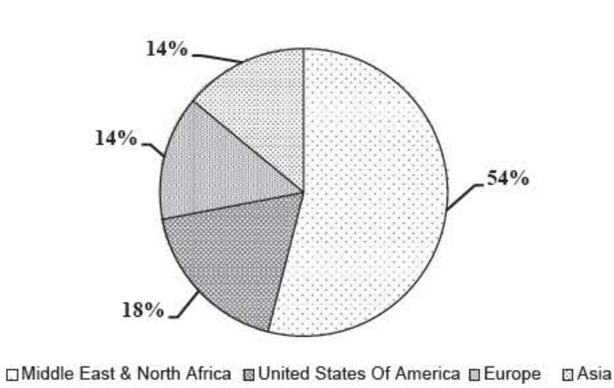

Figure 4. Worldwide regional distribution of desalination technologies [4].

desalination plants are located on the Mediterranean coast and the Balearic Islands, and the rest on the Canary Islands.

In the Gulf Region, thermal processes that include MSF and multi-effect distillation (MED) account for 90% of the production. The main process in Spain is RO with 95% of all the desalination plants [4]. In the Red Sea, the third highest concentration of desalination plants can be found, with a combined capacity of over 14% capacity of the world. The remaining 1% consists of other desalination technologies in other parts of worlds (Figure 5). Although seawater desalination is a well-established technology in this part of the world, the era of large-scale desalination projects is emerging in other parts of the world. In California, about 20 projects of seawater desalination are expected by 2030 [4].

Environmental challenges

Environmental impact assessment (EIA) is a common technique, to protect natural resources. In Spain, an EIA was established in 1986 as a basic regulation in environmental matters with Royal Decree 1302/1986 of 28th June, in agreement with European Directive 85/337 [14–16]. Further regulations were issued later, such as the Environmental Impact Assessment Decree (EIA), which includes a list of those activities where an EIA is mandatory. These include desalination projects in which capacity of seawater desalination is greater than 3000 m^3/day [14,17]. The EIA Decree is the basic regulation for Spain, as different regions have autonomous communities which are entitled to produce their own procedures, including the authority to issue their own screening and procedures. There are three such autonomous communities, including the Canary Islands, with the regional act 11/1990 of 13th July on Ecological Impact Assessment. Desalination plants over 5000 m^3/day of water production are listed within the projects requiring an Ecological Impact Detailed Assessment [14,16].

Although desalination offers a range of benefits, concerns are still raised because of potential negative impacts as shown in Table 1 [18]; mainly in regard to the concentrate and chemical discharges, which may impair coastal water quality, affect marine life, and

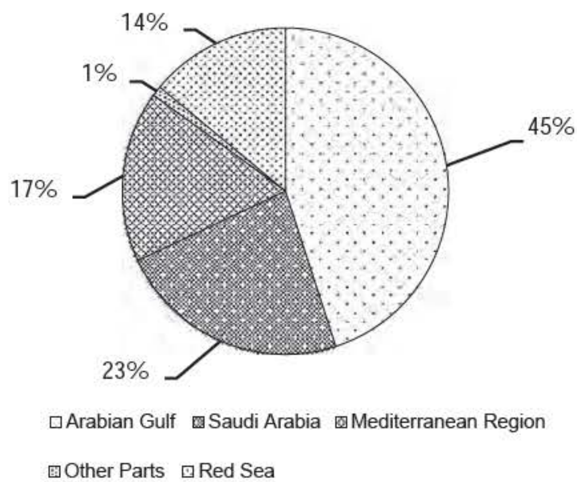

Figure 5. Distribution of desalination plants, based on Xevgenos et al. [4].

Table 1. Potential negative impacts of desalination.

Sr#.	Environmental impacts of desalination
1	Impact on the marine environment
2	Intensified use of energy
3	Impact on groundwater
4	Noise pollution
5	The use of land

pollute the air. The environmental impact on marine life is significant enough to require a comprehensive environmental evaluation of all major desalination plants [19].

The use of land

The environmental value of land varies with its use, and depends also on the population density and on public awareness. In many places, this value is negligible, but in others with limited seashores, where tourism and conservation of nature are competing, e.g. the State of Israel, the value may be high. The total area required for a seawater desalination plant (including holding ponds and pumps) is approximately 25 acres [2]. Such a plant can produce 100 million m^3 of water per year [2]. The development of the coast of Israel provides for only limited areas for heavy industry, and no building is allowed within 100 m from the shoreline [2]. One solution to minimise the use of coastal land is locating the plants farther inland but this introduces the challenge of using pipes for transporting large amounts of seawater and brine; with an increased risk of polluting the aquifer through leakage [2]. Placing the desalination plants adjacent to areas with operating infrastructure can minimize this impact.

Impact on groundwater

Pipes of seawater that are laid over an aquifer could leak and permit brackish water to enter the aquifer. This has the added risk of accentuating the problems of Palestinians, since they maintain that Israel has taken their water resources [20]. The coastal aquifer of Israel lies below most of the cities as it extends along the Mediterranean shores for the desalination plant. This necessitates the proper sealing of pipes and the installation of detectors, which stop the pumping in case of a malfunction. The ideal site for a plant is an area where the probability of harm to the aquifer is very low [2].

Desalination plants can have a negative impact on groundwater in several ways. As mentioned, seawater or brine can leak from pipelines, resulting in penetrating groundwater aquifers. The construction process (drilling, or installation of pumps) can also pollute groundwater. Finally, it is possible for a poorly designed sub-surface intake to cause intrusion of saltwater into freshwater aquifers.

Noise pollution

RO plants are noisy. Most of the noise is produced by the high-pressure pumps and the functioning of turbines for energy restoration [21]. Therefore, noise abatement measures must be effective in any plant near to a population centre. Noise pollution can be decreased by building canopies over the pumps and appropriate acoustical planning of the plant.

Intensified use of energy

The intensified use of energy by a desalination plant results in a direct impact on the environment since the energy requirements of the plant increase with the production of electricity, the burning of fuels and, in turn, boost the process of global warming. The amount of energy required to desalinate 1 m^3 of brackish water varies with the plant and technology [2].

For MSF plants, 1 m^3 of water produced requires 12 kWh of thermal energy and 3.5 kWh of electrical energy, which has a maximum operating temperature of 120 °C [22]. These figures are lower for MED plants which operate at lower temperatures (<70 °C) and require 6 kWh of thermal and 1.5 kWh of electrical energy per cubic metre [22]. RO plants require 4–7 kWh/m^3 of thermal energy and 1–2 kWh/m^3 of electrical energy depending on the size of the plant and energy recovery systems installed (Table 2). To illustrate these figures, it can be estimated that a middle-sized RO plant having a capacity of 24,000 m^3/day and an energy demand of 5 kWh/m^3 including thermal, and electrical energy requires about 125,000 kWh/day [22]. The plant can supply 48,000 four-person households with water while the energy required for this desalination plant could supply about 10,300 four-person households with electricity. Environmental concerns associated with the intensified use of energy are the emission of air pollutants and cooling waters from the electrical power generation, the fuel source, and transportation of fuel [22].

Impact on the marine environment

The marine environment is adversely affected by desalination plants because of the positioning of the feed pipes and the brine discharge pipes. The initial impact during laying of the pipes is temporary but even this temporary effect can be substantial, especially in rocky habitats and coral reefs. The main impact is from the discharge of the brine to the sea, and its magnitude depends on the environmental and hydrogeological factors characteristic of the sea such as bathymetry, waves, currents, and depth of the water column. These factors determine the extent of the mixing of brine with seawater [23].

Hopner and Windelberg divide the global marine habitats into 15 categories according to their sensitivities to water desalination plants [23]. Table 3 shows that the shores of the ocean are the sites most suitable for the construction of desalination plants. The most sensitive regions are mangrove flats.

Table 2. Specifications of different desalination technologies [22].

Factors associated with desalination technologies	Multi-stage flash desalination	Multi-effect desalination	Reverse osmosis
Temperature (°C)	120	<70	<50
Thermal energy (kWh/m^3)	12	6	4–7
Electrical energy (kWh/m^3)	3.5	1.5	1–2

Table 3. Top 15 most sensitive marine habitats to desalination plants based on Hoepner and Windelberg [23].

1	Mangal (Mangrove flats)
2	Salt marsh
3	Coral reefs
4	Seaweed bays and shallow
5	Algal mats
6	Shallow low energy bay and semi enclosed lagoon
7	Fjords
8	Sabkhas
9	Low energy sand, mud and beach rocks flats
10	Estuaries and estuary similar
11	High energy soft tidal cost
12	Coastal upwelling
13	Mature shoreline (Sediment mobility)
14	Exposed rocky coast
15	High energy oceanic coasts, rocky or sandy, with coastal parallel current

Composition of the discharge brines

In all desalination plants, the concentration of the discharge brine is higher than that of natural seawater. The salt concentration of the brine is usually double that of the seawater [2]. In addition to a higher salt concentration, discharge brine also contains chemicals used in the pre-treatment stage of desalination. The amount and type of chemicals used depend on the chosen technology and quality of water needed. Anti-scaling materials, surfactants, and acids used for lowering the pH of water are usually the chemicals found in the discharged brine. The salts returned to the sea are identical to the ones already present but higher in concentration. In RO desalination plants, the discharge concentration is 30–70% more than the original seawater; in MSF plants, it is usually 10–15%; for MED plants, it is 7–12% [2]. The chemicals used in the pre-treatment of water are usually as below [3,22,24,25].

- NaOCl or free chlorine, used for chlorination and prevention of biological growth.
- H_2SO_4 or HCl, used for pH adjustment.
- $FeCl_3$ or $AlCl_3$, used for the flocculation and removal of suspended matter from the water.
- Sodium hexametaphosphate $(NaPO_3)_6$ and similar materials prevent scale formation on the pipes and on the membranes.
- $NaHSO_3$ used to neutralise any remains of chlorine from the water.

All these materials are approved by the United States Environmental Protection Agency and most of them are used in drinking water systems. Chemicals dissolved in seawater contribute similar ions to those already present. For example, sulphuric acid increases the concentration of the SO_4 ions to 3020–3050 mg/l [2,24–27]. Cleaning of membranes is conducted 3–4 times a year. The used chemicals and detergents – for removal of carbonate deposits, such as citric acid and sodium polyphosphate – are weak. The rinse water is kept in a titration container and after titration and neutralisation of cleaning materials, it is disposed of either to an authorised salt disposal site, or by the continuous flow of small quantities together with the brine back to sea. The high dilution rate of fifty to one million ensures a very low concentration of the rinsing materials in the discharged brine. Table 4 shows the flow of feed water and discharged brine in a desalination plant, Table 5 shows the number of chemicals used for the treatment of brackish water and their doses.

Table 4. Properties of feed seawater and discharged brine based on Zfaty [3].

Properties	Feed seawater	Discharged brine and rinsed water
Hourly flow (m^3)	13,000	6,750
Concentration of salts (mg/l)	40,500	77,920
Total amount of salt (t/h)	526	526

Table 5. Chemicals and their amount used in pretreatment stage based on Chandrashekara and Yadav [3].

Chemicals	Doses (mg/l)	Flow (kg/h)	Daily amount (t)	Accumulated volume (m^3)
Sodium hypochlorite	6	80	1.9	120
Sulphuric acid (98%)	30	390	9.4	100
SHMP (Scale remover)	6	80	1.9	120
Iron chloride	4	50	1.2	120
Sodium bisulphate	4	50	1.2	120

Table 6. Cleaning and rinsing of the membrane based on Zfaty [3].

Cleaning substances	Yearly amount (t)	Storage volume (m^3)
Citric acid	70	30
EDTA	30	10
Sodium tripolyphophate	50	20

Table 6 shows the cleaning substances used to clean the membranes of a desalination plant in Ashkelon, Israel [3,28].

Salinity and temperature

Salinity and temperature are two controlling factors for the distribution of marine species. Marine species usually dwell in favourable environmental conditions. Most organisms can adapt to minor deviations from optimal salinity and temperature conditions, and might even tolerate extreme situations temporarily but they cannot tolerate unfavourable conditions for long [9]. The continuous discharge of reject streams with high salinity and temperature can be fatal for marine life and, can cause a permanent change in species composition. Marine organisms can either be attracted or repelled by new environmental conditions and those that are adaptive will prevail in the discharge site. Owing to the different densities, RO and thermal desalination plants affect different realms of the sea. The concentrate of RO, which has a higher density than seawater, will spread over the sea floor in coastal waters unless it is dissipated by a diffuser system. In contrast, the rejected streams of the desalination plants coupled with the power plant cooling water are typically positively or neutrally buoyant and will affect open water organisms [9].

Calculation of the carbon footprint for desalination plant in United Arab Emirates

For a water desalination project, the carbon footprint calculation methods used for the four energy consumption stages are as below [29–31].

Material production (concrete, steel, etc.)

$$\mathrm{CF_m} = \Sigma\beta_i \times C_i \tag{1}$$

where $\mathrm{CF_m}$ represents the carbon emission of the material productions, β_i is the emission factor for the production of material and C_i is the consumption of the construction materials [15].

Material transportation

$$\mathrm{CF_i} = \Sigma\beta_d\sigma_d \times \frac{S_i}{v} \times \frac{Q_i}{L} \tag{2}$$

where $\mathrm{CF_i}$ represents the carbon emission of the material transportation, σ_d is the amount of diesel consumed by one truck per hour, β_d is the emission factor for the burning of diesel fuel, Q_i represents the transported quantities of the material, L is the capacity of one truck, S_i is the transported distance, v is the speed of the truck [29,31].

Construction (earth, filling, excavation, etc.)

$$\mathrm{CF_c} = \Sigma(\beta_d C_{di} + \beta_e C_{ei}) \tag{3}$$

where $\mathrm{CF_c}$ represents the carbon emissions of construction, C_{di} is the consumption of diesel in the construction project, C_{ei} is the consumption of electricity in the construction project, β_e is the emission factor of electricity.

Carbon emissions during the construction period are apportioned according to the operation period. Assuming the operation period is σ years and the annual transportation of water amounts to Q_w, the carbon footprint $\mathrm{CF_{w1}}$ of water resources during the construction period can be calculated by the following formula [29–31].

$$\mathrm{CF_{w1}} = \frac{\mathrm{CF_m} + \mathrm{CF_i} + \mathrm{CF_c}}{\sigma \times Q_w} \tag{4}$$

Operation and maintenance

The operation stage includes the carbon emissions $\mathrm{CF_o}$ from the consumption of electricity, while the maintenance stage mainly includes the carbon emissions $\mathrm{CF_{ma}}$ from the replacement and repair of materials and equipment [29,30]. The carbon footprint $\mathrm{CF_{w2}}$ of water desalination in the operation and maintenance period is calculated as.

$$\mathrm{CF_{w2}} = \frac{\mathrm{CF_o} + \mathrm{CF_{ma}}}{Q_w} \tag{5}$$

The carbon footprint $\mathrm{CF_w}$ of the water desalination project is then calculated as.

$$\mathrm{CF_w} = \mathrm{CF_{w1}} + \mathrm{CF_{w2}} \tag{6}$$

The impacts of desalination plant energy consumption on the environment are highest during the operational stage compared to the construction and other stages [16]. The UAE uses three different techniques for water desalination: RO method, the MSF method, and the multiple effect distillation (MED) method. The different techniques have different energy consumption rates [16], as shown in Table 7.

During the production of one cubic metre of freshwater, the carbon footprint of UAE desalination plants was estimated to be 2.7 kg CO_2 for the MSF method, 1.2 CO_2 for the MED method, and 2.3 kg for the RO method.

The carbon footprints of the desalination plant construction stage were mainly the result of the energy and raw material consumption during the equipment manufacturing process. These activities include the manufacturing of centrifugal pumps, and other special pumps, RO membranes, evaporators, and condensing systems [21]. According to the data for a desalination plant [29], the carbon footprint for the construction period was estimated to be 10% of the operation stage, as shown in Table 8.

Therefore, the total carbon footprints of UAE plants were estimated to be 3.0 kg CO_2 for the MSF method, 1.3 kg CO_2 for the MED method, and 2.5 kg of CO_2 for the RO method [16,21].

Technology improvements for the future

RO has advanced greatly in all respects: in new construction and pipe materials, membranes including RO and ultra-filtration pre-treatment membranes, efficient pumps, electric motors and anti-scalants [32–34]. With all the latest components such as large diameter high rejection membranes (including boron and bromide), the carbon footprint of desalination will be reduced. Desalination will become the least environmentally intrusive water sources in semi-arid regions such as Spain, China, California, and Australia [34–36]. The use of ultra-filtration membranes to pre-treat seawater may also result in returning chemical free backwash to the ocean along with the seawater concentrate. This may be feasible if ultra-filtration eliminates the use of coagulants and other chemicals. New technologies such as forward osmosis (reverse-RO, entropy recovery-osmotic power) may also become commercially viable [36,37]. Osmotic power uses two sources of different salinity of water or liquid (seawater RO concentrate and waste water) in combination with a semi-permeable membrane, an energy recovery device (isobaric based), a booster pump and a Pelton impulse turbine in one instance or directly via the SWRO plant. By using this equipment and the osmotic pressure that exists between these two liquids, energy can be recovered. This new process has already been patented and prototypes have been constructed. Other patents supporting an energy recovery device directly have also been issued [38–40].

Table 7. Specification of water desalination plants in United Arab Emirates, based on Ref. [29].

Water desalination techniques	Capacity (m^3/d)	Thermal energy (kWh/m^3)	Electricity (kWh/m^3)	Total emissions (tCO_2/d)	Carbon footprint (kg CO_2)
RO plant	6.3×10^5	7.0	3.0	1.4×10^3	2.3
MED plant	6.2×10^5	6.0	1.5	7.3×10^2	1.2
MSF plant	5.1×10^6	12	3.5	1.4×10^4	2.7

Table 8. Total carbon footprints of desalination plants in United Arab Emirates based on Liu et al. [29].

Water desalination techniques	Carbon footprint of operation stage (kg CO_2)	Carbon footprint of construction (kg CO_2)	Total carbon footprint (kg CO_2)
RO plants	2.3	0.2	2.5
MED plants	1.2	0.1	1.3
MSF plants	2.7	0.3	3.0

Outlook

The process of desalination is about to become more widespread. The environmental impact of any technology must always be considered. The main purpose of desalination is to offset present or future deficits in potable water, by producing water of good quality at a reasonable price [33,36]. The quality and amount of desalinated water produced highlight several additional environmental advantages. The added environmental advantages of desalination are:

- Improvement to the quality of water available by adding desalinated water that is free of pollutants, carcinogenic materials, organic materials as well as offending colour, taste, and odour.
- The advantages to the average household of softening the water include the prevention of clogged pipes, improved laundry and dishwashing efficiencies, and the prevention of scale formation in boilers and kettles [33,36]. The advantages to industry include saving on water softening expenses, and reduced costs for anti-scalant materials. The softening of water also reduces the use of detergents, which in turn, improves the quality of sewage water.

At present, a standard EIA procedure for evaluating a desalination project is not available. The existing general concept of EIAs should thus be used with reference material and a methodological approach that is specific to the desalination plant. This should include essential data on all relevant impacts of the desalination activity, and a framework for conducting monitoring activities in order to evaluate the environmental impacts of seawater desalination. The World Health Organization (WHO) has initiated a project and five technical work groups for the preparation of a guidance document on desalination for safe water quality [33,36]. The technical work groups addressed a broad range of issues, including technological, health, nutritional, microbiological, sanitary and environmental impacts relative to desalination plants. The eventual result should, be an EIA with the authority of WHO behind it, which can be applied to any EIA study for desalination plants.

Disclosure statement

No potential conflict of interest was reported by the authors.

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EXHIBIT 18

Health effects caused by noise: Evidence in the literature from the past 25 years

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Health Effects caused by Noise: Evidence in the Literature from the Past 25 Years

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Traffic noise is the most important source of environmental annoyance. According to the Environmental Expert Council of Germany, severe annoyance persistent over prolonged periods of time is to be regarded as causing distress. Previously, extraaural noise effects were mostly assessed using a paradigm in which the sound level played the major role. On the basis of this paradigm the relatively low sound level of environmental noise was not considered to be a potential danger to health. In contrast to this numerous empirical results have shown long-term noise-induced health risks. Therefore a radical change of attitude - a change of paradigm - is necessary. For an immediate triggering of protective reactions (fight/flight or defeat reactions) the information conveyed by noise is very often more relevant than the sound level. It was shown recently that the first and fastest signal detection is mediated by a subcortical area - the amygdala. For this reason even during sleep the noise from aeroplanes or heavy goods vehicles may be categorised as danger signals and induce the release of stress hormones. In accordance with the noise stress hypothesis chronic stress hormone dysregulations as well as increases of established endogenous risk factors of ischaemic heart diseases have been observed under long-term environmental noise exposure. Therefore, an increased risk of myocardial infarction is to be expected. The results of individual studies on this subject in most cases do not reach statistical significance. However, according to the Environmental Expert Council, these studies show a consistent trend towards an increased cardiovascular risk if the daytime immission level exceeds 65 dB(A). Most of the previous studies on the extraaural effects of occupational noise have been invalidated by exposure misclassifications. In future studies on health effects of noise a correct exposure assessment is one of the most important preconditions.

Keywords: Noise, environmental, occupational, annoyance, stress hormones, cardiovascular risk.

Introduction

The Federal Immission Protection Act (Bundes-Immissionsschutzgesetz) specifies adverse environmental noise effects on the general public or in specific neighbourhoods as

- hazards, such as health risks,
- substantial losses, e.g. in property values,
- substantial disturbances.

Acute noise events which do not cause permanent health impairments are considered as non-substantial. However, effects of long term noise exposure, which do not habituate but increase the long-term risk of physical damage, are assessed as health hazards.

The issue of personal losses in terms of material assets will not be considered in this paper.

Most questionnaires used to evaluate the degree of individual noise disturbances, offer a scale of answers ranging from “not disturbed at all” to “very much disturbed”. To meet the criterion of substantial disturbance only such persons are included who classify themselves in the intermediate range or higher. Table 1 depicts mean noise levels L_{den} (reference time period: 24 h, with supplementary malusses of 5 dB and 10 dB added to evening and night time level respectively) at which 20% of the interviewed persons felt significantly or very much disturbed.

Table 1. Relationship between traffic noise levels and disturbance for different types of traffic noise

20% of interviewed persons: noise source:	(substantially) significantly disturbed at L_{den}	very much disturbed at L_{den}
aircraft flight noise	51 dB(A)	61 dB(A)
road traffic noise	57 dB(A)	65 dB(A)
rail noise	63 dB(A)	78 dB(A)

The data are taken from a recent meta-analysis (Miedema and Vos, 1998) of studies on the dose-response relationship between various types of traffic noise and their disturbing effects. It is clearly shown that at identical noise levels the disturbance by aircraft noise is greater than that by rail or road traffic noise.

Paradigms of occupational and environmental noise effects

The legal basis on noise protection at the workplace (cf. Regulations on the Prevention of Accidents, 1990) contain regulations both about preventive medical measures and the right to claim damage compensation. Because these two cases require different levels of evidence for noise-induced health impairments, they may briefly be discussed at this point. With regard to damage compensation, clear evidence is required of a causative connection between defined noise exposure and the postulated health impairment. In the case of preventive health protection, however, any reasonable assumption of a possible health hazard justifies protective measures. From the point of view of preventive medicine the quality of the evidence connecting noise exposure and health hazards is usually classified in one of three categories:

- sufficient
- limited
- inadequate

Up to now, the only noise induced occupational disease acknowledged with sufficient evidence is noise induced hearing loss.

According to ISO 1999, occupational noise induced hearing damage does not occur below immission levels of L_{eq} = 80 dB(A) with reference to 40 working hours per week. Higher exposure will increase the risk of permanent hearing threshold shifts – also for listeners to loud music. An analogy is observed between noise-induced hearing impairment and the damaging effects of exogenous toxic substances. The effects of toxins and of loud noise on the hearing capacity is proportional to the total amount absorbed and to the total sound energy immitted respectively. For all extraaural noise effects no analogy is found to toxic substances.

The majority of studies on extraaural work noise effects were based upon the paradigms of aural noise effects and have erroneously used persons with noise exposure below 85 dB(A) as “non-exposed” control groups. Additionally, ear protection - which is normally only partly used - was rarely taken into account. This has lead to severely underestimated noise effects resulting from exposure misclassifications of up to 30 dB and bereaving such studies of any relevant contribution to the question of work noise-induced extraaural health impairments. Therefore the conclusions being drawn from these studies are false (Babisch, 1998). There are only a few studies, in which such incorrect methods were avoided. These studies, however, have revealed a significant increase in cardiovascular diseases as well as increased mortality rates following long-term work noise exposure (Zhao et al.1991; Ising et al. 1999; Melamed et al. 1999).

There is a major need, therefore, to abolish such paradigmatic errors of the past, and not to draw misleading conclusions from earlier methodically incorrect occupational noise studies.

Table 2. Review of recent studies on the relationship between traffic noise disturbance and increases in stress hormones.

+ : significant increase; = : no change; ø : not measured

First author	Year	Noise type (test nights/yrs) n	acute/ chronic noise	L_{eq}[dB(A)] (L_{max})	Test persons n	Recor-dings n	Adrenaline	Nor-adrenaline	free cortisol
Maschke	1992	Flight noise 8 nights	acute	**29-55** (55-75)	8	64	+	=	ø
Maschke	1995	Flight noise (8 nights)	acute	**29-45** (55-65)	28	224	+	=	+
Evans	1998	Flight noise (1.5 years)	chronic	**53/62 ***	217	217	+	+	ø ***
Harder	1999	Flight noise (40 nights)	acute + chronic	**42** (65)	15	600	=	=	+
Ising	1999	Flight noise (1-3 x 10s)	acute	(90-100) *	68	272	=	=	=
Carter	1994	Road noise (2 nights)	acute	**32** (65-72)	9	18	=	=	ø
Babisch	1996	Road noise (years)	chronic	**45-75***	200	200	=	+	ø
Braun	1999	Road noise (years / 2 nights)	acute + chronic	**<45/ 53-69 ***	26	152	=	+	+
Evans	2001	Road noise (years)	chronic	**46/ 62 * L_{dn}*******	115	115	=	=	+
Ising	2001	Road noise (years)	chronic	L_{max}:30/42 (at night)	56	56	ø	ø	+ **

* outside level ** 1st half of night *** only total cortisol measured **** day and night level

On the other hand, Jansen and Notbohm (1994) have come to the conclusion that the risk of cardiovascular disease can scarcely be increased by traffic noise, *since the noise effect research has failed to provide unambiguous findings in spite of essentially higher noise exposure*. Even more extraordinary is the assessment quoted by the above authors, based solely on the noise level, as “healthy / indifferent / unhealthy or disturbing / substantially disturbing / hazardous”. Moderator variables such as situative factors are not taken into account.

Their model, which led to this overestimation of the noise level, is valid only for direct noise effects such as hearing damage.

extraaural noise effects i.e. physiological, psychological and mental, are believed to be in analogy with aural noise effects. The authors argue as follows: *The lower the sound intensity measured the greater is the variation in the reactions observed in terms of individual and situational influences, with the result that any scientific statements on extraaural noise effects are subject to considerable limitations.*

The first part of this statement is correct, but the conclusive part seems rather preposterous. It is true that in laboratory tests with very high sound levels these are closely correlated with the noise effects, but they yield no information on the effects of environmental noise. In the sound level range of environmental noises, the moderators play a decisive part (Deutsche Forschungsgemeinschaft, 1974). Therefore, environmental noise effects must be analyzed using adequate methods.

Environmental noise effects cannot be extrapolated from short-term laboratory findings, as has been shown in a study: “Stress reactions and health hazards induced by traffic noise exposure, comparison of methods between field and laboratory trials” (Ising, 1983). Several hours of exposure to road noise under field conditions at level L_m = 60 dB(A) caused greater blood pressure reactions in self-estimated noise sensitive persons than in those who were noise insensitive. Short-term sound exposure in the laboratory with intermittent noise at L =100 dB(A) showed opposite results. No correlation between blood pressure reactions under field conditions with hours of exposure and laboratory studies with a duration of several minutes could be established.

This shows that results of short-term laboratory tests cannot be used as a model of long-term effects caused by environmental noise exposure. Therefore, the dose-response diagram in Table 1 is not apt to be used as a basis for assessing environmental noise effects. As a consequence, such paradigmatic errors of the past ought to be recognized as such and be eliminated.

Serious mistakes were also made when establishing limiting levels for environmental noise immission (Maschke et al. 2001a,b). This was a result of inadequate interdisciplinary cooperation. A prerogative of any competent future studies in the area of noise effect research should therefore consist of requesting and planning a close cooperation between the physico-technical, the socio-psychological and medical as well as the epidemiological disciplines. Positive examples today are the interdisciplinary working group " Problems of Noise Effects" of the Federal Environmental Agency (UBA) and among the larger research projects the flight noise study of the German Research Association (Deutsche Forschungsgemeinschaft, 1974) as well as the studies on the health effects of military low-flight noise conducted on behalf of the UBA (Curio and Ising 1986, Ising et al. 1991) and the Caerphilly-Speedwell cardiovascular studies (Babisch et al. 1999).

Psycho-social noise effects

A major result of the DFG-Study was the finding that noise disturbances can only be predicted to a maximum of one third by acoustic measures such as noise level, exposure time, frequency range etc. Non-acoustical variables, such as situative and individual moderators, exert a considerable influence on noise processing while remaining unchanged under noise exposures (Guski 2001).

Evidence of disturbances resulting from environmental noise has been designated as definitely sufficient and assigned an initial threshold L_{dn} = 42dB(A) (outside) in the "Noise and Health" report of the Health Council of the Netherlands (1994). Jansen and Notbohm quote L_m = 45–55 dB(A) as the range of the threshold for reactions by the population (based on a disturbed contingent between 0 and 20%) (Jansen and Notbohm, 1994). Ortscheid and Wende (2000), in their assessment of flight noise based on currently available literature, come to the conclusion that the boundary to substantial disturbance is reached with a flight noise of 55 dB(A) in the daytime and 45 dB(A) at night (outside).

In their report the two types of noise effects "disturbance" and "health impairment" play a central part in their objective to develop protective measures. In its special assessment "Environment and Health", the panel of experts for environmental questions (1999) adopted the following viewpoint on questions of disturbance by environmental noise: *In Western Europe the trend has become apparent that the number of citizens suffering from serious disturbance is decreasing, but those subject to less serious disturbance is increasing. The main source of disturbance is road traffic noise. In the "old" Lands of the Federal Republic 68% of the population are disturbed, in the "new" Lands the rate is 83%. Approximately 50% of the population are disturbed by flight noise and 20% each by rail and industrial noise. Under constant noise exposure the degree of disturbance remains unchanged. There are no indications as to people habituating to noise. If the disturbance persists over longer periods of time this strain is to be classified as negative stress (distress).*

Noise-induced sleep disturbances and endocrine reactions

In the past an arousal reaction was considered as being the only relevant health effect of nocturnal noise. In the above mentioned expertise "Environment and Health" it is quoted, however: According to (Maschke, 1998), merely considering the arousal reaction does not take into account either the derangement of the physiological sleep *structure, nor the interference with the normal sequence of the sleep stages and the detrimental effects of compensation.*

Although there is no proof yet as to whether and to what extent prolonged noise exposure with ensuing sleep disorders will cause health detriments as described by Maschke, the Environmental Council give their opinion as follows: *From our point of view it cannot be excluded that the observed sleep disturbances may adversely influence health and performance capacity in the long term.*

Therefore for reasons of medical prevention it is necessary principally to avoid noise-induced impairments even when below the arousal threshold.

Acute and chronic stress hormone increases during sleep have been measured even at relatively low sound levels. In a prospective interventional study on children, Evans et al. (1998) found significant increases in adrenaline and noradrenaline excretion after a new airport had been opened. Total cortisol showed a tendential increase, but free cortisol was not measured.

In a field survey on persons living in the neighbourhood of the Berlin Tegel Airport, using recorded simulated night flight noise, an increased adrenaline excretion was measured after the first two test nights. In comparison, an increase in cortisol excretion was found after the third and fourth test nights. As few as 16 overflights at maximum levels of 55 dB(A) – the mean level during test nights being 30 dB(A) – induced significant stress hormone increases and a distinctly deteriorated subjective sleep quality (Maschke et al., 1995). In this study, however, the question on the influence of habituation to night-flight noise remained unanswered.

Harder et al. (1999), therefore, measured free cortisol excretions during three test nights without noise exposure and 37 test nights with simulated flight noise played-back into the bedrooms via loudspeakers. The mean values in the test group showed an acute increase in cortisol excretion only after flight noise test nights two and three. In the following, the mean cortisol excretion values went back to normal, merely superimposed by slight alterations in a seven day rhythm. The most impressive result was a significant increase in cortisol excretion with values above the normal range during the last two weeks under night flight conditions (Maschke et al., 2002). This study has shown that long-term nocturnal noise exposures may lead, in persons liable to be stressed by noise, to permanently increased cortisol concentrations above the normal range.

As part of a survey on “Traffic and health in densely populated Berlin areas” the catecholamine excretion of 200 women was measured (Babisch et al. 1996). Women whose bedrooms were orientated towards streets with rather high noise levels (mean levels at night L_m > 57 dB(A) (outside)) showed significantly increased excretion values of catecholamines compared to those of women living in relatively quiet homes (L_m < 52 dB(A). The results remained stable after controlling covariables (smoking, alcohol, social status etc.).

Additionally, stress hormone excretions were measured in test persons who lived in noisy streets and were asked to leave their bedroom windows open in order to further increase the noise level. These test persons had for several years been exposed to nocturnal mean traffic noise levels between 53 and 69 dB(A) (outside). Acute noise level increases of 9 to 18 dB(A) through leaving the windows open, resulted in a mean increase of free cortisol excretion by one third. A comparison with a control group living in quieter surroundings (L_m < 45 dB(A) showed that the noradrenaline and cortisol excretions in the heavy traffic noise group was higher in concentration even when their windows were kept closed. This finding gives evidence of persistent stress hormone increases as a result of long years of nocturnal noise exposure (Braun, 1999).

Evans et al. (2001) examined children exposed to moderate road traffic noises (outside daytime level L_m > 60 dB(A)). Their night-time urine contained increased concentrations of free cortisol and cortisol metabolites compared to those of children living in quieter areas (outside daytime level < 50 dB(A)), whereas no differences in catecholamines were observed.

Also, in a study on children with high traffic noise exposures day and night, mainly caused by heavy goods vehicles (Ising H. and Ising M., 2002), a significant increase in excretion of free cortisol and cortisol metabolites was found in the first half of the night, but not in the second half. A comparison of these findings to those of children living in quieter surroundings clearly illustrates an interference of nocturnal noise exposure with the spontaneous circadian rhythm of normal cortisol release.

A review of recent studies on the relationship between traffic noise levels and stress hormone increases is given in Table 2. In only two out of ten studies no stress hormone increases under traffic noise conditions were found. Among five flight noise studies only one (Ising et al. 1999) failed to find stress hormone increases, the reason being that in this case noise exposures were too short in duration and incidences only rare. These were caused by occasional overflights of military aircraft in the late evening hours. The negative results of a road traffic noise study (Carter et al. 1994) has been caused by a methodological error, as stress hormone concentrations were presented rather than hormone excretions or concentrations related to creatinine.

It should be added, however, that - although mostly stress hormone increases were observed - in some rare cases decreased excretions of stress hormones were found under nocturnal noise conditions, (Ising und Braun 2000, Harder et al. 1999).

The Health Council of the Netherlands (1994) classified the evidence of biochemical noise effects as limited. Yet, the results of the presented studies demonstrate that noise exposures over time periods of years may induce, in a certain percentage of exposed persons, permanent changes of the stress hormone regulation, along with possible consequences in terms of functional and organic damages. A decisive factor in the assessment of noise-induced health effects are persistent stress

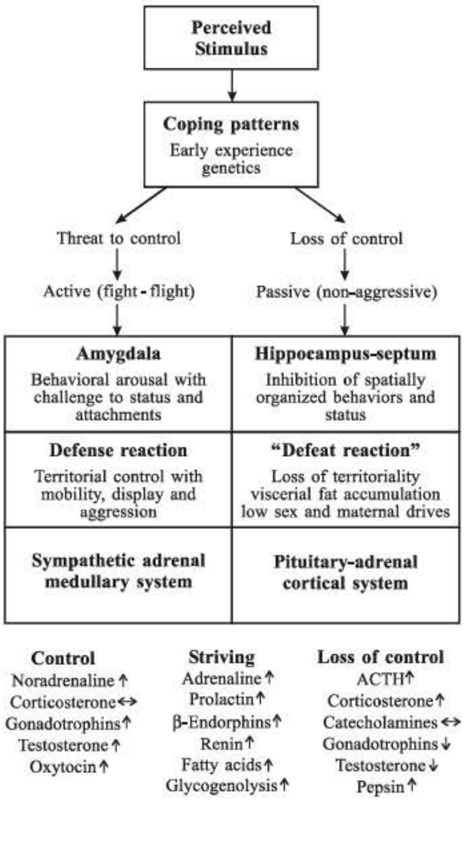

Figure 1. Psychophysiological stress model according to Henry (1992)

"Defens reaction is activated when organism is challenged but remains in control. With loss of control there is activation of the hypothalamopituitary adrenal axis, and the gonadotrophic species preservative system shuts down. Viseral fat accumulates with a Cushingoid distribution, and there is a shift from active defense to a passive nonaggressive coping style." (Henry, 1992).

reactions. Up till now, the majority of studies investigating noise stress effects were based on measurements of the catecholamines adrenaline and noradrenaline and of cortisol.

In terms of the psycho-physiological stress model of Henry (1992), displayed in Figure 1, these stress hormones may be viewed as “guiding substances” for the identification of stress reaction types described there. An increase in cortisol for example shows activation of the hypothalamus, pituitary and adrenal cortex system (HPA system). The consequences of long term activation of the HPA system, may among other things, be insulin resistance, stress-ulcers and cardiovascular diseases.

Environmental noise and cardiovascular risk

The hypothesis of an increased risk of cardiovascular diseases is derived from the stress concepts (Selye 1956, Henry 1992, Björntorp 1997). As shown above, noise exposure may lead to acute and chronic changes of the physiological stress hormone regulation. The different types of stress reactions may lead to derangement of normal neuro-vegetative and hormonal processes and exert an adverse influence on the equilibrium of vital body functions. These include cardiovascular parameters such as blood pressure, cardiac function, serum cholesterol, triglycerides, and free fatty acids, hemostatic factors (fibrinogen) impeding the blood flow in terms of increased plasma viscosity (Friedman and Rosenman 1975), and presumably blood sugar concentration as well. Pathological changes of these parameters may be caused by a variety of endogenous and exogenous factors representing the classical risk factors of cardiovascular diseases. In this context, disturbing noise as well as stress inducing noise at night time is to be classified as an exogenous risk factor in the development of

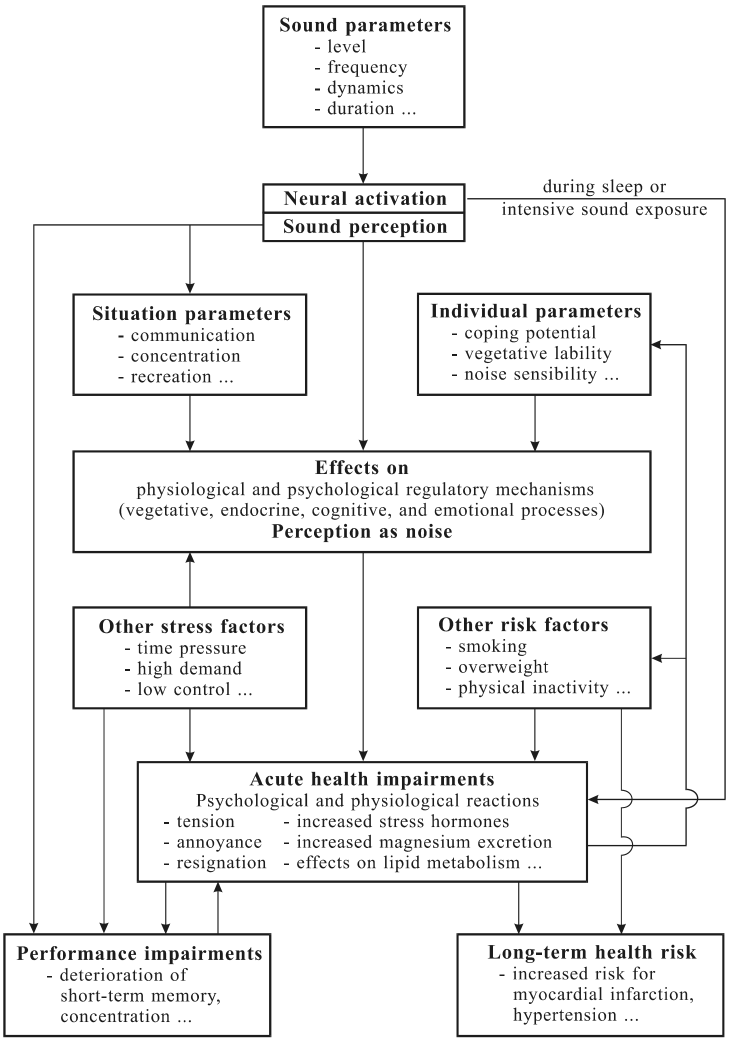

Figure 2. Model of noise perception and psychophysiological effects of noise, risk factors and cardiovascular diseases.

atheriosclerosis, hypertension, ischemic heart disease and myocardial infarction (VDI-Richtlinie 3722, 1988; Babisch 2001; 2002).

Maschke et al (2003) assessed the traffic noise exposure at day and night time separately and found a dose dependent and significant increas of lifetime prevalence of hypertension in persons with $L_{eq\ night}$ > 50 dB(A) but not with daytime noise exposure.

In Figure 2, these effects are depicted in a diagram. Sound or noise immissions are processed via central pathways and activate the neuro-endocrinological systems either by inducing direct effects as in the case of work noise, or in the case of relatively low environmental noise levels or during sleep, through instant signal processing in the amygdala which is itself linked with cortical, limbic and hypothalamic centres (Spreng 2000) – or inducing indirect stress effects like disturbances of communication and concentration.

Concerning noise and cardiovascular risk the expertise “Health and Environment” states as follows: Noise, when acting as a stress factor, may enhance the pathogenesis of several health disorders. This is the case with cardiovascular diseases.

The long-term consequences of noise induced increase of stress hormones have to be investigated in epidemiological studies. Studies on the relationship between road traffic noise and coronary heart diseases are briefly described with the following conclusion:. ... “*The studies presented are lacking in test power on account of too few cases in groups with higher noise exposure; the results are statistically insignificant ...*
Nevertheless, the Environmental Council is of the opinion that the results show a consistent trend. The threshold level for possible noise-induced risk of myocardial infarction has been established at a daytime immission level of 65 dB(A).”
With mean road traffic noise exposure levels of more than 55 / 65 dB(A) (daytime / night time) (outside), however, an increase in the risk of myocardial infarction by 20% is to be expected.
According to the evaluation of the Health Council of the Netherlands (1994), evidence of an increased risk of cardiovascular disease induced by traffic noise exposures above L_m = 70 dB(A) is considered as being sufficient.

The concurring tendencies and the basic consistency of the traffic noise studies known so far yield sufficient scientific reasons for preventive protection measures to be taken against noise-induced risk increases of cardiovascular disease.

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SPECIAL REPORT

The Permitting of Desalination Facilities: A Sustainability Perspective

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Abstract **Desalination provides a partial solution to water scarcity. While the desalination process provides much needed water to coastal areas, it also has various environmental impacts. Older operations entrain and impinge large and small organisms during the collection process, use significant amounts of energy, and produce substantial volumes of waste brine. These short- and long-term impacts warrant the involvement of environmental health practitioners.**

Sustainable water supplies depend on more than just the weather. Accordingly, we start by analyzing the rising global demand for drinking water and the ongoing deterioration of the oceans. Next, we detail known impacts of desalination, and discuss alternatives for addressing water scarcity. We challenge environmental health practitioners to help meet current and future drinking water needs with respect to environmental sustainability. The ocean is finite. We should ask the right questions so as not to consume it at an untenable pace.

Introduction

In the midst of a drought, public opinion in California focuses yet again on a search for new supplies of drinking water. An option frequently mentioned in the popular media is the technology of desalination (Rogers, 2014). A common argument is that we have a virtually unlimited water supply from the ocean—the technology for desalination is available, the need is clear, and therefore we should proceed with building the treatment plants. Time and technology advance rapidly, and we can now deploy mobile desalination vehicles around the world for small-scale water emergencies (see photo on page 29).

Drought conditions extend well beyond the borders of California, creating environmental challenges in various parts of the globe. Many parts of the world struggle with water scarcity issues (Briffa, van der Schrier, & Jones, 2009), and these trends have emerged over extended periods of time (Rogers, 2014).

The World Health Organization (WHO) recognizes multiple impacts from desalination (WHO, 2007). Thoughtful decision makers must evaluate desalination against all available alternatives for drinking water, and the technology may be more applicable in some areas than others. Stakeholders must consider conservation measures and financial sustainability in addition to site-specific environmental issues.

The environmental health profession adapts as new conditions evolve. Historically, our role focused on short-term, human health concerns, especially from contamination by pathogens. With increasing knowledge of chemical toxicity, our role expanded to regional approaches that address contaminated aquifers. Today's issues of population growth, food supply, and energy production require attention to the physical availability of sustainable water sources. Many aspects of current drinking water regulations focus on short-term impacts, but future generations will depend on our decisions today for the sustainable use of common pool resources.

Environmental health practitioners face a number of issues associated with desalination. For example, a joint effort of the City of Santa Cruz Water Department and the Soquel Creek Water District reveals a complex system of public health concerns and related permits for the construction and operation of a single desalination plant (The City of Santa Cruz Water Department and Soquel Creek Water District, 2015). At the state level, policy makers in California are also addressing the issues of desalination and formulating new rules (California Environmental Protection Agency, 2015). The long-term viability of desalination decisions on both coasts requires an understanding of short- and long-term consequences.

We start by analyzing the rising global demand for drinking water and then examine the ongoing deterioration of the oceans. We detail the known impacts of desalination, and discuss a range of alternatives for drinking water supplies. With an understanding of the interconnectedness of desalination and environmental health, we argue that the profession has an obligation to be more involved in the decision-making process. With a better understanding of desalination operations and their impacts, our profession should ask

Portable desalination vehicle. Reprinted with permission from G.A.L. Water Technologies Ltd.

the necessary questions before consuming this finite resource.

Rising Global Demand for Drinking Water

Water consumption data indicate that heavily populated countries consume great amounts of water. The three most populous countries—India, China, and the U.S.—are the world leaders in freshwater withdrawals (World Bank, 2015). Existing data also indicate that drinking water consumption per capita varies significantly across continents. For example, residential drinking water consumption in the water-strapped nation of Australia was as low as 42 gallons per person per day (Melbourne Water, 2014), while U.S. estimates were significantly greater at 80 to 100 gallons per person per day (U.S. Geological Survey, 2015). The numbers suggest that countries such as the U.S. should look at a combination of consumer behaviors and emerging technologies as ways of ensuring water security for future generations.

Worldwide droughts drive the need for new sources of drinking water. Data from Europe indicate a trend of increasing drought conditions over multiple years (Briffa et al., 2009). In the U.S., approximately 29 states maintain areas with drought conditions. The conditions are noticeably elevated in the western, southwestern, and southern coastal states (National Drought Mitigation Center, 2015). The growing influence of droughts requires adjustments to consumer behavior and drinking water infrastructure. Consumption habits, drought conditions, and growing populations accelerate water scarcity concerns. Ironically, many people in drought areas live next to large bodies of water.

Millions of people live, work, and recreate in coastal areas. In 2001, more than half of the world's population lived within 124 miles of a coastline (United Nations, 2016). Population values of U.S. cities along the coast indicate a similar trend. In the last decade, coastal areas included 5 of the 10 most populous cities and 7 of the 10 most populous counties (Wilson & Fischetti, 2010).

Historically, groundwater and surface water provided drinking water to large coastal populations even in the presence of access to seawater. As pressure on historic water resources increases, desalination becomes a more attractive option. Desalination, however, requires that we manage the oceans—the ultimate common pool resource—with respect to environmental values, commercial resources, and social benefits for future generations.

Degradation of the Oceans

Stakeholders need to consider desalination in the context of other environmental impacts. The current and future consequences on ocean ecosystems occur in addition to existing impacts from other sources. The geospatial distribution of existing desalination plants can be useful in understanding site-specific effects and potential concerns (Dimitriou, Angeliki, Vasiliki, Maria, & Christina, 2014).

Environmental health practitioners recognize the variety of point and nonpoint discharges to oceans from stormwater flows, aquaculture, oil spills, and sewage outfalls (Sindermann, 1995). Regulators often respond to these issues as localized, independent events with short-term effects. These discharges can lead to beach closures or other short-term, visible impacts. One need only recall the recent BP oil spill in the Gulf of Mexico, however, to recognize the longer term consequences to wildlife and beach areas. Furthermore, research continues to assess the impact of plastic waste in coastal zones (Baztan et al., 2014).

The ocean acts as a global carbon dioxide sink. In this role, it is subject to acidification from increased atmospheric levels of carbon dioxide. Data indicate that despite the high alkalinity and tremendous mass of the ocean, the average pH of the ocean surface has dropped from 8.2 to 8.08 in the last 50 years (Schnoor, 2013). These observations refute the notion that the ocean is an infinite and resilient resource. Such a shift requires further attention. Meanwhile, research continues on the long-term combined impacts of acidification and changes in salinity (Durack, 2015). The combination of site-specific and global impacts from desalination underscores the importance of detailing a list of recognized impacts.

Known Impacts From Desalination

Desalination presents negative impacts on ecological elements of ocean systems. Fortunately, the application of lessons learned from management of freshwater resources can mitigate some of these impacts. Currently, permitting processes in the U.S. address some concerns by requiring environmental impact assessments that identify and mitigate environmental health issues over time (WHO, 2007).

Specifically, desalination causes biological impacts in the form of entrainment and impingement (National Research Council, 2008). Entrainment occurs when intake pipes pull small aquatic organisms such as plankton, fish eggs, and larvae into a desalination plant. Organisms die off when subjected to high temperatures or high-pressure elements in the system. Impingement refers to trapping of fish or other larger organisms against water intake screens, which can cause injury and death. We can mitigate these impacts by installing underground collection pipes at the bottom of the ocean, which adds to the cost of installation and maintenance.

Furthermore, evidence from desalination activity in the Mediterranean region indicates negative impacts to sea grass in the presence of elevated salinity (Laspidou, Hadjibiros, & Gialis, 2010). Additional studies and monitoring may provide a deeper understanding of impacts from desalination. Agencies should provide coastal stakeholders with information on these various impacts in readily available, easy-to-read formats.

Desalination consumes significant amounts of energy, and older technologies are likely to use fossil fuels (Gude, Nirmalakhandan, & Deng, 2011), which can produce air pollution and negative health consequences. Flash processes rely on the heat of distillation to separate the salt and water, while membrane technologies require energy to move masses of water across a membrane. Ongoing research continues to evaluate the use of renewable energy sources such as solar, wind, and geothermal technology to support desalination (Ghaffour et al., 2014). An increased use of renewable power to support desalination can reduce air pollution and the associated health impacts.

Liquid discharges from desalination produce brine. Therefore, agencies must consider changes in salinity to receiving waters during plant permitting and operation. Historical work by the U.S. Department of the Interior's Office of Saline Water in the early 1970s identified and addressed concerns related to brine disposal (Rinne, 1971). Their work focused on brine discharge characteristics such as pH, metals, and chemical contaminants. The concluding recommendations suggested copious amounts of dilution and dispersion.

Increased salinity from desalination facilities may also contribute to hypoxia in the bottom layers of a bay (Hodges et al., 2011). In the current regulatory landscape, disposal regulations continue to incorporate dilution, dispersion, and mixing zones to reduce brine toxicity with respect to ecological sensitivity (Ahmad & Baddour, 2013). It is not entirely clear as to how long this strategy might be effective, nor is it entirely clear how ecological changes may have secondary impacts on environmental health.

Brine disposal continues to be problematic and costly for existing coastal or inland plants. Expenditures related to brine disposal can vary from 5% to 33% of total desalination costs (Abdul-Wahab & Jupp, 2009). The time and energy required to move brine off site drives disposal costs in an upward direction (Laspidou et al., 2010). Agriculture and aquaculture can provide some financial relief as limited alternatives for brine disposal. For example, brine solutions can irrigate almond, olive, and pistachio crops (Abdul-Wahab & Jupp, 2009). This could be significant in California, where almonds occupied 935,804 farming acres in 2012 (U.S. Department of Agriculture, 2012). Currently, the almond industry endures criticism for growing a product with a relatively high water footprint that equates to one gallon of water per almond (Mekonnen & Hoekstra, 2010). Further research will also increase our understanding of the impacts from agricultural applications on groundwater contamination and stormwater runoff.

Research indicates that waste brine byproducts in liquid, solid, and slurry states maintain potential commercial value (Hajbi, Hammi, & M'nif, 2010). Specifically, salt from desalination is a useful component in road base, in the manufacture of dust suppressants, and in the production of hypochlorites (Abdul-Wahab & Jupp, 2009). Alternatively, aquaculture has various uses for brine that are already commercially valid. For example, tilapia and spirulina grow in waters with high alkalinity and salinity (Mohamed, Maraqa, &Al Handhaly, 2005). Alternatively, if land is available, then entrepreneurs could collect and manage the waste brine in solar ponds. Solar ponds hold thermal energy, transfer it to water, and ultimately generate commercial heat, steam, or electricity (Abdul-Wahab & Jupp, 2009).

Desalination is actually a variety of technologies. For example, among thermal technologies there are at least five alternatives (Shatat & Riffat, 2012): multistage flash distillation, multiple-effect distillation, vapor-compression evaporation, cogeneration, and solar water desalination.

Site-specific conditions are likely to dictate the use of each application. Distillation methods that rely on the combustion of carbon-based fuels are likely to be present in areas such as oil-rich nations in the Middle East. Alternatively, cogeneration is more feasible for desalination when an adjacent operation has significant amounts of discharge heat. Furthermore, solar-powered processes or those that rely on forms of renewable energy have the potential to reduce harmful air emissions associated with fossil fuel consumption.

Alternatives

Environmental health practitioners can play a role in educating the public about well-known alternatives to desalination. For example, water management techniques such as rainwater harvesting and arid landscaping can lower consumption rates of existing sources. When communities bypass such fundamental approaches in favor of desalination, they ignore the advantages of proven techniques. Desalination consumes volumes of ocean water, while conservation minimizes the consumption of ocean and fresh water resources.

Other alternatives to desalination include drip irrigation practices for agriculture and improved water recycling within various industries. While the benefits of these practices are not always immediately evident to the average consumer, they could account for significant reductions across the country.

Administrative changes to drinking water pricing may influence consumption habits in some settings. The general public may not be aware that existing pricing for water does not reflect the true costs of the water—this fact has been known for a long time (Capen, 1939) and continues today with calls for water rights and free markets (Bailey, 2015).

Tiered pricing programs might provide an incentive to curb water consumption, while increasing the feasibility of other technologies. For example, as drinking water prices rise, treated wastewater becomes a more cost-effective technique for recharging existing groundwater sources. The feasibility of this approach increases with improvements in technology and policy learning across jurisdictions.

Alternatives are not limited to new technology, but can also be explored in the different applications of existing technologies. For example, desalination could be restricted to industrial uses only. In such applications, the quality of the distilled water need not be the quality of drinking water, but the industrial use of seawater would reduce resource pressure on freshwater sources.

Finally, technologies continue to improve. Given the evolving nature of technology, price structures, and water availability, the question as to the appropriate role of the environmental health practitioner arises.

Discussion

Environmental health practitioners can play a significant role in the future of desalination. Their actions should align with social, financial, and environmental aspects of sustainability. Social sustainability derives strength from transparent, democratic practices, while the complexities of environmental sustainability require simplification. Financial sustainability in regional settings requires analysis and attention to cost and ability of ratepayers to absorb such burdens. Going forward, environmental health practitioners should

- participate in the public process by speaking at public hearings or providing input during public comment periods.
- share credible desalination information or educational resources with various stakeholders such as other governmental agencies, the private sector, and nonprofit organizations and community groups.
- anticipate local consequences and call for offsets, compensation, or design modifications during the design and permitting of desalination facilities.

The impacts of consuming vast quantities of seawater are not clear. Therefore, does the ocean need a global water rights system for protection? Such a water rights system could be similar to that for existing freshwater sources. Despite its enormous size, the evidence accumulates on the insults to this vast ecosystem. In the face of this growing evidence, can we afford to continue testing the assimilative capacity of the ocean?

Until now, this finite resource tolerated human impacts and degradation. In decades prior, we did not fully understand the correlation between rising carbon dioxide emissions and ocean acidification. Going forward, environmental health practitioners maintain a critical role in monitoring ocean water consumption and the impacts of desalination. Ultimately, significant desalination decisions should support the existence of future generations.

Solutions to our water supply in general, and more specifically to the permitting of facilities, will inevitably require a multifaceted approach with special attention to three issues:

1. Conservation of existing water resources through changes in behavior or technology.
2. Efficient and effective use of drinking water with alternative grades of water for industrial activities.
3. Long-term financial viability that supports sanitary practices and sustainable economic activity.

It is thus imperative that environmental health practitioners look at all methods of responsible water use. Oceans provide local foods, support recreation, and absorb carbon dioxide emissions. Furthermore, coastal states maintain some of the largest cities in the world. This dynamic context prompts us to ask: Have coastal regions exhausted the alternatives to seawater consumption? That is, have these regions exhausted conservation practices, rainwater harvesting, and administrative techniques such as tiered pricing? The evidence overwhelmingly points against such exhaustion. Similarly, if industrial activity or agribusiness are the big water users, then what have they done in the interest of managing sustainable water supplies for future generations?

These provocative questions require answers. It is not our intent to point fingers at a few critical players. Our larger concern is that environmental health practitioners find a place in the desalination dialog. Moreover, the principles of sustainability and the long-term viability of the ocean as a drinking water resource deserve ongoing evaluation. Consumptive approaches like desalination reduce resource availability over time, while conservation measures reduce pressures on a given resource. In the areas of water, food, and energy, sustainable approaches might derive new strategies to meet the needs of future generations.

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Article

Minimizing the Environmental Impact of Sea Brine Disposal by Coupling Desalination Plants with Solar Saltworks: A Case Study for Greece

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Abstract: The explosive increase in world population, along with the fast socio-economic development, have led to an increased water demand, making water shortage one of the greatest problems of modern society. Countries such as Greece, Saudi Arabia and Tunisia face serious water shortage issues and have resorted to solutions such as transporting water by ships from the mainland to islands, a practice that is expensive, energy-intensive and unsustainable. Desalination of sea-water is suitable for supplying arid regions with potable water, but extensive brine discharge may affect marine biota. To avoid this impact, we explore the option of directing the desalination effluent to a solar saltworks for brine concentration and salt production, in order to achieve a zero discharge desalination plant. In this context, we conducted a survey in order to evaluate the potential of transferring desalination brine to solar saltworks, so that its disposal to the sea is avoided. Our analysis showed that brine transfer by trucks is prohibitively expensive. In order to make the zero discharge desalination plant economically feasible, efforts should be directed into developing a more efficient technology that will result in the production of only a fraction of the brine that is produced from our systems today.

Keywords: solar saltworks; desalination plants; sea brine disposal; GIS tools

1. Introduction

1.1. The Water Shortage Problem in Greece

Several countries such as Greece, Saudi Arabia and Tunisia face serious water shortage issues today [1]. Increased water demand due to economic growth, irrigation needs, declining precipitation levels and over-abstraction of groundwater are all factors that create fresh water shortage problems; these factors appear even more intense in many regions of Greece and specifically in the Aegean Archipelago islands [2]. Particularly during the summer period, the population of the islands may be up to five-times more than the winter, thus resulting in severe water shortage problems. This is true due to the following reasons:

- In some islands of the South Aegean and the Cyclades, the average annual precipitation is less than half the corresponding value for mainland Greece, which is approximately 700 mm.
- During the summer months, most islands experience a heavy seasonal rise in population due to tourism, a higher water demand due to increased temperatures and very limited precipitation that amounts to about 7% of their total annual rainfall.
- Most Greek islands and other arid coastal areas have a particularly bold relief with steep slopes, hills and mountains and little forest or green coverage. As a result, surface flows move with great momentum in a torrent-like fashion, cannot be withheld by vegetation—as it is very limited—and cascade their way down to the sea, with only a small percentage of that flow recharging groundwater and aquifers.
- Aquifers are usually small and connected to the sea. Intense groundwater pumping to cover fresh water shortage in the islands results in the drop of the water level, which is followed by the influx of seawater, making groundwater brackish and essentially destroying the aquifer.

On the other hand, it is clear that the development and the quality of life in the arid coastal regions of Greece with tourist development depend mainly on the sufficiency of water resources [3]. Water resources are quite limited, thus restraining the economic development of local societies. To face increased potable water requirements, more than 1,000,000 m^3 of clean water are transported annually to these areas at a cost sometimes approaching the value of eight € per m^3 [4]. Even if one ignores the high price of transporting water by ships, it is also energy-intensive, thus unsustainable in the long term. On the other hand, wind- or solar-powered desalination plants are suitable for providing desalinated water to communities where renewable energy sources such as wind or solar radiation abounds, as is the case in the Greek islands [5], or other areas in the Mediterranean with similar characteristics [6]. However, in many cases, the construction of desalination infrastructure projects is avoided, because of social reactions surrounding the potential environmental impacts of desalination plants. Thus, water continues to be transported by ships. The cost is very high and burdens the State, while at the same time, the local communities suffer from the consequences of the unreliability of water transport.

This paper attempts to show how important proper design of operations is and how current practices need considerable improvement in order to overcome the negative environmental impacts of desalination plants, thus making desalination the number one choice for feasible and environmentally friendly water production in the arid regions of the Mediterranean.

1.2. The Environmental Impacts of Desalination Plants and Mitigation Strategies

Recently, there has been a lot of discussion in the literature on the environmental impact of desalination plants, especially for those in Spain, since the Water National Plan of the country included desalination as one of the technologies for supplying water for human consumption, tourist uses, as well as agricultural or industrial consumption [7]. European legislation makes an Environmental Impact Assessment (EIA) mandatory for desalination plants producing over 5,000 m^3 of water per day.

Environmental impacts of desalination plants include the indirect impact of creating an increased demand for electricity production. Fossil fuel-powered desalination plants have environmental effects related to the emission of greenhouse gases or other pollutants associated with power generation [8]. This negative impact could be overcome if renewable energy sources (RESs), such as wind turbines, solar panels, geothermal energy, photovoltaic units, hydrodynamic energy, *etc*., are used instead of fossil fuels. Luckily, wind and solar energy are usually abundant in the coastal Mediterranean areas [4]. Plants that rely exclusively on RESs have already been built and currently operate successfully in Greece.

Desalination plants directly impact the marine environment by returning the relatively high temperature concentrated brine to the sea. Einav *et al*. [9] indicated that the extent of vulnerability of the marine environment to salinity differs from place to place. It is measured by the nature of the marine habitat (coral reef, rocky beach or sandy surfaces) and by the origin of the surrounding organisms. Although data that document the effects of the hyper-saline desalination plant effluents are very scarce, it is now clearly documented that, especially in the Mediterranean region, the Posidonia seagrass (*Posidonia oceanica,* endemic plant in the Mediterranean sea) habitat is very sensitive to high salinities derived from brine discharge [6,10,11]. If desalination brine were not disposed of to the sea at all, this impact could be eliminated.

Another impact on the marine environment is realized when different products used in chemical cleaning of membranes and pretreatment cleaning are disposed of in the sea. These products are all contained in the desalination brine; therefore, potential negative impacts from disposing of the brine in the sea are avoided if the brine is collected and transported to saltworks. Naturally, if the salt produced is directed for human consumption, appropriate measures should be taken.

Noise pollution around the desalination plants is also an important issue [12]. High pressure pumps and energy recovery systems, such as turbines, produce significant level of noise—in some cases over 90 dB. Aside from that, the adverse effect on land use cannot be underestimated, as these plants are located on coastal areas that may have tourist interest. Recently, a floating autonomous environmentally friendly and efficient desalination unit was developed by researchers of the Aegean University and currently operates in the Aegean Sea [13]**.** These small plants not only rely on RES to function, but have the added advantage of not being located on the coast, but floating further out at sea; this way the impact related to noise pollution and adverse effect of land use could be overcome.

The idea of constructing a zero effluent desalination plant has been suggested before [12]. In this paper, we evaluate the option of transporting the brine from desalination plants to saltworks, thus operating existing desalination plants with zero effluent. To our knowledge, the possibility of coupling desalination plants and solar saltworks in order to produce a zero discharge desalination plant, and at the same time, possibly produce a useful product, salt, has not been suggested before. Through our empirical analysis, we explore different transportation routes and collect data on the cost of brine transportation, so as to assess the feasibility of this coupling. We finish our analysis with conclusions and recommendations on how the desalination process should be improved and made more efficient and environmentally friendly with minimal environmental impacts.

2. Materials and Methods

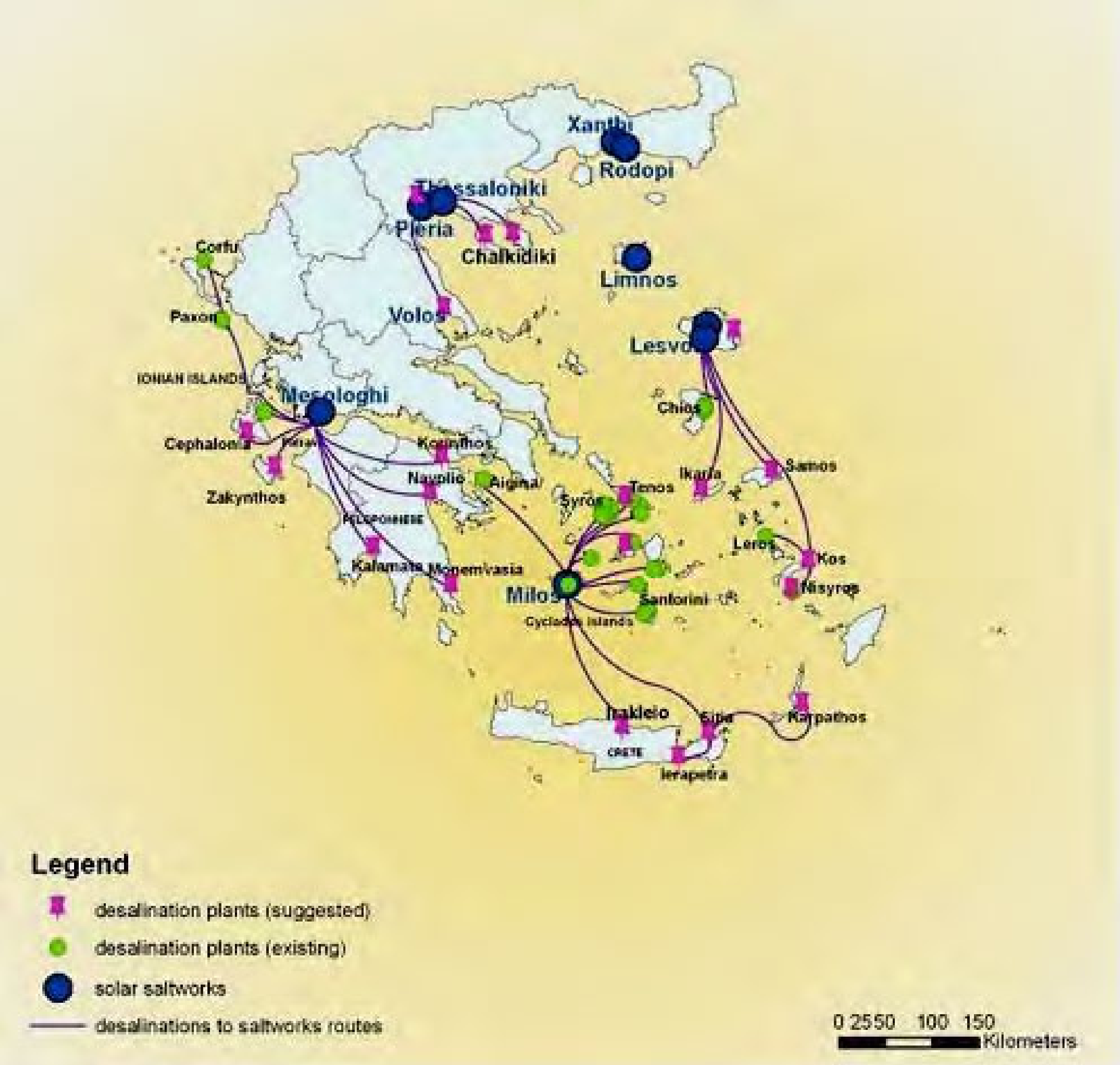
In order to assess the possibility of transferring brine produced by desalination plants to solar saltworks to produce salt, we collected data regarding the locations of both desalination plants and solar saltworks in Greece [14]. Solar saltworks, both natural and artificial, have existed in Greece for a very long time and are important wetland ecosystems [15,16]. There are currently 34 reverse osmosis desalination plants in Greece (Table 1 [17]). We prepared a list of potential locations where new desalination plants could be built. Ideal candidates for such locations are relatively large coastal urban centers in Greece that face water shortage issues today and are expected to face a more serious problem in the future due to population increase, tourism, or lack of high-quality potable water resources (or a combination of all of these) [18]. Our initial assessment for choosing such locations was confirmed after consulting with several local officials on the needs and current and future water resource deficits of the coastal urban centers under investigation. In our effort to couple desalination plants with solar saltworks minimizing brine transportation costs from the former to the latter, we imported locations of existing and suggested desalination plants and solar saltworks in Greece into a Geographic Information System (GIS). Mapping the data in a GIS facilitated our analysis relevant to plant and saltworks locations, their respective distance from each other, their proximity to ports or major land transportation routes, and different modes of transportation that need to be used in order to couple them. The solar saltworks (blue circles) and the desalination plants (green circles) that operate in Greece are mapped in Figure 1, as well as the desalination units that we suggest to have constructed (pins). In Figure 1, we also show the suggested routes that could be followed for the transport of brine from each desalination plant (origin) to the closest, or most easily accessible saltworks unit (destination). Some routes that connect island units are serviced solely by ships, while others are covered by a combination of ship and truck transfer. The origin-destination pairs and corresponding modes of transportation for each pair are listed in Table 2.

The locations of desalination plants and solar saltworks are dispersed around the country in such a way that plant-saltwork pairs and connecting routes seem to emerge naturally and make the use of a linear programming model (or a similar optimization model) that would calculate the minimum distance between pairs unnecessary. Thus, all Cyclades islands and Crete plants connect with the Milos saltworks, all Dodecanese islands connect with Lesvos, all Peloponese and Ionian islands plants connect with Mesologhi, and all other northern plants connect with saltworks in Thessaloniki. Whenever there was debate regarding which saltworks a desalination plant should pair with, other factors like transportation schedules made the final decision. For example, one may argue that the Monemvasia plant in the south-eastern Peloponese should pair with Milos based on their physical distance; however, there is no year-around ship service to connect the two locations, so Monemvasia pairs with Mesologhi via truck service.

Table 1. Desalination plants in Greece (adapted from [17]).

Desalination Unit	Construction Year	Capacity (m^3/d)	Operational Status
Syros 1st (Ermoupoli)	1992	800	Operational
Syros 2nd (Ermoupoli)	1997	800	Operational
Syros 3rd (Ermoupoli)	2001	2×250	Operational
Syros 4th (Ano Syros)	2000	250	Operational
Syros 5th (Ano Syros)	2002	500	Operational
Syros 6th (Ermoupoli)	2002	2000	Operational
Syros 7th (Ano Syros)	2005	1000	Under construction
Syros 8th -9th (Poseidonia ×2)	2002	2×250	Operational
Syros 9th -10th (Poseidonia ×2)	2005	2×500	Under construction
Schoinousa	2004	100	Under construction
Mykonos (Korfou-old)	1981	500	Operational
Mykonos (Korfou-new)	2001	2000	Operational
Paros (Naousa)	2001	1200	Operational
Tenos (Old)	2001	500	Operational
Tenos (New)	2005	500	Operational
Santorini 1st (Oia)	1994	220	Operational
Santorini 2nd (Oia)	2000	320	Operational
Santorini 3rd (Oia)	2002	160	Operational
Sifnos	2002	500	Operational
Chios 1st–2nd (Omiroupoli ×2)	2005	2×1000	Under construction
Chios 3rd (Omiroupoli)	2000	600	Operational
Chios 4th (Omiroupoli)	2005	500	Under construction
Nisyros (Old)	1991	300	Not operational
Nisyros (New)	2002	350	Operational
Cephalonia, Ithaki 1st	1981	620	Operational
Cephalonia, Ithaki 2nd	2003	520	Operational
Leros (municipality)	2001	200	Operational
Corfu (Kassopaion)	2001	500	Operational
Corfu (Ag. Georgios)	2002	500	Operational
Paxon 1st (municipality)	2005	330	Operational
Paxon 2nd (municipality)	2005	150	Operational

Figure 1. GIS map of Greece with desalination plants (suggested and existing), solar saltworks and routes for the transportation of brine.



Naturally, one of the most important factors in assessing the feasibility of operating a zero discharge seawater desalination plant system is cost. In this case, the largest cost is incurred in transporting the brine from desalination plants to saltworks. In this paper, we make a rough estimate of that amount: adding the cost of transporting brine by ships and/or special trucks. We acquired these figures either from published literature or personal interviews with transportation companies. Specifically, for the cost of transporting brine by truck, we obtained quotes from special truck companies that transfer liquids. The average price is 0.24 €/km/m^3 of brine and we multiply it by the distance traveled to estimate the truck transportation cost, as shown in Table 2. Regarding transportation by ship, we do not have a price quote per km, but we have two prices per m^3 of brine: one for transporting brine from island to island (estimated at 4.8 €/m^3), and one from the mainland to the islands (8.21 €/m³) [19]. The latter cost is also used for the calculation of brine transportation from Karpathos Island to Sitia, Crete, as well as from Irakleio and Sitia, Crete to Milos Island. Table 2 tabulates all costs for all origin-destination pairs.

Table 2. Routes and costs of transporting brine from desalination units to solar saltworks.

Desalination plant locations (origin)	**Solar saltworks locations (destination)**	**By ship**	**By truck**	**Distance by truck (km)**	**Cost for transporting brine by ship (€/m³)**	**Cost for transporting brine by truck (€/m³)**	**Total Cost (€/m³)**
Chios island	Lesvos island	✓			4.8		4.8
Samos island	Lesvos island	✓			4.8		4.8
Ikaria island	Lesvos island	✓			4.8		4.8
Kos island	Lesvos island	✓			4.8		4.8
Nisyros island	Lesvos island	✓			4.8		4.8
Leros island	Lesvos island	✓			4.8		4.8
Aigina island	Milos island	✓			4.8		4.8
All Cyclades island locations	Milos island	✓			4.8		4.8
North Crete (Irakleio)	Milos island	✓			8.21		8.21
South Crete (Ierapetra)	Milos island via Sitia	✓	✓	58	8.21	13.92	22.13
East Crete (Sitia)	Milos island	✓			8.21		8.21
Karpathos island	Milos island via Sitia	✓			8.21+8.21		16.42
Nayplio	Mesologhi		✓	220		52.8	52.8
Monemvasia	Mesologhi		✓	372		89.28	**89.28**
Kalamata	Mesologhi		✓	259		62.16	62.16
Korinthos	Mesologhi		✓	164		39.36	39.36
All Ionian island locations	Mesologhi via Patra	✓	✓	44	4.8	10.56	15.36
Volos	Pieria		✓	200		48	48
Kassandra, Chalkidiki	Thessaloniki		✓	86		20.64	20.64
Sithonia, Chalkidiki	Thessaloniki		✓	125		30	30

3. Results and Discussion

The cost of operating a zero discharge desalination plant is partially offset by the profits realized from selling the extra salt produced by the desalination effluent brine. Also, with desalination plants becoming zero effluent, there is no need for the construction of a metallic non-corrosive pipe (50 m to 1000 m in length) and diffuser that discharges the effluent brine deep in the sea. The cost of this pipe is estimated at 1,500 €/m, for a total of several thousand €. Needless to say, the largest savings are realized when, with the construction of the desalination plants, the coastal arid sites can become autonomous and will not need to have water brought in. From 2004 to 2006, the Greek government paid approximately 25.5 million € for the transportation of water to the arid islands that face serious water-shortage issues, with 9.5 million € spent for water transportation in 2006 alone. Just for comparison purposes, it is estimated that the 25.5 million € that the government has spent in three years for transporting water could be used for the construction of 15 seawater desalination units with a capacity of 30,000 m^3 per day in total, with an indicative water production cost of 0.4 €/m^3 [19].

When looking at the data from Table 2, we see that the cost of transporting brine by truck is prohibitively expensive. Since we have a per-km rate that is relatively high, locations that are a few hundred kilometers away can add up to almost 90 €/m^3 of brine transported. If one compares this cost to the cost of transporting water (the very process that we find unsustainable and we want to avoid) of less than 8 €/m^3, we see that such a transfer is even more expensive and unsustainable.

The question that is relevant here is how much brine is produced for the production of 1 m^3 of desalinated water? Currently, using today's technology, this number is relatively high. Processes vary in efficiency, but usually produce about 1 m^3 of brine for every 1 m^3 of desalinated water. In order to make desalination an environmentally friendly process, we should re-design the process, using the minimization of the effluent brine as a design criterion. This way, we will ensure that the proper technology is employed in order to produce a design that actually makes less effluent brine, since it is expensive to transfer to a saltworks and dispose of it without any environmental impacts.

Even when transported by ship and taking the most inexpensive of the two cases, it is still going to cost 4.8 €/m^3 for the brine transport, which compares to about 0.4 €/m^3 for the production of desalinated water. So, in the best case scenario, and given that for every liter of desalinated water produced we produce another liter of brine, the proper disposal of brine to a saltworks still costs about 10-times more than the production of desalinated water. Therefore, to balance out the cost of the useful product (water) with the cost of safe disposal of the process waste (brine), we need to ensure that the technology is such that brine is produced at a rate of 10 to 1, *i.e.*, for every 10 liters of desalinated water produced we make only 1 liter of brine. Nowadays, improved efficiency in the desalination process is usually a result of improved membrane technology that also comes at a lower price. Our analysis showed that to make this process sustainable and environmentally friendly, it is also necessary to significantly reduce the waste (brine) produced, something that has been generally overlooked. This analysis is valid only under the assumption that the water is produced at the location in which it is consumed, *i.e.*, there is no need to transfer the desalinated water. Naturally, this is the preferred practice, as transporting water may give rise to hygienic issues and water quality deterioration due to its transport; moreover, transporting high quality potable water requires the installation and operation of a high quality infrastructure that would prove prohibitively expensive. Therefore, all desalination plants are built where there is a water shortage problem and water produced is only intended to cover the needs locally.

4. Conclusions

Water shortage has become one of the greatest problems of modern society, mostly due to the explosive increase in population, along with the socio-economic development and the climate change. In order to deal with water shortage problems, Greece has resorted to solutions such as transporting water by ships from the mainland to the islands that face a more serious water shortage problem, a practice that is expensive, energy-intensive and unsustainable. The promising process of seawater desalination to supply the country with potable water is suitable for providing desalinated water to arid coastal regions in Greece and other Mediterranean countries that face similar issues. Desalination systems, however, produce concentrated brine that may heavily affect marine biota when it is disposed of in the sea. To avoid this impact, we explore the option of directing the desalination effluent to a solar saltworks for brine concentration and ultimate salt production in order to achieve a zero discharge desalination plant. A survey was conducted on the locations of possible desalination plants and solar saltworks in Greece and the data mapped in a GIS, in order to assess the distances between desalination plants and solar saltworks and to investigate the economic potential of transferring effluent brine to solar saltworks, so that disposal of brine in the sea is avoided. Our analysis showed that brine transfer by trucks is prohibitively expensive and that efforts should be directed into developing a more efficient technology that will result in the production of only a fraction of the brine that is produced from our systems today, in order to make the zero discharge plant economically feasible.

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