Guide to Green Infrastructure and Low Impact Development in the City of Rockport and Aransas County, Texas

Front cover renderings: Jake Irvin (top); Ryan Beatty (bottom).

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"Come Sea the Beauty and Charm of Rockport!"
Photo by: Brian Grunberger

“Much of environmental planning has to do with edges—the lines and ribbons in the landscape where one environment gives way to another. No edge is more important than that between land and water.”
~ William Marsh

GREEN INFRASTRUCTURE AND LOW IMPACT DEVELOPMENT IN THE CITY OF ROCKPORT AND ARANSAS COUNTY, TEXAS

1. INTRODUCTION

This document contains design guidelines for incorporating Green Infrastructure (GI) and Low Impact Development (LID) strategies in the City of Rockport and Aransas County, Texas (Figure 2). It stems from a collaboration between the City of Rockport and the 2018 Regional Planning Studio in the Department of Landscape Architecture at Texas Tech University (Figure 1). Example implementation projects produced by students over the course of the semester are included to illustrate how these guidelines can be applied in specific ways within the local conditions. This approach to new development or redevelopment practices will contribute to a more resilient community of the future that is better equipped to deal with the impacts of extreme weather events and a changing climate. Natural disasters are increasing not only in number but also in their magnitude or severity and can no longer be thought of as the exception—they are the norm. A resilient community is one that manages recovery, applies lessons learned, prepares, and implements plans in the period following or between event(s). These practices help communities adapt and build capacity to withstand or mitigate the effects of future disruptions.

The timing of this document is significant, which coincides with the passing of the Water Infrastructure Improvement Act (H.R. 7279) in January 2019 (WIIA).[i] The added flexibility provided by the new law will allow communities to implement GI practices to meet water quality standards. GI is defined in the WIIA as, ["the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters."] This highlights the foundation of GI, which promotes the use of natural processes to infiltrate or reuse stormwater runoff in a beneficial way at the point where it is generated. The WIIA also specifically calls for regional offices of the U.S. Environmental Protection Agency (EPA) to "promote and integrate the use of green infrastructure" approaches to reduce water pollution, protect water resources, comply with regulations, and achieve other environmental, public health, and community goals.

Figure 1: Students and faculty from Texas Tech University's Department of Landscape Architecture meet with city and community leaders in October 2018. Source: Neale Currie.

2. ROCKPORT AND ARANSAS COUNTY, TEXAS

The city of Rockport, Texas, is located in Aransas County and is the county seat (Figure 1). It lies on the Live Oak Peninsula between the Gulf of Mexico and the southern shoreline of mainland Texas and is surrounded by Aransas and Copano Bays. Rockport has experienced a steady growth in population over the last several decades and is currently estimated at 10,000 people. The overall population in Aransas County is approximately 25,000. Historically, Rockport's economy was dominated by shipbuilding and farming, but in the 20th century transitioned to a tourist, fishing, and shrimping base. The area's location along the Central Flyway, a major bird migratory route in North America, is also a strong draw for naturalists and an important part of local ecotourism. The Aransas Bay National Wildlife Refuge provides a refuge and breeding ground for a wide array of bird life, including the endangered Whooping Crane. Rockport and Aransas County are noted for their beautiful windswept live oak trees, a dominant feature of the local landscape. It is also home to the state's oldest live oak, "Big Tree," a Champion Virginia Live Oak estimated to be over 1,000 years old (Figure 5).

The delicate estuarine ecosystem surrounding Rockport creates a stunningly beautiful natural environment treasured by visitors and residents alike. Its Gulf Coast location, however, also makes it susceptible to tropical cyclone systems. The area has been impacted by several hurricanes over time and was the site of landfall of Hurricane Harvey on August 25, 2017. The Category-4 storm caused significant damage locally with catastrophic rainfall totals across the Houston and Southeast Texas region surpassing all previously recorded in the United States. Many homes, businesses and crafts (boats and airplanes) across Aransas County were lost or significantly damaged, as were the Rockport City Hall and Rockport-Fulton High School. Nearly every home in the Holiday Beach community was severely damaged or destroyed by storm surge and violent winds. In addition to the economic toll extracted by Harvey, the city has also seen a 20% reduction of its population.

It is in the wake of recovery from Hurricane Harvey that this document is produced. The emphasis on GI and LID in the rebuilding process is an intentional strategy to address local flooding and drainage problems. Although the area receives an average of 36” of precipitation annually, it can also experience long periods with no rainfall or torrential rain from tropical storms. In times of storm, Rockport’s relatively flat, low-lying terrain atop a high water table leads to flooding with water having few places to drain.

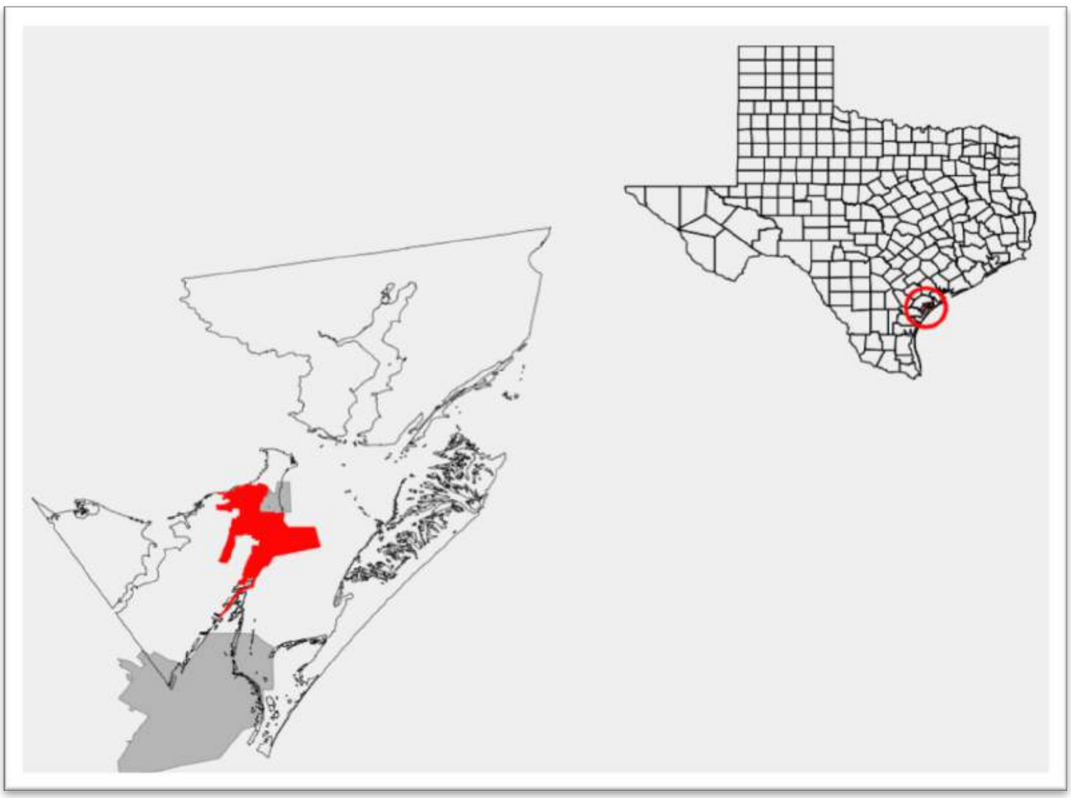

Figure 2: The City of Rockport and Aransas County, Texas locations. Source: Wikipedia.

3. ADDRESSING WATER QUALITY

Capturing rain water where it falls is an important solution to urban runoff. The Clean Water Act (CWA), first enacted in 1972, has been the major piece of legislation governing surface water quality protection in the United States. Along with regulating municipal wastewater treatment facilities, the CWA governs pollutant levels in discharges and runoff. This important law was put into place to protect our water for safe drinking, recreation, and the health of fish, shellfish, and wildlife. The CWA requires a stormwater pollution prevention plan documenting stormwater control measures (also known as best management practices, or BMPs) to be implemented that will prevent degradation of nearby water bodies. The CWA mandates compliance with the National Pollutant Discharge Elimination System (NPDES), which controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

Point source pollution, such as that from industrial and sewage treatment plants, is easier to identify and, therefore, regulate. Nonpoint source (NPS) pollution differs from point source pollution in that it originates from a variety of diffuse, and often unrecognized sources. NPS runoff is filled with many harmful things such as excess fertilizers, herbicides and insecticides from agricultural lands and residential lawns. It contains oils and grease from automobiles and pavements; bacteria from pet waste and leaking septic tanks; sedimentation and siltation from construction sites or lands that have been stripped of topsoil; salts and acids from abandoned mines; and many more noxious contaminants. This polluted runoff is one of the leading causes of poor water quality, affecting the water supply for both human and nonhuman use (Figure 3).

Many communities are challenged by deteriorating infrastructure and the economic difficulties in meeting requirements of the CWA. The enactment of the 2019 Water Infrastructure Improvement Act (WIIA) will make it easier for communities to use GI to efficiently and economically meet critical water management goals while protecting the health, safety, and well-being of their residents. Closely related to GI is low impact development (LID), defined by the EPA as the “systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat.” The EPA interprets GI as the management of wet weather flows using LID processes, and the “patchwork of natural areas that provide habitat, flood protection, cleaner air and cleaner water.”[ii] LID is a regulatory response seeking better land development practices to enhance property values, respect the environment, and benefit both individuals and the community.[iii] To achieve these goals, many localities and states have adopted standards that combine comprehensive land planning and engineering through LID. This involves such things as nonconventional stormwater management techniques, open space requirements, narrower streets, smaller lot sizes, and reduced setbacks. Such elements are well-suited to contemporary planning and zoning approaches to land use policy, for example form-based code, new urbanism and landscape urbanism designs (discussed below). Other LID techniques include rain gardens and bioretention methods that use the natural filtering ability of trees, plants, and grading to remove pollutants from stormwater runoff at the point of discharge. LID minimizes the need for expensive, underground stormwater systems tied to remote detention ponds.

Data from the EPA’s periodic National Water Quality Inventory reveal a pervasive problem of poor water quality in the nation’s water resources. Of particular concern is the degradation of estuarine areas, wetlands, and near-coastal ocean areas like those found in Rockport and Aransas County. Collectively, they represent areas rich in biodiversity and some of our most delicate ecosystems. As reflected in the CWA, the EPA has used a command-and-control regulatory approach to improve water quality by setting standards, requiring discharge permits, and enforcing penalties against violators. These standards have resulted in a slowing of the loss of wetland habitats, the recovery of many degraded estuaries and rivers, a rebound in fish populations, and the recovery of many formerly contaminated beaches to waters safe for swimming.

Figure 3: Example of nonpoint source pollution (NPS) illustrating the types of contamination commonly found in runoff that accumulates as it washes across various paved and urban areas and into downstream water bodies. Source: City of Pineville, LA.

However, there are inherent problems in the command-and-control regulatory approach that treats land, air, water, and living resources as separate entities rather than as an interrelated ecosystem. Embracing a more holistic approach that uses alternative solutions based on prevention, market mechanisms, economics, developing science, and land-use planning is in keeping with contemporary science and the interdependent nature of estuaries and human society. This shift has ushered in an adaptive governance approach that relies on stakeholder input, the use of local knowledge-based science, and technologies including GI and LID strategies, as exemplified by the passing of the 2019 WIIA.

4. THE CHANGING LANDSCAPE

Coastal communities occupy the edge between human and natural systems with each impacting the other. Therefore, a strategy to manage and protect them must also consider the anthropomorphic influences of human development. We all live downstream and no matter where we are situated, we are affected by the actions of those living and working in upstream locations. Pressures to accommodate population growth have significantly altered land use patterns over the last several decades, and thus upstream activities. Changing land cover and land use affects the physical, chemical, and biological conditions of downstream waterways; alters the makeup of flora and fauna; and fragments the landscape into smaller and more randomly scattered parcels. The impervious landscapes in developed and urban areas made of paved surfaces, storm sewer systems, and buildings don't allow runoff to percolate slowly into the ground. Instead, water accumulates and runs off rapidly in large amounts, increasing stream bank erosion and sedimentation downstream, and leading to flooding and negative effects on aquatic species. Along with increased water quantities and velocities, urban runoff becomes polluted when typical ground matter and other impurities picked up from a variety of sources are flushed into storm drains and carried into receiving water bodies, i.e. NPS pollution (Figure 3). The combination of a marked increase in the amount of land used per person, the increase in urban runoff, and the loss of the buffering and filtration provided by rural landscapes and wetlands dramatically affects the ability to maintain water quality within a watershed and thus compromises its ecologic and economic health.

Nearly all endemic terrestrial and aquatic species of flora and fauna are adapted to the stable water chemistry and consistent hydrologic patterns of infiltration, evaporation, transpiration, and groundwater discharge that are a part of our natural systems. Natural areas mimic sponges; they receive surface water, remove pollutants, trap sediments, and facilitate groundwater recharge in a gradual, balanced manner. Contemporary land-use practices, including row-crop agriculture, however, have dramatically altered ecosystems through the widespread conversion of rural lands to developed areas. Rural lands typically provided an important buffer between urban land and water, but once lost to urbanization, they are gone forever.

The incorporation of green infrastructure (GI) and other environmentally sensitive solutions to managing stormwater illustrates an adaptive governance approach to improving water quality. GI is a cost-effective, sustainable, and environmentally-friendly strategy that uses stormwater capture and reuse, infiltration, and evapotranspiration to maintain or restore natural hydrologies. This shift preserves the original vision of the environmental movement of the 1970s, now embodied in the response to the sustainability movement of the 1990s and 2000s, which emphasizes the need for ecological solutions and innovations. In contrast to the pipe-and-move philosophy of stormwater management that has been the dominant method for decades, GI and LID rediscover the ability of natural systems to perform needed functions in a more suitable and often more economical way.

LID and GI strategies accrue benefits ranging from small, site-specific practices (i.e. reduced pavement widths, the use of bioswales, rain gardens, and pervious pavements; increased residential densities; constructing or retrofitting buildings with green roofs; and using reclaimed water for irrigation) to large, regional scales (i.e. open space plans or conservation easements) and aim to manage water as close to its source as possible (Figure 4). LID incorporates many elements that combine value-adding features with non-conventional methods to measurably reduce the overall impact on the environment. Implementation plans (IPs), required by most states, can be used to specifically describe planned GI/LID practices including retrofits for current sites and/or the means of future pollutant load reductions. They can also outline post-construction requirements for groundwater recharge in impaired watersheds. Increasingly, local municipalities have adopted these methods into their land-use ordinances to reduce the stormwater volumes and pollutant loads generated by new development. It is imperative that future land development (which is governed at the local level) be shaped in such a way as to limit the volume of stormwater discharges and total impervious surface, while closely monitoring runoff to ensure that water quality and bank stability of receiving water bodies are not degraded.

Implementing "smarter" land development policy can also provide solutions to the problems of urban runoff in the following ways: encouraging infill development, replacing greyfield development with a mix of compact uses and open spaces in revitalization projects, preserving rural lands, revising local zoning and stormwater ordinances to allow for LID practices, and investing in community-wide GI such as connected trail systems and bikeways. These and other "smart growth" policies are good for more than reducing runoff. They also lessen air pollution, carbon emissions and other climate-changing impacts, while simultaneously protecting the valuable habitats and functions within an ecosystem.

In the period following a major disaster, a community must manage many changes that go beyond the physical impacts. Changes are occurring at a rapid pace outside the normal course of a community's trajectory and decisions must be made quickly. In the absence of a plan some of these changes will be beyond a community's control.[iv] The economic benefits realized through LID and GI practices in the post-disaster rebuilding process can help offset losses incurred. This can also help reduce vulnerability to negative impacts from future events.

Figure 4: An example of a rain garden designed to capture runoff from a nearby parking lot. Source: US Environmental Protection Agency.

5. GREEN INFRASTRUCTURE AND LOW IMPACT DEVELOPMENT TECHNIQUES

An emphasis on the benefits that the wise management of runoff can provide, including reduced risk and impact from flooding, is central to GI and LID practices. An integrated approach is appropriate when designing for flood-resistance and can be guided by three specific goals, listed as:[v]

1) Reduce flooding during extreme events
2) Provide healthy water for human and natural needs
3) Restore impaired waters

These goals can be achieved through comprehensive planning, good policy, and the accrued benefits of several small measures. A strategy to implement GI and LID on a community-wide scale or individual site-basis follows.

5.1 Understand existing conditions

Condition 1 – Map and classify environmental assets.

Environmental assets that provide ecosystem services such as flood protection for a community should be identified and mapped. Important features to be preserved, restored, and protected include: swales, drainageways, wetlands, streams, aquifers, aquifer recharge areas, floodplains, major native plant communities, steep lands, prime agricultural land, forests and woodlands, and certain soils. These assets can be classified using the four categories of natural processes described by Ian McHarg as follows.[vi]

a) *Those that perform work for man* – natural water purification; atmospheric pollution dispersal; climatic amelioration, water storage, flood, drought & erosion control; topsoil accumulation, forest and wildlife inventory increase.
b) *Those that offer protection* – estuarine marshes and floodplains, etc.
c) *Those that are unique or especially precious* – important areas of geological, ecological and historic interest; wildlife corridors and habitat.
d) *Those which are vulnerable* – beach dunes, spawning and breeding grounds, and water catchment areas.

This classification forms a gross hierarchy of intrinsic suitability and is useful when making development decisions with LID or GI in mind. It is important to protect key ecosystems because changes to parts of the natural system affect the entire system. The effect of filling estuarine marshes or clearing upland forests is related to the water regimen and can result in floods and drought. The construction of outlying suburbs and siltation of river channels are related as upstream hydrology is altered and runoff increases.

Condition 2 – Map and classify disturbances.

In addition to its environmental assets, a community must also locate and map disturbed elements in the landscape, such as buried/piped streams, contaminated areas (i.e. brownfields), abandoned development (including greyfields), spoil areas, hazard areas (i.e. floodplains), and degraded soils. Climatic conditions should also be noted and whether or not existing conditions could provide opportunities for renewable energy strategies such as solar or wind power.

Condition 3 – Identify and protect cultural and historic assets.

Cultural and historic elements are some of the things that contribute to a community's uniqueness and create a sense of identity. As such, they should be noted for protection and their ability to serve as anchor nodes for new or re-development and as destinations along strategic paths/trails. This may include important buildings like the Fulton Mansion, unique natural features such as "Big Tree," sites with special histories associated with Aransas County or Rockport, or planned infrastructure expansions (Figure 5).

Figure 5: A unique natural feature in Aransas County includes “Big Tree” located at Goose Island State Park. Big Tree is a Champion Virginia Live Oak estimated to be over 1,000 years old and was at one time the largest live oak in the U.S. Source: Melissa Currie.

5.2 Develop Guidelines for New or Redevelopment

The resultant map of environmental assets and disturbed environments will reveal areas that need to be protected as well as opportunities for redeveloping underused or blighted areas. This first layer forms an important base for forward-looking development decisions that help build community capacity. Development guidelines to build on the community’s assets follow.

Development Guideline 1 – Avoid development in flood-prone areas and within floodplains.

Floodplains are relatively flat, low lying areas adjacent to inland and coastal waters that provide very important functions in the landscape. They allow for overflow of waterbodies when extreme rain events occur and provide an impoundment area while water levels recede. Urban or suburban development should be avoided in these areas to protect lives and properties. Parks, recreational, or sports uses with minimal structures (e.g. restrooms or pavilions) are compatible with floodplains. This is a practical approach to land use that leaves more appropriate upland locations available for development while leaving floodplains open without disrupting their natural hydrologic function(s).

Development Guideline 2 – Reduce Impervious Land Cover.

Most stormwater runoff in urban environments comes from impervious surfaces, which include roads, buildings, and parking lots. The natural water cycle is disrupted when land is converted from a natural or rural state to developed land. The capacity for rainwater to infiltrate the soil is lost, which leads to an increase in the volume and velocity of runoff (Figure 6). Water quality is also reduced through the picking up of various pollutants in runoff as described above. Temperatures in runoff from impervious surfaces are also increased which has a negative effect on the health of fish populations in receiving water bodies by lowering dissolved oxygen levels. Reducing the amount of impervious surface is a key strategy in LID for managing stormwater (Figure 7). This can be achieved by:

- Paving less and reducing impervious footprints
  - Make use of existing infrastructure by redeveloping infill sites or greyfields
  - Implement a "road diet" – reduce lane and driveway widths
  - Rethink parking lot design by lowering the number of required spaces in a parking lot, reducing the size of spaces, and allow shared parking for adjoining uses
  - Use parking garages to minimize surface parking lots: encourage a "park once" strategy by constructing parking garages in central locations that allow residents to drive to commercial areas, park, and then walk to many nearby destinations

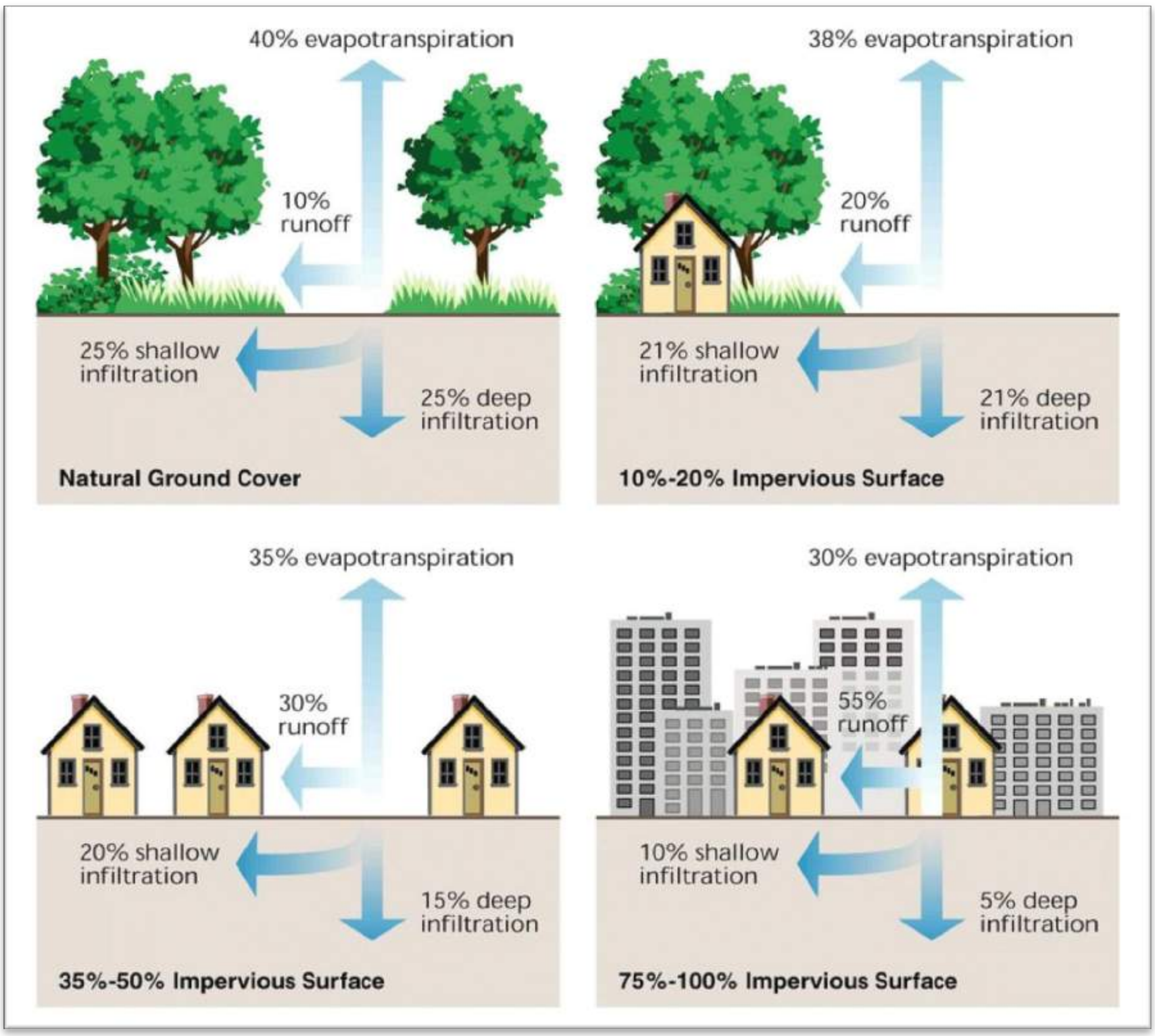

Figure 6: Diagram showing the changes in rates of infiltration, runoff, and evaporation as impervious cover increases. Source: Federal Interagency Stream Restoration Working Group.

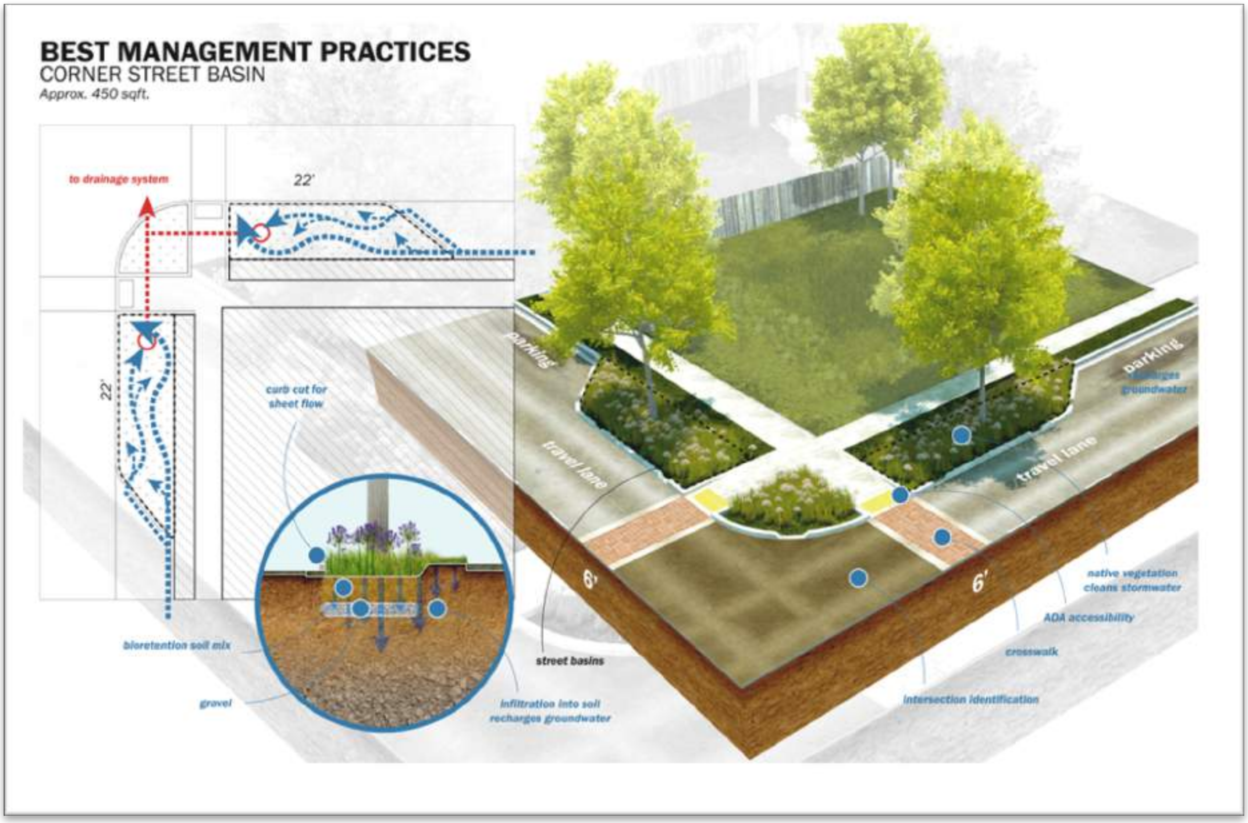

Figure 7: Diagram showing the streetside implementation of Green Infrastructure methods including reduced paving widths and the infiltration of stormwater into soil to allow groundwater recharge. Source: Green Infrastructure Toolkit – Georgetown Climate Center.

Development Guideline 3 – Manage water as close as possible to where it falls.

Hazards such as droughts, fires, flooding, or hurricanes are natural events, but they become disasters when they interact with human systems.[vii] Flooding in the natural environment is part of the water cycle. It supports processes that maintain and replenish topsoil, groundwater, habitats, and needed nutrients.[viii] In the urban environment, however, flooding is often the result of increased runoff from large amounts of impervious surfaces and upstream development. Design strategies at several scales can help mitigate urban flooding and the impacts of stormwater runoff.[ix]

- Design for small rain events – places an emphasis on impervious areas and "first flush" (first ½" of rainfall)
  - Direct downspouts to planter boxes, vegetated areas, rain gardens, etc.
  - Eliminate curbs and direct runoff from paved areas to planted/vegetated areas
  - Use green roofs (may or may not be occupiable)
  - Capture and reuse water through multiple practices
    - Direct runoff from rooftops to cisterns or rain barrels
    - Rainwater harvesting for irrigation
  - Conserve water
    - Use graywater systems to recycle and reuse water on site

        - Use native plants that can thrive in the local climate with minimal supplemental water requirements
        - Reduce the amount of lawn, for example replace with a planted meadow or prairie grass
        - Implement xeric landscape design
    - Plant trees along streets and in medians
    - Use pervious pavements

- Design for moderate rain events (1/2 to 1-1/2" of rainfall)
    - Retain natural landscapes where possible
    - Bolster the urban canopy by planting trees, understory shrubs and plants
    - Convert vacant or abandoned lots to urban gardens and green space
    - Create a network of rain gardens, bioretention areas, and bioswales to allow for infiltration, cleanse runoff, and provide storage for stormwater
    - Use underground stormwater management techniques such as infiltration trenches, perforated pipes, drywells, porous pavements
    - Create terraced landscapes
    - Use structural soils in urban areas to promote tree growth, increase root density, cleanse runoff, and allow water infiltration

- Design for large rain events (1-1/2" to 3" of rainfall)
    - Use larger bioretention areas and rain gardens
    - Vegetated swales with long flow paths to maximize the time runoff is conveyed through the swale

- Design for extreme events (3" or more of rainfall)
    - Combined flood measures – i.e. the "sponge city" approach
    - Protect and restore riparian buffers along rivers, streams, wetlands, and coastlines
    - Protect and restore wetlands, both those naturally occurring and "constructed."
    - Increase vegetative cover in urban, suburban, or rural/agricultural areas.
    - Increase the urban canopy by planting street trees and requiring all new development to comply with landscape requirements

Some of the benefits derived from the restoration and/or construction of wetlands and increased vegetative cover include:

- Provides vital habitat for plants and animals
- Improves water quality
- Provides for groundwater recharge
- Provides opportunities for passive recreation and education
- Protect and restore soil health
- Practice crop rotation
- Encourage urban agriculture

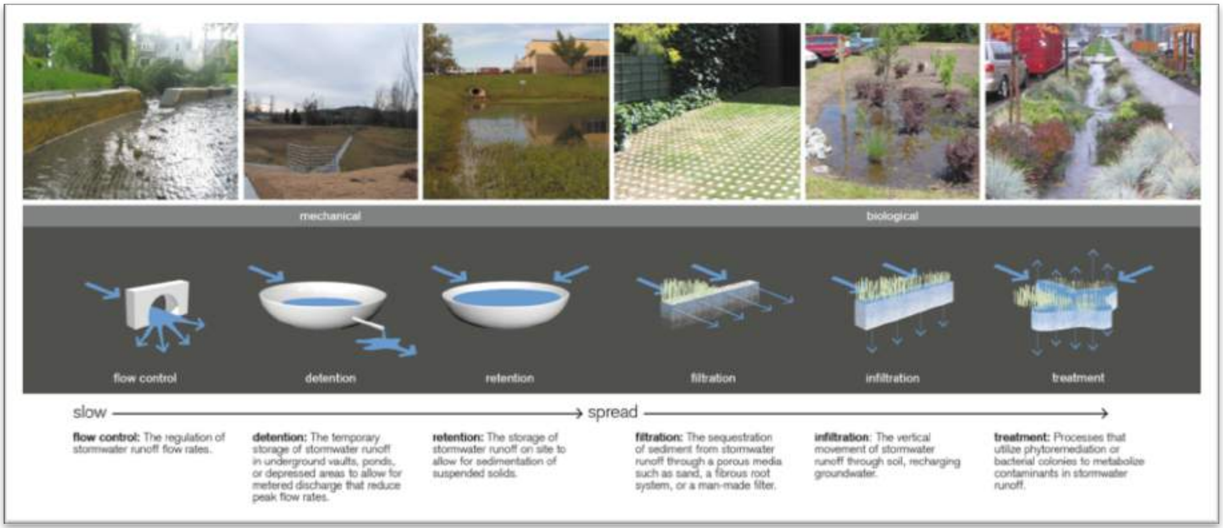

Figure 8: Diagram showing various LID and Green Infrastructure methods. Source: University of Arkansas Community Design Center.

5.3 Site-Level Techniques for Implementing GI and LID

This section presents commonly used, scalable techniques for implementing GI and LID on new sites or the redevelopment or existing sites. The best approach is to combine several techniques to realize the maximum benefits of low-impact development and green infrastructure. The practice of dispersed, small site applications addresses most rain events with an emphasis on first flush management.

PAVING APPLICATIONS

- Porous pavements – a system used for surface paving that includes a subsurface gravel infiltration bed. The porous paving material (asphalt, concrete, or pavers) allows water to infiltrate through it and continue down through the gravel bed. This option can be used to detain runoff, thus saving land, and is particularly useful in urban redevelopment projects.

- Reinforced turf – a system of cells made of plastic, concrete or other material that prevents soil compaction and allows turf to grow in the voids. The cells create structural support. This application is commonly used for temporary or occasional vehicular travel ways, or for overflow parking.

- Selective curb treatment – eliminating curbs along the edges of paved areas or roads allows runoff to be directed into adjacent bioswales or rain gardens to provide water for vegetation. Alternatively, flat (ribbon) curb edges or curb cuts can be used to accomplish the same purpose.

STRUCTURE APPLICATIONS

- Green roofs – an engineered roof system consisting of a layered system of drainage, irrigation, root barriers, and waterproofing. They can be designed to be occupied or not, and often provide enhanced aesthetics for higher floors overlooking a rooftop garden. The soil/growing medium layer may range from 1" to 6" for lightweight plantings or up to several feet deep for larger trees and shrubs with irrigation. All plants should be drought tolerant and larger trees can be aligned with building support columns.

- Roof runoff – can be directed to cisterns or rain barrels and stored for use in on-site irrigation, or discharged into planted areas including lawns, rain gardens, or planter boxes. Open bottom planter boxes allow for water infiltration through a gravel bed and cleansing from first flush before discharging into a storm drainage system.

- Graywater Harvesting – water that has been used once (except from toilets) can be reused for irrigation.

LANDSCAPE APPLICATIONS

- Bioretention Areas – also called rain gardens, are shallow depressions that capture runoff. They are planted with a variety of trees, shrubs, and perennials that mimic upper canopy, middle story, and ground floor conditions. Native or native-adapted plants should be chosen able to withstand both drought and flood conditions and that possess the ability to form a dense root layer to cleanse pollutants from runoff. Rain gardens can be used in residential lawns, in medians, along roadways, or in other areas adjacent to impervious surfaces.

- Bioswales – used to convey runoff from paved areas to retention ponds. The use of bioswales to connect a series of rain gardens creates a green network effective at reducing the quantity and velocity of runoff, increasing the time runoff is in a swale to allow for greater infiltration, and enhancing water quality.

- Subsurface infiltration beds – a uniformly open-graded aggregate bed under a vegetated or paved surface. Provide for storage and infiltration of runoff and are especially useful for athletic fields and parking areas. May be sloped in hilly or terraced areas.

- Tree trenches – a linear feature typically found along streets and sidewalks where runoff can be directed. These planted strips promote the health of street trees, especially when combined with structural soils designed to allow tree roots to penetrate more deeply than the compacted subsurface found beneath pavement.

- Street Bump-Outs – an extension of curbs that creates a widened landscape space to capture street runoff. Most effective when used at intersections, which increases their size and ability to handle more water. Can be used in a retrofitting strategy for "greening" urban areas and traffic calming.

6. THE TRANSECT: A FRAMEWORK FOR READING THE LANDSCAPE

The specific approach for applying GI and LID strategies within Rockport and Aransas County, Texas was to view the study area through the urban-rural transect, also called "the Transect." Ecologists and naturalists use the concept of transects to describe an ecosystem's characteristics and the transition from one to another (Figure 9). A transect follows a line cut through a portion of the environment to illustrate the different habitats that occur along the path. Urban planners, and most notably architects Andrés Duany and Elizabeth Plater-Zyberk, adopted the concept of the transect beginning in the early 2000s and applied it to patterns of human development (Figure 9). Standards written for the first transect-based codes became the basis for the SmartCode, released in 2003 by Duany Plater-Zyberk & Company. The Transect is useful in organizing a town or city and its outlying areas by classifying it in six zones based on the level of urbanization present (Figure 10). It is a useful regional framework for land development and planning across a spectrum of rural, urban, and suburban environments.

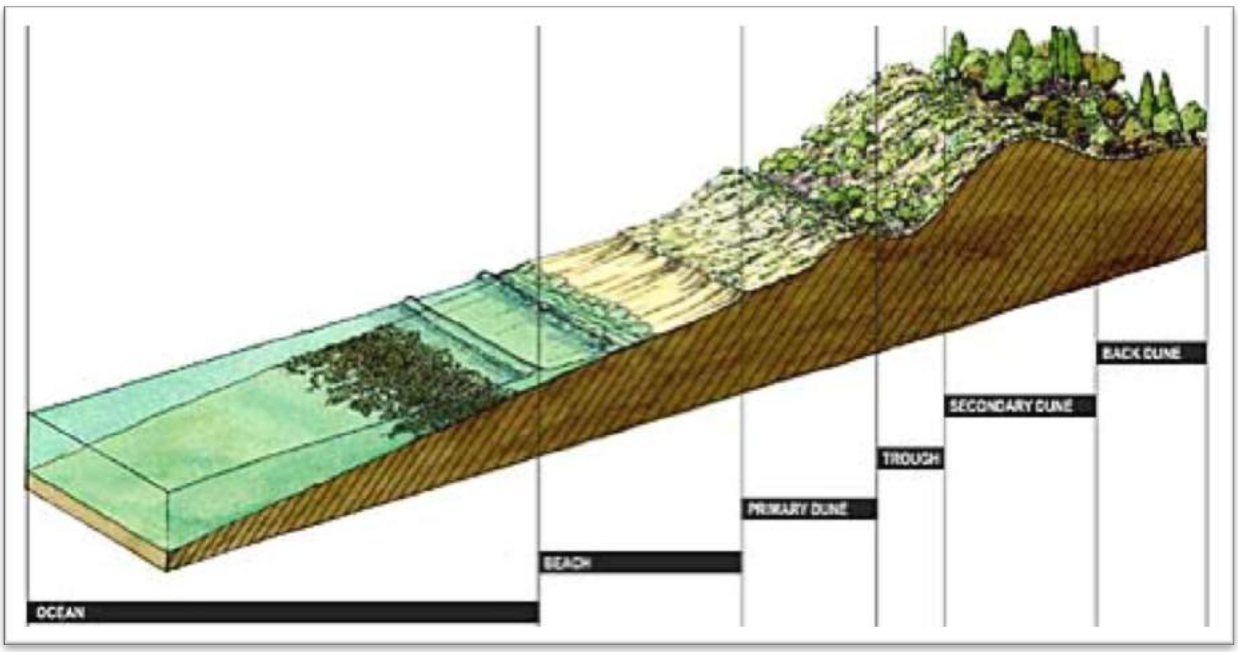

Figure 9: An ecological transect showing a coastal condition. Source: Center for Transect Studies.[x]

The six zones of the Transect include:

- T1-Natural
- T2-Rural
- T3-Sub-Urban
- T4-General Urban
- T5-Urban Center
- T6-Urban Core
- SD-Special District

As seen in Figure 10, the Transect depicts the landscape transitioning from a natural, undisturbed state in zone T1 through zone T6 in increasing levels of urbanization. Representative land use patterns within each zone are shown in plan view directly below its elevation. As the zones increase in development density and population from rural to urban core, corresponding road conditions, housing arrangements, and building type intensify. The T6-Urban Core zone is typified by high rise buildings and intensely developed downtowns. Thus, the T6 zone is not always present in a local Transect—for example in small towns—where the areas of greatest density more closely match the T5-Urban Center zone. The SD-Special District zone is assigned to areas dominated by a specific use that do not fit into a neighborhood, such as a university, historic, or medical district. The Transect zones are detailed below.[xi]

It is important to note that the Transect zones do not necessarily lie directly adjacent to one another as shown in the simplified diagram. Rather, they depict the general condition of each zone and may be located in multiple, noncontiguous areas forming a patchwork within the same Transect. The Transect zones are more fully illustrated as they are applied to local conditions in a subsequent section of this document.

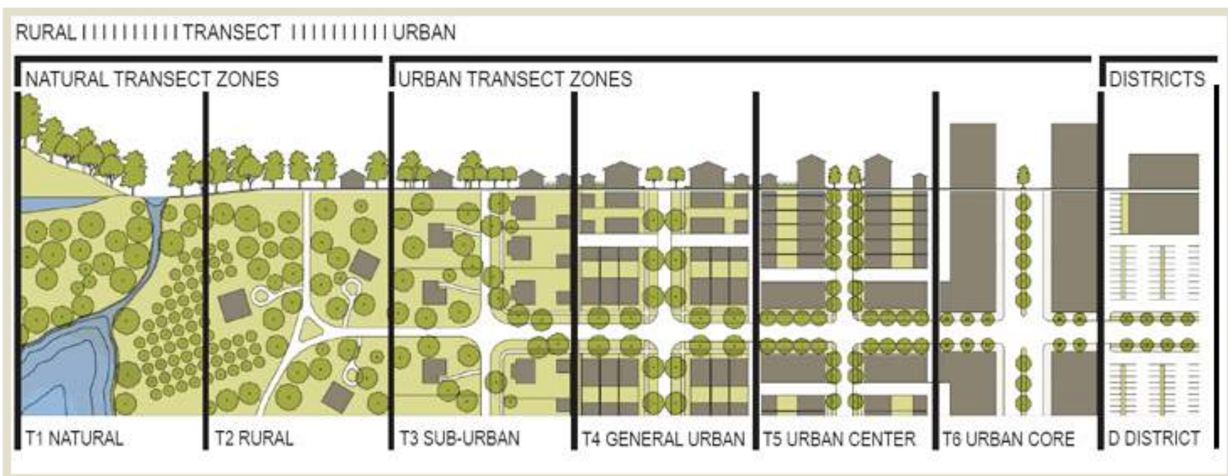

Figure 10: The generic urban-rural Transect. Source: Miami21.org, based on Center for Transect Studies.

The Transect is useful in analyzing and understanding human places, and ultimately in the development of new settlements that embrace the best of historic urbanism. This approach to reading a landscape is based on an understanding that the Transect exists as *place* and *evolves* over time.[xii] The ability to describe and define Transect zones thus gives it the ability to form a foundation for zoning codes that are more responsive to human needs. It is, therefore, commonly used as the building block for zoning using Form-Based Code (FBC), which is having a major impact on the design of our built environment. FBC uses regulating plans that are not based on lots and uses, but rather the location of the lot in relation to an overall plan and the type of street it faces.[xiii] Other differences are build-to lines, rather than setbacks, which facilitate “enclosure” within streetscapes by maintaining a more consistent vertical edge in urban areas. These differences allow space to be shaped by the form desired and not by strictly separated uses or arbitrary zoning lines. In 2011, the city of Miami, Florida, overhauled the city’s zoning codes through the drafting and adoption of *Miami 21*,[xiv] the first instance of a city adopting FBC using New Urbanism and Smart Growth principles based on the Transect. The visionary *Miami 21* plan earned the 2011 National Planning Excellence Award for Best Practice by the American Planning Association and is a model for cities looking forward into the 21st century.

In addition to FBC, Landscape Urbanism (LU) is an important urban design theory that first emerged in the U.S. in the 1990s. It looks to the landscape as the basic building block of the contemporary city.[xv] It is a response to the deindustrialization and decentralization of cities, and the economic, social, and cultural shifts this caused. LU seeks to address spaces marked by toxicity and/or social pathologies left behind as industries followed the massive exodus to the suburbs. Landscape Urbanism explores the overlap of architecture, landscape architecture, and urban design and is most often associated with the works of landscape architect James Corner. Corner and his firm Field Operations have produced such notable projects as the redevelopment of Fresh Kills Landfill in Staten Island and the repurposing of an abandoned, elevated railroad in New York City as the High Line park (Figure 11). Both are exemplary brownfield redevelopments that address pressing issues cities face including such things as capped landfills, toxic sites, and abandoned railways blighting the urban landscape.

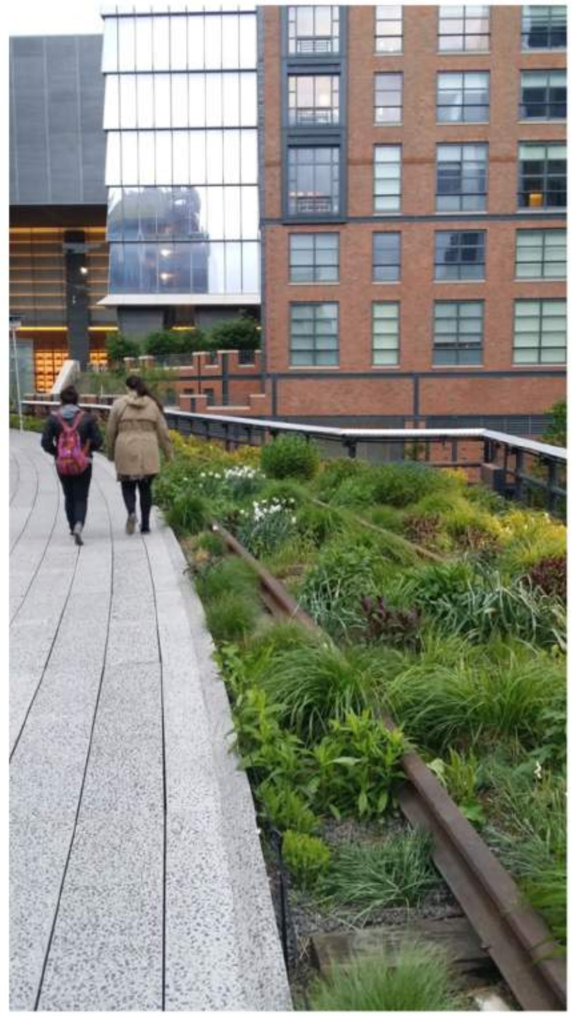

Figure 11: The High Line park in New York City, featuring Landscape Urbanism design, was formerly an abandoned elevated railroad. Source: Melissa Currie.

Central to LU projects is the intent to reintroduce ecology into the built (human) environment through GI strategies. LU principles are grounded in the ideals that design must adapt to the environment it is in, not the other way around, and that the urban environment must respect the underlying ecology of its place. It is a natural evolution of the philosophy and ecologically-based techniques described by landscape architect Ian McHarg in his influential text, *Design with Nature*.[xvi]

All of these approaches can be crystallized in the idea of a “sponge city,” a term used to describe an approach to urban development that produces a built environment able to absorb, cleanse, and reuse rainfall to reduce the frequency and severity of flooding. Just as the common household sponge contains solids and voids of different sizes, the sponge city capitalizes on the use of open spaces and other infiltration techniques in the built and natural environments to soak up excess water. This is an important step in realizing a resilient city able to endure times of stress, such as medium- or large-scale flooding events. It is this perspective that provides the basis for the GI and LID development guidelines contained herein. In the following section, example applications for potential new development are presented and organized according to the Rockport/ Aransas Transect (Figure 12).

6.1 Natural and Rural Zones

The T1-Natural and T2-Rural Transect zones lie beyond the neighborhood zones. The T1-Natural zone comprises barrier islands, wilderness, wetlands, forests, and other undisturbed areas of high environmental value. T1-Natural includes lands unsuitable for development due to topography (i.e. steep slopes), hydrology (i.e. wetlands or aquifer recharge areas), vegetation (unique ecosystems and habitats) and also lands permanently protected from development.

The T2-Rural zone comprises countryside lands where some development may occur, but it is not promoted as existing infrastructure (roads and utilities) is limited or absent. Lands are in an open or cultivated state with settlement sparse. T2 includes woodlands, agricultural lands, grasslands, or desert.

6.2 Sub-Urban Zone

The T3-Sub-Urban zone is typically found on the outskirts of town and often does not follow a grid development pattern. It is dominated by low-density residential uses but contains some civic and commercial uses such as churches, schools, or small stores. Infrastructure includes irregular road networks, cul-de-sacs, and municipal utilities.

6.3 Urban Zones

The T-4 General Urban zone is mixed-use but primarily residential with higher densities in the form of single-family detached homes, duplexes, townhomes, and apartments. Building types are varied and distinct neighborhoods are present, often with nodes and commercial centers nearby including civic uses and corner cafes. Commercial and mixed-use buildings are not as large as those in the urban core, and open space manifests as parks and greens.

T-5 Urban Center zone is the urban core in many smaller towns or cities with a main street character rather than downtown urban core. It typically features a tight street network, street trees, and higher density mixed-use buildings. Uses include retail, offices, townhomes, and apartment complexes. Residential units are often located above shops and buildings are attached, two to four stories high, with aligned fronts.

The T-6 Urban Core zone is the highest density area with greater variety of uses and civic buildings of regional importance. The core is the node of greatest activity with high pedestrian and vehicular traffic. Blocks in the core are large, buildings are greater than four stories and highly varied in use. Open space is often in the form of plaza spaces and parking frequently in structured garages or on-street.

6.4 Special Districts

In the Transect, the SD-Special District zones are urbanized areas that contain a particular activity that do not match the other zones. Uses in the SD-zone include, for example, major transportation facilities (i.e. airports, depots), industrial districts, university campuses, historic downtown areas, or hospitals and medical districts.

7. EXISTING CONDITIONS AND OPPORTUNITIES IN ROCKPORT AND ARANSAS COUNTY

As referred to in the above GI/LID Implementation section, the first strategy is to understand existing conditions. Landscape Architecture students in the 2018 Regional Planning Studio at Texas Tech University began their projects by first examining a broad range of conditions present in the City of Rockport and Aransas County at the watershed-level. A class trip to Rockport held during the semester allowed students to see the area, engage in local activities, talk to residents, and tour significant sites. In addition, a meeting was held with the class and numerous local officials and organizational staff involved with the community where needs were discussed and focus areas mapped. Samples of student plans outlining existing opportunities and constraints are included below.

The analysis included in Figure 13 identifies Rockport as a, “community of tradition and culture, natural beauty and sport, unity and strength.” Opportunities are to focus on the area’s history, new economic opportunities, and preserve its culture. These goals stem from those identified in resident’s responses to surveys conducted by the city. Wide roads and available vacant parcels present many opportunities to implement LID and GI projects on a variety of scales. The plan emphasizes environmental elements including protecting habitat, preservation of wetlands and a goal to reach and maintain a healthy coastal system. Restraints identified include aging infrastructure, development in flood zones and on unstable soils, and declining health of wetlands and urban ecologies.

The analyses shown in Figures 14 and 15 identify a number or opportunities for the community to grow sustainably, including implementing a living shoreline, using existing wetlands and golf course for stormwater management, proposed constructed wetlands, the identification of areas for growth connected by commercial corridors, and focusing on ecotourism. Potential constraints include areas prone to flooding, and improvements needed to the existing seawall to increase stormwater capacity and protect habitat.

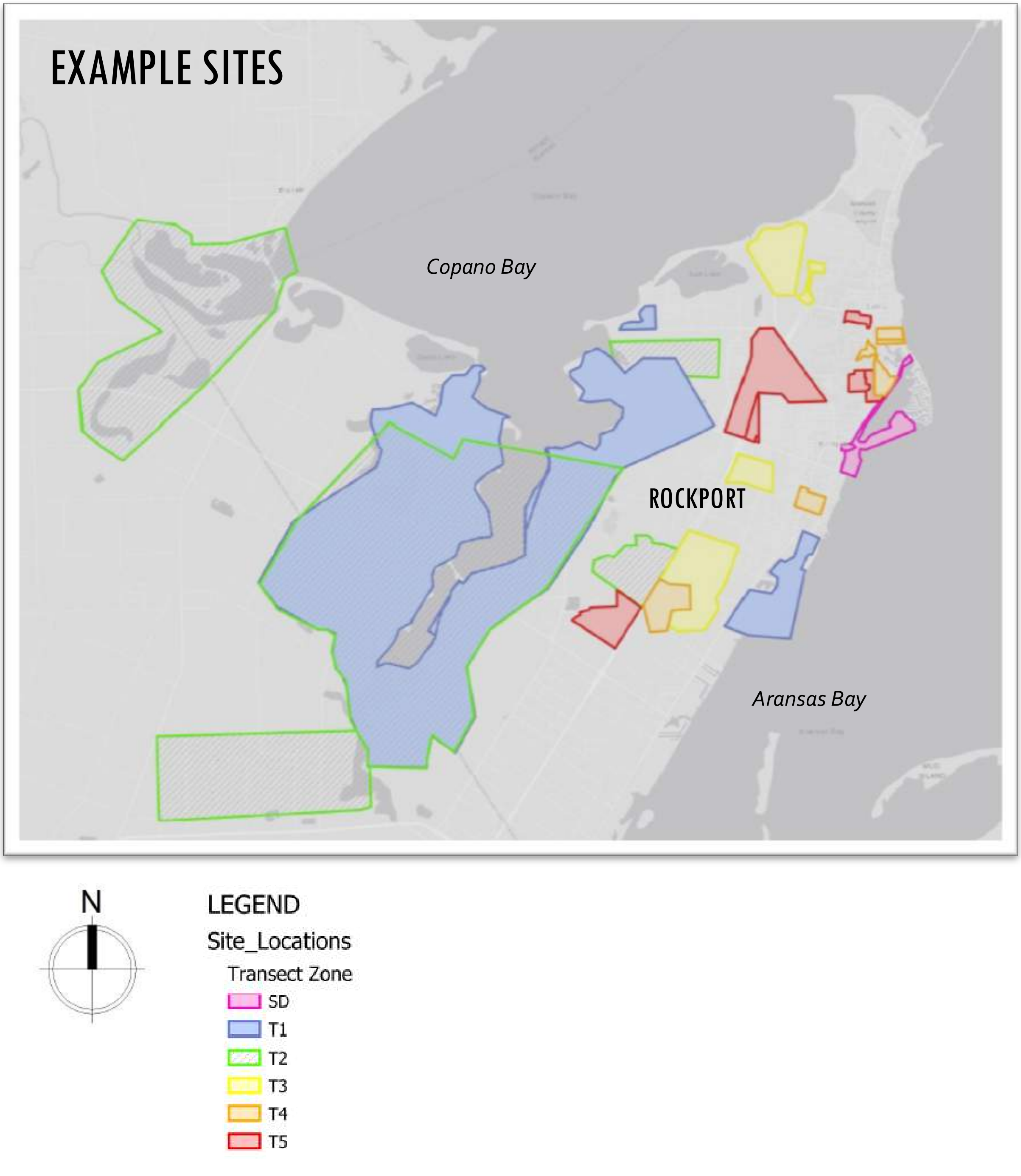

Figure 12: Distribution of example study sites and Transect Zones in Rockport and Aransas, County, Texas. Source: Melissa Currie.

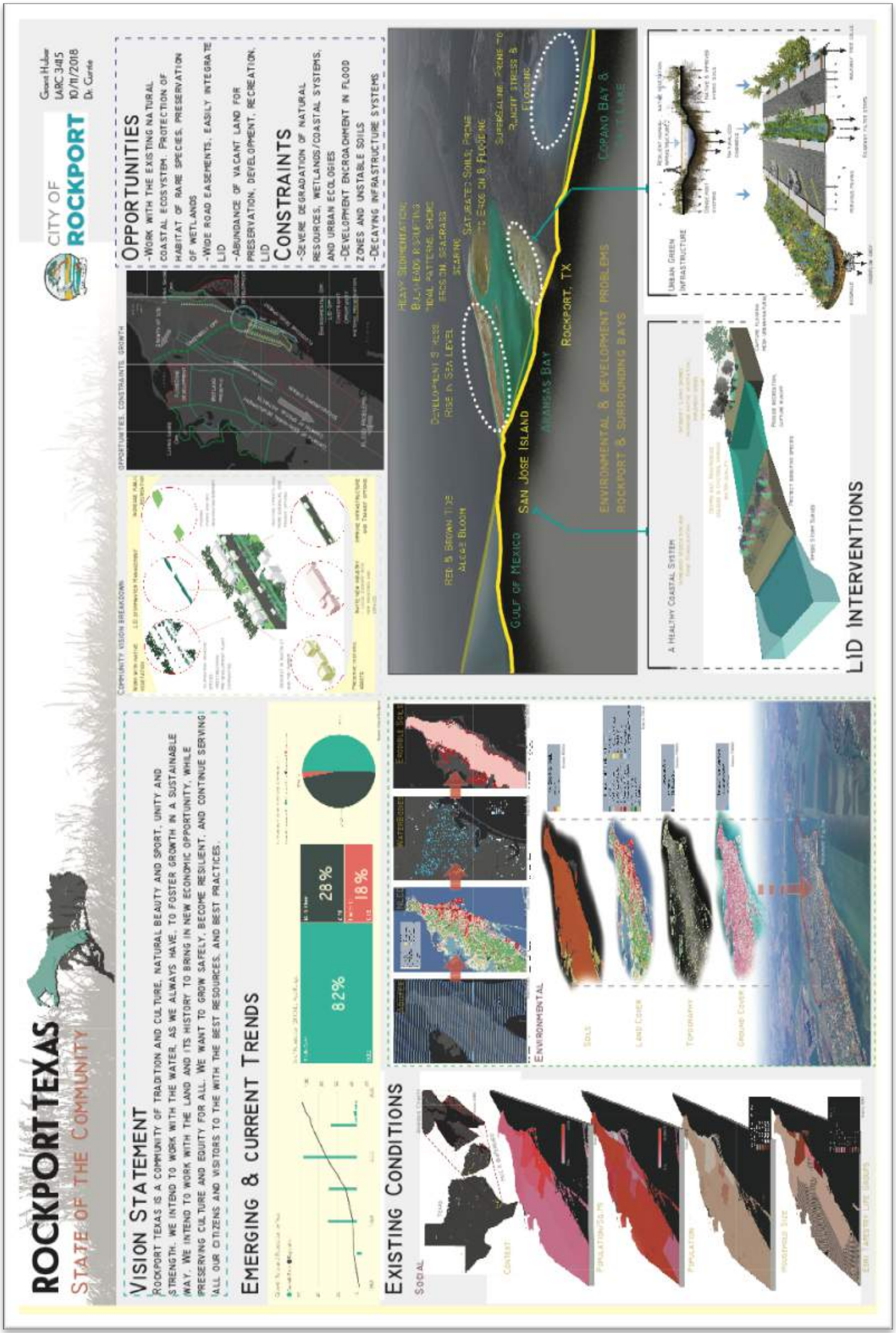

Figure 13: A plan of existing conditions, opportunities for growth, and constraints in Rockport and Aransas, County, Texas. Source: Grant Huber.

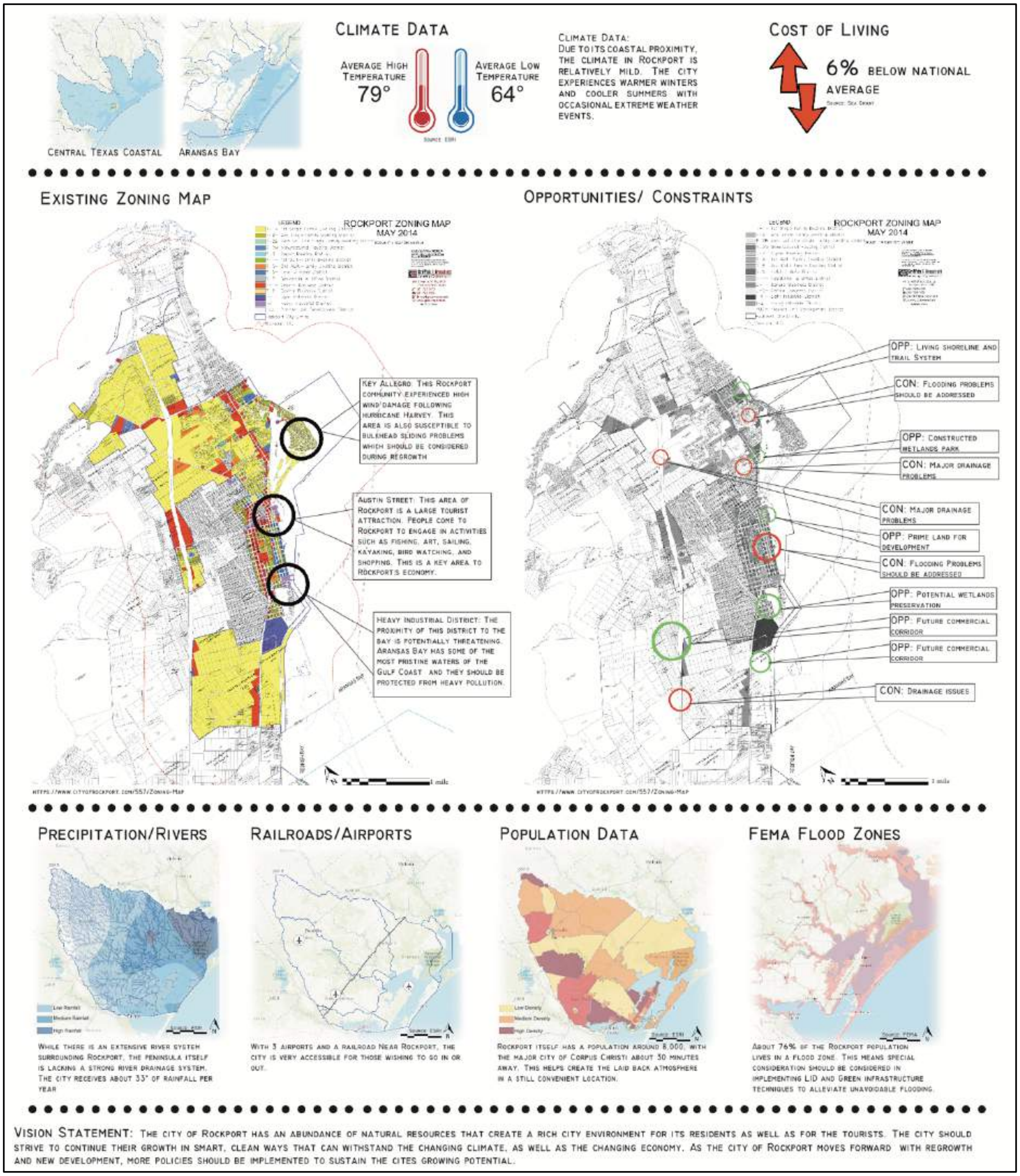

Figure 14: Opportunities for, and constraints to, growth in Rockport and Aransas, County, Texas, identified through an analysis of existing conditions. Source: Elizabeth Lane.

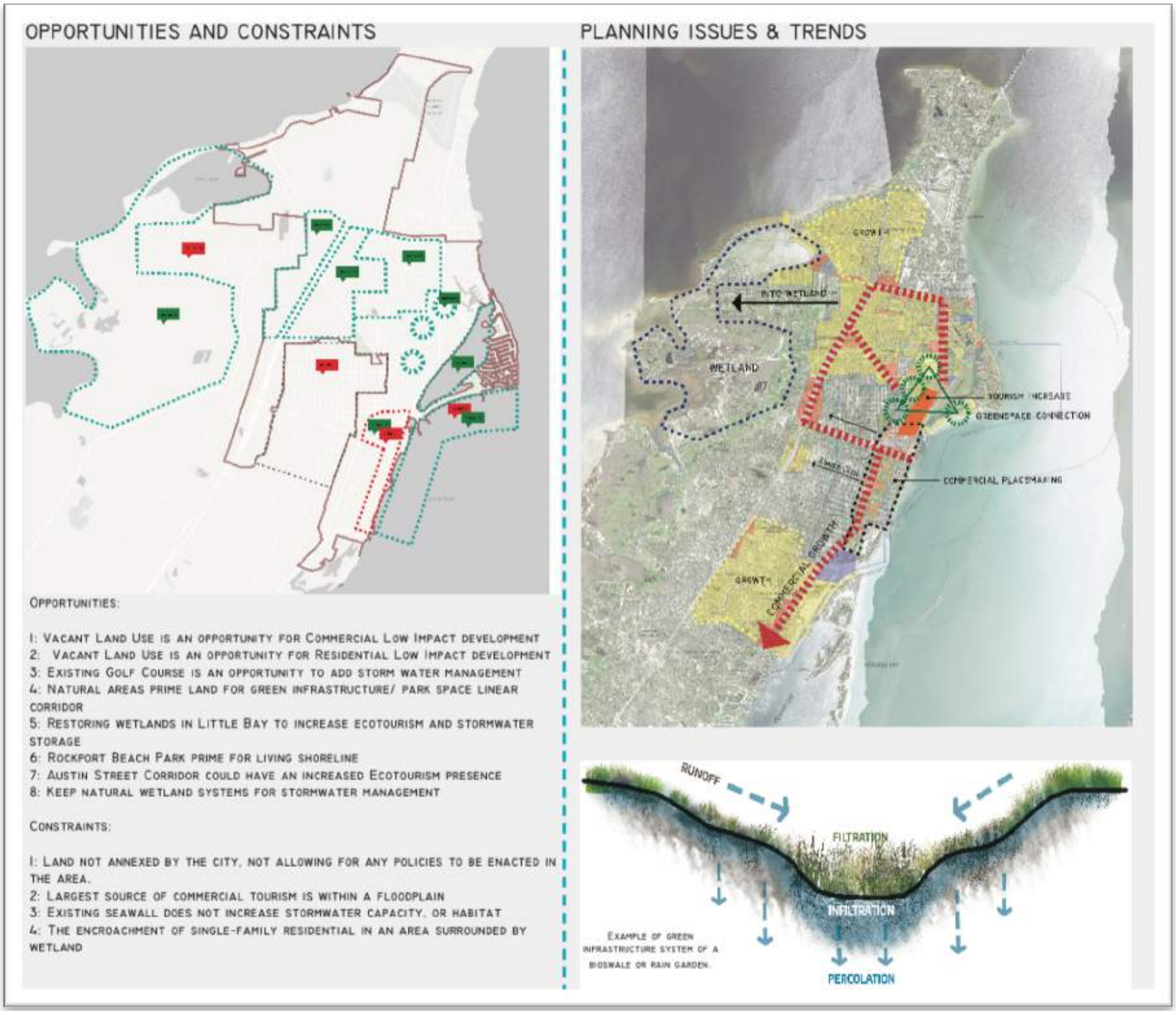

Figure 15: Opportunities for, and constraints to, growth in Rockport and Aransas, County, Texas, identified through an analysis of existing conditions. Bioswale/rain garden detail shown. Source: Michael Tsapos.

8. GREEN INFRASTRUCTURE & LOW IMPACT DEVELOPMENT ACROSS THE ROCKPORT AND ARANSAS COUNTY TRANSECT

Because the Transect exists as *place* and *evolves* over time, it is specific to location—meaning the Transect for Austin, Texas, for instance, will be different from that of Rockport, Texas. As described by Andrés Duany, the use of the Transect in design and development promotes "immersive environments" where the whole is greater than the sum of its parts. Thus, all urban elements can be situated in the Transect continuum. By way of example, a split-rail fence is appropriate in the T2 Rural zone but would be out of place in the T5 Urban Center. Likewise, street and road design will vary across the Transect from dirt to gravel to paved, to the addition of curbs, wider rights-of-way, and medians.

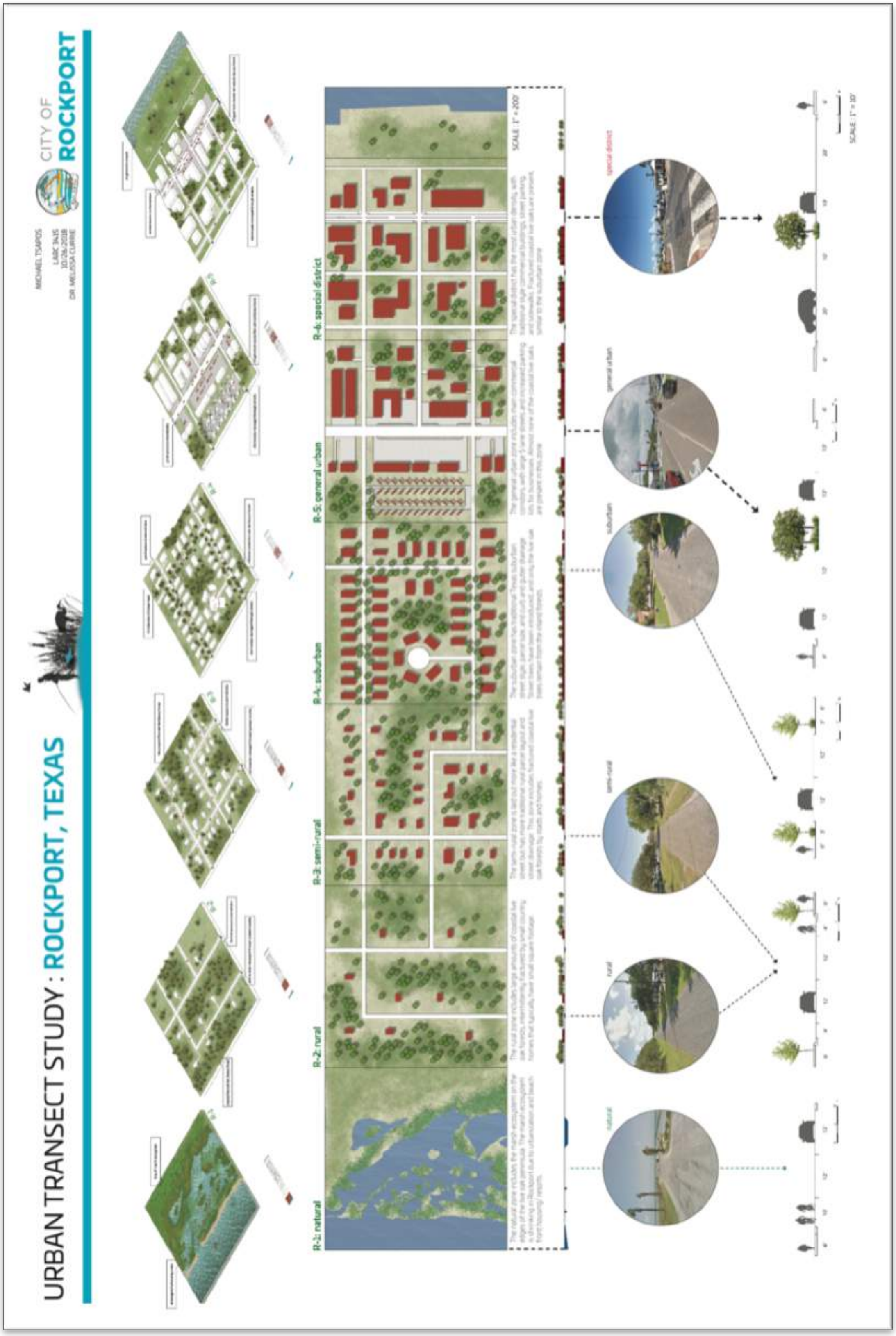

Figure 16: Rockport and Aransas County, Texas, Transect with Roadway Details. Source: Michael Tsapos.

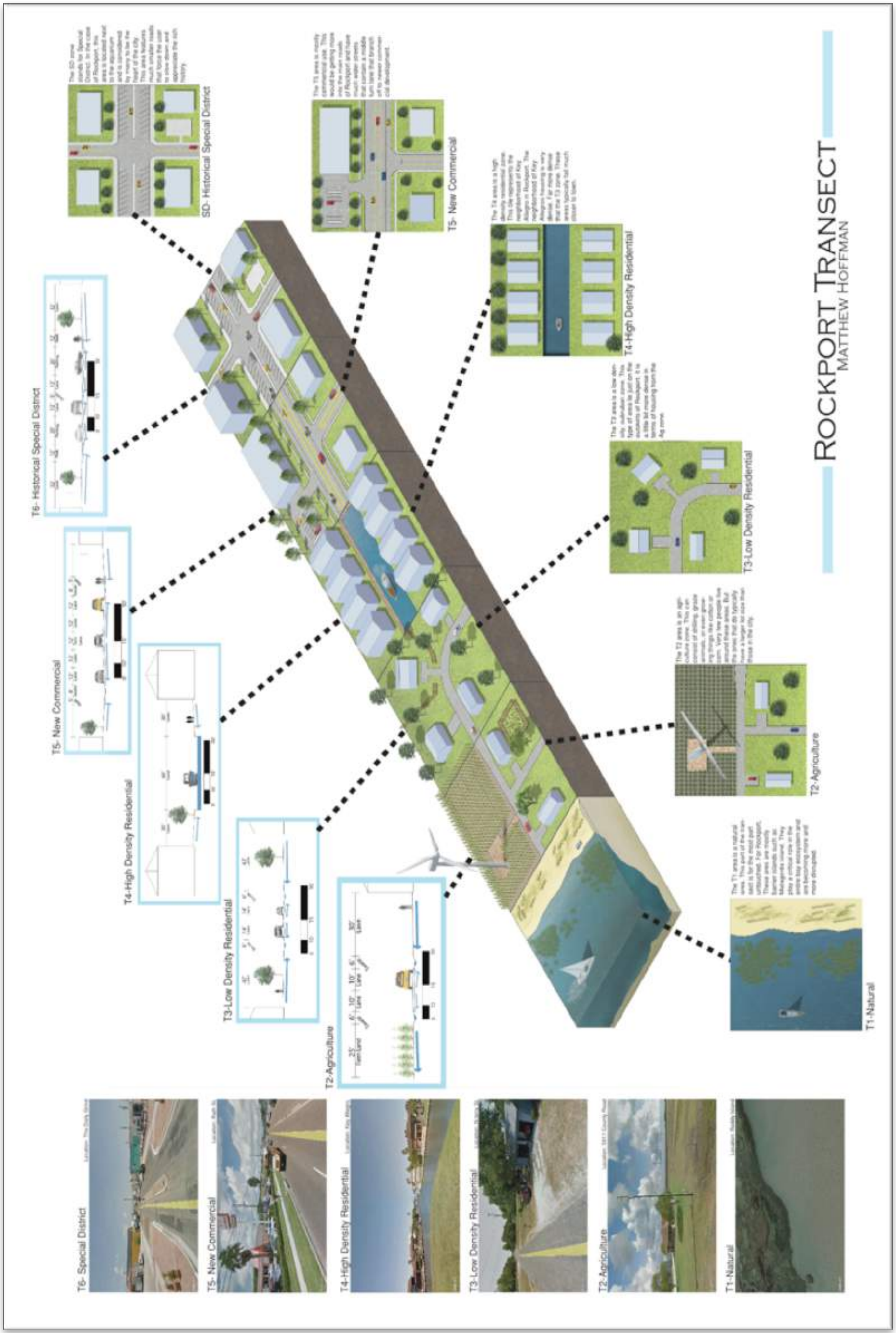

Figure 17: Example Transect for Rockport and Aransas County, Texas, showing existing road conditions and applicable proposed roadway sections across the Transect. Source: Matthew Hoffman.

The Transect developed for Rockport/Aransas as a part of these guidelines include zones T1 Natural through T5 Urban Center plus the SD Special District (Figures 16 and 17). The SD zone encompasses the Rockport Heritage District in downtown, extending several blocks east and west of Austin Street and between Liberty and Market Streets. Figure 18 depicts a detailed Transect for the local T1 Natural zone expanding inland from the Gulf of Mexico through the estuarine system of bays and coastal wetlands.

Figure 18: Detailed T1 Natural Zone Transect for Rockport and Aransas County, Texas. Source: Grant Huber.

Student projects representative of potential development within the Transect zones across Rockport and Aransas County and prepared during the Fall 2018 semester are included in the attached appendix. Selected excerpts containing suggested uses for each Transect zone and site-level LID/GI interventions are contained in the following sections. Proposals address stormwater management needs, plant and material palettes, and the implementation of low-impact development, smart growth, and green infrastructure methods. When viewed as a comprehensive vision the projects begin to demonstrate how the “sponge city” concept can be realized in Rockport.

9. TRANSECT ZONE GUIDELINES AND EXAMPLE PROJECTS

9.1 T-1 Natural and T-2 Rural Transect Zones

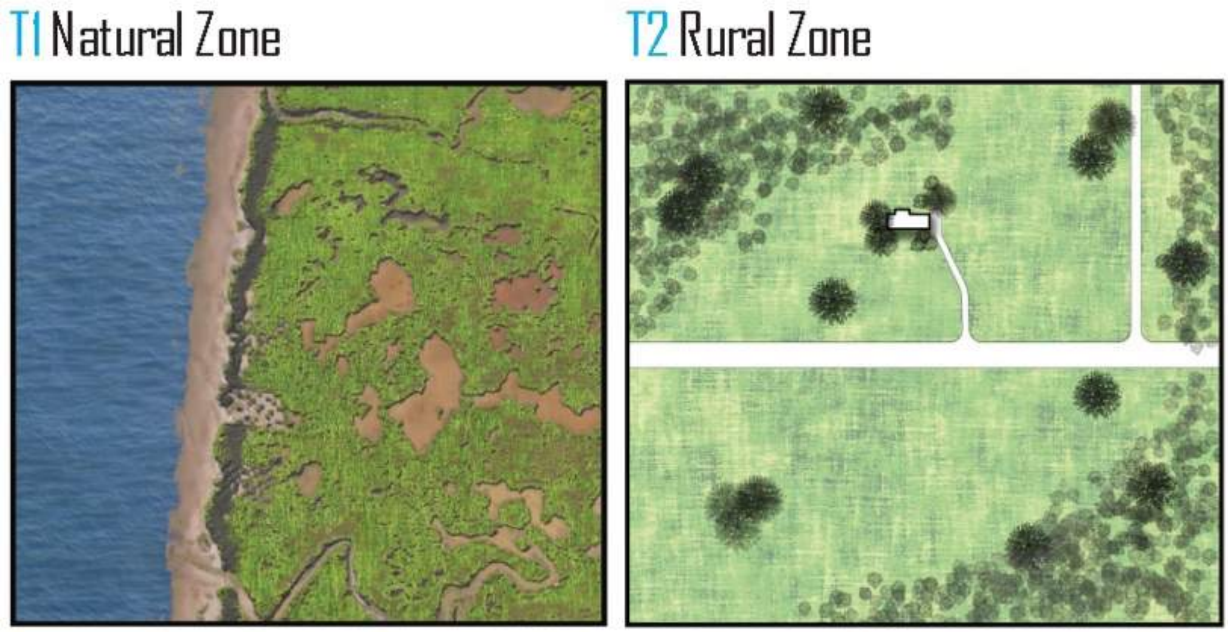

Figure 19: T-1 and T-2 Transect zones. Source: Connor Jones.

Recommended uses in the T1-Natural zone include lands for ecological restoration, constructed wetlands, trail and/or bikeway networks, regional or large parks, and nature preserves. Development is discouraged.

Recommended uses in the T2-Rural zone include farming/agriculture, large-lot residential (1-ac or larger), industrial agriculture, camps, large parks and recreation, greenways, and ecological or agricultural tourism. Roads maintain a rural condition.

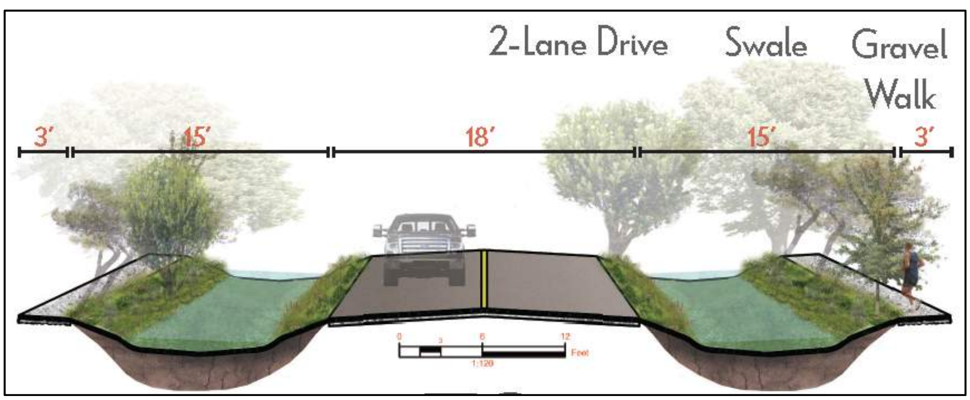

Figure 20: Typical Roadway Section in the T-2 Rural Transect zone. Source: Grant Huber.

Figure 21: T-1 Transect zone example project addressing issues of flooding, pollution, and the degradation of coastal wetlands, bays, and prairies, while educating and engaging the community in its connection to nature. An ecological restoration focus around Port Bay features proposed oyster reef rejuvenation, a regional wetland park, and bauxite remediation. Source: Grant Huber.

Figure 22: T-1 Transect zone example project combining multiple recreational uses, birdwatching, and ecological restoration along the shoreline. Source: Connor Jones.

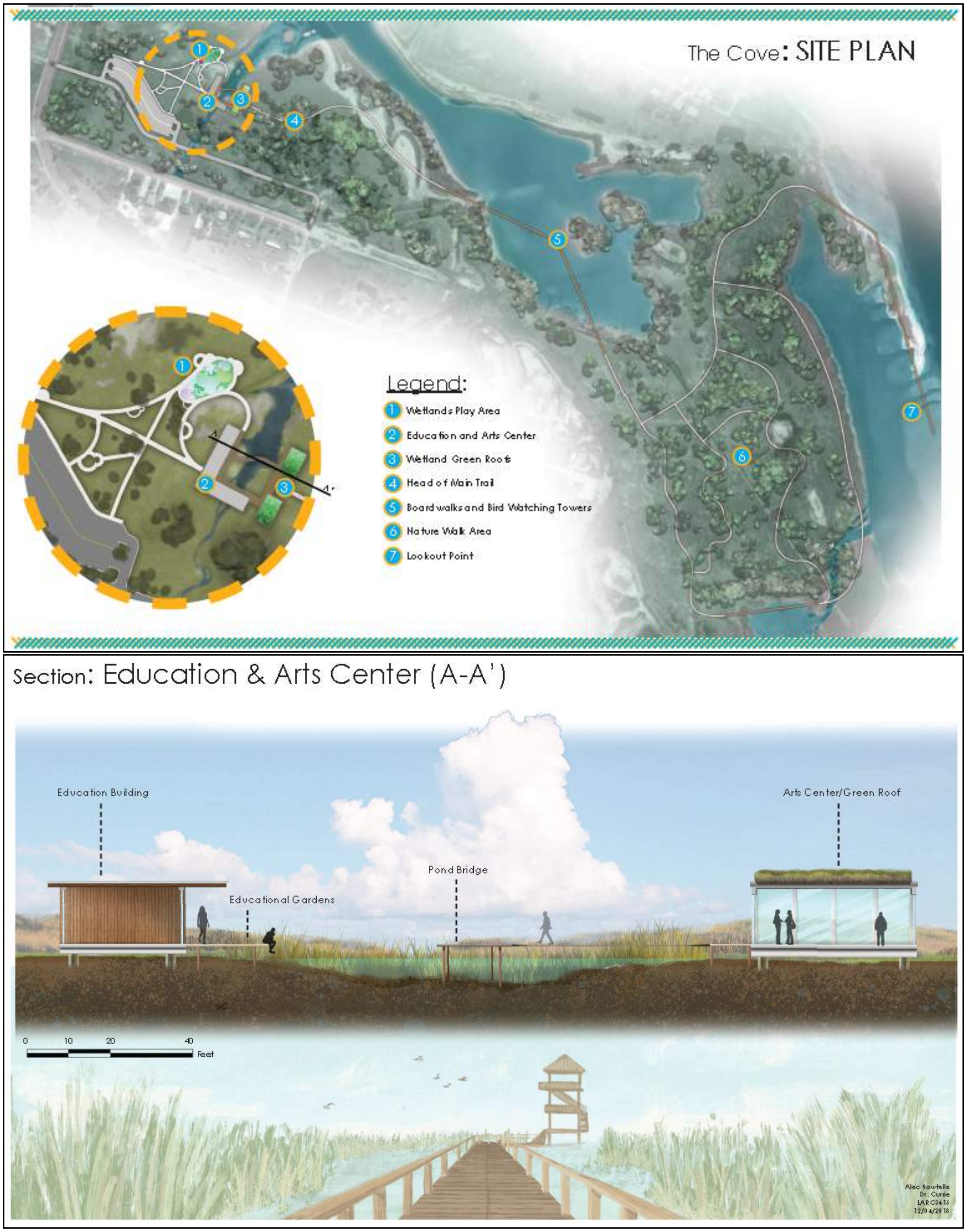

Figure 23: T-1 Transect zone example project featuring a constructed wetlands, education and arts center, lookout towers, elevated boardwalk, and nature walks. Source: Alec Sawtelle.

Figure 24: T-2 Transect zone example project featuring a 367-acre site combining recreation, resilience, and research. Design features include an Environmental and Agricultural Research Facility, outdoor amphitheater, eco-hotel, wedding chapel, extensive walking trails, and campgrounds. (Note: only lower half of site is shown). Source: Grayson Borchardt.

9.2 T-3 Sub-Urban and T-4 General Urban Transect Zones

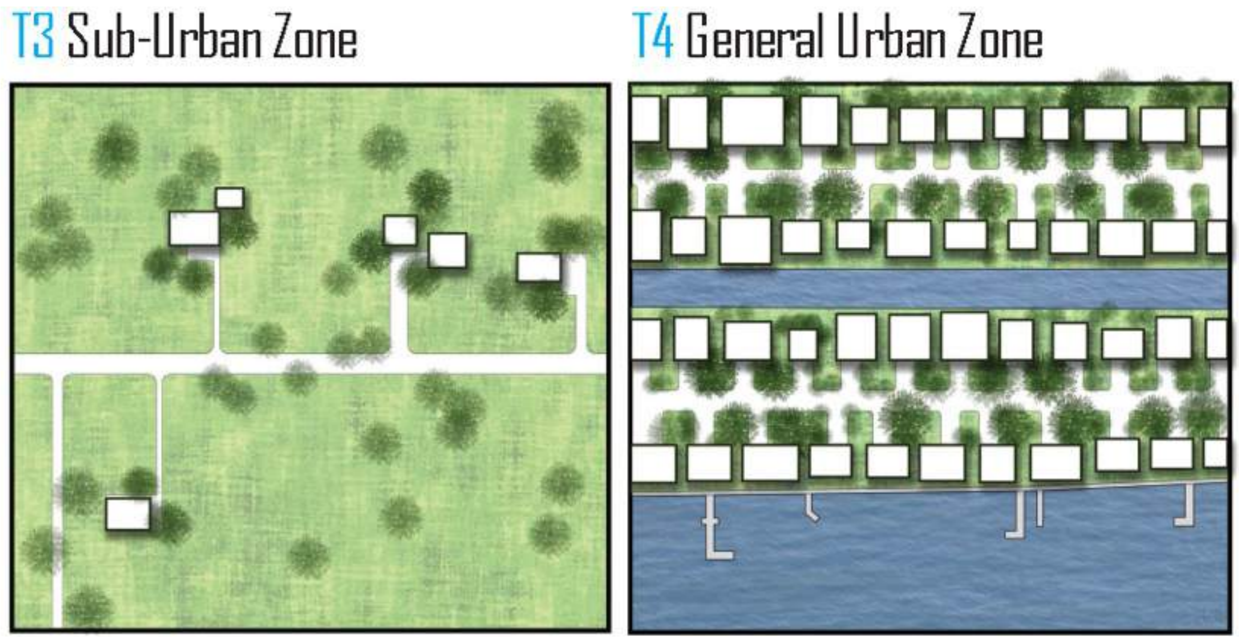

Figure 25: T-3 and T-4 Transect zones. Source: Connor Jones.

Recommended uses in the T3-Sub-Urban zone include residential, small-scale commercial, tourist attractions, small farms, and recreational parks. Some mixed-use may occur, but big-box retail is discouraged. Residential density should range between 2 to 8 units per acre, lot sizes up to 2-acres, and front setbacks 20 to 40 feet from roadways. Few curbs on roads.

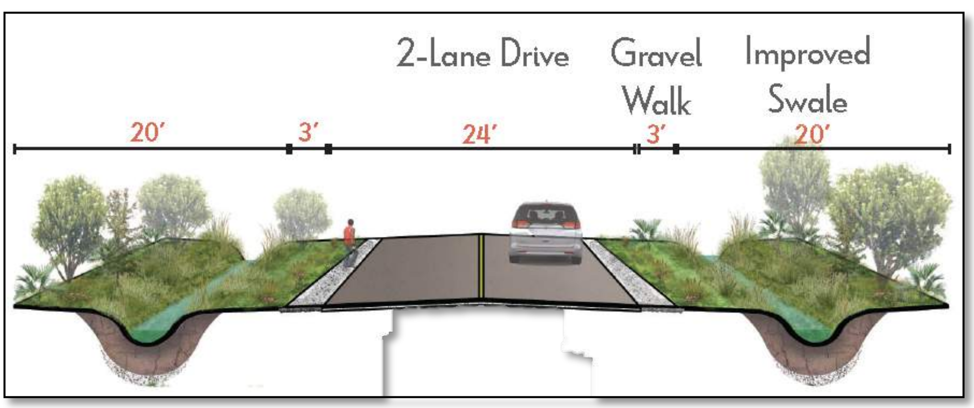

Figure 26: Typical Roadway Section in the T-3 Sub-Urban Transect zone. Source: Grant Huber.

Recommended uses in the T4-General Urban zone include medium- to high-density residential, mixed use areas, commercial developments, parks, tourist attractions, and educational, civic, or institutional uses. Walkability is stressed with neighborhood centers accessible within a five to ten-minute walk. Setbacks from roadways are suggested at 5 to 25 feet with front porches encouraged. Streets should have sidewalks and curbs on both sides. Residential lots are smaller than in T-2 or T-3 zones with densities ranging between 6 to 20 units per acre.

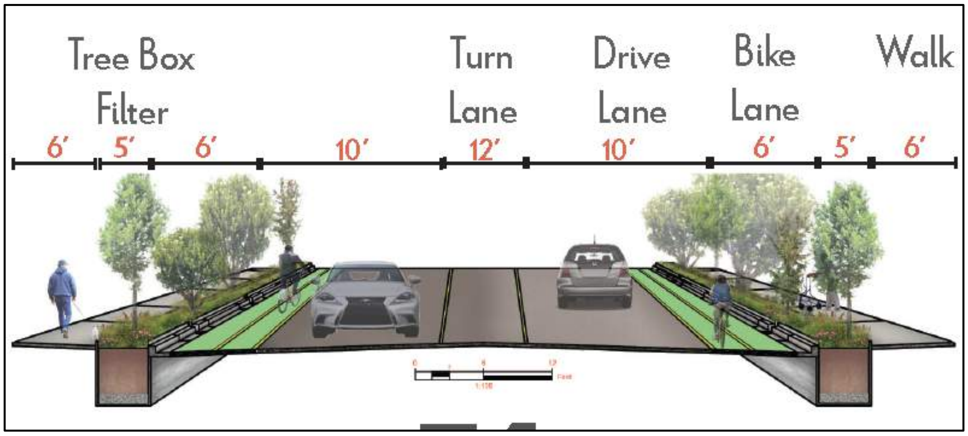

Figure 27: Typical Roadway Section in the T-4 General Urban Transect zone. Source: Grant Huber.

Figure 28: T-3 Transect zone example project showing a boardwalk within a proposed wetland recreation park and Botanical Garden near residential development. Source: Cuauhtemoc Zaragoza.

Figure 29: T-3 Transect zone example project featuring a large greenspace surrounded by mixed residential uses. Source: Cuauhtemoc Zaragoza.

Figure 30: T-4 Transect zone example mixed-use project combining development with nature. The design features commercial, hotel, and residential development surrounding by a boardwalk system, mangroves, and wetlands. Source: Ryan Beatty.

Figure 31: T-4 Transect zone example project creating a network of "blue" open spaces forming a new "Heritage District." The Blue Ribbon will provide major entertainment/recreation opportunities and connect Port Bay and Aransas Bay while providing flooding and storm attenuation. Source: Christopher Perez.

9.3 T-5 Urban Center and SD Special District Transect Zones

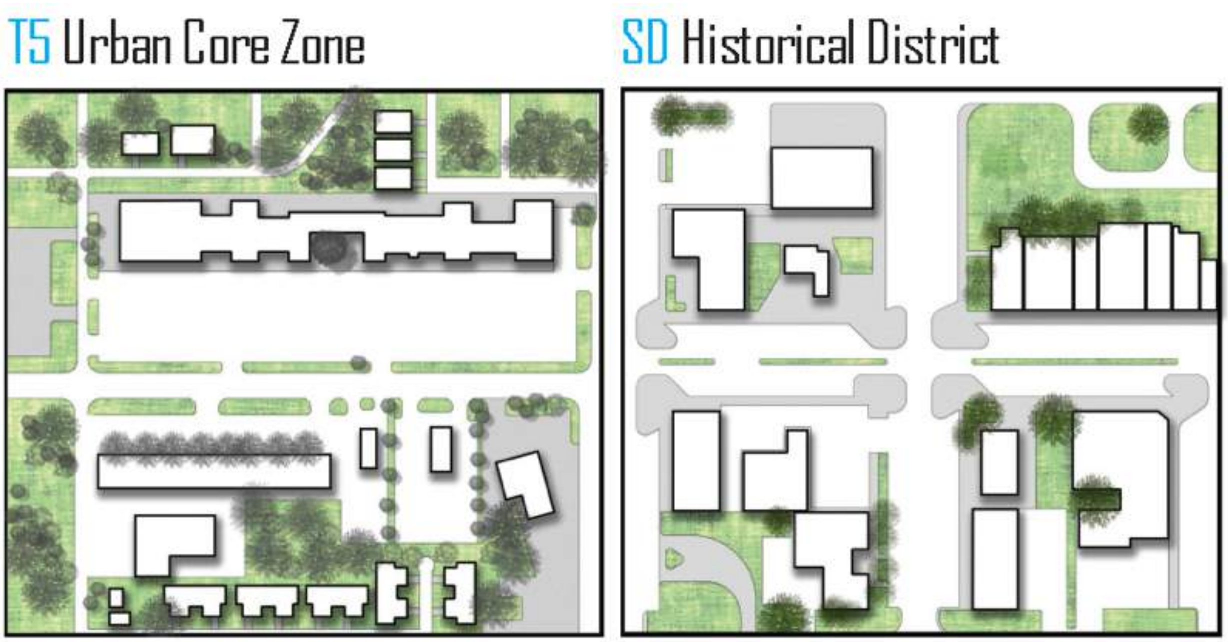

Figure 32: T-5 and SD Transect zones. Source: Connor Jones.

Recommended uses in the T5-Urban Center zone include various residential uses such as multifamily, small lot single-family, duplexes, or townhomes; mixed-use centers; schools; more intensive commercial development; small parks or plazas; and civic and institutional uses. Residential density should range between 10 to 40 units per acre, front setbacks are short and sidewalks wide. Roadways include boulevards and have an urban feel with curbs, medians, and street trees.

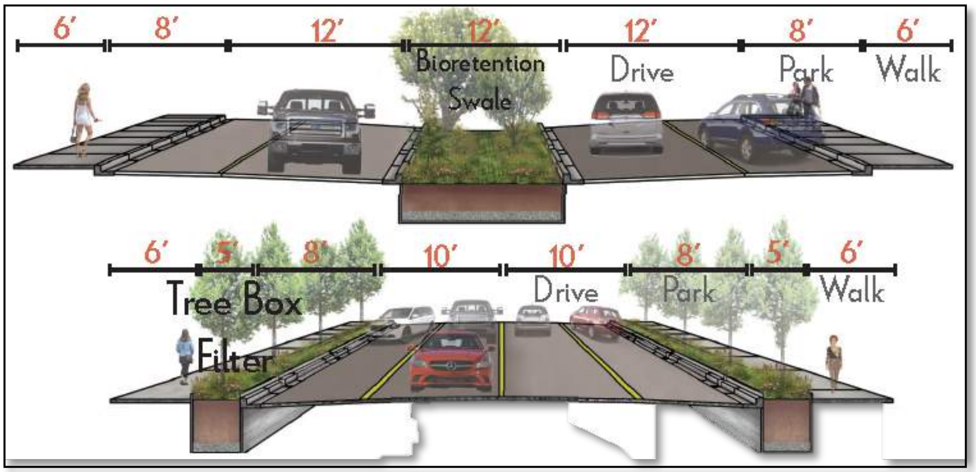

Figure 33: Typical Roadway Sections in the T-5 Urban Center Transect zone. Source: Grant Huber.

Recommended uses in the SD-Special District zone include preservation of the historic district, office, special tourist areas, retail, civic, residential uses (plus those above businesses) and commercial uses of all types. Street trees, wide sidewalks, and no- to short front and side setbacks create a continuous building front along sidewalks to promote pedestrian and bike activity. Connections to adjacent neighborhoods and waterfront are encouraged. On-street parking is typical.

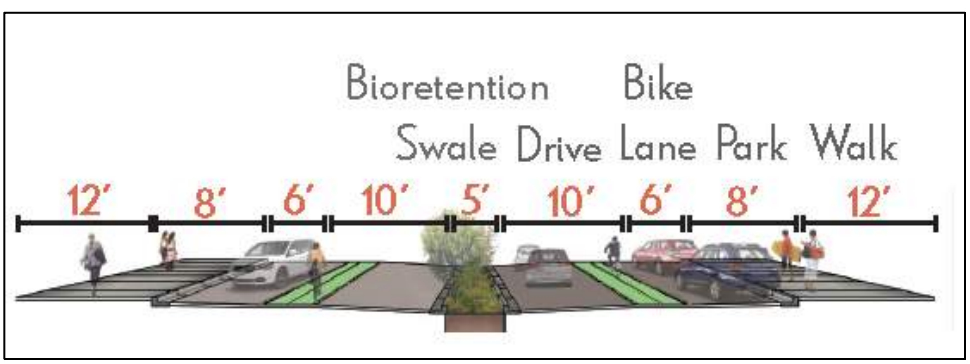

Figure 34: Typical Roadway Section in the SD Special District Transect zone. Source: Grant Huber.

Figure 35: T-5 Transect zone example mixed-use project featuring a connected bioswale system reaching to the Bay. Residential, parks, and commercial spaces are included with a green roof corridor. Source: Arturo Villalba.

Figure 36: SD-Special District Transect zone example project featuring a new City Hall anchored by a lighthouse within a mixed-use neighborhood. A round-about connects the redesigned neighborhood to a linear park creating a dynamic gateway to the city. Source: Samantha Stec.

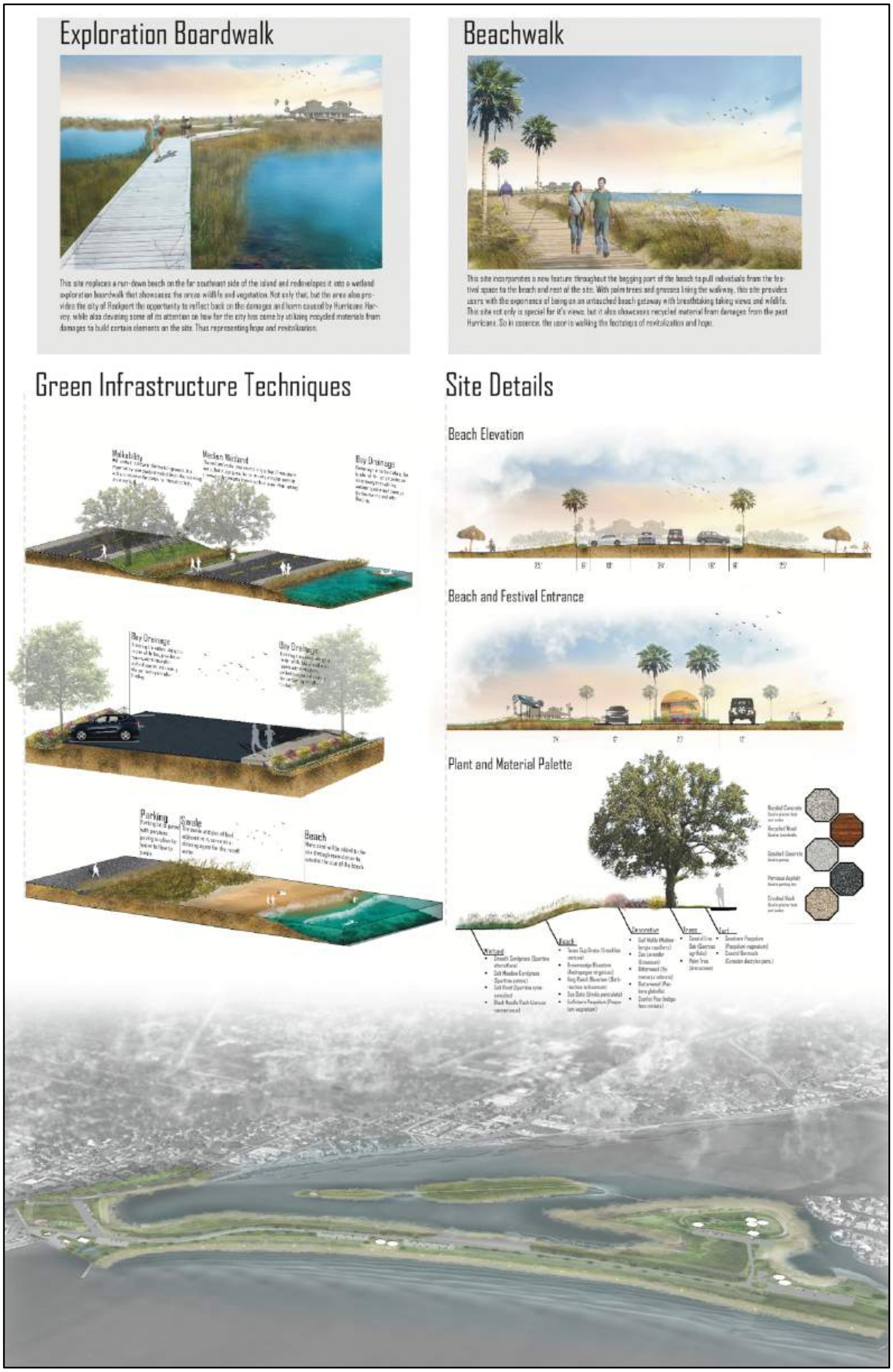

Figure 37: SD-Special District Transect zone example project at Rockport Beach. Source: Andrew Castilleja.

Figure 38: SD-Special District Transect zone example project featuring a created salt marsh along Little Bay to increase stormwater capacity, protect from storm surge, and serve as a regional park system. A berm system, sediment traps, and floating wetlands protect the existing retail areas and proposed aquarium, amphitheater, yacht club, and park. Source: Michael Tsapos.

10. LID/GI SITE-LEVEL IMPLEMENTATION EXAMPLES

Figure 39: Potential LID application directs runoff into a rain garden in an institutional or civic setting. Source: Grayson Borchardt.

Figure 40: T-1 A Wetland Recreational Center and walking paths filter runoff and allow for groundwater recharge. Source: Mario Carranza.

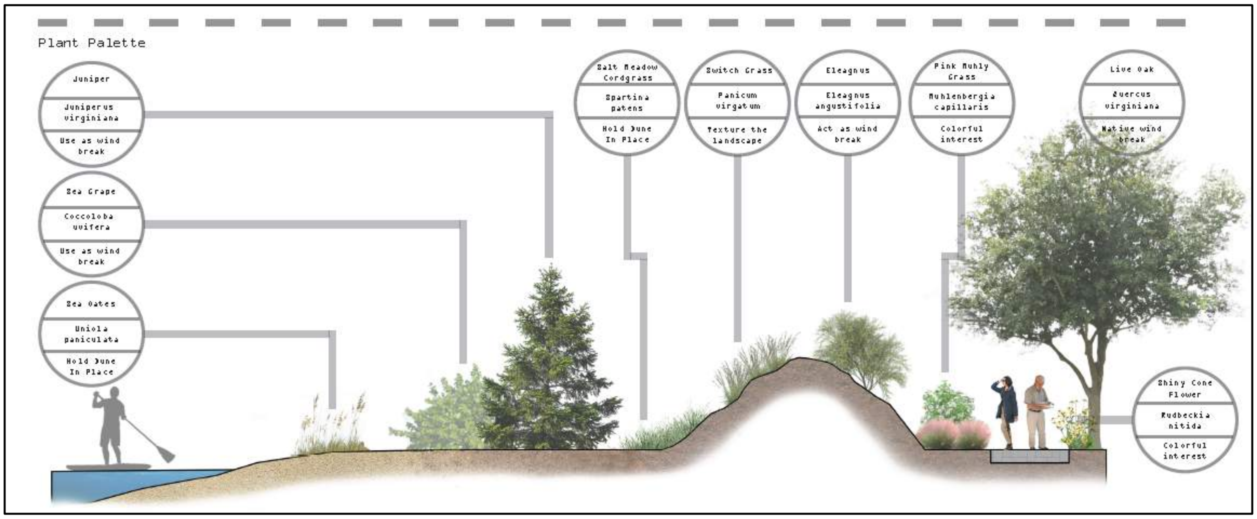

Figure 41: Raised berms protect the Historic District from flooding and provide new opportunities for recreation. Source: Matthew Hoffman.


Figure 42: Proposed mangroves, raised house elevations, and short trees protect homes from flooding and wind damage in residential development. Source: Ryan Beatty.

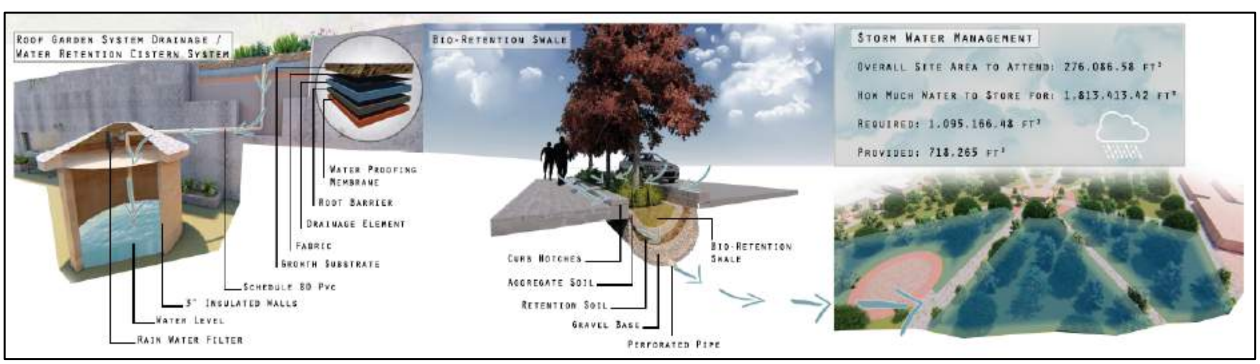

Figure 43: A variety of low-impact development techniques combined on a site work together for cumulative benefits. Source: Arthur Villalba.

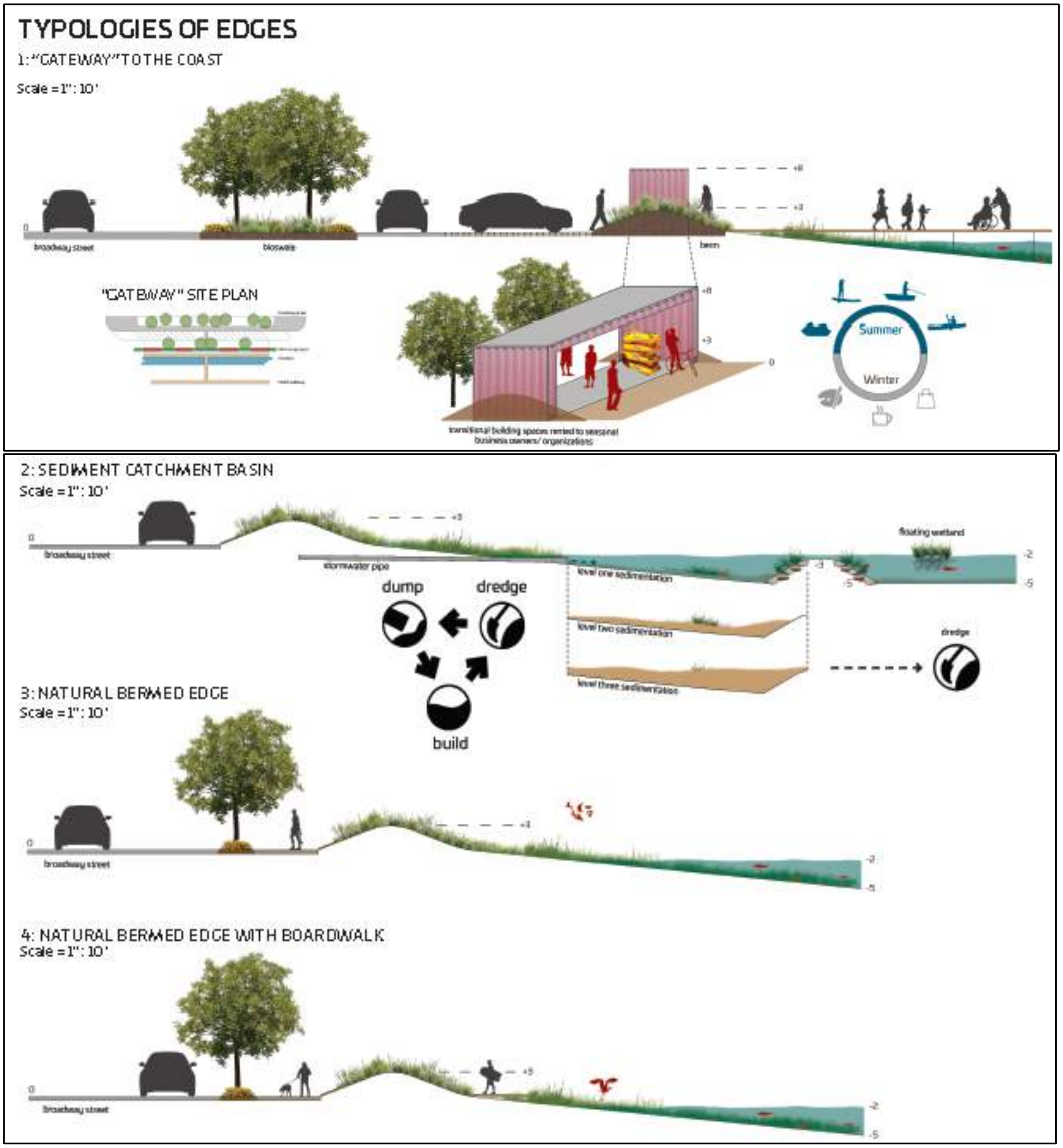

Figure 44: A shoreline protection strategy is combined with a variety of low-impact development techniques encourage a healthy shoreline and ecotourism industry. Source: Michael Tsapos.

11. STUDIO INFORMATION

Fall 2018 Regional Planning Studio
Texas Tech University, Department of Landscape Architecture
Melissa A. Currie, PhD, RLA

Graduate Teaching Assistant: Tyson Watson

Students:

T1	Mario Carranza	T2	Brandon Berend	T3	Elizabeth Lane
	Grant Huber		Grayson Borchardt		Jake Owen
	Connor Jones		Oscar Flores		Jimmy Rosenkranz
	Chris Rhinehart		Cody McCord		Tyler Smith
	Alec Sawtelle		Matthew Walls		Cuauhtemoc Zaragoza
T4	Bryce Arrington	T5	Kimberly Bonilla	SD	Andrew Castilleja
	Ryan Beatty		Landrey Edwards		Matthew Hoffman
	Christopher Perez		Robert Garza		Jake Irvin
	Marie Reinke		Hayden Vanskike		Samantha Stec
	Elijah Simpson		Arturo Villalba		Michael Tsapos
	Hayden Vilfordi				

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