REEXAMINING THE FUNCTIONS OF URBAN BRIDGES WITH NATURE AND PEOPLE IN MIND: A VISION FOR NORTH MAIN STREET BRIDGE FORT WORTH, TEXAS

By Amanda Hinton

THESIS

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SUPERVISING COMMITTEE:

Chair: Taner R. Ozdil, Ph.D.

Member: Diane Jones Allen, Ph.D.

Member: Amy A. Archambeau, Ph.D.

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ABSTRACT

REEXAMINING THE FUNCTIONS OF URBAN BRIDGES WITH NATURE AND PEOPLE IN MIND: A VISION FOR NORTH MAIN STREET BRIDGE FORT WORTH, TEXAS

Amanda Hinton, MLA

The University of Texas at Arlington, 2023

Supervising Faculty: Taner R. Ozdil, Ph.D., ASLA

How can nature be incorporated into infrastructure bridges to promote connections in urban landscapes? The Paddock Viaduct, known today as the North Main Street Bridge in Fort Worth, Texas was formally opened on July 3, 1914. Designed by Brenneke and Fay to improve transportation to the North Fort Worth district, the bridge was the first reinforced concrete arch bridge in the nation to use self-supporting reinforcing steel and ball and socket joints (Paddock Viaduct - Main - Historic Fort Worth, 2017).

Fort Worth in the mid-1900s, like many growing cities, was experiencing the repercussions of heavy flooding issues that come when a city's infrastructure expands beyond the capacity of its local river corridor's ability to process excess stormwater runoff. Federal funding was used in hopes of strengthening the Trinity River's levees by straightening the Clear Fork and West Fork of the Trinity. Through this process, the natural meandering flow of the river was replaced by a channel system. Thousands of trees that lived in the escarpment banks were wiped out, and the levees became barriers that kept both flood waters at bay and people away (Panther Island - Central City Flood Project, 2022). With the influence of the "Halprin Plan" and the creation of the Trinity River Master Plan (*Confluence: The Trinity River Strategic Master*

Plan, 2018), steps have begun to be taken to mitigate damage caused to the local ecosystem and continuous flooding hazards.

The purpose of this thesis research is to re-examine the functions of urban bridges to blend nature, people, and vehicles while illustrating a vision by designing North Main Street infrastructure bridge along the Trinity River Corridor at Panther Island, Fort Worth, Texas. The goal is to investigate how the structure can be improved to be a vital connection and an extension of nature to strengthen the relationship of both people and urban landscapes across the Trinity's levee. This research studies how a conventional infrastructure bridge can be improved to support nature while being a functional amenity to people and vehicles.

This research uses qualitative techniques to explore the research questions in this master design thesis (Sommer & Sommer, 2002; Deming & Swaffileld, 2011). The methodology consists of using *People Places* approach of examining case studies nationwide to analyze the success of the design elements implemented in the increasingly popular deck parks and plazas such as Salesforce Park in San Francisco, California (Francis & Marcus, 1998). By analyzing the effects of crossings and bridges built for wildlife that have been implemented in an urban setting, we can similarly analyze the benefits of improving the North Main Street bridge along the Trinity River corridor that connects downtown Fort Worth, Texas to the master planned Panther Island district. The research findings demonstrate the positive impacts associated with reconnecting fragmented communities that were in some way separated before. The findings and literature also reveal the beneficial effects of incorporating more natural elements into a design and into urban areas. By combining these, the research shows the added potential a space like these can create recreationally with amenities for the communities.

In conclusion, the historical significance of the North Main Street Bridge in Fort Worth, Texas, should not be understated - it was an innovative engineering feat that played a crucial role in improving transportation for the region. However, as we look to preserve its historical design, we must also ask ourselves how we can incorporate nature into similar infrastructure projects to promote sustainability, connectivity, and community in urban landscapes. By exploring the potential of the design elements retrieved from the research, blending a design seamlessly with the natural environment creates infrastructure that is not only functional but also enhances the quality of life for all those who use it. This research demonstrates how integrating natural elements into design projects, such as bridges in urban landscapes, can enhance connectivity for both pedestrians and vehicles. By proposing a redesign and enhancement of the North Main Street Bridge in Fort Worth, Texas, this study highlights the potential of incorporating multimodal access to create a more cohesive and sustainable urban environment.

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Chapter 1: Introduction

1.1 Background to study

As cities continue to urbanize, it's important to explore ways to expand green spaces within them. Oftentimes in developing landscapes such as cities, nature is overlooked, and open undeveloped land is highly desirable. There is a notion that acquiring and developing urban spaces is necessary for preservation. What if this could be reversed in a way that we instead redevelop the existing infrastructure to restore some of nature and create a new balance?

To an unfamiliar eye, sitting just north of downtown Fort Worth, Texas along the West Fork of the Trinity River, a grove of trees clings to a small well-preserved escarpment. North Main Street Bridge serves as the connection that carries vehicles from the top of the escarpment adjacent to downtown, down to the Panther Island district across the river and the levees.

Urban developments and cities are here to stay. They are only increasing in size and density as time goes on. As a society, we used to live by and work with nature, but in today's world, we see less and less of it in our daily lives. The beauty of nature is that it is regenerative and adaptive. Experiments conducted by the *American Psychological Association* have found that being exposed to natural environments improves working memory, cognitive flexibility, and attentional control, while exposure to urban environments is linked to attention deficits. "There is mounting evidence, from dozens and dozens of researchers, that nature has benefits for both physical and psychological human well-being," says Lisa Nisbet, Ph.D., a psychologist at Trent University in Ontario, Canada, who studies connectedness to nature (Weir, 2020 p. 50). "You can boost your mood just by walking in nature, even in urban nature. And the sense of

connection you have with the natural world seems to contribute to happiness even when you're not physically immersed in nature." (Weir, 2020).

Realizing the immediacy of these concerns, this design thesis will explore how natural spaces can be increased and integrated into an urban environment. When less typical places are looked at, their utilitarian use can be reexamined to become a biodiverse recreational amenity. Considerations for how to connect people back to nature, by reconnecting fragmented landscapes and disconnected communities within a city will be explored in all aspects.

1.2 Purpose of study

The purpose of this study is to re-examine the functions of urban bridges to blend nature, people, and vehicles while illustrating a vision by designing North Main Street infrastructure bridge along the Trinity River Corridor at Panther Island, Fort Worth. The goal is to investigate how the structure can be improved to be a vital connection and an extension of nature to strengthen the relationship of both people and urban landscapes across the levee.

1.3 Research Questions

1. How can nature be incorporated into infrastructure bridges to promote connections in urban landscapes?
2. How can connections be improved with multimodal access for both pedestrians and vehicles in urban landscapes?
3. What can be learned from the design of North Main Street bridge in Fort Worth, Texas?

1.4 Definitions of Key Terms

Adaptive Reuse is the process of adapting old structures and sites for new purposes (Pape, 2018).

Ecosystem Restoration is the process of assisting in the recovery of an ecosystem that has been degraded, damaged, or destroyed (*What is Ecological Restoration, 2023)*

Fragmentation breaking up a larger/intact habitat into smaller dispersed patches (*Dramstad,* 1996)

Multimodal Transportation includes public transportation, rail and waterways, bicycle, and pedestrian. Multimodal access supports the needs of all users whether they choose to walk, bike, use transit or drive (*Multimodal Transportation,* n.d.-b).

Urban Ecology is the study of the ways that human and ecological systems evolve together in urbanizing regions (Niemela et al., 2011).

Urbanization refers to the concentration of human populations into discrete areas. This concentration leads to the transformation of land for residential, commercial, industrial and transportation purposes (*Urbanization - Overview*, 2022).

Viaducts are long elevated roadways usually consisting of a series of short spans supported on arches, piers, or columns ("Definition of Viaduct," 2023).

1.5 Research Methodologies

This research uses qualitative research methods to examine the benefits and opportunities of improving the infrastructure of bridge connections in an effort to blend urban sprawl and nature (Sommer, 2002; Deming & Swaffileld, 2011). The research looks at multiple aspects of the design and thus requires a multi-method approach to be successful. The research begins by collecting literature and reviewing precedent studies through the literature review, see figures 5 – 9. The analysis continues by reviewing secondary data sources with in the literature, and is further advanced through passive observations with visits to the site. Finally the research is concluded with analysis of four case studies looking at different typologies of bridges ranging

from a rooftop park, a land bridge, and two elevated parks with one involvoing working with historical infrastructure (see figures 21 – 26). These methods come together to analyzing the benefits of improving upon bridges built within an urban setting, such as North Main Street bridge along the Trinity River corridor, to blend its design seamlessly with the surrounding natural environment while improving its functionality.

The procedures consist of using *People Places* approach of examining case studies nationwide to analyze the success of the design elements implemented in the increasingly popular deck parks and plazas such as Salesforce Park in San Francisco, California (Francis & Marcus, 1998). By analyzing the effects of crossings and bridges built for both wildlife and people, and that have been implemented in an urban setting, we can similarly analyze the benefits of improving the North Main Street bridge along the Trinity River corridor that connects downtown Fort Worth, Texas to the master planned Panther Island district.

1.6 Significance and Limitations

Urbanization and growth seem to happen regardless of their impact on the natural environment and preservation efforts. This study has potential to bring attention to the need to incorporate nature into a design and planning efforts as part of development practices. So, the significance of this specific research is the development of a model concept for designers and planners to be able to implement across future improvement projects of infrastructure along the Trinity River Corridor.

However, this study is focused on the Trinity River Corridor with its unique wooded escarpment and may not be applicable to other regions. Fort Worth, Texas lies within the Cross Timbers and Prairies ecological region. Early travelers to this region coined the name “cross timbers” based off their repeated encounters with timbered areas that acted as barriers to their

travel over the prairies. Today, there are few large tracts of undisturbed woodlands remain, and it is possibly one of the most fragmented vegetative corridors in Texas. Many of the woodlands in this region have been cleared for pastures, croplands, horse and cattle ranches, and urban and rural developments, including portions of the cities within the DFW metroplex. Continuous urban growth and expansion throughout this region will continue to impact wildlife habitat resources in the future (Cross Timbers and Prairies Ecological Region, n.d.).

Limitations to the study include the knowledge and research of the researcher within the landscape architecture field. Collaboration with structural engineers, civil engineers, architects, and other related experts will need to be conducted for conception of a masterplan. The research is additionally limited to the site selection of a vehicular bridge that spans across the Trinity River, Trinity Trails, and portions of the adjacent levee embankments.

1.7 Chapter Summary

The purpose of this design thesis is to study and examine the possibilities associated with bringing nature and people together by redesigning aged infrastructure bridge. This research specifically focusses its attention on a narrowing escarpment located on the banks of the Trinity River between Downtown Fort Worth and Panther Island which envisioned to be a new site for a mixed-use development.

Chapter One introduced and defined the purpose of this research, focusing on research questions, terms, and study procedures. Chapter Two outlines and reviews current literature related to matters of the study such as effects of fragmented landscapes, critical local improvement projects and masterplans, and precedent studies with similar concerns and focus. Chapter Three provides a description of the research methods used in this thesis. Chapter Four focuses on the analysis and findings gathered from selected case studies. Chapter Five

concentrates on the design process, including a schematic design to envision a new form of bridge to address these concerns. Chapter Six then summarizes and concludes the study.

Chapter 2: Literature Review

2.1 Nature in the Built Environment

Landscape architecture is simplified to be the study and practice of designing the outdoor environment. It is the planning, designing, researching, and stewardship of the built and natural environments. Landscape architecture and planning are disciplines focused on landscape change (Collinge, 1996). Ecological design on the other hand is a design method that "minimizes environmentally destructive impacts by integrating itself with living processes" (Van der Ryn and Cowan, 1996). It aims to preserve the original biological diversity of a site, minimize soil erosion, and reduce invasions of exotic species (Collinge, 1996, as cited in Kreiger, 1991).

The goal of ecological studies for design is to understand the spatial composition in the landscape being manipulated. Spatial composition in landscape ecology describes the landscape as if it could be broken up into sections of forms and patterns. This then can be used to create a spatial hierarchy, where certain areas of a space feel more important than others. By combining the thoughtful intent of landscape ecology with landscape architecture principles that focus on improving a space with meaningful development, we create an opportunity for future change and direction in design.

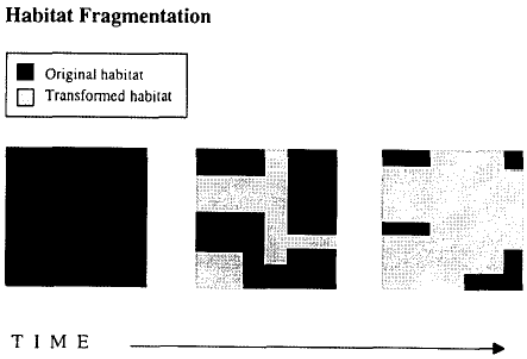


Fig. 1. Diagrammatic representation of the generalized process of habitat fragmentation. Dark areas refer to the original habitat type, light areas to transformed habitat. Over time, the original habitat type is reduced in area, and remnants of the original habitat type are isolated from one another.

Figure 1 Habitat Fragmentation
Source: Ecological Consequences of Habitat Fragmentation: Implications for Landscape Architecture and Planning

2.1.1: Fragmentation

The alteration of "prairie to agricultural field, from old-growth forest to clear-cut, and from coastal scrub to housing development" sends a rift through native ecosystems (Collinge, 1996, p 60). Urbanization, development, and conversion of the land alter the integrity of ecological systems. This disruption may allow invasive species of both plants and animals to overtake native habitats. After modifications have settled, the remaining original inhabitants of the land are left with an area that has been predominantly reduced in size. The resulting area can be left disconnected from previously adjacent habitats (Fig. 1) leaving populations of plants and animals subdivided, which can increase the probability of extinction (Wilcox, 1980; Wilcove et al., 1986; McNeely et al., 1990; Saunders et al., 1991 as cited in Collinge, 1996).

Naturalists, conservationists, and land managers generally refer to these two components of land transformation, habitat loss, and isolation, as 'habitat fragmentation.' Habitat fragmentation has been called "the most serious threat to biological diversity and… the primary cause of the present extinction crisis" (Wilcox & Murphy, 1985, p. 884 as cited in Collinge, 1996).

Throughout history, naturally occurring disasters were the cause of isolated habitats or reduced populations of plants and animals. However, today this same form of habitat fragmentation is caused by the intense development associated with the continually growing population and urbanization. In its strictest sense, 'fragmentation' is the breaking of a whole into smaller pieces (American Heritage Dictionary, 1979; Zipperer, 1993; Forman, 1995 as cited in Collinge, 1996). Collinge asks, "How do spatial patterns of land transformation due to human activities vary?" She answers by diverting to two scenarios of a habitat naturally over time becoming smaller due to landscape changes that happen within its vicinity, which we will in a

later section explain its impact. Alternatively, an area of native habitat may be severed by the construction of a new road, inevitably leaving the separated parcels fragmented.

2.1.2: Fragment Characteristic: The ‘Edge’ Phenomenon

Ecological studies suggest the results of habitat fragmentation are influenced by one of the fragment characteristics such as area, shape, degree of isolation, context, or habitat quality. In nature, forests dominate with their vertical structure. Their interiors can vary greatly from the exterior or 'edge' of the habitat. Temperature, humidity, wind, and light can create several microclimates on the forest edge, affecting the plant and animal communities and the diversity living there. This 'edge effect' may not only influence the environment at the edge of the fragment but may permeate the habitat remnant for tens of meters (e.g. Ranney et al., 1981; Harris, 1984; Lovejoy et al., 1986; Chen et al. 1992 as cited in Collinge, 1996). Forest edges additionally were found to contain a greater variety of vegetation and xeric-adapted plants, lending to a higher richness than the forest interior. In suburban settings where development ran adjacent to the edge, areas were found to experience altered conditions as well. In a northern Delaware suburban landscape, 95% of these human activities occurred within 82 m of the forest edge (Matlack, 1993b). Thus, changes in forest conditions due to human activities may permeate the forest interior as far or further than microclimatic changes (Collinge, 1996).

Understanding these circumstances could make a significant difference when considering the designs and planning of areas adjacent to an edge. By knowing now that cutting back into a forest area for new development can disrupt several ecosystems in addition to the forest itself, landscape architects and similar disciplines can look further into how to reduce the overall impact they make and lessen the effect of this type of fragmentation.

2.1.3: Fragment Characteristic: Fragment Size and Area

Like the edges discussed above, the size of a fragmented habitat influences its surrounding ecological processes. Habitats that are smaller in overall area, will have a greater portion of the edge effect, as we recall that an edge permeates into an area several meters before balancing out and creating an interior climate. For example, if altered edge conditions extend 50 m into a deciduous forest habitat, then a deciduous forest remnant of 1 ha will be entirely edge habitat (100%> and will have no interior habitat conditions, a 10-ha fragment will have 5.3 ha of edge (53%) and 4.7 ha of interior (47%), while a forest remnant of 100 ha will have 19 ha of edge (19%) and 81 ha of interior habitat (81%) (Fig. 2).

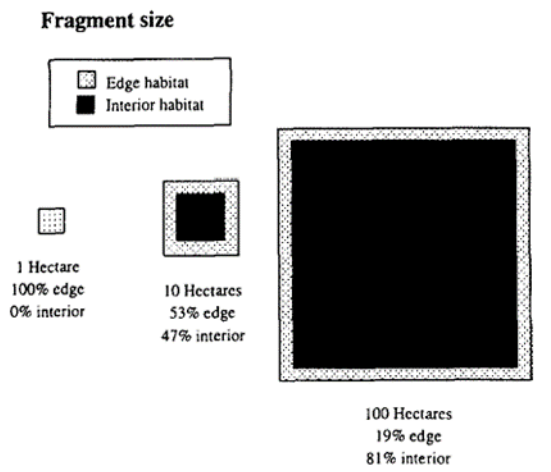


Fig. 2. Relationship between habitat fragment size and edge effects. As fragment size increases, the relative proportion of edge habitat decreases, and interior habitat increases. Edge width is assumed to be 50 m. Light areas are edge habitat, dark areas are interior habitat.

Figure 2 Fragment Size
Source: Ecological Consequences of Habitat Fragmentation: Implications for Landscape Architecture and Planning

Ecological studies observed that plant and animal species differed depending on the size of a fragmented habitat. For example, a study of grassland bird communities showed that approximately 79% of the grassland bird species were present in a 1000-ha grassland fragment, while only 31% of the bird species occurred in 10-ha grassland fragments (Herkert, 1994 as cited in Collinge, 1996). A decline in a species can be directly related to the decline in habitat loss.

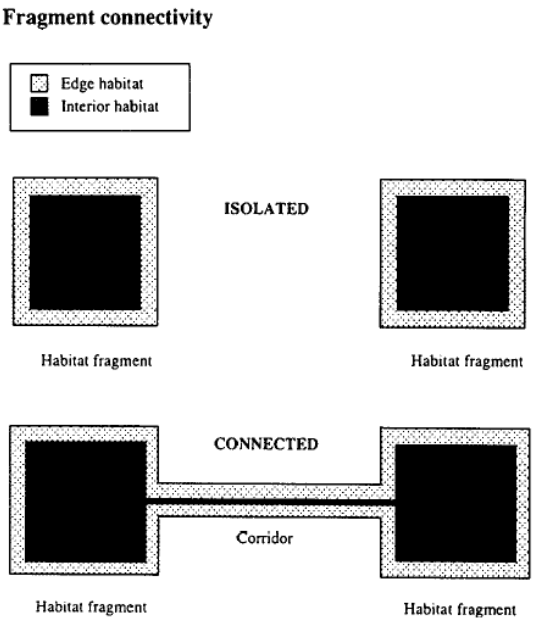


Fig. 3. Diagrammatic representation of two isolated habitat fragments contrasted with two habitat fragments connected by a vegetated corridor, showing edge effects of fragments and corridor. Light areas are edge habitat, dark areas are interior habitat.

Figure 3 Fragment Connectivity
Source: Ecological Consequences of Habitat Fragmentation: Implications for Landscape Architecture and Planning

2.1.4: Fragment Characteristic: Fragment Connectivity

Landscape connections play an important role in ecological dynamics within and between habitats (Forman and Godron, 1986; Bennett, 1990; Saunders and Hobbs, 1991; Taylor et al., 1993 as cited in Collinge, 1996). A landscape connection can be attributed to a corridor of native vegetation. These corridors can be utilized by wildlife to safely cross from one fragmented section to another. Keeping a corridor filled with native vegetation can allow for plant species to continue thriving, and over time create a thin linear edge of linkage.

2.1.5: Fragment Characteristic: Fragment Shape

In addition to the size mentioned above, the shape of a fragmented habitat can influence its users as the interior-to-edge ratio fluctuates. For example, a square, 100-ha habitat fragment will have a lower perimeter/area ratio and a greater proportion of interior conditions than will a rectangular fragment of equal area (Fig. 4) and would seem to be preferable in maintaining pre-isolation conditions for native species which require interior habitat conditions (Diamond, 1975; Forman and Godron, 1981, 1986; Schonewald-Cox and Bayless, 1986; Soul & 1991 as cited in Collinge, 1996).

In design, a fragment could be manipulated in a way that provided a sufficiently large enough interior to allow species to still thrive while maintaining the intricate shapes of a habitat. Humans as they develop have a tendency toward linear patterns, such as city blocks and roadways, this however has been shown to significantly influence the flow of organisms between habitats (Collinge, 1996).

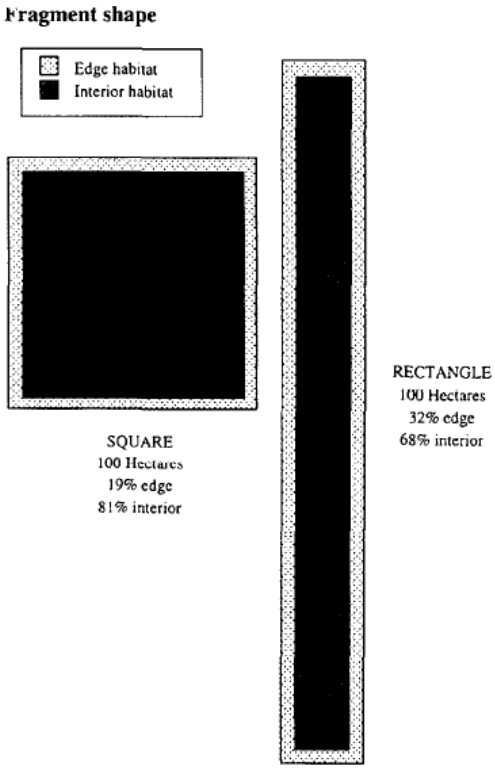


Fig. 4. Relationship between habitat fragment shape and edge effects. A square habitat fragment maintains a greater proportion of interior habitat than does a rectangular fragment of equal area. Edge width is assumed to be 50 m. Light areas are edge habitat, dark areas are interior habitat.

Figure 4 Fragment Shape
Source: Ecological Consequences of Habitat Fragmentation: Implications for Landscape Architecture and Planning

2.1.6: Fragment Characteristic: Fragment Context

The location of the native habitat with respect to its surrounding landscape will influence a fragment's success. The assertion of Janzen (1983) that "no park is an island" emphasized the influence of surrounding habitat types and human activities on the ecological integrity of areas reserved for conservation. The type, intensity, and degree of dissimilarity of habitat types, land uses and human activities adjacent to habitat fragments may markedly influence the flow of nutrients and materials, and the persistence of plant and animal species in the fragments (Forman and Godron, 1986; Stamps et al., 1987; Buechner, 1989 as cited in Collinge, 1996).

Neighboring fragments can however serve to be useful when developing. In the midwestern United States, planted riparian buffer strips composed of herbaceous and woody

species have effectively reduced the input of agricultural pollutants from crop fields into adjacent streams (Colletti et al., 1995 as cited in Collinge, 1996).

Fragmentation as it relates to the world today is further proof that we are losing our connection with nature. The author predicts that those who maintain large, connected patches of native vegetation with a minimal edge will likely be more effective in protecting and preserving native species and habitats. In urban areas, this will become exceptionally important as growth and development continue. By maintaining these connections of biodiverse landscapes and habitats, we can continue to have meaningful green spaces in the dense urban environment, that have a positive impact to our quality of life.

2.1.7: Importance of Landscape Architecture and Planning

Landscape architects have an increasing opportunity to involve the principles of landscape ecology in new plans and designs. A well-known example of the principles of fragment characteristics being utilized is in New York's Central Park. Andropogon Associates focused on maintaining large portions of the already forested sections of the space and finding a way to create multiple connections of corridors that would allow species to move throughout the park alongside the human users of the space. By incorporating the understanding of the consequences of ecological division, landscape architects and planners can bring diversity back into development. In conclusion, Collinge predicts that those who maintain large, connected patches of native vegetation with a minimal edge will likely be more effective in protecting and preserving native species and habitats (Collinge, 1996).

2.2 Precedent Studies

The purpose of this section illustrates primarily visionary projects within the same field as this research, as well as one historically successful project with similar inclinations. Separate

from the case studies that will be discussed in the Findings and Analysis chapter, these precedent studies allow for the exploration of different typologies of bridge design.

2.2.1: Landshape – Modular Constructions of Wildlife Crossings

ARC—Animal Road Crossing—is an interdisciplinary partnership working to facilitate new thinking, new methods, new materials, and new solutions for wildlife crossing structures (What Is ARC | Wildlife Crossing Structures | ARC Solutions - Animal Road Crossings, 2022). ARC created in 2010, an international competition to design a series of crossings connecting the northern and southern Rocky Mountains. The basis behind this competition was to design a bridge for wildlife to be able to safely cross a major intersection. In comparison to this research, the team was able to develop a blueprint for a framework of a bridge that could be remodeled and used for future projects.

Landshape, crafted by Zwarts & Jansma Architects, in collaboration with OKRA Landscape Architects, Iv-Infra, and Sjef Jansen Plan Ecology, was a finalist in the competition for their buildable, affordable, adaptable, modular design. What makes the structure unique is that the framework is flexible and can be re-used in various formats or in other projects. The most important feature, and what inspired the name landshape, is that the architecture forms to the existing curves of the landscape. "The team produced a physical entity that connects culture and nature" blending the ecology of the site directly into and onto the design itself (Berkers et al., 2012, p. 1).

2.2.1.1: Culture and Traditions Impact on Nature

Incorporating nature and culture together is more widely adopted in regions such as the Netherlands, where tradition, open space, and infrastructure overlap more frequently. In the US, building natural connections is still in its infancy as we do not have as much tradition that leans

on the natural world built in the age of industrialization. As urbanization continues, however, a need sustainably ‘green’ crossings and knowledge for innovative building techniques becomes more prevalent.

The location for the future design winner was chosen based on monitoring by state officials and members of the community. West Vail Pass in Colorado was deemed an ideal location to test a new design. The surrounding flora was resilient toward construction, and there was plentiful fauna that would benefit as well.

An additional criterion for the design was the implementation of 25 different variations of the structures as the final deliverable by the end of the project scope in real-time. Creating a design that was sustainable and met the criteria of being unified yet unique would pose to be a challenge for the teams.

2.2.1.2: Landshape

The creators behind Landshape took an innovative approach and created a repeatable, modular structure. Unique to its construction, the framework of the build would be made of a flexible shell of textile membrane fabric that would allow itself to be re-used from one design to the next, like a cast or mold. This was an especially critical development as 25 crossings would need to be built as cost-efficiently as possible. A symmetrical double-arch shape was chosen to be the most efficient, in terms of materials and ability to bear the weight. The crossing would also take into consideration the users on its surface, by incorporating upward-facing arcs along the edges to block noise and lights from the passing cars on the highway underneath. Realistically, the only setback to the efficiency of the system was molding the exterior portions of the bridge to fit into the landscape itself with little impact to the existing landforms.

Other considerations to be used in all crossing designs as determined by Berkers et al. (2012) are as follows:

- An embankment or screen blocking light, noise, and road movement
- Trees or bushes are planted on and along the embankment
- Vegetation along the sides, rich in herbs and shrubs
- Short, dry, nutrient-poor soil tolerating vegetation with open spaces
- A layer of varied, local soil material at least 12 inches (30cm) thick

Monitoring of the system would remain simple and would only be necessary for the beginning to ensure proper use and maintenance by all users. With one of the original motivators

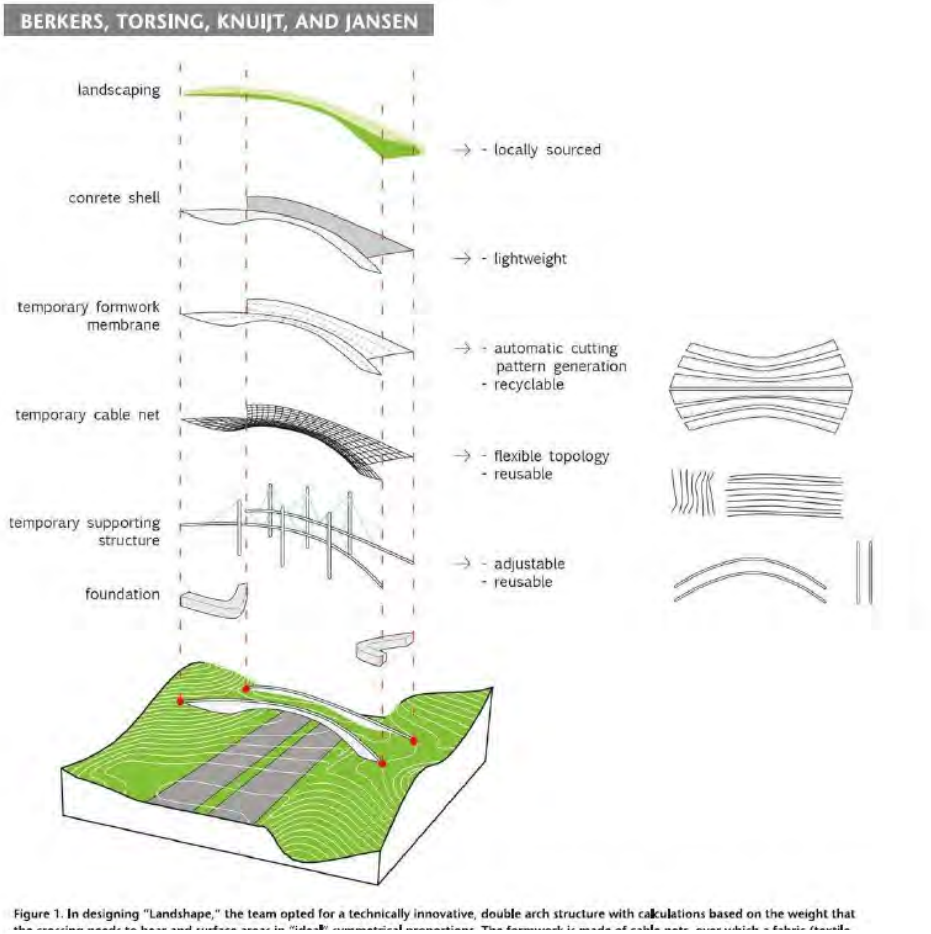


Figure 5 Landshape Form
Source: Landshape"-Modular Constructions of Wildlife Crossings

behind this design being to provide a successful crossing for local wildlife, monitoring of the site would be conducted following completion. Should the monitoring prove to show a lack of use, modifications could be made to vegetation and entrances. Over time though the crossing should become self-sustaining, and just another part of nature for its users. For the current study, site monitoring might be beneficial in guaranteeing optimal performance of the area in line with the design objectives. (Berkers et al., 2012).

2.2.1.3: Engaging the Public

A unique way of involving the community and the visiting public is a proposed app that allows people to watch the animals moving around and utilizing the bridge. This is an important example of bringing humans closer to nature in a safe manner and brings new and continued interest to the idea of building more sustainable, ecologically friendly designs. The team also proposed ways of allowing visitors to interact directly with the bridge crossings. A visitors' center would provide a space to educate the public about the structure itself, its reason for being built, and the historical conservation efforts that took place.

To ARC, wildlife crossing structures create a unique opportunity of showing people the positive effects of working with nature. Many are oblivious to a problem until the light is shown upon it, and these connections present visible solutions. "People need to move around, and they use highways to do that. When people learn that wildlife [and ecology] has the same needs that they do, they understand there's a problem to solve." —Harvey Locke, conservationist, and ARC partner (*What Is ARC*, 2022).

2.2.2 Jinan Bridges - Jinan, China

Figure 6 Jinan Bridge
Source: https://www.sasaki.com/projects/jinan-bridges/

The Jinan Bridges are a set of five bridges envisioned for a new city center for North Jinan, Shandong in China. Designers at Sasaki recognized the ecological opportunities of this region, and this understanding shows through their design principles. Firstly, they asked the question: How can something as utilitarian and rational as a bridge become a landscape element? (Jinan Bridges, n.d.). At the core of the design, the team sought to unite architecture with the landscape and the ecology of the Dasi River. The new riverfront landscape would be molded to the existing topography where possible, to allow the river, wetlands, and existing flora and fauna to flourish. The bridge forms were inspired by traditional Chinese paintings and are intended to be an extension of nature.

The second major principle of this design was how to make it resilient to natural conditions it would be exposed to when flood waters occur. For materials, the team selected

concrete for its durability. The bridge is supported at points with arches that are linked diagonally across the bridge. Ribs connect to a diaphragm shell that offers additional support, while displaying a three-dimensional geometrical design. In addition, the ribs that support the shell allow for a bridge deck above for a unique pedestrian experience.

The bridge connections complete the link in Jinan's open space network while providing a space for walkers, joggers, cyclists, vehicles, and nature to interact simultaneously.

2.2.3 Ribbon Bridge – Canberra, Australia

Figure 7 Ribbons of Life
Source: https://worldlandscapearchitect.com/ribbons-of-life-a-living-bridge-in-canberra/?v=7516fd43adaa

Futuristic creation of urban forests and parks are inseparable just like people and wildlife in the ecosystem (Holmes, 2021). The design objective of the project is to create a seemingly natural link over the river to connect the existing Commonwealth Avenue.

The design proposes two ‘ribbons’ that twine around the existing road bridge and tram tracks. One band is a wildlife corridor that consists of wetlands, bushland, woodland, and a meadow that provides food, water, and shelter for many species currently separated by water. The second band is a linear park for people with programs such as a boardwalk, terrace plaza, observation deck, and observation channel under the water allowing visitors to see the wildlife of the river. Key elements for the linear park also involve a bird observing platform above the wildlife section, a plaza overlooking the existing water jet, and laser projection art on the sides of the bridge.

The curve form and texture represent the body of the Rainbow Serpent which is a source of life and prosperity to the Australian Aboriginal culture and Ngunawal traditions. The forest that spans over the bridge absorbs greenhouse gas emissions aiming for a Zero Emission Target in 2045 set by Australian Capital Territory Climate Change Strategy. Solar panels are incorporated into the walkways of the bridge to generate clean energy, for use with lighting and operations on site (Holmes, 2021).

As city makers, landscape architects have the responsibility to create designs that act to slow down climate change before the extinction of more species, to protect the resources we possess and use [them] wisely (Holmes, 2021).

2.2.4 Freeway Park – Seattle, Washington

Figure 8 Freeway Park Overview
Source: https://www.tclf.org/landscapes/freeway-park

With the installation of Interstate 5 in 1964, Seattle's downtown neighborhoods found themselves divided physically. The city officials approached landscape architects Lawrence Halprin and Angela Danadjieva to develop a park that would restore pedestrian access to Seattle's Capitol Hill and First Hill neighborhoods. The park is now widely recognized as one of the first to be built over a freeway (*Freeway Park,* 2016).

At over five acres, the park takes users through a maze of signature architectural forms with spaces that are flexible for large gatherings or solitary walks. The plaza is filled with various water features and board-formed concrete planters. The plantings on site were curated to

reconnect the urban environment with the local forest landscape found outside of the city. To preserve the history and legacy of the park, renovations began taking place in 2010 to restore some of the fountains and foundations. Today, a canopy of mature trees and grassy plazas display seasonal blooms over the freeway.

Figure 9 Freeway Park Water Feature
Source: https://www.tclf.org/landscapes/freeway-park

2.3 City of Fort Worth Projects and North Main Street Bridge

2.3.1 Panther Island

The City of Fort Worth, like many developing metropolitan regions, has created a Comprehensive Plan to promote sustainable growth as it continues to expand in areas situated in or near its downtown core (2022 Comprehensive Plan, 2022). One of those major projects is the Panther Island District, which in recent years has been rezoned by the city as mixed-use. In 2006,

Figure 10 Panther Island Vision
Source: https://pantherislandcc.com/central-city.php

the Panther Island Development Standards and Guidelines were constructed and became an award-winning proposal adopted by the City of Fort Worth (*Panther Island Form Based Zoning District*, 2016). It would promote the mixed-use rezoning with high-density development and an urban waterfront district like no other in the area. It envisions 10,000 housing units and up to 3-million square feet of commercial, retail, and educational space to allow residents the ability to

live, work, and play within a walkable distance. The plan is pedestrian-friendly, provides a new association with the Trinity River, and a vital connection between districts that historically have been fragmented from previous developmental improvements.

The project's Urban Design Plan included a fully integrated park and network of trails, which connects to a new lake, canals, and marinas. Seven themed parks are spaced throughout the design, as well as pocket parks, plazas, and play areas. View corridors between buildings allow for unique opportunities for green spaces connecting the district's new park system.

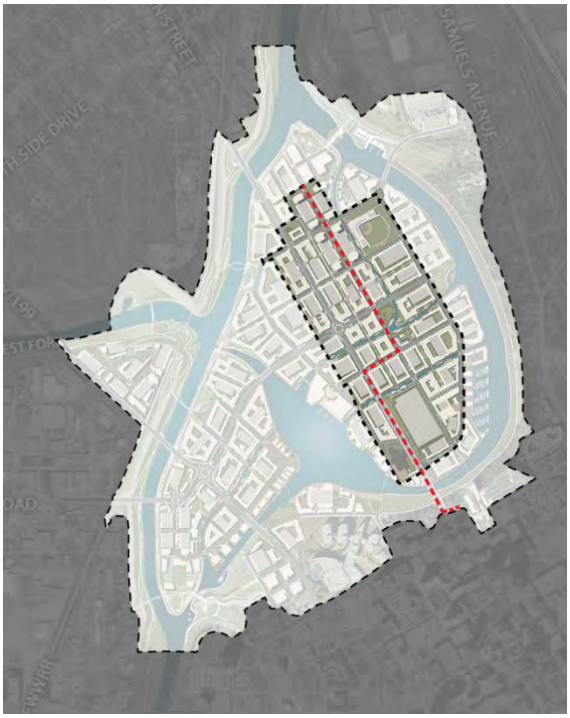


Figure 11 Panther Island Fixed Transit Rail Plan
Source: https://pantherislandcc.com/central-city.php

Historically, Panther Island once included a fixed rail trolly that ran North and South along North Main Street. A traffic impact study was conducted in 2006 by the City of Fort Worth and recommended the reimplementation of the fixed rail transit west of the current Main Street Bridge (Paddock Viaduct), however, no major changes or design improvements have been suggested for the Main Street Bridge which is the major concern in this research (Panther Island Phase I – Fixed Transit Line, n.d.).

2.3.2 Panther Island Central City Flood Project

As part of the Comprehensive Planning for the growing city, in an alignment with the Panther Island vision, the U.S. Army Core of Engineers and the City of Fort Worth also started Panther Island Central City Flood Project in early 2000s. This major infrastructure project planned to address the risk of flooding in the area, as well as solve some of the current flooding

happening in downtown due to the overloaded stormwater system. The two main components include the rerouting of a section of the Trinity River within the Panther Island district and modifying a large park on the east end of Fort Worth to better manage flood events.

Construction for the 1.5-mile bypass channel, which will reroute parts of the Clear Fork and West Fork Trinity Rivers, has begun. This will in turn restore over 2,400 acres of flood protection back to established Fort Worth Neighborhoods. Improvements create a new channel and levee system, as well as new TXDOT vehicular bridges (Central City Bypass Channel, n.d.).

Figure 13 Panther Island Canal Proposal
Source: https://pantherislandcc.com/central-city.php

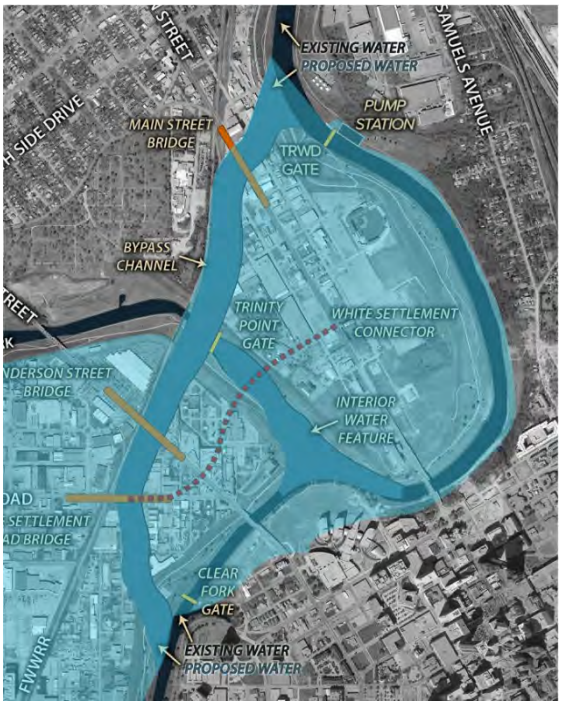


Figure 12 Panther Island Flood Way Protection
Source: https://pantherislandcc.com/central-city.php

2.3.2.1 Pedestrian Bridges

Because the Panther Island District falls under the purview of the U.S Army Core of Engineers supervision, the pedestrian bridges' impact on the flood control project creates an opportunity for new connections over the constructed bypass channel. Two new pedestrian

bridges are proposed to be built to provide public access. The District recently signed a contract with the engineering firm HNTB to design the bridges that will be constructed simultaneously with the building of the bypass channel. They are scheduled to be completed in 2026 and 2029. Woody Frossard, Tarrant Regional Water District's project manager for the Central City flood control project remarked "The public asked for continuous trail access throughout the project area, and these pedestrian bridges will help provide that access." (Lamb, 2022).

Figure 14 Panther Island Proposed Canal Pedestrian
Source: https://pantherislandcc.com/central-city.php

2.3.3 Heritage Park Plaza and Paddock Park

Another major project planned for the area was Heritage Park Plaza and Paddock Park. Commissioned in 1976 and closed in 2007, Heritage Park designed by renowned landscape architect Lawrence Halprin, is proposed to receive a $34.2-million renovation. The park, which was closed due to increasing crime rates and safety concerns, will once again become an iconic

symbol of Fort Worth by reconnecting the downtown area to the Trinity River West Fork (*Heritage Park & Surrounding Park Improvement Projects, 2022).*

Figure 15 Heritage Park Concept Plan
Source: https://www.fortworthtexas.gov/files/assets/public/communications/documents/city-council-presentations/briefing-on-heritage-park.pd

Designs and concepts for the park were completed in 2015, addressing concerns such as the fast-moving vehicular traffic around the park. Pedestrian improvements will take place along the street and to the nearby Paddock Park which currently sits as a large two-acre traffic island. "The idea emerged, 'Let's not just do Heritage Park in isolation. Let's make it part of a bigger vision," said Costa. "…to relate downtown more effectively to the river. Because right now, you could be standing in Sundance Square and have no idea that there's a big river a short distance away. Historically, we've had a kind of disconnect between the city and the Trinity River. And so, this project aims to correct that historical oversight." (Sadek & Francis, 2022).

Some opportunities in the park include public art displays, education, historical preservation of the La Corte Barrio ruins, pathways through the tree canopy, river stairs that allow interaction with the Trinity, and accessibility and multimodal improvements.

Figure 16 River Stairs
Source: https://www.fortworthtexas.gov/files/assets/public/communications/documents/city-council-presentations/briefing-on-heritage-park.pd

Even though there has been at least three major plans and projects for this portion of the City of Fort Worth, there has been very little plans for the natural conditions, escarpment, the riparian zone, and the connections between downtown and Panther Island.

2.4 Chapter Summary

Examination of the literature review reveals the importance of including nature in urban design to reduce ecological fragmentation. Ecology plays a vital role, so by maintaining patches of undisturbed landscape, the biodiversity of an area can be preserved. This chapter looked at conceptualized and successfully built designs that relate to the topic of research. Some of the

common themes identified in the review include the need and ability to reconnect communities, materials that support flexible construction and cost savings, and finally environmentally beneficial designs. In conclusion, the literature confirms the value of reviewing similar designs, as well as designs adjacent to the project location, so that the design can consider the findings discovered and align with those visions set forth.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This study will utilize mixed methods of qualitative techniques to explore the design of an urban landscape in Fort Worth, Texas (Sommer, 2002). This research will additionally look at the possible opportunities of improving the ecology and connections over the Trinity River using existing infrastructure. Edge conditions and existing infrastructure will be studied to inform a design to be modeled throughout the Trinity River in future projects.

3.2 Study Location

The location of the site was chosen based on the criteria of knowing what typology of urbanization the research needed to influence. Urban, suburban, and rural contexts were considered as how they connected with one another. The category of taking an urban area and connecting it to a suburban area was chosen due to the increasing pervasiveness of urban sprawl in our society today. Taking a sampling around the Dallas-Fort Worth metroplex, the design focused on the arterial connection between the up-and-coming Panther Island district and downtown Fort Worth. This space straddles the Trinity River, encompassing the vehicular bridge, nearby Trinity Trails, and a piece of dwindling escarpment. Along the levee of this space, the southern portion of the banks are home to a small escarpment of flora, while the northern portion of the banks can be seen as an example of ecological degradation with the exposed land of the levee having little to no biodiversity.

3.2.1 Site Selection

The selection of the site occurred early in the development of the research and design. The site was narrowed down and selected based on a criterion of typology and context. The researcher looked at opportunities within suburban, urban, and natural environments, as well as associations between those contexts. Site location considerations were kept within the local Dallas-Fort Worth metroplex for the advantage of being able to visit the site and design for the conditions found. The North Main Street Bridge and surrounding Trinity River riparian corridors were chosen due to the proximity to the two urban contexts of Downtown Fort Worth and the proposed master planned community within the Panther Island District, as well the adjacent wooded escarpment lining a portion of the southern edge of the West Fork Trinity River.

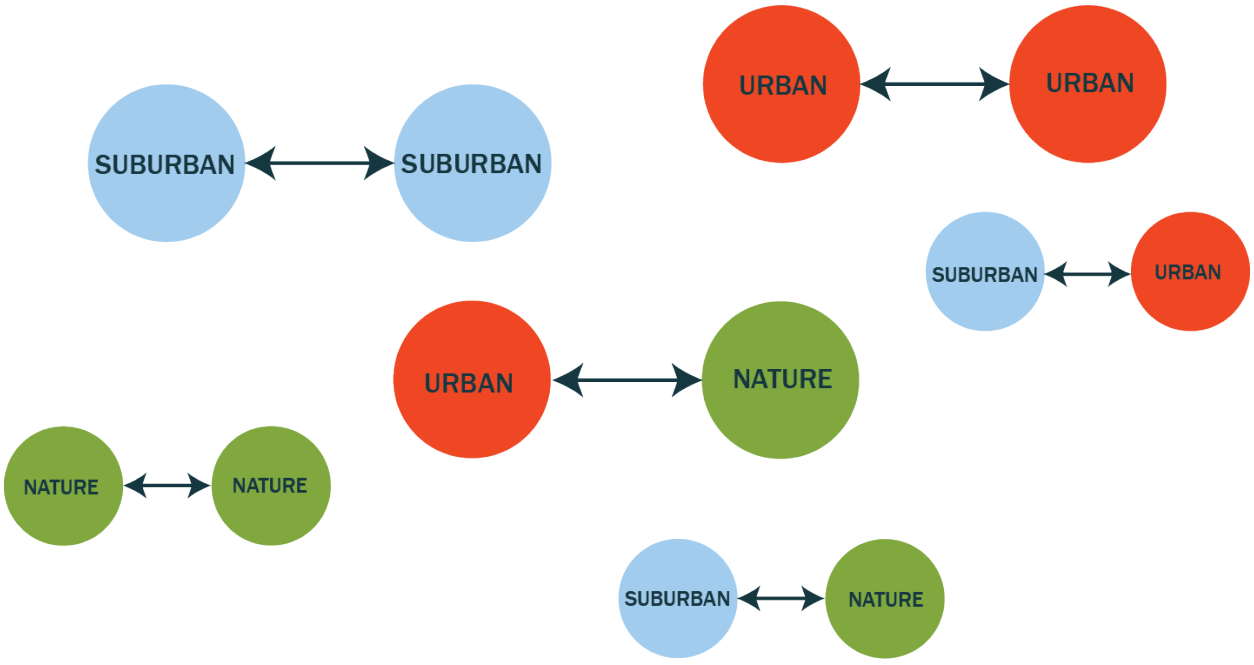


Figure 17 Site Selection Options (Adapted from Illustrator)

3.3 Study Population

With the knowledge that the study population will be located around the fragmented communities of Downtown Fort Worth and Panther Island, the study population was narrowed down to the two adjoining zip codes of those regions: 76102 and 76164. The demographics of these two regions were analyzed to determine how each community can benefit from an improved connection between these two sites. The study population of this thesis also included any people observed at the study location and their behavior during the passive site observation process, however, those people were not be approached or interacted with for this research.

3.4 Research Design

This research used qualitative techniques to explore the research question in this master design thesis (Sommer & Sommer, 2002; Deming & Swaffileld, 2011). To answer the determined research questions, the research aimed to explore two methods of research strategies outlined in Sommer & Sommer *A Practical Guide to Behavioral Research* (Sommer & Sommer,2002). The use of case study analysis and passive observation aimed to answer the following questions:

- How can nature be incorporated into infrastructure bridges to promote connections in urban landscapes?
- How can connections be improved with multimodal access for both pedestrians and vehicles in urban landscapes?
- What can be learned from the design of North Main Street bridge in Fort Worth, Texas?

This research used knowledge collected from literature and case studies to understand similar constraints in this field, as well as how to constructively design an archetype to be used in future projects. To find examples of works with similar intentions, a proposed project by OLIN+OMA Studios called 11th Street Bridge was identified to be an ideal model for study.

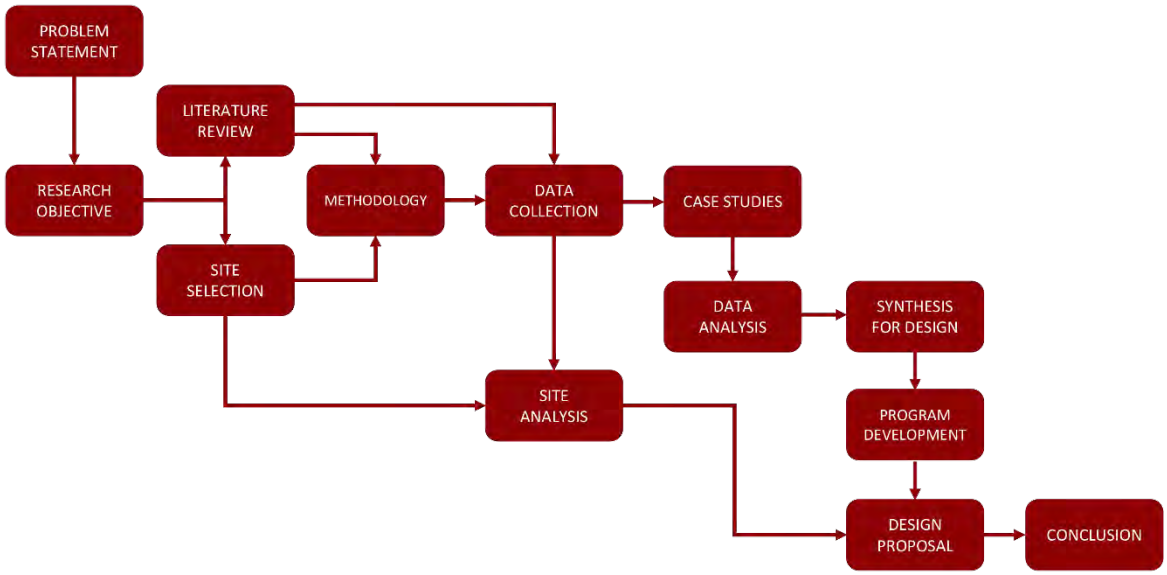


Figure 18 Methodology Flow Chart (Adapted from Illustrator)

There are several types of research design based upon observational strategies that are particularly relevant to landscape architecture. First, observations and records can be ordered by reference to a particular *site* or place. Place is a location where biophysical features, human activities, and social meanings and values combine to create a distinct identity (Relph 1976; Deming & Swaffield, 2011). By visiting and observing users of the chosen site, as well as the site conditions, the data collected could be analyzed to better inform the needs and wants for the design.

3.5 Data Collection Methods

3.5.1 Case Studies

A selection of four projects highlighting bridge and park design was analyzed as precedence for this design thesis using interpretations from *A Case Study Method for Landscape Architecture by Mark Francis (2001).* These cases were narrowed down from a selection of proposed and built designs, as well as typologies of various bridge and park designs. Data for these projects was collected from multiple forms of literature and research studies. Additionally, criteria for consideration of the targeted studies included the project's ability to incorporate nature into the design, multimodal access, pedestrian-focused design, cost-effectiveness, and sensibility.

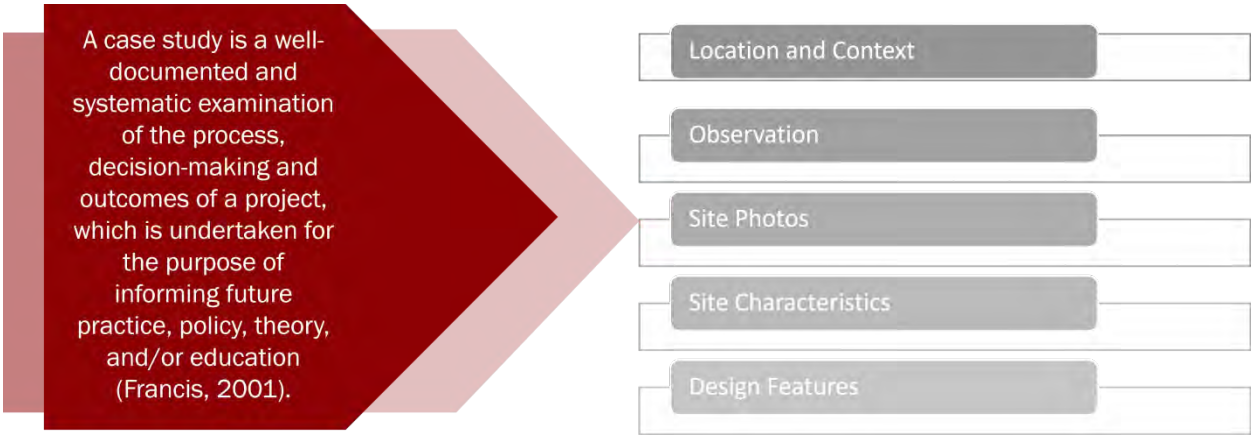


Figure 19 Case Study Analysis (Adapted with Power Point)

3.5.2 Secondary and Site Data

Data for this design thesis was further collected with visits to the site. Observations of conditions in the area of interest were compiled using descriptive strategies from Deming and Swaffield (2001). Criteria for consideration of the target area included site existing conditions,

vehicular circulation, pedestrian usability and safety, opportunities for improvement, and future programmatic elements.

3.6 Data Analysis Methods

Using a multi-method approach is intended to allow greater flexibility and a greater breadth of information gathered (Sommer & Sommer, 2002, pp. 6-7). Using Sommer and Sommer's 2002 5th edition of A Practical Guide to Behavioral Research – Tools and Techniques, and Deming and Swaffields 2011 edition of Landscape Architecture Research, qualitative research is able to be utilized in this analysis.

3.6.1 Case Study Analysis

Analysis of the four case studies is based on the data collection methods of Deming and Swaffield (2011). Characteristics from each case study were categorized into a matrix based on themes and programs extracted from each. This data was then be used to generate objectives, programs, and design elements for the supplemental design.

Figure 20 Case Study Analysis (Adapted with Photoshop and The Noun Project)

3.6.2 Secondary Data & Site Analysis

This research analyzed data collected through secondary resources which included literature review findings and resources, online library research, and two site visits that utilized passive observation techniques.

3.7 Design Process

The process for the conceptual schematic design was to conduct research through review of different selections of literature, selected precedent studies, passive observation, and in-depth case studies. These processes aided in the selection and design of the site. Once the site was selected, a visit to the space was necessary in order to collect data for inventory and analysis. Once the site and proposed programming were found to be adequate for the proposal, a design could be formed by conducting site inventory and analysis of the site, using the research to inform a design program, from which a concept and then schematic plan of the design could be created.

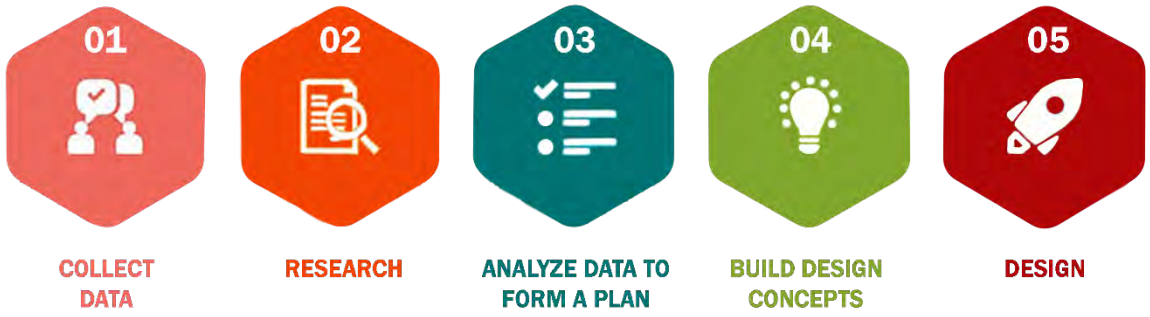


Figure 21 Design Process (Adapted with Photoshop and The Noun Project)

3.8 Bias and Error

The purpose of this study looks at the a how more nature can be incorporated into an urban area; thus, a bias against the idea that urban spaces do not currently maintain enough

nature within the city limits exists. Additionally, there is possible bias and error with research referenced in the secondary studies, as well as data gathered from on-site observation and inventory.

3.9 Chapter Summary

Chapter 3 discussed the study location, study population, research design, data collection methods, data analysis methods, design process, and the bias and error in methods. This chapter covered the methodology adhered to for this research. Following the qualitative methods, the research design combines literature review, precedent studies, secondary data, passive site observation, and in-depth case studies to access the likelihood of adding nature to an infrastructure bridge that will allow people and vehicles to coincide harmoniously.

CHAPTER 4: ANALYSIS AND FINDINGS

4.1: Introduction

This chapter provides key findings from examinations of the selected case studies following strategies and evaluations methods outlined in *People Places* (Francis & Marcus, 1998). Case studies were selected based on their similarity to the proposed site, their ability to connect with nature and local communities, and their typology in reference to bridge design. The data collected from the case studies are analyzed and categorized graphically using a design criteria matrix that identifies areas of opportunities and programs for the bridge and its surroundings. The analysis of four separate case studies, outlined in section 4.3 below, aids the researcher in understanding essential features to cultivate a design that brings both nature and people together in an urban environment.

4.2: Case Study Analysis and Findings

4.2.1 Salesforce Park - San Francisco, California

Location: San Francisco, California

Size: 5.4 acres

Date: Completed July 2018

Designer(s): PWP Landscape Architecture, Pelli Clarke Pelli Architects

Land Type: Brownfield

Initial Budget: $33.28 million

Typology: Rooftop Park

Salesforce Transit Park is a 5.4-acre green space situated atop the roof of Salesforce Transit Center, a new major hub for transit in downtown San Francisco. The transit center is part of a 10–15-year phased project of improvements, with the rooftop park having been completed in 2018. Located between Second and Beale streets, spanning over four city blocks, the community park connects the new East Cut neighborhood with prime open space in the rapidly growing downtown sector (Kiers, A. Haven and Elyse Mack, 2021).

Salesforce Park appears to be intended as a multifunctional space for active and passive recreation, education, and escape for office employees and nearby residents. The project seeks to provide a fully accessible intensive green roof that can reconnect urban residents and visitors back to nature in a highly dense area of the city. Placing a focus on nature and living systems provides an opportunity for improved mental and physical health while promoting well-being. In a survey conducted by Landscape Performance, 95% of 87 surveyed visitors reported feeling happy while in the park, and 76% of 21 surveyed visitors reported that the park improved their mental health or well-being, in contrast with 37% of surveyors on street level who reported higher to moderate stress levels. The park also enhances educational opportunities with visitors stopping for 33 seconds on average to read interpretive signage. Within the limits of the park, noise levels are reduced by .06 to 7.65 decibels in comparison to street level (Kiers, A. Haven and Elyse Mack, 2021).

Landscape Architect Adam Greenspan with PWP Landscape Architecture curated hundreds of understory plants and over 50 tree species to create a dozen themed gardens that are woven through the space. Mediterranean regions from around the world with comparable climates to northern California are showcased around Salesforce Park as users are guided along curvilinear pathways that provide experiential settings, both contemplative and social (*Salesforce*

Transit Center Park - PWP, n.d.). Visitors can experience a desert garden, prehistoric garden, and redwood forest, as well as species from Australia, South Africa, and Chile. At the northeast end of the park, a subsurface-constructed wetland garden is adapted to process greywater collected on site from the roof-top park and sinks in the terminal building. By allowing it to naturally filter and be processed, it can be reused in the toilets throughout the park. In addition to recycling water, the park actively absorbs carbon dioxide created by the transit exhaust within the terminal below. To create a topography that blurs the distinction between roof and ground, the park integrates mounded vegetated hills with domed architectural skylights that allow daylight into the terminal below (*Salesforce Transit Center Park - PWP*, n.d.). The unique ecosystem created by the biodiversity of the park supports 96,432 square feet of pollinator and wildlife habitat, becoming a haven for birds, butterflies, and other pollinators of the area (Kiers, A. Haven and Elyse Mack, 2021).

The research for this study highlights the significant impacts of incorporating urban ecosystems into an area of high density built environment. By being able to bring both native gardens and gardens of adapted flora into the landscape, users experienced greater levels of happiness while in the space. Through innovative design, the designers were able to make the space fully accessible to all visitors through the use of stairs, escalators, elevators, and even a gondola. The park is a beautiful and unique place for people to gather, sit and relax in and away from the elements, and it successfully fulfilled the team's original goal of connecting the surrounding downtown neighborhoods to local green spaces.

Figure 22 Salesforce Park. From top left, overhead, pathways, open lawn, theme gardens, plan view
Source: https://www.pwpla.com/salesforce-transit-center-park

4.2.2 11th Street Bridge Park – Anacostia, Washington, D.C.

Location: Anacostia, Washington, D.C.

Size: 5.4 acres

Date: Completed July 2018

Designer(s): PWP Landscape Architecture, Pelli Clarke Pelli Architects

Land Type: Brownfield

Initial Budget: $33.28 million

Typology: Pedestrian Bridge

Originally built in the 1960s, the 11th Street Bridge carried vehicles across the Anacostia River which still divides much of the city from its southeastern quadrant. The western side of the river exhibits influences from its industrialized past, as well as techniques from the designs of Pierre Charles L'Enfant's classical plan which defines street patterns with crisscrossed diagonal avenues and intersections that host civic buildings and public spaces. The eastern side of the river is characterized by its hilly terrain, lending to a less formal structure of its street patterns. Today the West is emblematic of the nation's capital and a higher income demographic, while the East is home to a largely African American community and D.C. native residents. "The Anacostia River has divided Washington, D.C. for generations," said Scott Kratz, vice president of Building Bridges Across the River. About a decade ago, the 11th Street Bridge reached the end of its lifespan, but many saw an opportunity to save the bridge and its pilings in hopes of a project that would become "an anchor for more inclusive development" in D.C. and help communities on both sides of the Anacostia "re-engage with the river and reconnect with each other" (Green, 2021).

Beginning in 2011, Building Bridges Across the River (BBAR) hosted 200 meetings over two years listening to the diverse communities along the river to understand the demands for the newly proposed park space. BBAR and the District Department of Transportation initiated an eight-month-long design competition, in which the team comprised of OMA+OLIN design firms won out with their innovative X-design bridge park. With the creation of the competition, a set of design principles and values were developed based on the data gathered at the 200 community meetings (Competition Design Principles, n.d.).

11th Street Bridge Park Design Principles as outlined by Building Bridges Across the River:

1. Stitch Together the City
2. Engage the River
3. Elevate Public Health
4. Establish an Economic Development Engine
5. Embrace the Water
6. Celebrate the Rich History of the Region
7. Explore Innovation
8. Activate the Space and Place
9. Activate the Space and Place
10. Capture the Rhythms of the Day and Seasons
11. Manage Sound
12. Create an Eco-System
13. Build for Durability, Flexibility, and Legacy (Competition Design Principles, n.d.)

11th Street Bridge Park Values as outlined by Building Bridges Across the River:

- Everyone is welcome.
- Respect the river by being environmentally sensitive.
- Be state-of-the-art, relevant, current – flexible, and adaptable for future use.
- Employ the highest aesthetics and design standards.
- Be culturally rich, innovative, and unique.
- Ensure the safety of all park visitors and the river's natural inhabitants.
- Encourage healthy living practices through outdoor recreation and increasing food literacy (Competition Design Principles, n.d.)

The design team's apparent approach to achieving the design principles described above was to create a pedestrian link with the 1,000-foot-long park, utilizing the remaining pieces of the abandoned infrastructure. *OMA+OLIN* sought for the park to be fully accessible, with no slope in the park or landings exceeding a 5 percent grade. The orchestrated landscape offers a continuously shaded pathway that is within 20 minutes of walking distance from either side of the Metro. Great thought was put into how the size and shape of the design could affect the park. The most straightforward way to ensure that the investment in the Bridge Park would benefit the east side of the river was to simply make the bridge wider on that side, allowing for a concentration of programs and space (*Featured Projects — OLIN*, n.d.). The width of the landings was reduced to 30 feet wide on the western Capitol Hill side, and 127 feet wide to the east of the Anacostia. A 16-foot-wide two-way bike lane and pedestrian path, an environmental education center with an outdoor classroom, kayak and canoe launch, amphitheater, community

restaurant with affordable options, and a large terrace for markets and other events are among the many programs the design further proposes.

Throughout the concept, the design takes into consideration several environmental objectives. Examples include planted rain gardens and advanced stormwater systems such as water-receiving landscapes that will capture, cleanse, and reuse the stormwater. Restoration of shoreline plantings is proposed to provide habitat and improve the ecological integrity along the river. A proposed pollinator garden will help provide forage for bees, butterflies, and other pollinators whose populations have been declining (*Environmental Metrics for Washington, D.C.'s 11th Street Bridge Park*, 2017). One of the unique aspects of the design is the ability to address some of the water clarity issues within the river. On the east side of the 11th Street Bridge Park, the OMA + OLIN design proposes an aeration waterfall on the lower level that can serve to oxygenate water in the river, paired with wetland plantings this could improve the quality of the river at this location.

The research for 11th Street Bridge Park reveals how repurposing with innovative design can be accomplished successfully in an area that has been previously overlooked when it came to increasing amenities for surrounding communities. The research showed the use of stormwater management, durable and flexible construction, and accessibility for all with no slopes greater than 5% in the park. The competition team was able to create an urban ecosystem both on the bridge and in the surrounding park, as well as provide opportunities for clarifying the river water through plantings and an artful waterfall. By placing many of the crowd-pleasing amenities on the East Anacostia side of the river, the team strategically is able to aid in the economic growth of the nearby community. Through this placement they successfully bring the fragmented neighborhoods on either side of the river back together.

Figure 23 11th Street Bridge. From top left, overview, viewing platform, river park, amenity gathering space. Source: https://www.theolinstudio.com/featured-projects#/11th-street-bridge-park/

4.2.3 Robert L.B. Tobin Land Bridge – San Antonio, Texas

Location: San Antonio, Texas

Size: 150’ Wide by 150’ Long – Approximately 0.5 acres

Date: Completed 2020

Designer(s): Rialto Studio, Inc. is the prime consultant, and worked with Stephen Stimson Associates, Arup, D.I.R.T. studio, Cade Bradshaw, Ashley Mireles

Land Type: Park

Initial Budget: $25 million in Bonds

Typology: Land Bridge

Nearly three years ago, situated to the north of downtown San Antonio, two parcels of a park sat separated by Wurzbach Parkway. The Robert L.B. Tobin Land Bridge is the first of its

kind, at the scale that it is, to be built in the United States. Opening at the end of 2020, the land bridge unites the two sides of Hardberger Park and reconnects pedestrians and wildlife again over a major highway.

Hardberger Park came to be after the acquisition of Voelcker Farm, a 311-acre previously operated dairy farm that was degrading and susceptible to the expanding developments of a growing city. With the support of Mayor Phil Hardberger, the land was conceptualized to be a 'cultivated wild' which comprised of preserving Heritage trees and woodlands, restoring endangered grasslands, and embracing the traits of the three eco-regions of Texas that the area encompasses. The concept of the park as a 'cultivated wild' interprets and integrates the rich cultural history of San Antonio with the diverse and resilient ecologies that are native to the region (*Hardberger Park Land Bridge — STIMSON*, n.d.). The park dedicates 25% of its land to recreation with low impacts on the site, and the remaining 75% to preserving and restoring the landscape.

The land bridge is named after Robert L.B. Tobin, for his contribution and sponsorship of the feasibility study that confirmed the success of such a bridge. His donation that completed the private funding, along with city bonds, brought the bridge to fruition.

With input from the community, the park is programmed to be a passive landscape with education and restoration opportunities. Within the large landscape, outdoor rooms are thoughtfully spaced throughout to host environmental education programs with an emphasis on urban ecology. Along the western edge of the bridge, a vegetated corridor provides a sanctuary for wildlife. Two wildlife blinds, which act as edging along the bridge, shield passing lights emitted by the vehicles below. The perforated patterns on the blinds do their part to conceal but are artfully influenced by the site's flora and fauna and curated by local artists.

A unique experience on-site can be found within the treetops on an elevated Skywalk made up of weathered steel. Gently sloping down from 18-feet above the ground, the 1,000-foot-long Skywalk features a 6-foot walkway and shaded seating areas for wildlife viewing. Bicycles, however, are not permitted to be ridden on the bridge but may be walked along.

The land bridge structure was built to minimize costs in construction and water usage. An innovative “saddle” design was developed to lessen the amount of soil required on the surface of the bridge. On the underside of the bridge, a ribbed support network can be found which reduces construction expenses. Further underneath the bridge to the south, an approximately 100,000-gallon underground cistern collects rainwater that falls onto portions of the site. A subsurface trench acts like a French drain carrying water to a small sand-filled basin, which filters the water before falling into the cistern. The collected water is used on-site to irrigate the planted vegetation.

The research for this case demonstrated the ability to reconnect both fragmented landscapes and wildlife, by rejoining the two sides of the park previously split by the freeway. The park has effectively integrated native plantings into its design, carefully preserving the existing landscape and implementing a sophisticated stormwater system to nourish the newly introduced flora. Existing trails connect to new pathways over the bridge, and the dual use of the wildlife viewing blinds serve as an artful shade structure for a break from the Texas sun for visitors in the park. Situated near the heart of San Antonio, this bridge design is specifically crafted to support and promote the thriving urban ecosystem around it.

Figure 24 Tobin Land Bridge. From left, wildlife screening, overhead view
Source: https://www.stimsonstudio.com/hardberger-park-land-bridge

Figure 25 Tobin Land Bridge. From left, skywalk, trail connections (Ozdil, 2023)

4.2.4 Continental Pedestrian Bridge – Dallas, Texas

Location: Dallas, Texas

Size: 2,100-acres - 1/3 miles long

Date: June 2014

Designer(s): WRT, LLC

Land Type: Elevated Park

Initial Budget: $12 million

Typology: Historically Adapted Pedestrian Bridge

The Continental Pedestrian Bridge connects West Dallas, a largely Hispanic and historically overlooked community to the Design District and downtown to the East. As a part of the Trinity River Corridor Project, the newly built Margaret Hunt Hill vehicular bridge rendered the Continental Bridge useless. The historic bridge, which was originally built in the 1930s as a way for vehicles to cross the Trinity River, was re-envisioned beginning in 2012 as a pedestrian promenade that would link walkers and cyclists from the developing eastern Trinity Groves district back to the heart of Dallas.

At 60 feet wide and 2,105 feet long, the 2,100-acre park installment posed a couple of construction challenges to the design. A major challenge being the age of the bridge, with limited capacity for loads of 125lbs/sf for both live and dead loads (*National Register of Historic Places Registration Form*, 2015). The design specified a new layer of paving, sheets of weathering steel to hold new meadow-inspired plantings, lightweight shade structures in place of large shade trees, and a misting fountain that does not require a water-holding tank on site. Crews were additionally able to raise the side railings to enhance safety and drill new shafts to replace older weakening columns with strong new ones.

The design team at WRT coordinated with the State Historic Preservation Office to ensure compliance with the bridge design with the guidelines laid out for working with a historic piece. WRT further helped coordinate access to the bridge from surrounding streets and adjoining developments to establish a seamless circulation system (*Continental Pedestrian Bridge*, n.d.). The design included adding parking, pathways, shade trees, and flexible spaces for markets, and fairs to the adjacent Gateway Park which serves as an entrance to the bridge park to the West.

“There’s no other way to cross the river here,” Davis says. “You can’t cross on the Margaret Hunt Hill Bridge unless you walk the Commerce or go down to Sylvan, the new bridge over here. A lot of people use this to get downtown, bikes and what have you” (Zeeble, 2014). The promenade features passive recreational activities with 39 trellis and shade structures placed over the pathways and lounge chairs, as well as a meditation labyrinth. To cater to its more active users and families, the park includes a playground with colorful geometric climbing blocks, spray water features, Bocce ball courts, chess tables – regulation and life-size, and flex spaces for concerts, gatherings, and other events. Many hope this renovation will help encourage more revitalization in West Dallas.

The review of the Continental Pedestrian Bridge provided this research with the opportunity to examine a local case that also stretches over a part of the Trinity River Corridor. This restoration uses innovative design techniques to reuse an aging bridge by adding to its existing structure, much like the design for this project illustrates. The bridge remains accessible to all and allows for communities to be connected more effectively and safely. One of the disadvantages to this design, that is primarily due to how much weight the structure could endure being added to it, is that the bridge does not play host to much of a biodiverse ecosystem. Some planters were added to enhance the aesthetic of the site; however, they do little for the urban ecosystem the study strives to implement. The shaded seating and gathering places creates an ideal place to gather for visitors, and the artful colored walkways provide clear paths for those biking, walking, and running.

Figure 26 Continental Bridge Park. From left, trinity trails, view of downtown from bridge
Source: https://www.keranews.org/government/2014-06-16/its-fabulous-dallas-continental-bridge-reopens-as-a-park-no-cars-allowed

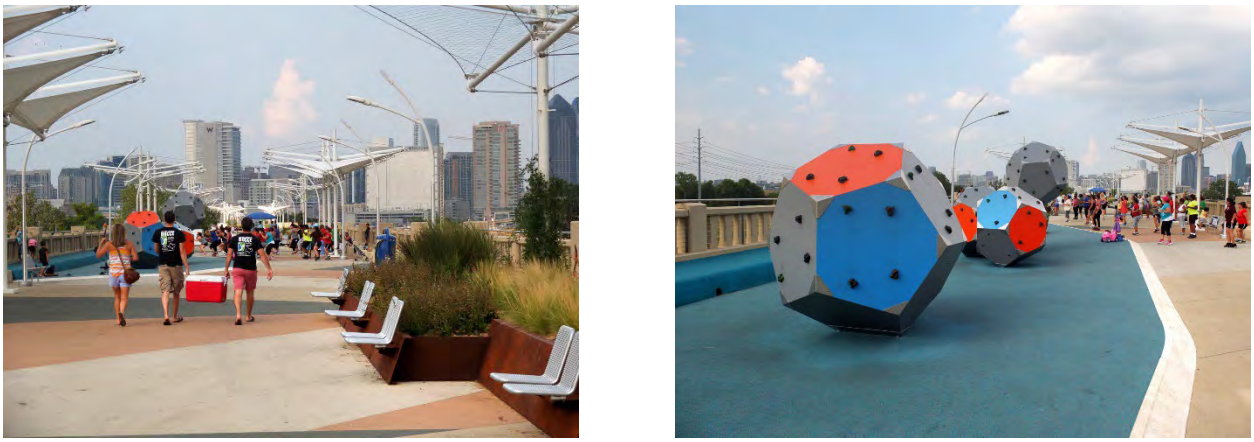


Figure 27 Continental Bridge Park. From left, amenity space, children's climbing area.
Source: http://www.blogoutside.com/blog/2014/8/6/continental-bridge-park-and-bocce-in-the-rain

4.3: Identified Design Strategies, Program Elements and Themes

The research conducted identified and analyzed four case studies outlined previously. These case studies were found to have design strategies, principles, programs, and themes that aligned with this thesis proposal. The main programs from each project were identified and categorized in the below matrix graphic.

The following programs were native plantings and educational signage, preservation, urban ecosystem, engagement with the river, stormwater management, innovative design, durable and flexible construction, accessibility to all, multimodality, shaded seating, bicycle

amenities, trail connections, public art installations, reconnect fragmented landscapes and communities. In summary:

- Native planting and educational signage is found in two of the projects. The use of native plants over invasive or adapted species is a preferred method for supporting a biodiverse ecosystem. In both cases, native species were used to enhance the landscape, as well as bring nature to a site where it otherwise did not previously exist. Signs are placed in the landscape to educate users about the types of plants, as well as their benefits.
- Preservation is seen in two of the cases by way of celebrating the existing nature on site, and adaptive reuse of an existing infrastructure bridge. By preserving what is already on-site, a design can look to save cost and valuable history.
- Urban ecosystems is utilized by adapting the designs and plantings with the unique conditions found within cities and other similar highly developed areas. With urban ecosystems, the design can hope to bring pollinators and other small fauna back to the landscape.
- Engagement with the river can be seen with the 11th Street Bridge Park. This allows visitors an opportunity to positively interact with the river that once divided their community.
- Stormwater management can be recognized in many upcoming designs today. The ideas are prevalent in three of the case studies with both innovative and more typical solutions. The use of rainwater harvesting, capture, and reuse can be seen with wetlands, underground cisterns, and multifunctional water features.

- Innovative design is something designers consistently consider, however in three cases it is highly utilized. Innovative design allows for new ideas to be discovered and tested. In all three instances, they were successful in construction, and in cutting costs.
- Durable and flexible construction signifies the intent of the designers to build a project that will be timeless and low maintenance. Two of the projects expressed durability with their designs, however through the analysis, the researcher found that all the projects demonstrated thoughtful intent with construction.
- Accessibility to all signifies the understanding and need to create parks that people with varying ability levels may enjoy. Inclusive design is prevalent in many projects today. Creating an environment such as a park that allows for wheelchairs, gentle slopes, and rest points validates the designer's want for their parks to be appreciated and welcoming to all.
- Multimodality is important as it allows the design to be utilized and accessed by several means of transportation. Users are able to use public transportation or their own vehicles to access the parks. The parks also allow for bicycles and pedestrians to coexist within a space. Three of the cases demonstrate multimodal functionality.
- Shaded seating is a welcome addition to these designs as it provides users, and in the case of the Tobin Land Bridge - animals, refuge from the elements. Covered seating is provided within all the projects, from trees to the structure itself providing shelter. This inclusion in designs allows for a site to be used year-round in some instances.
- Bicycle amenities is significant in that it caters to the multimodality aspect and brings an additional demographic of park users to a space. Three of the projects boast space for bicycle users. Having designated lanes and parking for bikes allows visitors to enjoy the

park actively while keeping those in favor of a more passive experience safe from the quick-moving bikes.

- Trail connections signifies that a design can connect to the existing infrastructure or is creating new opportunities for connection outside of its boundaries. Two of the cases actively express the ability to connect to an existing trail system, while in the case of the Continental Pedestrian Bridge, we see the potential for future connections with the Veloweb and Trinity Trails found in Dallas, Texas.
- Public art installations are significant as it allows the public to connect and engage with the park on another level. Having both temporary and permanent art pieces featured in a park brings uniqueness to the space. In the case of the Tobin Land Bridge, local artists were brought in to create designs along the shaded seating animal viewing shelters.
- Reconnecting fragmented landscapes signifies the understanding of the importance of working with nature, rather than against it. By reconnecting fragmented landscapes, designs can hope to improve biodiversity in an area, as well as reintroduce native plants that attract beneficial animals like pollinators back into a habitat. Two of the cases achieve this in their design.
- Reconnecting fragmented communities is significant for overall economic development and improvement. This theme is achieved in all four cases, reconnecting urban neighborhoods and suburban neighborhoods to their adjacent downtown areas, as well as users of a park that were divided by a highway.

By analyzing the findings from the case studies, the figure below is intended to provide a clear overview of how each of the extracted programs was utilized (or not) in the overall designs.

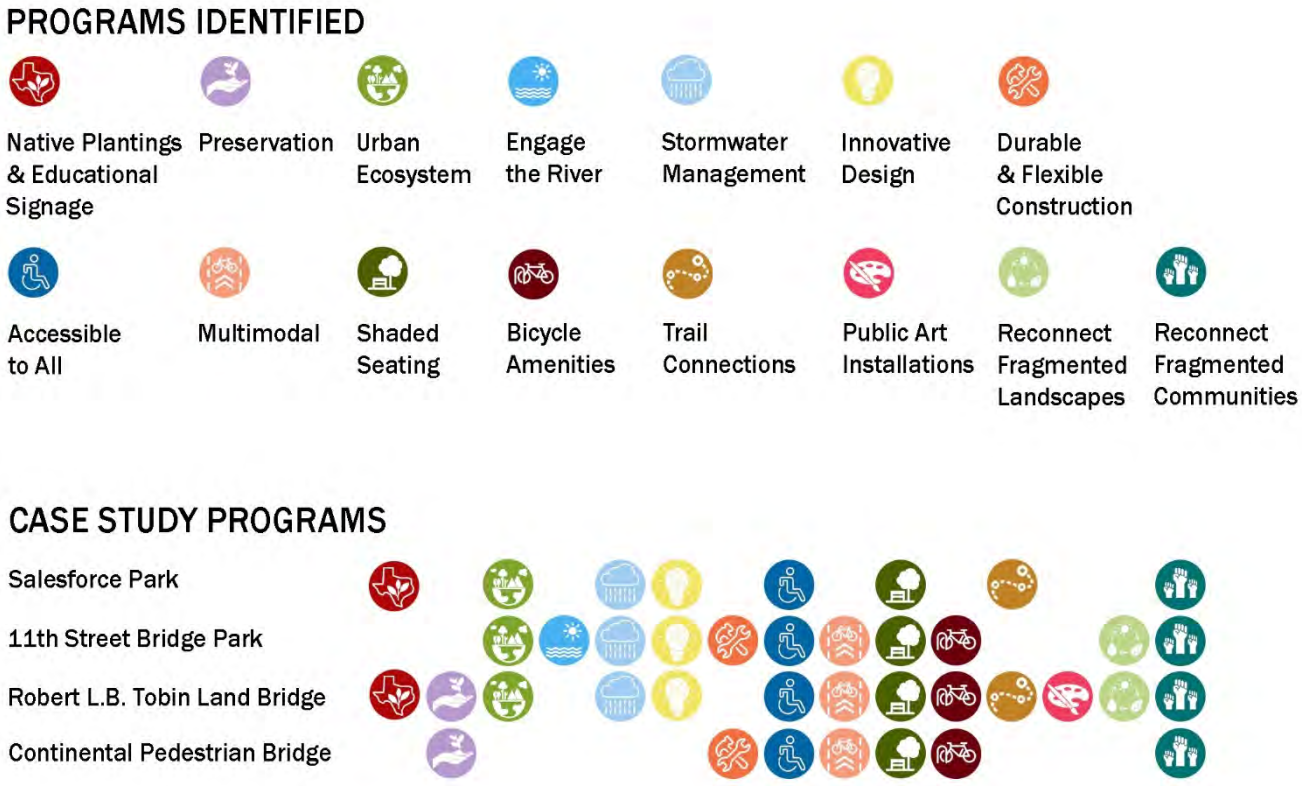


Figure 28 Case Study Analysis (Adapted with Photoshop and The Noun Project)

CHAPTER 5: DESIGN

5.1: Introduction

This chapter reviews the site selection, inventory, and analysis associated with the typical design process. Based on the research, the findings are synthesized to suggest additional infrastructure that is added to the North Main Street Bridge to promote connections within urban landscapes. Reflection of the literature review findings and programming identified with the research is then refined leading up to the conceptual design. Finally, the schematic plan is presented with the details below.

5.2 Site Selection

5.2.1 Site Selection Process

When analysis began on the ideal location for a design to be conceptualized, three interchangeable scenarios were considered. This type of research and design could be implemented firstly in a scenario that connected two suburban communities. The location under consideration was the Dallas Escarpment District which lies on the border of Dallas and Grand Prairie, Texas. This district is located southeast of Mountain Creek Lake along Spur 408. This location shows the effects that a highway can have when it is constructed between two previously connected communities. With the addition of the highway, and the expansion of Dallas' present and projected growth, the nearby escarpment conditions that border the lake and eventually meet back up with the Trinity River are at risk of being demolished and developed over. This can be seen in the aerials of the site as a warehousing sector has begun to claim some of this land already.

In a second scenario, the researcher looked at the context of connecting two urban communities. The Dallas Fair Park District was reviewed as it had the potential of addressing the issue of economically fragmented communities, as well as studying the effects of flooding concerns from the heavily impervious framework of nearby Downtown Dallas. The significance of studying an area with high-density urban living is that it could potentially have a greater benefit to a larger part of the population.

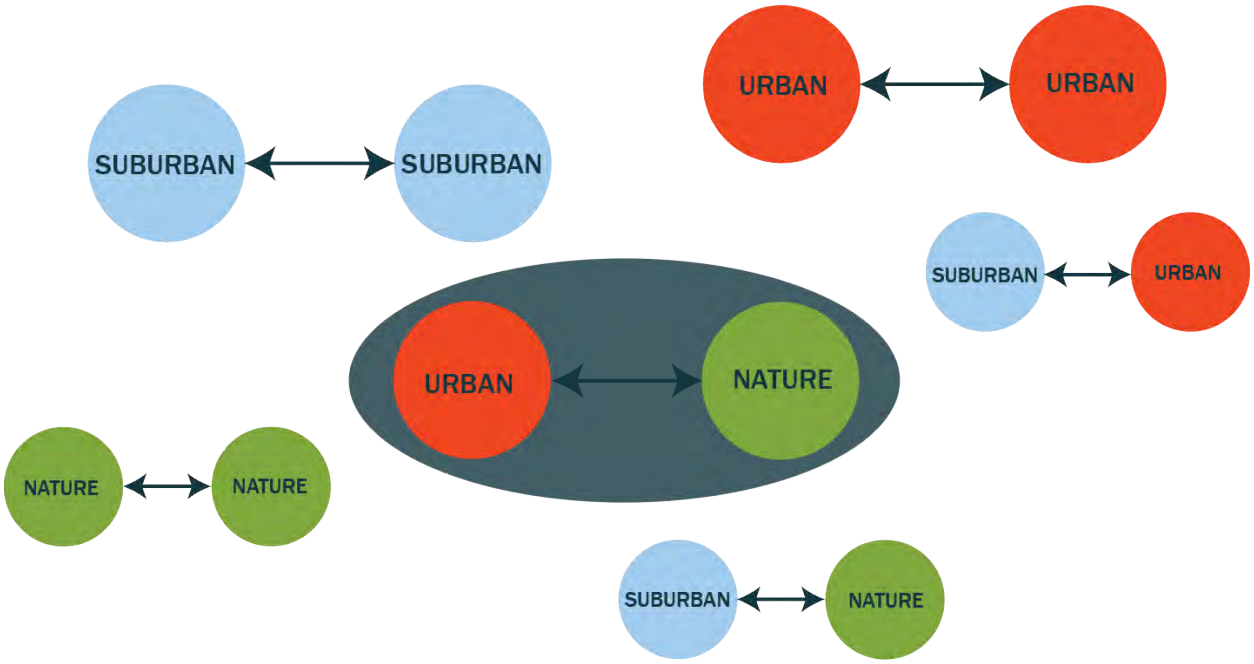


Figure 29 Site Selection Context (Adapted with Illustrator)

Finally, the researcher determined that the scenario of connecting an urban area to nature is most critical in growing urban areas, as this aligns most with the initial motivation of the design thesis research. The selected area, however, is unique in that it will in the near future eventually connect two urban communities to the escarpment and the riparian zone. The location described is a portion of an escarpment along the West Fork Trinity River, just north of Downtown Fort Worth, Texas. With the growing developments of the city, the escarpment is at

risk of being developed as well. In aerial images, we can see that for many years the escarpment remained untouched, but after 2005 the Tarrant County College system removed a large portion of the wooded area to build a new campus. Along with other developments along the banks, this further fragmented the existing ecology of the site.

Figure 30 Forest Escarpment Development Encroachment (Adapted with Photoshop and Illustrator)

5.2.2 Site

For pedestrians walking along the Trinity Trails approaching the North Main Street Bridge, also known as the Paddock Viaduct, the architecture is remarkable with its large swooping archways that straddle the West Fork Trinity River. To the South lining the trail near the bridge, a narrow grouping of trees and greenery make up a thriving but dwindling natural escarpment. To the North of the river and trails, a tall mound of earth protects the nearby Panther Island from major flood events. The levee is essentially barren, save for a few sporadic oak trees and grasses. The bridge which towers over 100 feet above the trails, serves as a vehicular connection between Downtown Fort Worth and Panther Island.

The Paddock Viaduct Bridge was formally opened on July 3, 1914, as a part of a multi-bridge construction project totaling $600,000 for five bridges, with the Paddock Viaduct accounting for half of that budget. Ten thousand people gathered to witness parades, speeches, and fireworks. In a symbolic gesture of cross-river unity, at a signal an automobile carrying dignitaries from the south side of the river drove north over the bridge, and an automobile carrying dignitaries from the north side of the river drove south over the bridge, both cars passing through “a rope of carnations and evergreen” that was stretched across the middle of the bridge (*Bridges Past, Present, and Future*, 2018).

In 1957, Federally funded improvements to strengthen the levees led to the straightening of the Clear Fork and West Fork of the Trinity. This removed the natural meandering way of the river, in favor of a channel system. Thousands of trees along the banks were wiped out, and the levees became barriers that kept both flood waters at bay and people away. It was not until 1971, after the droughts that left the Trinity a ditch for dumping, that a local citizen’s group formed Streams and Valleys, Inc. as an organization charged with the beautification of the Trinity River and its tributaries. The “Halprin Plan” was developed for the area to provide low-level dams, extensive multi-user trail systems, and lighting, while planting thousands of trees and vastly improving public areas(*Confluence: The Trinity River Strategic Master Plan*, 2018). In 2002, with the creation of the Trinity River Masterplan, steps began to be taken to mitigate stormwater, protect against flooding, and enhance parks and trails ever since its introduction. With the enhancement and addition of more parks and amenities utilizing every option available to bring green spaces back into this urban area should be looked at.

5.3 Inventory and Analysis

5.3.1 Regional, City, and District Context

The design site, located in Fort Worth, Texas, can further be identified by its location within the Cross Timbers and Prairies ecoregion. Rainfall is variable, averaging about 35 inches in the east region where Fort Worth resides. Grassland species such as little bluestem, Indiangrass and big bluestem are common. American elm, Osage orange, and Live Oak trees are more common here, replacing the post oak of the east. Decreasing moisture discourages clusters of trees, and trees form isolated stands. Flameleaf sumac, redbud, Mexican plum, and Eastern red cedar become more prevalent. Wildlife is a mixture of eastern forest and prairie species. (Cross Timbers and Prairies, n.d.)

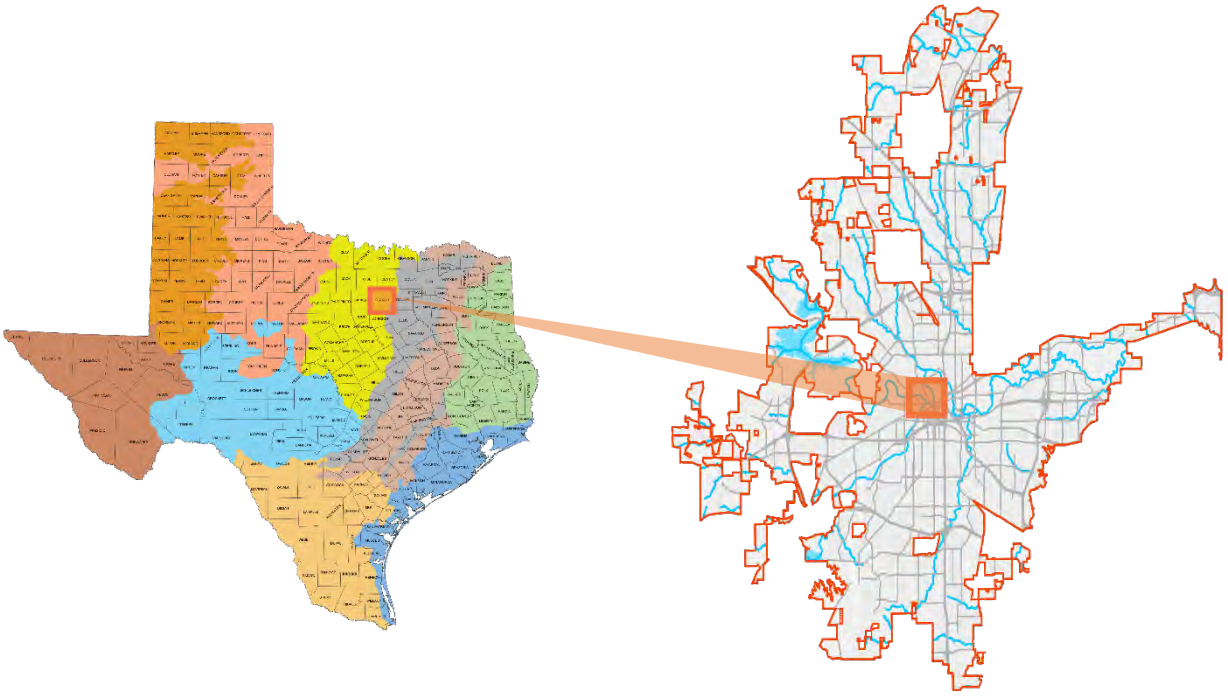


Figure 31 Regional and City Context (Adapted with Photoshop)

5.3.1.1 Demographics

Research of the site revealed demographically that the median age for the area was primarily those 25 to 34 years of age. The ethnicities most prevalent in the area were White (Not Hispanic or Latino) making up 38.2%, Hispanic or Latino making up 35.3%, Black making up 18.5%, Asian making up 4.8%, and those associating with two or more races making up the remainder. The demographic statistics reviewed for this study population were separated into two zip codes that make up the area surrounding the chosen design site, 76102 and 76164. Illustrated below are additional details regarding each:

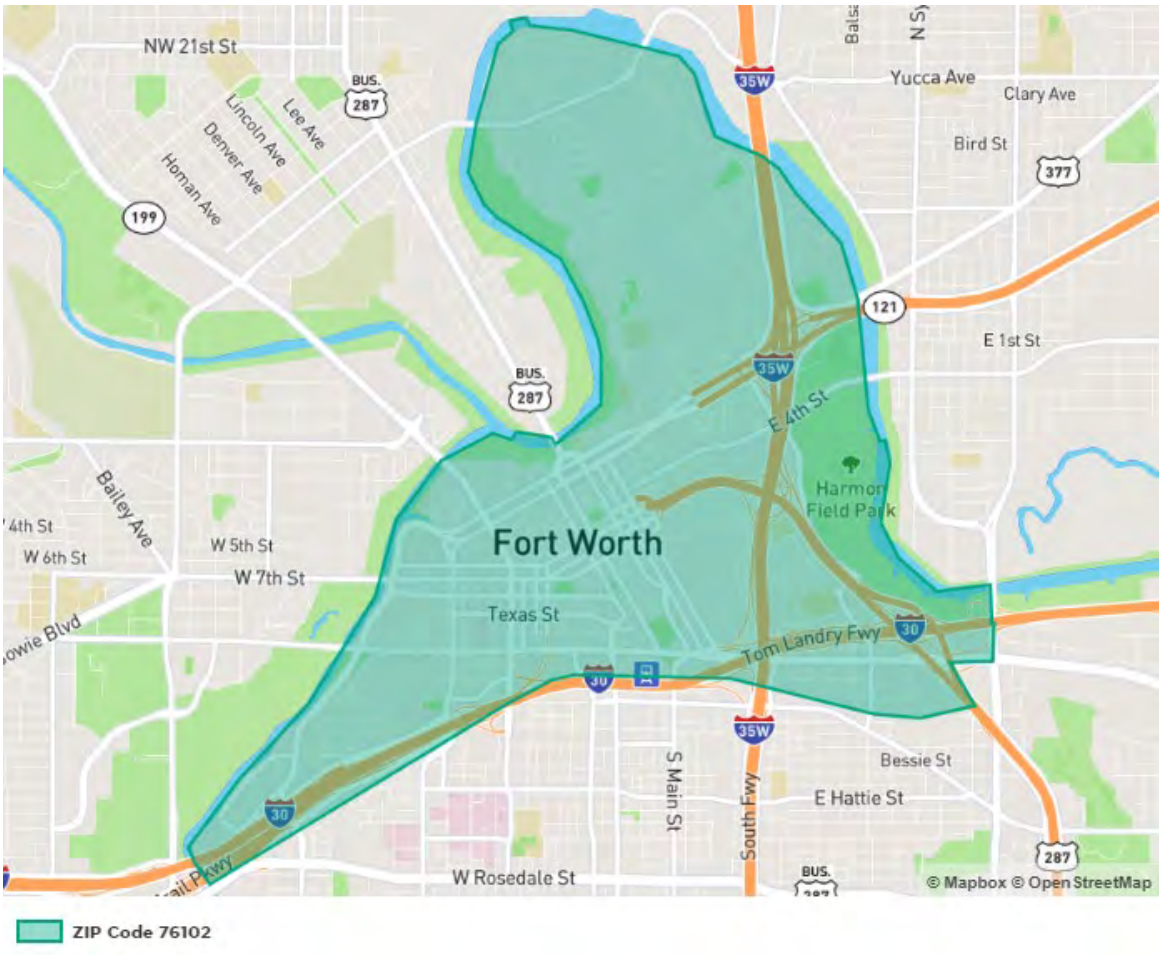
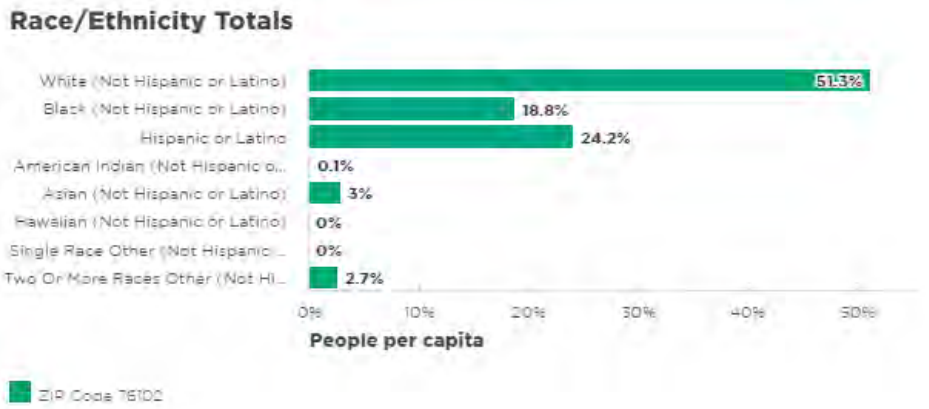
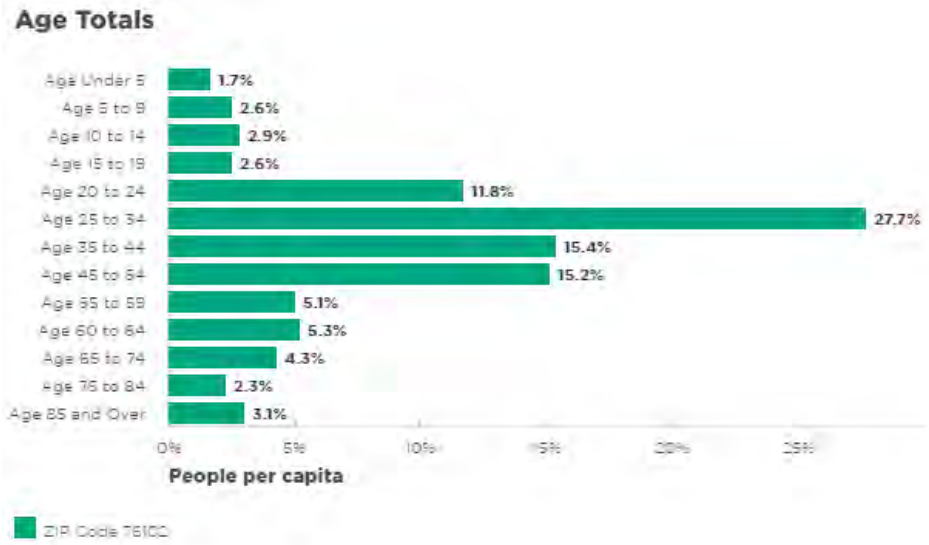


Figure 32 Panther Island District
Source: https://reports.mysidewalk.com/a7453eb3f3





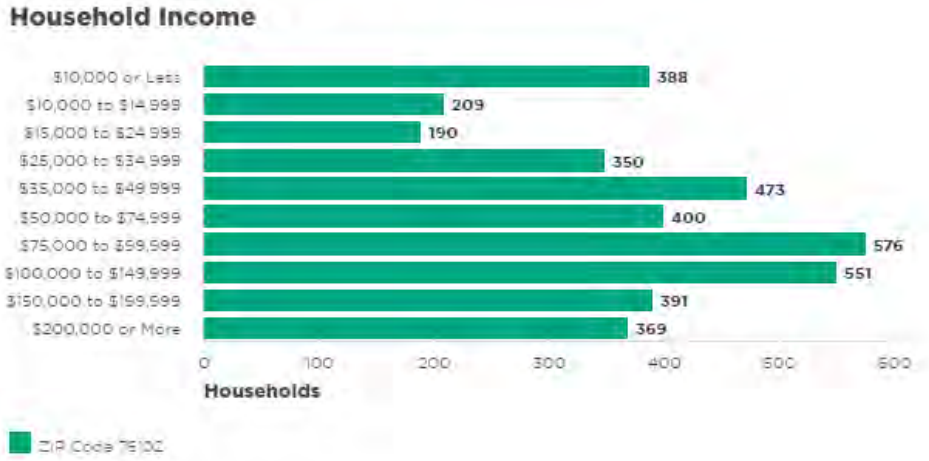


Figure 33 Panther Island District Demographics
Source: https://reports.mysidewalk.com/a7453eb3f3

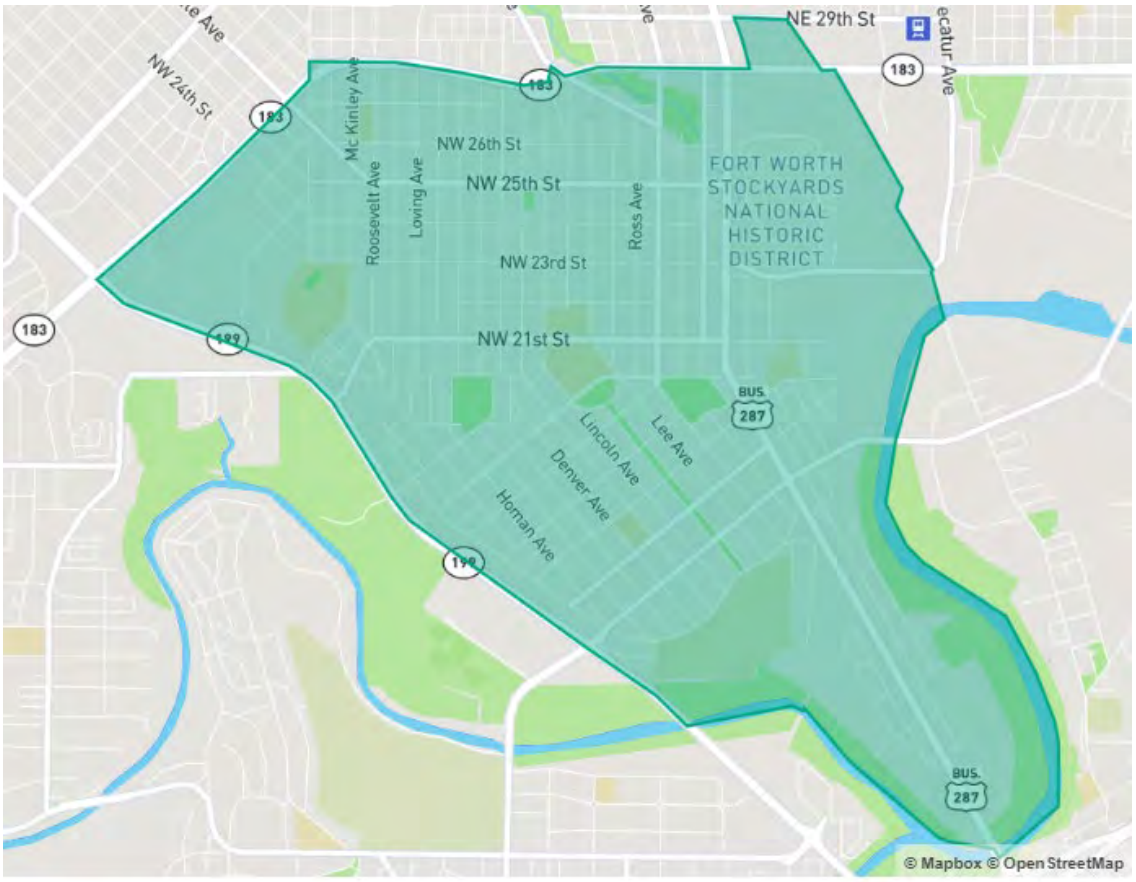
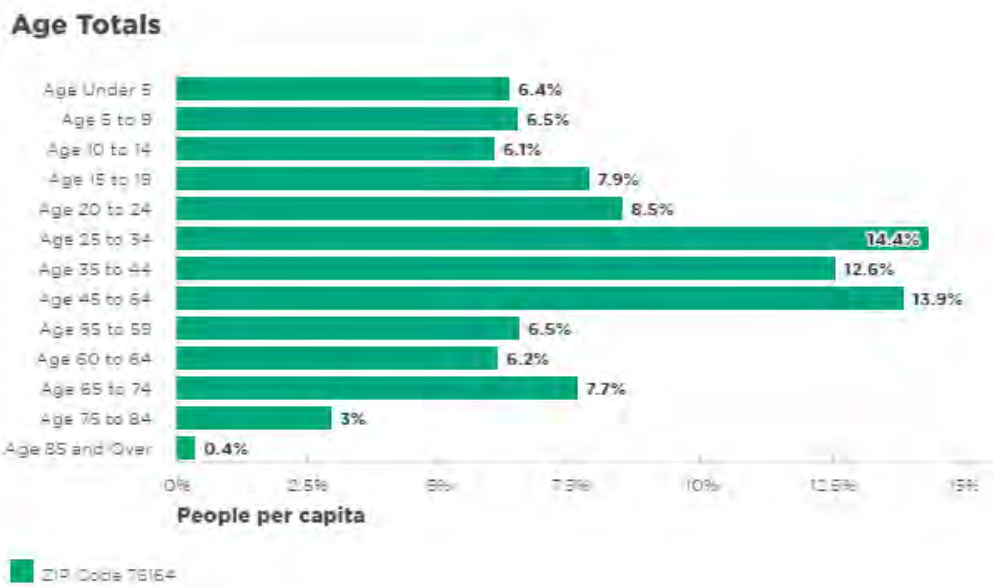
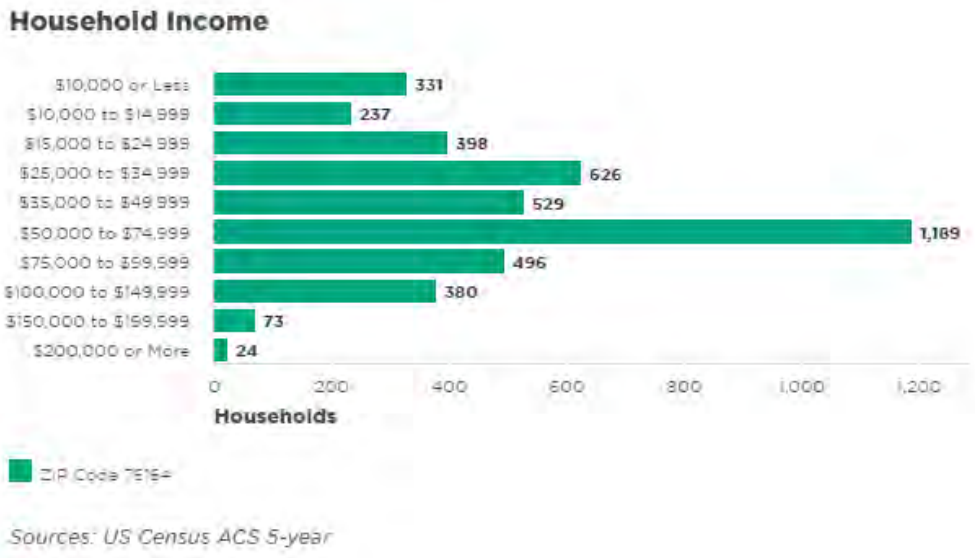


Figure 34 Downtown Fort Worth District
Source: https://reports.mysidewalk.com/cf262f6b4e



Sources: US Census ACS 5-year



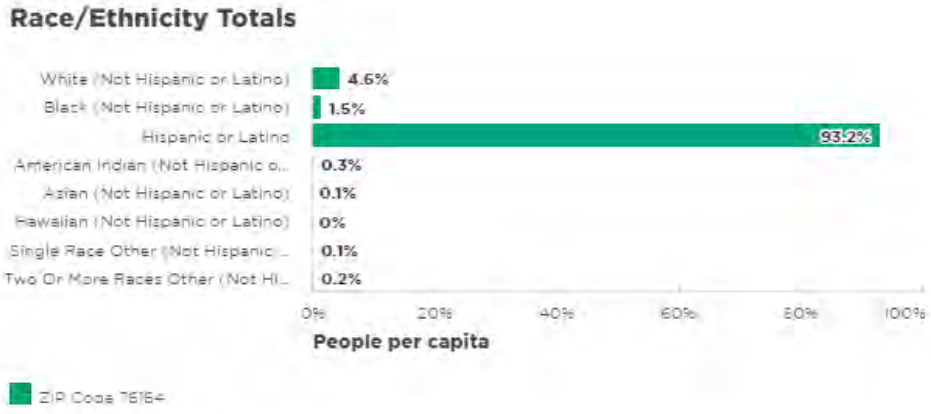


Figure 35 Downtown Fort Worth District Demographics
Source: https://reports.mysidewalk.com/cf262f6b4e

5.1.3.3 Site Analysis

The following figure demonstrates important aspects of the site inventory process specific to the Fort Worth region within a 1-mile radius of the site location. Features include street circulation, pedestrian circulation, green and open space, tree canopy coverage, the current river channel addition that is under construction, and the location of two planned pedestrian bridges as a part of the Trinity River Vision.

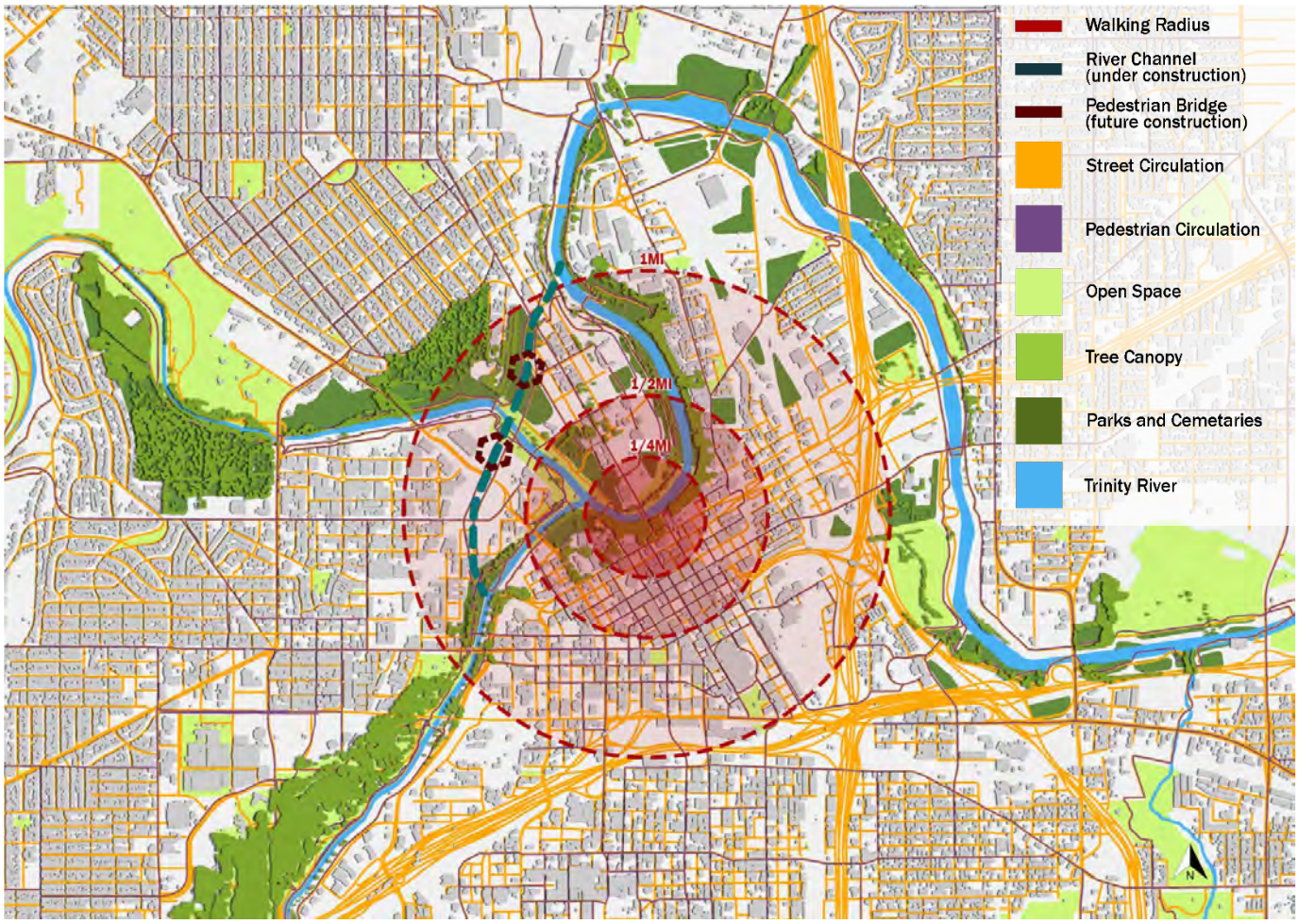


Figure 36 Site Inventory and Analysis (Adapted with GIS, Photoshop, and Illustrator)

As a part ofthe Panther Island Master Plan, one of the first initiaves was to rezone the area. Panther island, as shown above, is now zoned Mixed-Use similarly to downown Fort Worth. Between these two areas are public parks, recreation, and open space.

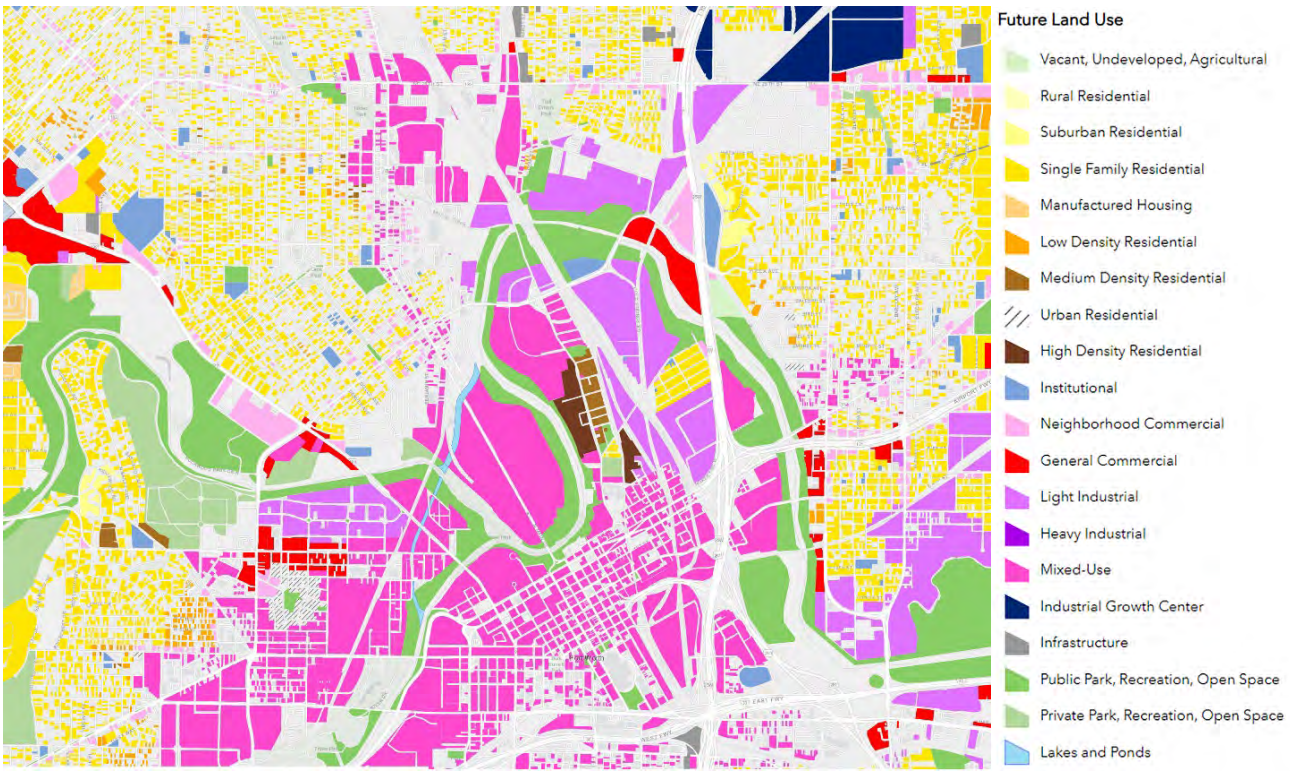


Figure 37 Land Use Map (Adapted with GIS)

When researching multimodality aspects of Fort Worth, the Fort Worth Active Transportation Plan revealed curren research and implementation of additional bikeways for pedestrians in and around the city. The figure 38 supports the demand for and benefits of active transportation options through the use of surveys and observation.

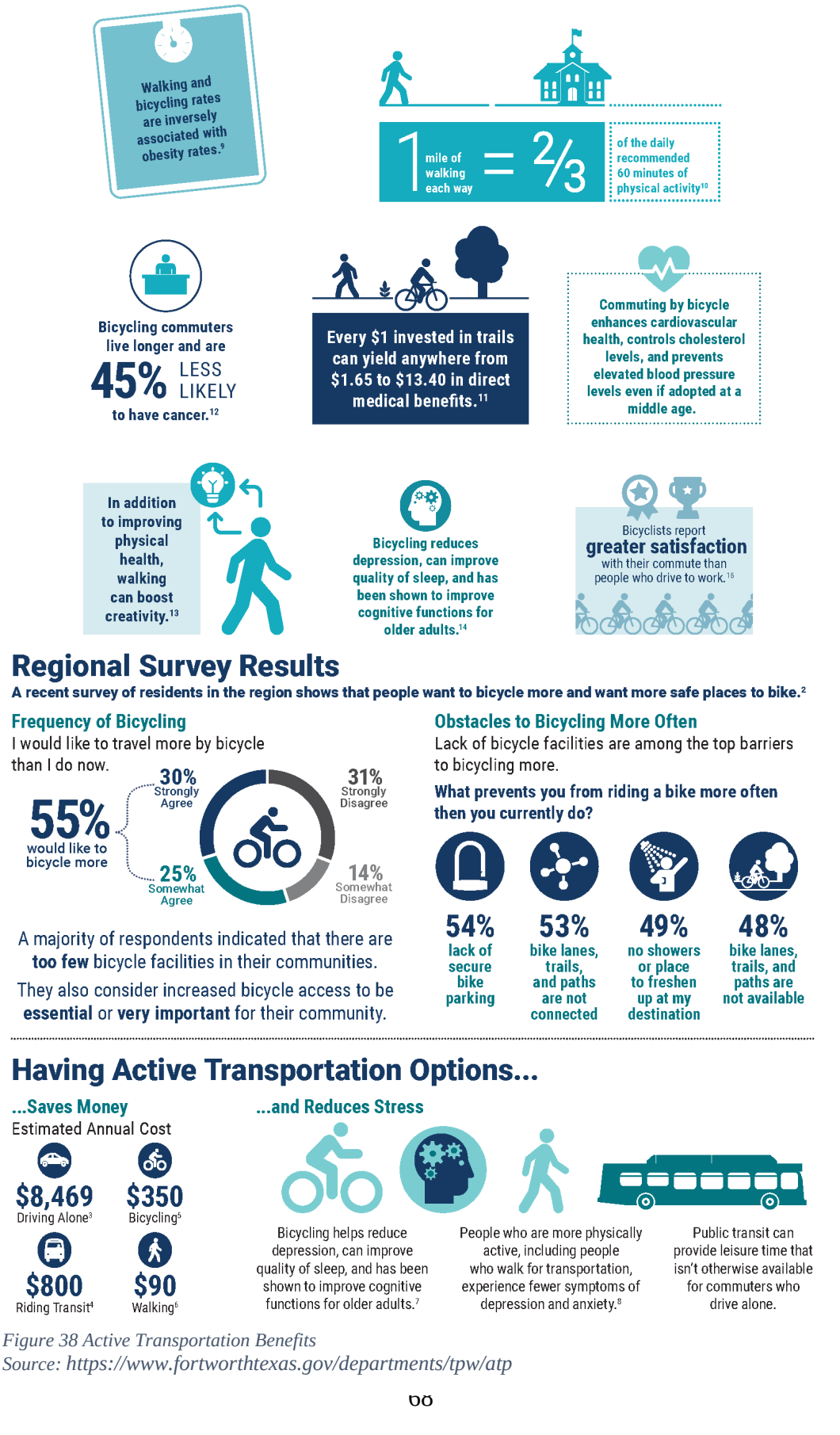


Figure 38 Active Transportation Benefits
Source: https://www.fortworthtexas.gov/departments/tpw/atp

5.3.1.3 Site Observation Visit

Upon choosing the site, the researcher went to the location to gather images and observational data for inventory and analysis. The site was visited in February around the end of wintertime for North Central Texas and again in April during the peak of springtime. The figures below illustrate the conditions found on site during these times, see Figures 38 - 42 for observation details.

Figure 39 North Main Street Bridge Sidewalk (Adapted with Illustrator)

Figure 41 Trinity Trails Approaching North Main Street Bridge (Adapted with Illustrator)

Figure 40 Flood Damaged Dock (Adapted with Illustrator)

Figure 42 Northern Levee Looking Down from North Main Street Bridge (Adapted with Illustrator)

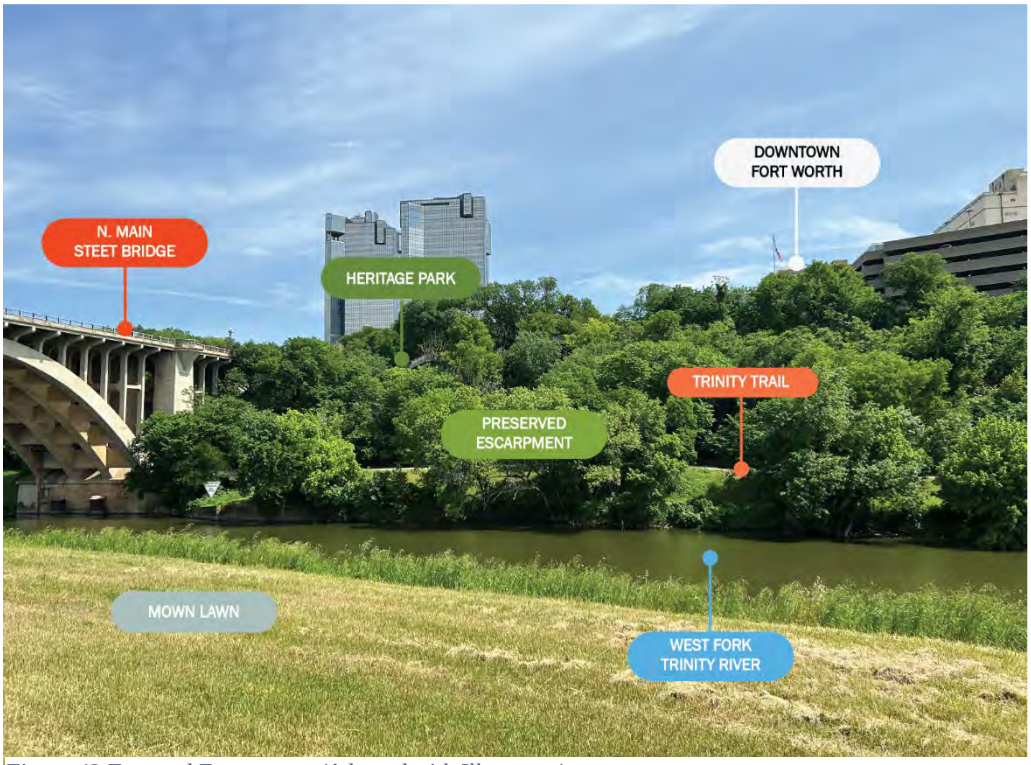


Figure 43 Forested Escarpment (Adapted with Illustrator)

Site Imagery – February 2023

Figure 44 Passive Observation Visit in February 2023 (Enhanced with Photoshop)

Site Imagery – April 2023

Figure 45 Passive Observation Visit in February 2023 (Enhanced with Photoshop)

5.4 Design Program

These programmatic elements are derived from the findings of the case studies outlined in chapter four, as well as observations gathered at the site by the researcher. In addition to the programming accessed in chapter four, the following themes were grouped together based on their likeness to coincide with one another in each of the case studies. The following programs stood out to the researcher as most attainable for the selected design site:

- Native Plantings, Educational Signage, and an Urban Ecosystem

  Currently the Trinity River and previous interference to the natural flow of the river channel has left one bank of the river with a natural escarpment, while the opposite bank features a handful of established trees. While preserving as much existing canopy as possible, the lower eastern section of the bridge will allow for a naturalistic extension of the escarpment over the river on. The upper section to the east and west will allow for additional native plantings in a more urban setting.

- Shaded Seating, Accessibility to All, Stormwater Management

  Areas for shaded seating will allow both passive and active users to enjoy the space. Creating an inclusive environment for small gatherings and rest points for all visitors to the Trinity Trails. With the addition of many new trees on site, stormwater can be better managed and absorbed through natural root systems, as well as tree wells designed to hold excess water that collects on the original portion of the N. Main Street Bridge. Cisterns will additionally be placed at the site to collect, filter, and reuse rainwater for future irrigation needs.

- Multimodality, Bike Racks and Bike Repair Stations, and Trail Connections

With more multimodal access, bicycle users may become more frequent. Racks for storage and a rest stop that allows minor repairs to be made will be included on site. Vehicular circulation will not be impeded and will remain continuous along the N. Main Street Bridge. Pedestrians and bicycles will gain new pathways through the improvements made with the concept design. In alignment with the Fort Worth Active Transportation Plan (ATP) the city and this concept aim to assist in a seamless network of on- and off-street bicycle and pedestrian facilities for people of all ages and abilities to walk, access transit, and bicycle ((North Central Texas Council of Governments, 2019) along the Trinity River Trails system.

Figure 46Bike Amenity Repair Station (Lowthian, 2014)

- Art Installation Space

The upper east and west sections of the bridge will provide opportune spaces for temporary and permanent art installations that the City of Fort Worth will be able to change at their discretion.

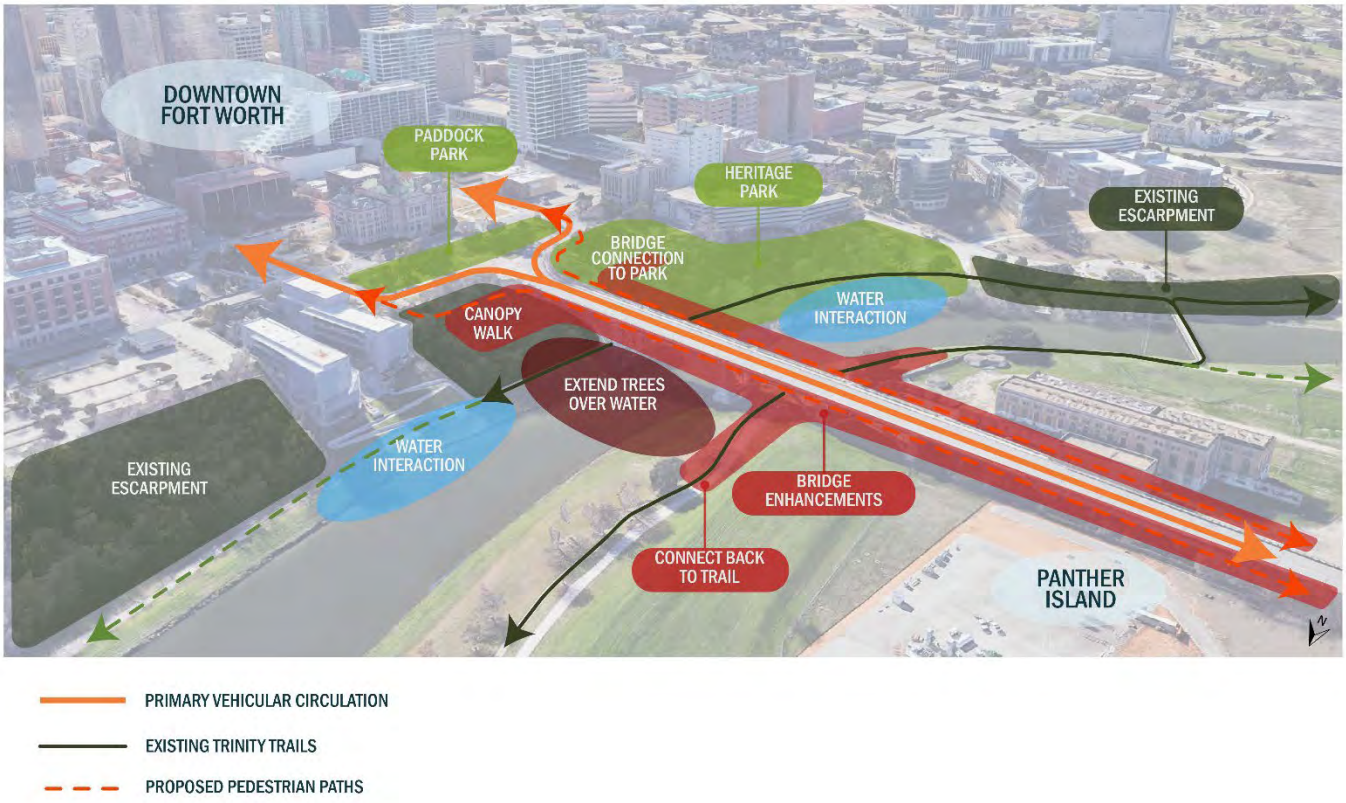


Figure 47 Concept Plan (Adapted with Illustrator)

The initial idea for a concept was to add to the existing infrastructure of North Main Steet Bridge to better the connection for people along the roadway and bring them closer to nature while preserving the nearby escarpment. The concept evolved to include improved multimodal walkways, passive and active spaces, interaction with the existing escarpment while preserving the nature, connection to Heritage Park, interaction with the Trinity River, and connections to the Trinity Trails.

5.6 Schematic Plan

While the City of Fort Worth and other surrounding entities propose to make improvements to the nearby parks, neighborhoods, levees, and Panther Island District, an opportunity to improve the connection between these sites has emerged. The schematic plan shown in the below figure X, is developed from the above concept in figure X using the design elements and findings that were analyzed in Chapter 4 (Figure X).

The concept introduced the idea of adding to the existing bridge, therefore preserving its unique and historical conditions. The design achieves this by building onto either side of the bridge with minimal impact to the original structure. Each side features a complete connection from Downtown Fort Worth to Panther Island. These connections include at minimum 16-foot-wide multi-modal trails for pedestrians and bike users. The North Main Street Bridge will remain the primary mode of travel for motorists, with the only enhancements being the planting of street trees and greenery to assist with the capture and processing of stormwater on the bridge.

The design includes multiple areas for recreational gathering spaces, including shaded seating, children's play areas, public art installation spaces, and viewing platforms. Among these amenity spaces, users can find native plantings, a lush grassy lawn with partial shading from urban adapted trees, and a pollinator-friendly habitat garden with education signage (Figure X and X). Near the Downtown end of the bridge, a unique seating structure can be found in the form of the immediately surrounding West Fork Trinity River. This structure features locally sourced rock as the bench and a planter with additional native plants of the region (Figure X).

One of the initial research questions of this thesis inquired: How can nature be incorporated into infrastructure bridges to promote connections in urban landscapes? The concept of extending the existing forested riparian corridor specific to this area resulted in a

lower section of bridge that reconnects the southern edge of the levee to the northern edge. The design allows for additional native trees and vegetation to be planted along the land bridge, essentially extending the escarpment over the river. This bridge design stretches over the river at a 5% grade, connects to the Trinity Trails on each side of the river allowing users to easily cross, and sits high enough to allow kayakers to pass under.

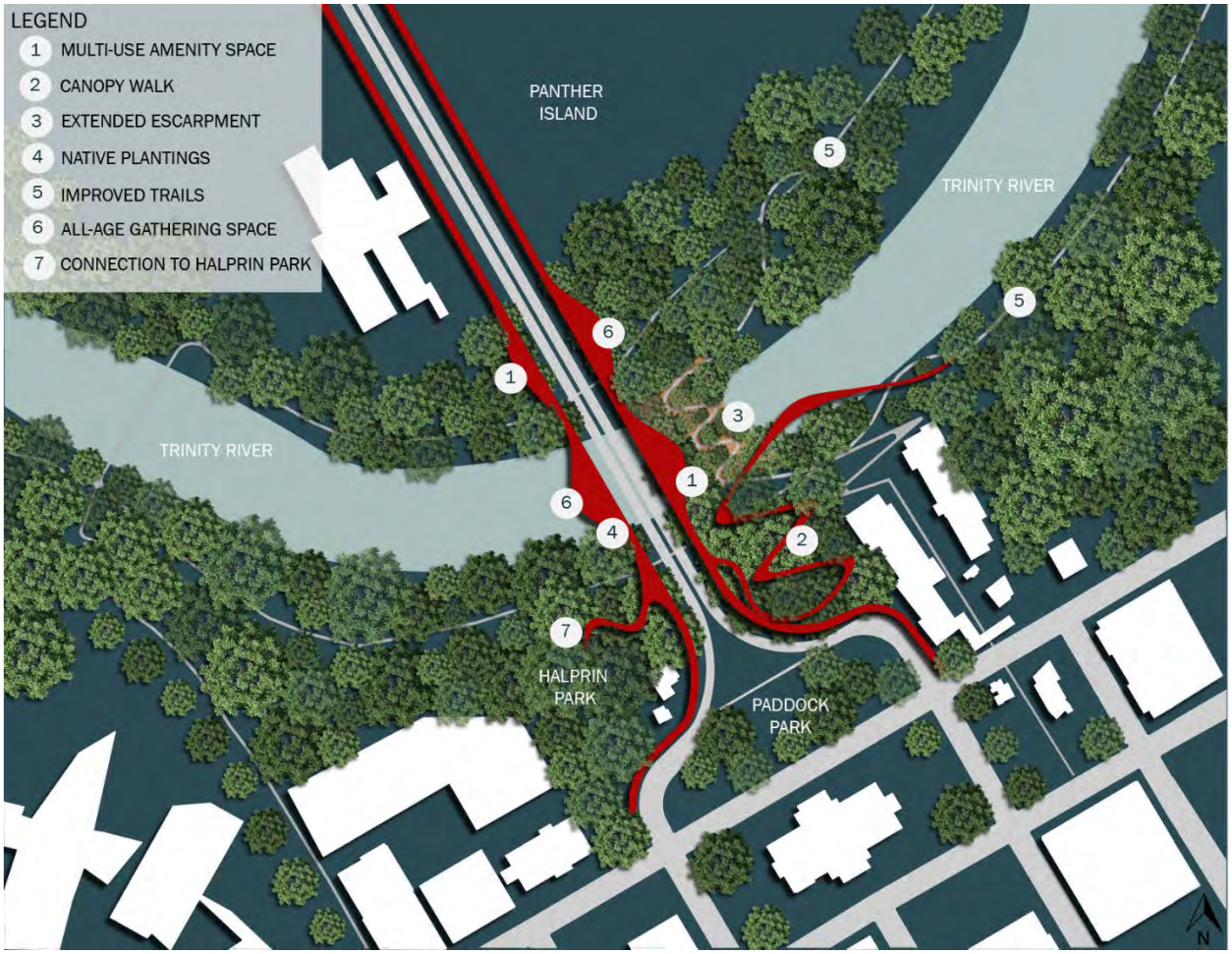


Figure 48 Schematic Plan (Adapted with AutoCAD, Photoshop, and Illustrator)

5.7 Design Details

Figures 48 - 54 illustrate the various design details with renderings to provide a better visual understanding of the vision for the enhancements to the North Main Street Bridge in Fort Worth, Texas.

Figure 49 North Main Street Bridge Enhancement Overview (Adapted with Lumion)

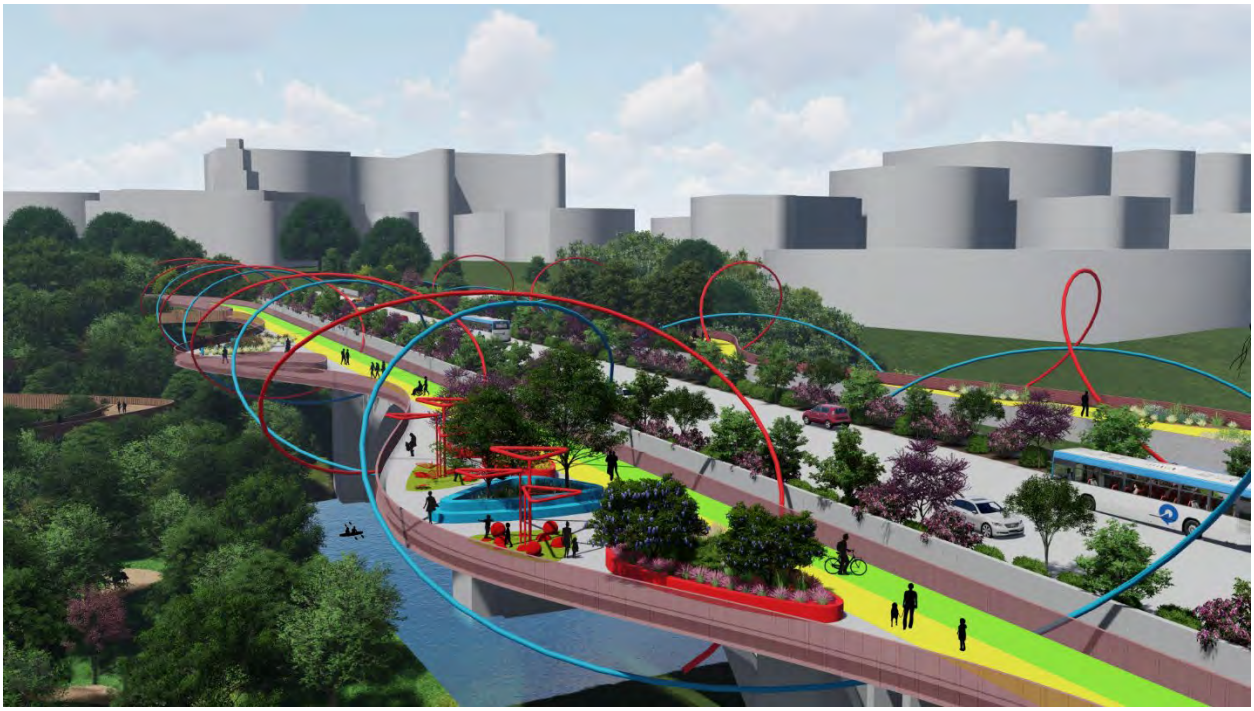


Figure 50 North Main Street Bridge Enhancement - All Age Amenity Area (Adapted with Lumion)

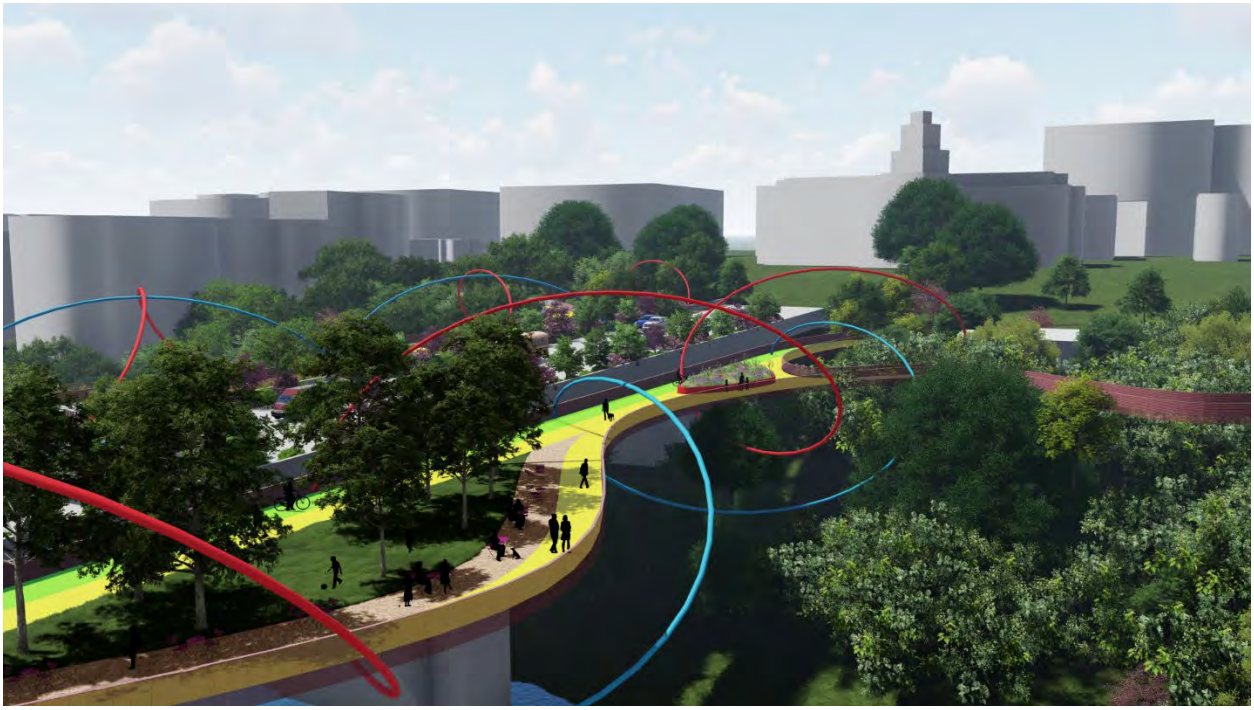


Figure 51 North Main Street Bridge Enhancement - Open Lawn and Seating (Adapted with Lumion)

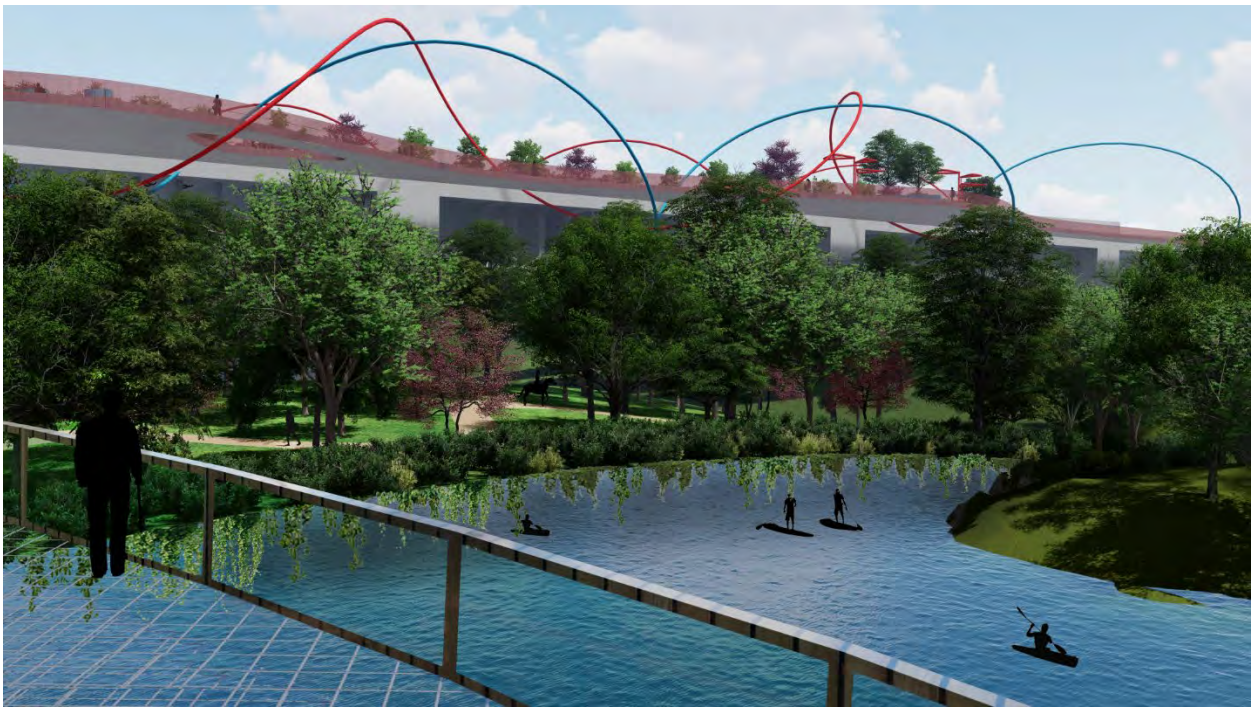


Figure 52 Canopy Walk Platform Overlooking the Land Bridge Crossing the Trinity River (Adapted with Lumion)

Figure 53 North Main Street Bridge Enhancement - Multimodal Trail Connections (Adapted with Lumion)

Figure 54 North Main Street Bridge Enhancement - Pollinator Friendly Garden (Adapted with Lumion)

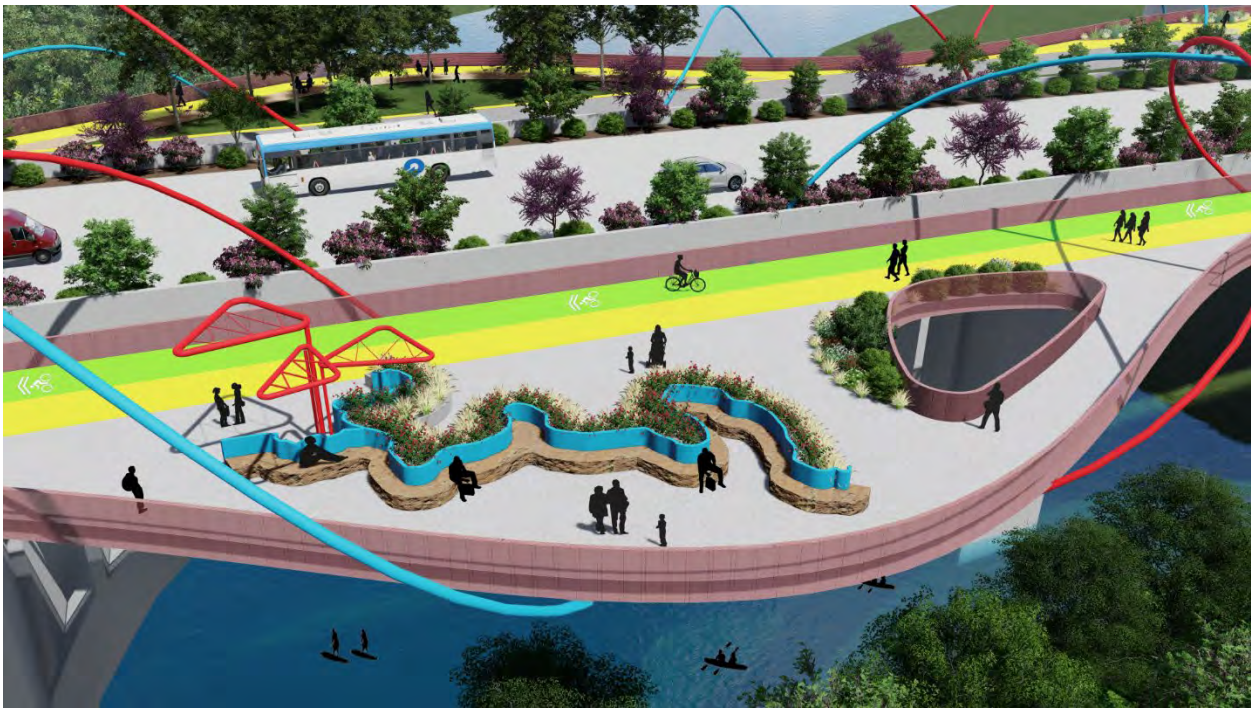


Figure 55 North Main Street Bridge Enhancement - West Fork Trinity River Inspired Seating Structure (Adapted with Lumion)

5.8 Chapter Summary

This chapter discussed the design process through inventory and analysis of the surrounding region, city, district, and site. Land use, demographics, and the importance of incorporating multimodality in urban areas were discussed to further substantiate the necessity of an enhancing design. By viewing the existing conditions on site and reviewing the design elements analyzed in Chapter 4, a concept was developed from the concept, a schematic plan was developed using the programmatic elements derived from the research. This was finally supplemented with detailed renderings of the design site.

CHAPTER 6: CONCLUSION

6.1: Introduction

A quote inspired by Lawrence Anthony stated, "In creating cities, we build habitats for ourselves, but in preserving and adding to nature, we create habitats for the soul.” The impact we have on the natural world, no matter how small it seems, chips away at the dwindling remnants of nature until there will be nothing original remaining. What we have must be preserved, and what is lost must now be reintroduced back into our daily lives. By using the existing infrastructure, additions to these designs can be made to bring nature, people, and vehicles together in single space.

6.2: Study Findings Summary

As cities continue to urbanize, it is important to explore ways to expand green spaces within them. The research primarily examined four case studies to determine the possibility and success of various typologies of bridges designed to bring nature, people, and vehicles together. As a solution, a total of fifteen programmatic themes were extracted from the researched studies and determined to be vital elements to the designs. The design elements were then used to develop the North Main Street Bridge enhancements. The design reconnects Downtown Fort Worth to Panther Island and the surrounding Trinity River corridor while maintaining its original function as an infrastructure bridge used to carry motor vehicles across the river.

6.3 Response to Research Questions

How can nature be incorporated into infrastructure bridges to promote connections in urban landscapes?

The research suggests that nature can be incorporated into the landscape surrounding the area, by way of the physical feature itself or through other plantings and stormwater capture systems. Looking at the case studies revealed there are now multiple typologies of bridge design that can sustain a biodiverse ecosystem on top of the structure itself, and in most cases blending it into the surrounding landscape.

How can connections be improved with multimodal access for both pedestrians and vehicles in urban landscapes?

Based on the findings from case studies, secondary data, and site observations, the research revealed that infrastructure bridges can be reimagined to incorporate features that allow pedestrians and vehicles to coincide by each other in a meaningful and safe manner. The case studies showed that different bridge typologies can allow for both pedestrians and motorists to cross in the same realm, as well as provide separate spaces for each within the same design. This design allowed for some separation between the two by bringing the pedestrians and bicyclists to a slightly lower level, creating a multi-purpose space for them, while improving the visual experience for vehicles traveling above.

What can be learned from the design of North Main Street bridge (Paddock Viaduct) in Fort Worth, Texas?

The research concludes that it is possible to have nature, people, and vehicles coincide in a space successfully. With innovative design and construction techniques improving daily, designers can explore more critical design ideas. Urban development is on an incline, but there are opportunities in many places to incorporate more nature into new or existing spaces. Existing infrastructure can be reshaped and reconfigured to provide a better experience to users. It can be added upon to create more interaction with the space and bring in more visitors. Finally, by looking at a structure from a fresh perspective, its hidden potential can be revealed.

6.4 Relevance to Landscape Architecture

By exploring urban design strategies and projects that activate the urban landscape, this research offers landscape architects valuable insights into how to enhance community connections and resilience. Landscape architects design outdoor spaces, such as parks, gardens, campuses, and urban plazas, with the goal of creating functional and aesthetically pleasing environments. The ability and knowledge to shape an outdoor environment and create spaces that are both functional and beautiful can be implemented into more and more scenarios as growth increases. Looking at building onto existing infrastructure is an opportune moment for landscape architects to incorporate more naturalistic and sustainable practices into future design.

6.4 Future Research

This thesis primarily focused on findings from literature, passive site observation, and case studies. Future research conducted should consider the opinions of experts in related fields. Experts to be considered for interviews can include those involved with the Panther Island Master Plan Vision, the City of Fort Worth, the Army Core of Engineers, those who have

worked on historical sites, those who have successfully implemented enhancements to the levee systems, and possibly those who have worked on similar designs such as those examined in the case studies from Chapter 4.

As the Panther Island masterplan is further developed, additional research may need to be conducted to ensure such a design aligns with visions for the district and the City of Fort Worth, as plans are ever-changing. During the research, there were comments circulating that a new vision may possibly be drawn up for the Phase I and II of Panther Island, as the original concepts were from 2007.

Further research conducted should look at the opportunity of placing such a structure at a different location. The further research may reveal the North Main Street Bridge to not be the only option available.

6.4 Final Thoughts

This thesis offers a solution to connecting communities in both nature and urban development. However, this solution is limited to the design centered around the infrastructure bridge and the surrounding escarpment in which it resides. To fully have nature, people, and vehicles intermingle with each other daily, further studies will need to research other possible sites within the urban context.

Though it may not be known to all, or a peak concern for most, adding green spaces to urban areas has a significant impact on both our environment and mental well-being. The research shows the benefit of having nature within a walkable distance. Entire cities do not have to change, but making small enhancements to existing infrastructure will allow for bigger

impacts down the road. Through innovative designs, urban development can become more beneficial to all.

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