PERCEPTIVE TRANSFORMATION OF THE PSYCHE USING LANDSCAPE LIGHTING: A METHODOLOGY AND DESIGN FRAMEWORK FOR THE CREATIVE AND INNOVATIVE USE OF LANDSCAPE LIGHTING IN INCREASING THE PERCEPTION OF SAFETY IN URBAN TRAILS

A CREATIVE PROJECT
SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE
MASTER OF LANDSCAPE ARCHITECTURE

BY

JACOB TAYLOR SANDERS
CHRIS MARLOW, COMMITTEE CHAIR

BALL STATE UNIVERSITY
MUNCIE, INDIANA
DECEMBER 2016
ACKNOWLEDGMENTS

The completion of this project marks the achievement of one of my biggest dreams and the end of a very challenging and rewarding period in my life and I could not have done it without massive support.

Thank you to my committee members: Chris Marlow, Mickie Marie, Simon Bussiere and Joe Blalock. I am so appreciative of your willingness to meet with me on your very busy and hectic schedules and for your open communication with me at any time. Thank you so much for your insight, critiques, support and immersion in the project.

To my studio and classmates I came in with during the summer and fall of 2013. Your humor, support and insight will never be forgotten. I feel extremely privileged to have gotten to know and work with such talented, brilliant and fantastic people and designers.

Lastly, to my beautiful, amazing, talented wife, my best friend and other half. I cannot express in words the gratitude that I have for all of your support throughout these past three years and throughout our entire marriage. You have sacrificed so much of your time and other efforts to support me in this endeavor and to take care of our two beautiful daughters. Thank you for everything you have done and do for me on a daily basis. I love you forever and always.
# 1: Introduction

Introduction ........................................................................................................ 10
The Problem .......................................................................................................... 10
Sub Problems ......................................................................................................... 11
Delimitations .......................................................................................................... 11
Assumptions ........................................................................................................... 11
Definition of Terms ............................................................................................... 11

# 2: Collection of Data

Literature Review .................................................................................................. 14
Case Studies ........................................................................................................... 24
Material Precedent Studies .................................................................................... 32

# 3: Site Review and Investigation

Site Selection ......................................................................................................... 46
Site History, Description and Context .................................................................... 46
Inventory and Analysis ........................................................................................... 48

# 4: Design Exploration

Design Concept .................................................................................................... 80
Design Program .................................................................................................... 81
Provo River Trail Master Plan .............................................................................. 83
Site Design ............................................................................................................ 88

# 5: Conclusion


# 6: References
TABLE OF FIGURES

2.1 / Pedestrian walk, lights and bike path along Syracuse Connective Corridor ............ 26
2.2 / Forman Park, memorial, sculpture and red benches with tree uplighting ............... 26
2.3 / Pavillion with red underlighting creating visual interest ..................................... 28
2.4 / Wood stairs and steps with downlight cove lighting ........................................... 28
2.5 / View of the parks uplit trees, downlit FDR highway and side lit benches ............ 28
2.6 / Downlighting and lighter colored pavers that add to safer feeling trail ............ 30
2.7 / Ambient, cove lit bollard made from wood and concrete .................................... 30
2.8 / Pavillion in St. Patrick’s Island Park with downlighting and light pavers .......... 30
2.9 / LED light tape ..................................................................................................... 33
2.10 / Square concrete benches with LED tape cove lighting ..................................... 33
2.11 / Wood bench with LED tape cover lighting ....................................................... 34
2.12 / Stone seating over hang with LED tape cove lighting ........................................ 34
2.13 / Planting beds with LED cove lighting integrated ............................................... 34
2.14 / Square lamp made with EL wire ....................................................................... 36
2.15 / Sculpture made with EL wire ............................................................................ 36
2.16 Various spools of EL Wire in various colors that are turned on........................... 36
2.17 / Tree silhouettes through wall ........................................................................... 38
2.18 / Colored light emitting concrete wall ................................................................ 38
2.19 / Colored light emitting concrete store front ....................................................... 38
2.20 / LED light wall with plexiglass .......................................................................... 40
2.21 / Interactive LED light wall .................................................................................. 40
2.22 / Water light painting LED wall .......................................................................... 40
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.23</td>
<td>Tree canopy illuminated by uplighting</td>
<td>42</td>
</tr>
<tr>
<td>2.24</td>
<td>Residential tree canopy with hidden uplighting</td>
<td>42</td>
</tr>
<tr>
<td>2.25</td>
<td>Zucotti Park at night with uplit tree canopy</td>
<td>42</td>
</tr>
<tr>
<td>2.26</td>
<td>Plank Pavers in front of building</td>
<td>44</td>
</tr>
<tr>
<td>2.27</td>
<td>Lighter gray and white plank pavers</td>
<td>44</td>
</tr>
<tr>
<td>2.28</td>
<td>Various shades of gray plank pavers</td>
<td>44</td>
</tr>
<tr>
<td>3.1</td>
<td>Site Context Map</td>
<td>47</td>
</tr>
<tr>
<td>3.2</td>
<td>Trail crossing under Railroad Bridge</td>
<td>50</td>
</tr>
<tr>
<td>3.3</td>
<td>Trail near N 1250 W and the park</td>
<td>50</td>
</tr>
<tr>
<td>3.4</td>
<td>Trail crossing under Interstate 15</td>
<td>50</td>
</tr>
<tr>
<td>3.5</td>
<td>Trail near Paul Ream Wilderness Park</td>
<td>50</td>
</tr>
<tr>
<td>3.6</td>
<td>Trash and other debris in vegetation</td>
<td>51</td>
</tr>
<tr>
<td>3.7</td>
<td>Trail mile marker post with blue graffitti</td>
<td>51</td>
</tr>
<tr>
<td>3.8</td>
<td>Trail crossing under University Parkway</td>
<td>51</td>
</tr>
<tr>
<td>3.9</td>
<td>Graffiti on building utility unit</td>
<td>51</td>
</tr>
<tr>
<td>3.10</td>
<td>Dark underpass under the UTA high speed railline</td>
<td>52</td>
</tr>
<tr>
<td>3.11</td>
<td>Stone bench at historic marker with black graffitti</td>
<td>52</td>
</tr>
<tr>
<td>3.12</td>
<td>Trail underpass below Interstate 15 with industrial lights</td>
<td>52</td>
</tr>
<tr>
<td>3.13</td>
<td>One of the few park signs along the trail</td>
<td>52</td>
</tr>
<tr>
<td>3.14</td>
<td>Physical / Psychological Barriers to Entry Map</td>
<td>54</td>
</tr>
<tr>
<td>3.15</td>
<td>Major Crime Hot Spots Map</td>
<td>56</td>
</tr>
<tr>
<td>3.16</td>
<td>Major / Minor Gateways and Pedestrian Crossings Map</td>
<td>58</td>
</tr>
<tr>
<td>3.17</td>
<td>Key Transportation Corridors Map</td>
<td>60</td>
</tr>
</tbody>
</table>
3.18 / Provo City General Plan Land Use Map ................................................................. 62
3.19 / Provo City Developed Parks Map ........................................................................ 64
3.20 / Provo City Major Arterials and Collectors Map .................................................. 66
3.21 / Provo City Map of Bike Lanes and Trails Map .................................................... 68
3.22 / Overall Site Analysis .......................................................................................... 70
3.23 / Target Area # 1 Site Analysis .............................................................................. 72
3.24 / Target Area # 2 Site Analysis .............................................................................. 74
3.25 / Target Area # 3 Site Analysis .............................................................................. 76
4.1 / Master Plan .......................................................................................................... 87
4.2 / Major Gateway Context and Existing Condition .................................................. 90
4.3 / Proposed Major Gateway Site Plan - Daytime ..................................................... 90
4.4 / Major Gateway Context and Existing Condition .................................................. 91
4.5 / Proposed Major Gateway Site Plan - Nighttime ................................................ 91
4.6 / Major Gateway Entrance ................................................................................... 92
4.7 / Major Gateway Interactive Map Perspective ....................................................... 92
4.8 / Minor Gateway Context and Existing Condition ................................................ 94
4.9 / Minor Gateway Site Plan - Daytime .................................................................. 94
4.10 / Minor Gateway Context and Existing Condition .............................................. 95
4.11 / Minor Gateway Site Plan - Nighttime ............................................................... 95
4.12 / Minor Gateway Perspective - Nighttime ........................................................... 96
4.13 / Pedestrian Bridge Existing Condition Example ................................................... 98
4.14 / Pedestrian Bridge Site Plan - Daytime ............................................................... 99
4.15 / Pedestrian Bridge Site Plan - Nighttime ........................................................... 100

TABLE OF FIGURES
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.16</td>
<td>Pedestrian Bridge Section - Nighttime</td>
<td>101</td>
</tr>
<tr>
<td>4.17</td>
<td>Pedestrian Bridge Perspective - Nighttime</td>
<td>101</td>
</tr>
<tr>
<td>4.18</td>
<td>Underpass Context and Existing Condition</td>
<td>103</td>
</tr>
<tr>
<td>4.19</td>
<td>Underpass Site Plan - Nighttime</td>
<td>103</td>
</tr>
<tr>
<td>4.20</td>
<td>Underpass Section 1</td>
<td>104</td>
</tr>
<tr>
<td>4.21</td>
<td>Underpass Section 2</td>
<td>104</td>
</tr>
<tr>
<td>4.22</td>
<td>View of Underpass at Night Heading West</td>
<td>105</td>
</tr>
<tr>
<td>4.23</td>
<td>View of Underpass at Night</td>
<td>105</td>
</tr>
<tr>
<td>4.24</td>
<td>Context and Existing Conditions of the Provo River Trail</td>
<td>108</td>
</tr>
<tr>
<td>4.25</td>
<td>Typical Site Plan for the Entire Three-Mile Trail</td>
<td>108</td>
</tr>
<tr>
<td>4.26</td>
<td>Context and Existing Conditions of the Provo River Trail</td>
<td>109</td>
</tr>
<tr>
<td>4.27</td>
<td>Section of the Trail - Nighttime</td>
<td>109</td>
</tr>
<tr>
<td>4.28</td>
<td>Typical Section of the Three-mile Focus Area of the Trail</td>
<td>110</td>
</tr>
<tr>
<td>4.29</td>
<td>Typical Perspective of the Three-Mile Focus Area of the Trail</td>
<td>110</td>
</tr>
<tr>
<td>4.30</td>
<td>Context and Existing Conditions of The Refuge</td>
<td>113</td>
</tr>
<tr>
<td>4.31</td>
<td>The Refuge Site Plan - Daytime</td>
<td>114</td>
</tr>
<tr>
<td>4.32</td>
<td>The Refuge Site Plan - Nighttime</td>
<td>115</td>
</tr>
<tr>
<td>4.33</td>
<td>The Refuge Central Mixed-Use District and Plaza Near the Branbury</td>
<td>116</td>
</tr>
<tr>
<td>4.34</td>
<td>Transit Station Context and Existing Conditions</td>
<td>117</td>
</tr>
<tr>
<td>4.35</td>
<td>Transit Station Site Plan - Daytime</td>
<td>117</td>
</tr>
<tr>
<td>4.36</td>
<td>Transit Station Context and Existing Conditions</td>
<td>118</td>
</tr>
<tr>
<td>4.37</td>
<td>Transit Station Site Plan - Nighttime</td>
<td>118</td>
</tr>
<tr>
<td>4.38</td>
<td>View of the Transit Station and At-grade Trail Crossing - Nighttime</td>
<td>119</td>
</tr>
</tbody>
</table>
4.39 / The Escape Context and Existing Conditions .................................................. 121
4.40 / The Escape Site Plan - Daytime .................................................................. 122
4.41 / The Escape Site Plan - Nighttime ................................................................. 122
4.42 / Perspective View of The Escape’s Main Plaza .............................................. 123
4.43 / The Prospect Site Plan - Daytime ................................................................. 126
4.44 / The Prospect Site Plan - Nighttime ............................................................... 126
4.45 / Nighttime Perspective View of The Prospect Looking West ....................... 127
1

INTRODUCTION
“For centuries, there was no greater threat to human survival than the darkness of night. The enemies it concealed, from scheming bandits to treacherous rocky paths, were palpable — a mere misstep on an uneven roadway during nighttime travel could result in a broken ankle, a serious and potentially fatal injury in ancient times. For that reason, many of the world’s most ancient roads were cut to follow the Milky Way, providing a guiding light for travelers...” - Chappell Ellison

INTRODUCTION

Our society has an increasing need for safe, well connected urban trails that allow people to move through the city 24 hours a day. Lighting in urban trails has been designed and installed for a long time, but without deep, thoughtful, integrative considerations in the landscape architecture designs or the design process. Cities are constantly moving and urban trails convey individuals to work, home, school, recreational opportunities, and many other events. This study addresses design principles and perception of safety in urban trails and how landscape lighting design can enhance and change these in the Provo River Trail.

THE PROBLEM

Many urban trails have issues with high crime rates due to poor lighting conditions. This allows predators and other potential criminals to find hiding areas and surprise individuals using the trail. Users of urban trails have a negative perception of unsafe conditions due to the lack of innovative use, placement, and installation of landscape lighting. This negative perception of unsafe conditions arises from two different occurrences. First, actual crime events that have happened on urban trails cause individuals to feel apprehensive about using the trail and lead individuals to seek other routes of conveyance. Secondly, perception of unsafe conditions arises from individuals hearing by word of mouth from people who have been residences of the city for many years, those with prior exposure to actual crime events that have happened on the trail, or those who have been affected by criminal occurrences on the trails. Lack of thorough landscape lighting design consideration and poor design implementation has also been a major cause of negative perception of unsafe conditions. If not corrected, crime occurrence rates on urban trails will most likely increase and activation of trails will decrease.
SUB PROBLEMS

• Lack of innovative lighting design principles results in increased perception of unsafe conditions and increased actual unsafe conditions.

• Lack of effective lighting design principles decreases urban trail activation 24 hours a day.

• Lack of lighting design focus early in the landscape architecture design process results in ineffective lighting designs that cultivate negative psychological perceptions of safety.

DELIMITATIONS

Several delimitations related to time, distance to the proposed site, the high cost of installing lighting, finding a contractor and setting up lighting interventions on site were not addressed. However, virtual experimentation of lighting using rendering software was heavily used. Also, in-person field studies and data gathering of current lighting conditions of the current trail posed a challenge so it is not included in this study. This study does not address the effect of lighting on circadian rhythms, wildlife, and mental health. Lastly, the entire 30 mile Provo River Trail was not studied. Only a small portion of the total length of the trail was analyzed and designed as an example using proposed methodology and research outcomes.

ASSUMPTIONS

There are currently three main current assumptions. First, the innovative, inventive, careful, and artful use of lighting in the landscape will ameliorate negative psychological perceptions of a space. Second, incorporating lighting as an integral part of the design process from the very beginning results in more effective and better activated landscape designs. Lastly, an increase in perceived safety brings actual safety and reduced crime.

DEFINITION OF TERMS

 Perception – “can be defined as our recognition and interpretation of sensory
information” (Williams). In this study, perception refers to an individual urban trail user’s psychological perception of whether or not conditions of a space are safe, especially when the psychological recognition of current lighting conditions leads to interpretation of safe or unsafe conditions.

Activation – The degree to which a space is utilized by individuals during all hours of the day. The number of individuals populating the site at one time measured during each hour of a 24 hour period.

Design Process – The activity of thorough gathering of contextual information, environmental, cultural, and others in which landscape architects engage analysis in order to provide the most effective, complete design solutions for spaces.

Actual unsafe conditions - Crime occurrence rates (specifically rape, assault, battery, kidnapping, and murder), poor visibility due to vegetation or other structural sight line blocks.

Perceived unsafe conditions – An individual’s psychological interpretation of a space due to actual events experienced or criminal acts seen or heard, whether by word of mouth or by other visual or audio sources.
2

COLLECTION OF DATA
LITERATURE REVIEW

The topic of lighting and the effect it has on perception of safety is a complex topic. In the following literature review, the topics of lighting and perception in relation to safety and activation were discussed, the outcomes of which helped to determine the best design process and the best course of action. First, the theoretical and scientific basis of how the human brain perceives a space in relation to safety and the role lighting plays in the equation were addressed. Next, the principles of lighting design, placement, documentation, and installation were discussed. Also included in understanding perception is the effect that sex, age, “physical features,” and “personal factors” have on a person’s perception of safety and activity in a space. Once an understanding of perception of safety in relationship to lighting and lighting principles were achieved, specific data gathering techniques, best research methods, and interpretation of the data in relation to the research question were discussed. The depth and breadth of analytical comparison of the gathered data and methodology for applying lighting design principles to the analyzed data will be presented. Case studies and precedent research were then addressed to gain a broader toolbox of creative uses of light and how each can be applied to the design process. After analysis was addressed, the design processes, techniques, and applications from manuals, process, bulleted lists, and technical guides were addressed. Finally, the post occupancy evaluation methodology for measuring a site’s success from lighting application and design was compared.

THEORETICAL AND SCIENTIFIC BASIS

Lighting plays a tremendous role in life on a daily basis. It is the first thing we see in the morning and the last thing we see when we go to bed. Without light no life exists; light is the essence of all life. As such, lighting plays an integral role not only in our physical well-being but in our psychological health. The way we feel is also directly linked to light. Many times the feeling of light is subconscious and not thought of as something directly linked to our daily perception of spaces and things. It is important in spaces and design to
understand not only how lighting looks aesthetically, but how it feels. This is well summed up by Linnaea Tillett, “you can light it to perform any of the tasks you want to perform, and I can make it look the way you want it to look. But how do you want it to feel?” That is a critical question when it comes to lighting a room (Tillett, 2013). Lighting design, placement and color can influence the psychological feeling of a space. This is key to perception of a landscape as safe and active, and when studied more in depth and implemented with care can create a feeling that people react to, “...based on what sense they are able to make of the scene and what interest they are able to find in it.” (Kaplan) Another quote gives a nice definition of perceived and actual safety “Social safety can be defined as the protection or the feeling of being protected against danger caused by human actions in the public sphere, and can refer to actual safety and perceived safety. Actual social safety reflects actual crime rates and may not always result in perceived social safety, that is, people may not feel safe although no dangers are present (Park, Calvert, Brantingham and Brantingham, 2008)” (Boomsma and Steg, 2014).

Another important aspect to remember in perception is that no two people perceive a space exactly the same. We are all different human beings with different personalities, likes, and dislikes. There are generic principles that can apply across the general population, but no two people see a place or feel a place exactly the same. Individual personalities and characteristics shape perception and have a large impact on how effective lighting is (Johansson, 2014).

As seen from the discussion above, perception due to lighting and other personal factors is extremely complex, but nonetheless key in being able to design a landscape to be activated and safe for many years.

CASE STUDIES AND PRECEDEENTS

Case studies and precedents are an important part of using creative lighting. Several case studies give valuable information into lighting techniques that can be applied in the lighting design process. One of the most valuable to this point is done by Linnaea
Tillett, a lighting designer who is renowned for taking a psychological approach to lighting. In one of her designs done in Syracuse, New York called Connective Corridor, the lighting technique used is solely psychological and was designed to be seen from all angles, signifying that the site is constantly active (Ulam, 2014). Another case study done on the East River Park in New York showed that a subtle approach to lighting could maintain views and break down psychological barriers (Brake).

DATA GATHERING, RESEARCH METHODS, INTERPRETATION

There are a variety of data gathering and research tools for all sorts of applications. Lighting tends to be a little trickier to measure and gauge, especially when perception is involved. Methodologies of gathering data need to include a multi-faceted approach, including questionnaires, lighting preference studies using rendering presentations, and a choice (Wolch, 2010). This methodology of showing individuals a specific lighting design or scene has been shown to be effective when doing lighting design (Wolch, 2010).

Once the research is compiled, a thorough analysis is required. The analysis needs to take into account a variety of factors as mentioned in the theoretical and scientific basis section. Applying the specific research methodology of presenting a variety of representations to a person is extremely important in making sure that the lighting design process is well thought out. Once data is interpreted, a good understanding of prior case studies, existing lighting design techniques, and precedent applications of creative lighting techniques needs to be applied. Now that a foundation of understanding has been established, the main problem and sub problems can be supported with evidence from articles, manuals, and guides. The evidence will make the case for the main problem: Many users of urban trails have a negative perception of unsafe conditions due to the lack of innovative use, placement, and installation of landscape lighting. The sub problems are as follows:

• Lack of innovative lighting design principles results in increased perception of unsafe conditions and increased actual unsafe conditions.
• Lack of effective lighting design principles decreases urban trail activation 24 hours a day.

• Unconsidered strategic placement techniques cultivate negative perceptions of safety.

• Lack of lighting design focus early in the landscape architecture design process results in ineffective lighting designs that decrease activation and increase negative perception.

PROSPECT, REFUGE, ESCAPE

The first and most important principle of perceived safety is the idea of prospect, refuge, and escape. Users of urban trails need to be able to see what is surrounding them from all directions. This is the idea of prospect. With prospect comes refuge and escape. People need to be able to perceive a way out of an unsafe or perceived unsafe situation. In relation to lighting this means that dark spots in an urban trail should be avoided by using lighting in order to both psychologically and physically contribute to the safe feeling of a user or prospect of the user. This is supported in multiple articles and is of extreme importance to effective lighting design that positively enhances safe psychological well-being. In fact, Blobaum and Hunecke argue that it is the single most important aspect to consider when lighting and its relation to perceived and actual safety. (Blobaum and Hunecke, 2005), (Boomsma and Steg, 2014), (Haans, 2012). An example of increased perceived safety can be seen in East River Park, New York. The park is designed to have an urban bike path and gathering space under an existing road. The underside of the FDR highway was a psychological barrier that was overcome by using lighting underneath the existing road in order to create an inviting space rather than a dark barrier to the piers on the other side. It is a very good example of the effect lighting has on can see that there is not refuge for crime committing individuals and good prospect they feel safe and will enter the space (Brake, 2014).
EMERGENCY SERVICES ACCESS AND VISIBILITY, NO PEDESTRIAN AUTOMOBILE ACCESS

Urban trails must be designed to accommodate emergency vehicles while not allowing regular traffic. Allowing regular traffic on the urban trail increases crime and increases unsafe psychological and physical conditions in users (Miami-Dade County Parks and Recreation Department, 2010). Also, being able to see police and other security personnel and features in the site contributes to a safe perception. “The visibility of safety also plays an important role in how people view their surroundings. Fisher and May cite several sources that suggest an increase in police presence reduces fear levels in individuals. It has been proposed that the visibility of police can reduce the fear of crime in an area (Winkel, 1986).” (Tracy and Morris, 2015). This principle also includes allowing clear site lines and open areas into the site with lighting in order to allow emergency personnel and security to see users and locate possible problems. Increasing the site lines and eyes on the urban trail by increasing lighting reduces crime (Miami-Dade County Parks and Recreation Department, 2010).

EXCESSIVE VEGETATION

When thinking about urban trails, one normally does not think about too much vegetation as being a problem but it is. Urban trails need to balance vegetation needs with lighting in order to decrease the amount of foliage blocking light from enhancing safe perception and physical safety. Too much foliage can block light, create refuge for those wanting to commit crimes, and cause an urban trail to appear unsafe from both a psychological aspect and a physical aspect.

LIGHTING FROM BEGINNING TO END REDUCES ACCIDENTS

In order to activate a site and increase perceived and actual safety an urban trail needs to have lighting installed from beginning to end. A variety of lighting installations and types can be used as long as they each conform to the standards as prescribed.
above (Blobaum and Hunecke, 2005). A number of pedestrian accidents can occur during the evening hours if an urban trail is not lit properly. Trails need to have proper lighting to prevent bikers, skateboarders, runners, and other types of active users from running into each other. In Lake County, Florida a study was done that showed “60 percent of bike fatalities” occurred during the hours after 6 p.m. (Rails to Trails Conservancy, 2015). Reasons for these accidents are due to poorly lit trails that do not allow users to see large holes, cracks, or other possible hazards. Lighting drastically reduces this actual safety concern, which can lead to a psychological perception that a trail is unsafe if lighting is not installed and the accidents reduced by proper lighting design and corrective action (Rails to Trails Conservancy, 2015).

MAINTENANCE, PEDESTRIAN ACCIDENTS

Lighting must be properly maintained in order to continually keep the park activated and free from crime and other unsafe conditions. When lighting and other aspects of urban trails are cleaned and maintained properly, crime decreases (Tracy and Morris). “Bulbs need to be kept clean to maintain desired luminescence. To prevent bulb breakages or theft, bulbs may be installed in wire cages. Consider posting signage on fixtures and trailheads requesting that trail users report any outages along the trail.” (Rails to Trails Conservancy). Another example comes from Linnaea Tillett, a leading lighting designer, “Nothing can undermine the visual quality of a space, including the perception of whether it is safe or not, more than burnt-out lamps or broken fixtures.” (Tillett, 2012). Lack of effective lighting design principles decreases urban trail activation 24 hours a day.

BALANCE INTERESTS

One of the largest problems in lighting is conflicting interests of users and residents who live in the surrounding neighborhoods. Many times lighting can be seen as a detriment if a space is lit during all times of the night to those who live in adjacent houses. Also, light pollution is a large issue in many of the same as well as other communities. In order to appease both sides a balanced lighting approach that accomplishes the above mentioned
criteria must be applied. This includes the possibilities of having sensors that allow lighting to come on when people pass by them, or having a few hours in the evening and morning when lights are turned on and the rest of the night they are off (Rails to Trails Conservancy, 2015). Another option is to use lighting design that uses downward facing lamps that do not pollute the night sky but also provide immediate prospect and sight lines around the user (Rails to Trails Conservancy, 2015). Many users of the trail may also not want to be bothered by intense flood lighting but rather have a simple and glowing approach that allows them to experience the nighttime ambiance and mood. Again, a balanced approach to placing lighting affects the trail’s activity level throughout the nighttime, as well as resident’s quality of life surrounding the trail.

SOCIAL AND COMMUNITY STRUCTURES

An understanding of the social and community structure when it comes to lighting is neglected on many fronts. Linnaea Tillett states “If we were indeed going to help the community we intended to serve, we needed to thoroughly understand its social dynamics. For example, lighting the street where drug dealers did business would simply force them to relocate onto another block. Illuminating a deserted street that lacked the more effective crime deterrents of “eyes on the street” or adequate policing, would mislead pedestrians into thinking it was safer than it was. We had to be careful that our interventions did not function as spotlights on potential victims (women) or valuable property (automobiles).” As Tillett has shown in her many lighting design projects, a deep understanding of the social and community dynamics of an area gives a more complete lighting design basis than just throwing a bunch of lampposts in and calling it complete. Tillett also shows that crime increases when social and other contextual factors are not considered when lighting design is produced. One of the best case studies for this social and community dynamics being taken into the light is the Connective Corridor designed by Tillett. The corridor really does a fantastic job of making sure that the lighting was really visible to the community and users because the social dynamics are in the context of a downtown and university. The
lighting helps to enhance the social dynamics of the downtown and university by cultivating an active environment along the corridor. Tillett’s quote “…street lighting could promote visibility, decrease feelings of fear, act as a psychological deterrent to offenders, and serve as a conspicuous sign of improvement to the aesthetic environment of a neighborhood.” (Tillett, 2012). Unconsidered strategic placement techniques cultivate negative perceptions of safety.

LIGHTING CROSSINGS, TRAILHEADS, ETC.

Lighting installations where people cross on urban trails as well as right at the trail head can improve positive psychological perception dramatically. It also people to immediately see their surroundings and to give a feeling of activity. According to the Ludlam Trail Design Guidelines “Lighting should be limited to within 50 feet of decision making areas or 150 feet of crossings” (Miami-Dade County Parks and Recreation Department, 2010). This also aligns with AASHTO guidelines that are as follows:

• Always in a tunnel or at overpasses
• Trailheads
• Bridge entrances and exits
• Public gathering places
• Along streets
• Crosswalks
• Where the path crosses another path or sidewalk
• On signage

These immediate and noticeable site amenities and areas are of extreme importance to lighting design and positively affecting psychological perception of safety and actual safety. Other factors that go along with this are “…soil content, overhead clearance, trail location, trail features, types of trail users and weather.” (Rails to Trails Conservancy,
UNIFORMITY AND LUMINANCE

Light comes in a variety of colors, types, wavelengths, and lumens. According to Haans (2012), “The amount and uniformity of illuminance, and perhaps also light spectrum are found to affect perceived personal safety”. This suggests that the amount and uniformity of light a person sees in the landscape affects perceived safety.

LOW TO THE GROUND / OR DOWNWARD FACING

Another influential design technique that can be used in installations is to place lighting low to the ground or facing downward in order to reduce light pollution and allow individuals to see the stars as well as to increase creative visual stimuli. Also, low to the ground lighting makes for easier maintenance which also leads to neater looking urban trails, which leads to increased safety along the trail as whole.

THE COLOR WHITE

A key aspect to lighting is its color and reflective characteristics. The color white reflects all light and absorbs no other color. During the night hours, white moonlight, (when the moon is out) glows and adds an ambient feeling to a site. Whether it is white paint or reflective white materials, the effect is the same. One of the important lighting installation principles to remember is that lighting does not necessarily need to be super bright and everywhere; in fact, many times those increase crime instead of deterring it. This is reinforced in two very relevant quotes by Linnaea Tillet: (1) “White has a tendency to make things visible,” according to painter Robert Ryman and (2) “Any horizontal or vertical surface near or under a light source can reflect light if painted white or a light color. The efficiency of existing lighting can be increased without adding new equipment by painting walled-in passageways, roll-down gates on storefronts or vertical posts a bright, light color.” (Tillett, 2012).

“Our ancestors used white chalk and paint to mark the sides of pathways. They
painted stones by the edge of the water to denote the danger line. White-washed tree bases acted as sign posts; piles of chalk caught the moonlight and Milky Way and amplified the effect of hand-held lanterns." (Tillett, 2012)

This strategic installation section now leads to the question: How does this apply to the landscape architecture design process? The design process will determine the most appropriate installation techniques types used in the urban trail.

Lack of lighting design focus early in the landscape architecture design process results in ineffective lighting designs that decrease activation and increase negative perception.

EARLY IMPLEMENTATION OF LIGHTING CONSIDERATION

A quote by Blobaum and Hunecke gives an excellent foundation for this question. They state, “Sufficient lighting and good prospect will function as relevant preconditions for escaping as well as for answering back. For both behavior strategies, it is important to perceive a potential danger as early as possible. These findings confirm the relevance of lighting, prospect, and possibilities of escape for the design of living in urban public places for men as well as for women. Therefore, characteristics providing prospect, escape, and sufficient lighting should already be considered at the early stage of the design...” This talks about the urban trail design as it is in physical sequence but it applies to the stages of the design process as well. If the goal of landscape architects is to improve the quality of life, health, ecological stability, and safety of the public than lighting should be at the forefront of the design process. A comment from Tillett about lighting designer Richard Kelly gives an interesting insight into how the urban lighting design process is not accomplished with a once-and-done, cookie cutter approach. The quote states, “His comments don’t add up to a simple prescription for urban lighting—probably because there isn’t one, or at least not a good one.” (Tillett and Gardner, 2015). This shows that effective urban trail design depends on a well-thought, integrative, socially conscious, and perceptively and psychologically analyzed process. Without this process, perceived safety and actual safety will continue
to go on as they have for a long time and lighting design will continued to be undervalued when it should be a forefront analytical topic in the design process.

POST-OCCUPANCY EVALUATION

The best way to see if a design has accomplished its goals is to perform a post-occupancy evaluation with quantitative and qualitative data. To measure the effectiveness of lighting design and installations in relation to perception of safety and actual safety a multi-faceted approach is needed. The same steps as shown above for implementation should be quantitatively and qualitatively measured, recorded, and then compared to the data taken after the evaluation. Psychological studies, site observations and surveys will need to be performed as well in order to understand fully the perceptive effect of the lighting design on safety. Before-and-after crime data is also important to gather when doing a post-occupancy evaluation.

PROJECT CASE STUDIES

Three sites that thoughtfully incorporated lighting design for psychological affect were studied to ascertain key lighting design methods, installation techniques, and lighting uses that most helped to solve the main problem and sub-problems of the project. All of the sites are located within the United States, with three in the state of New York and one in Minnesota.

These areas have realized the value of making sure urban spaces and connective fabric of the city are safe and able to be used 24 hours a day. Such redevelopment of urban public space has already begun, addressing the value and use of lighting and related tools to affect psychological change.
CASE STUDY #1 - Connective Corridor / Syracuse, New York

The Connective Corridor of Syracuse is an urban redevelopment project of a two-mile corridor that connects downtown Syracuse to the Syracuse University. This project started as a result of 1960s and 70s redevelopment that resulted in pedestrian sidewalks being lined with parking garages and other structures that were only busy during major sporting or other events. When not being used during these times, the area turned very quiet and deserted. This, along with the drab industrial lighting that occurs along most streets, created a psychological perception that the area was deserted and unused.

Linnaea Tillett was the project lighting designer hired to help ameliorate the aforementioned problem. She came up with the solution to use red colored bollard metal with white lights (see Figure 2.1) as well as red accents, public art (see Figure 2.2) seating and other pieces that helped create the public perception that the trail was always active, even if it was not. She stated “The objective here is more about changing perceptions than it is about people physically being able to see where they are going” (Ulam, 2014).

Red colored lights, benches and other accents do an excellent job of attempting to change the psychological perceptions of individuals using the trail. The bright white color of the light combined with the red creates a feeling of activity that can give one a sense of peace and well-being. Accents and lights also draw one through the two mile stretch of the trail. Applying Tillett’s methods could lead to an effective re-design of the Provo River Trail.
FIGURE 2.1 - Pedestrian walk, lights and bike path along Syracuse Connective Corridor
Syracuse, New York
(www.tilletlighting.com)

FIGURE 2.2 - Forman Park, memorial, sculpture and red benches with tree uplighting
(www.tilletlighting.com)
CASE STUDY #2 - East River Park / Manhattan, New York

The piers of New York have historically been used for commerce rather than being public waterfront. The East River has multiple highways that run around it, as well as bridges that cross over it, creating physical and psychological barriers to the waterfront. In recent years a massive effort to renovate and change the appearance and purpose of these waterfronts and piers has been undertaken. One of the pieces that spurred the interest of the city in redeveloping the east riverfront was the Hudson River Park project. This project helped reshape the city and surrounding neighborhoods and motivated the city to look at redeveloping the East River and east side.

The site had to overcome several challenges. The major one was the FDR highway, a psychological barrier to the waterfront. The streets and piers below the FDR are often considered an eyesore of concrete and motor vehicles that prevent public access to the East River. The underside of this highway made the pedestrian realm dark creating a barrier rather than enticing users to use the waterfront. In order to create public interest in using the waterfront, designers incorporated the underside of the road and its surrounding context into a linear park. Lighting was integral in breaking down the barriers to entry into the site and was accomplished by using colored lighting under the FDR, pavilion structures (see Figure 2.3) and under planting beds and seating. The amount of light used was less than the city traditionally designed with, but was done so carefully to entice people to use the site. Downlighting (see Figure 2.5) and cove lights (see Figure 2.4) were used in order to prevent a lot of light from escaping into the air, which helps to maintain quality night view of the river from both sides. As stated in an article in the May 2014 LAM magazine by Alan Brake about the firm did the lighting design, “Rather than flood the space with harsh light to deter crime, the firm made it a desirable enough destination that people will flock to it.” (Blake, 2014).

The Provo River Trail is very similar although on a smaller scale. A lighter approach to lighting while creating an interesting trail that draws users in could be extremely effective.
FIGURE 2.3 - Pavillon extends out from the East River front Pier. Red underlighting creating visual interest. (www.archlighting.com)

FIGURE 2.4 - Wood stairs and steps with downlight cove lighting along the pier outside the Pavillon (www.archlighting.com)

FIGURE 2.5 - View of the parks uplit trees, downlit FDR highway and side lit benches. (www.archlighting.com)
CASE STUDY #3 - St. Patrick's Island Park / Calgary, Alberta, Canada

St. Patrick’s Island Park is east of downtown Calgary on an island that is shared with the St. Patrick’s Island Zoo. The park has existed for quite some time, but due to many years of unuse and neglect the city finally decided to redevelop. One of the major concerns of the project was how lighting would affect wildlife that existed on the island. The 31-acre park is home to a wide variety of wildlife and light pollution negatively affects wildlife in a variety of ways. Tillett Lighting Design was hired due to their expertise and track record as designers that design dynamic and beautiful parks and other areas while using lower lighting output. (Gonchar and Lentz, 2016) According to Gonchar and Lentz Tillett, layered this approach by also looking at how little light they could use, and only where it was essential for people using the park at night so that they would feel at ease and be able to find their way out.” (Gonchar and Lentz, 2016).

The park has a variety of public uses, from trails to pavillons. Each of these areas has unique lighting properties that positively affect wildlife and the public without reducing safety or increasing negative perceptions of safety. At points where wildlife is not as prevalent, taller [downlit and shielded] pole lights were used to cast a pleasant ambient light on the lighter colored paver mix. These lights (see Figure 2.6) are 3000K (Kelvin) CCT downlit lamps according to Gonchar and Lentz. This paver mix positively enhances the feeling of safety as it reflects more light at lower light levels. The pavillion (see Figure 2.8) is downlit, which reduces light pollution while also creating a comfortable ambient feeling effect on the pillars and other structural members. Where disturbing wildlife is a concern, wood bollards (see Figure 2.7) with shielded downlights are used. These downlights prevent light from escaping to the sky while also adding a calming visual effect on the wood material and ground plane.

Using lighter colored materials and pole lights with shielded downlight among other low-lighting techniques can help to reverse any negative perceptions of safety along the Provo River Trail. As referenced in the literature review the color white should be used to
FIGURE 2.6 - Downlighting and lighter colored pavers that add to safer feeling trail.
(www.tillettlighting.com)

FIGURE 2.7 - Ambient, cove lit bollard made from wood and concrete.
(www.architecturalrecord.com)

FIGURE 2.8 - Pavilion in St. Patrick’s Island Park with downlighting and light pavers.
(www.tillettlighting.com)
ameliorate negative perceptions of safety. The comfortable feeling of Tillett’s use of warm white light feel safe; however the color white, as referenced in the literature, should be used along the Provo River Trail. Instead of using a warm white such as 3000K CCT, a 4000K to 5000K CCT cool white light should be used. The ambient effect of this light will be similar to Tillett’s but will be produce light closer to moonlight.
MATERIAL PRECEDENT STUDIES

In order to consider the best possible lighting outcomes for the Provo River Trail, numerous lighting materials, placement, and contexts were explored. Many of the materials are either lighting or hardscape materials. Any vegetation materials used along the trail or in parks will be native trees, ornamental grasses and some native perennials in order to maintain the natural feel of the trail. Native plant materials that can amplify the ambient light should be selected, as they will help to ameliorate negative perceptions of safety.

MATERIAL CASE STUDY #1 - LED Tape Used in Cove Lighting

LED tape is a very bright, Eco-friendly and versatile way to incorporate lighting into a wide variety of structures and elements in the landscape. Its flexible nature along with its ability to be powered by either a single source, battery or solar allows it to be placed where other types of lighting cannot. LED light tape also comes in a variety of colors, luminance and spacing. Effects of movement can also be applied to this type of lighting. Due to its low profile light tape is also very effective at becoming a hidden source of ambient light.

With all of these benefits, it is hard to see how LED light tape has any drawbacks. One of the few negative things about using light tape is that it does have limits on its flexibility whereas electroluminescent wire (which will be discussed in more detail later) can be flexed in multiple directions. In order to change direction horizontally the tape must be cut and connectors used. Vertically the tape is great and can take on a variety of shapes.

Figure 2.9 shows what the LED tape looks like before it’s installed. Figures 2.10-2.13 show how the lighting can be used in a cove configuration underneath benches to produce a comfortable ambient downlight that creates a feeling of security without overwhelming the surrounding site.
FIGURE 2.9 - LED light tape
(www.ledbulbs123.com)

FIGURE 2.10 - Square concrete benches with LED tape cove lighting
(www.sdisf.com)
FIGURE 2.11 - Wood bench with LED tape cove lighting. (blogs.djc.com)

FIGURE 2.12 - Stone seating overhang with LED tape cove lighting. (www.urbastyle.com)

FIGURE 2.13 - Planting beds with LED cove lighting integrated. (www.picapala.com)
MATERIAL CASE STUDY #2 - Electroluminescent Wire

Electroluminescent wiring has a variety of uses and comes in a variety of colors. It is extremely energy efficient and can be run off battery, solar or wired power sources easily. Like LED tape, it is extremely versatile and flexible and comes in a variety of colors.

The drawback to this type of wiring is that it runs at high frequency and can tend to get extremely hot and break down if long lengths are used. This creates a problem in the landscape where extremely long lengths would have to be placed and maintenance cost would be fairly high.

Figures 2.14 through 2.16, on the following page, show how the wire looks when powered and the variety of colors that it comes in along with application in the form of a structure.
FIGURE 2.14 - Square lamp made with EL wire. (www.inhabitat.com)

FIGURE 2.15 - Sculpture made with EL wire. (www.technabob.com)

FIGURE 2.16 - Various spools of EL Wire in various colors that are turned on. (www.scratchmypi.co.uk)
MATERIAL CASE STUDY #3 - Light Emitting Concrete

Light-emitting concrete is a fantastic new material that in itself does not require any power. The concrete is made with translucent filaments allow the light to come through. During the day the concrete allows natural light to pass through and silhouettes that block that light can be seen on both sides of the material. At night a variety of light sources can be placed behind it to create a variety of colorful lighting effects.

Figures 2.17 through 2.19 show what the material looks like under different conditions and the effects it creates.
FIGURE 2.17 - Tree silhouettes through wall.
(mtidry.wordpress.com)

FIGURE 2.18 - Colored light emitting concrete wall.
(www.durabilityanddesign.com)

FIGURE 2.19 - Colored light emitting concrete store front.
(www.archello.com)
MATERIAL CASE STUDY #4 - LED Light Walls

Light walls are generally structural elements that have single, bright LED lights incorporated into a circuit board that can be programmed to change color, brightness or appearance from touch. The lights can also be programmed to respond to touch and water or other effectors. This allows people to interact with the light sources while also enjoying their aesthetic and safe qualities.

The low maintenance cost, versatility, and ability to be dynamically manipulated by sensory inputs make these walls extremely desirable as center pieces or interactive sculptures.

Figures 2.20 through 2.22 show examples of LED light walls. One of the newest and inventive ways is the wall that allows people to paint with light using water. LED lights are connected to a circuit board that tells each light touched by water to glow. The more water on the light, the brighter it glows. This allows individuals to create and be expressive without the permanence of paint or other graffiti.
FIGURE 2.20 - LED light wall with plexiglass.  
(www.designboom.com)

FIGURE 2.21 - Interactive LED light wall.  
(www.youtube.com)

FIGURE 2.22 - Water light painting LED wall.  
(www.hipertextual.com)
MATERIAL CASE STUDY #5 - Uplighting

Uplighting is a highly effective way to highlight individual objects or to create and ambiently lit area effect. This type of lighting is usually accomplished by using ground spotlights to illuminate the targeted object. This type of lighting is effective because the source can be shielded or hidden to make the light seem like it doesn’t have a source. The light source used have a variety of different luminance and colors as well as types such as LED, halogen or others.

Uplighting does have its disadvantages. One of the major ones is that it produces light pollution. Light pollution is light escaping into the sky instead of being reflected or absorbed by the earth or other objects. This pollution leads to poor views of the night sky, as well as detrimental effects to wild animals in and around cities. One way to prevent or reduce this effect is to use surfaces above uplighting that either reflect or absorb the light.

Figures 2.23 through 2.25 show examples of uplighting tree canopies resulting a comfortable, warm and inviting feeling. Lighting the tree canopy by using ambient light creates a positive and safe mood, therefor reducing negative perception.
FIGURE 2.23 - Tree canopy illuminated by uplighting.
(www.manchesterconfidential.co.uk)

FIGURE 2.24 - Residential tree canopy with hidden uplighting
(www.houzz.com)

FIGURE 2.25 - Zucotti Park at night with uplit tree canopy.
(www.wow.com)
MATERIAL CASE STUDY #6 - Pavers

As stated in the literature review, one major element in the landscape that helps to ameliorate negative perceptions of safety in the landscape is the color white. White can be seen at night and is illuminated by the moon and other sources. Using multi-colored pavers with combinations of medium to light gray and white pavers boosts appearance of surfaces at night.

Figures 2.26 through Figures 2.28 show examples of configurations and uses of this paving pattern and how the colors help to guide users along a surface. Use of these pavers also allows for the appearance of even lighting across the landscape.
FIGURE 2.26 - Plank pavers in front of building. (www.tremron.com)

FIGURE 2.27 - Lighter gray and white plank pavers. (www.designrulz.com)

FIGURE 2.28 - Various shades of gray plank pavers. (www.basalite.com)
3

SITE REVIEW AND INVESTIGATION
The following section details the design considerations and proposals for the project. Included in this section are the history of the Provo River Trail, selection of the best focus section of the trail and creating a master plan for the selected section with detailed site plans for specific area prototypes and gateways, sections, diagrams, and other illustrations.

SITE SELECTION

Provo, Utah is a prime location for applying the principles discussed in the introduction and collection of data section. The city is unique in Utah because it contains the Provo River, which dissects the middle of the city. The Provo River Trail, which follows the river over a total length of 30 miles, is a major trail that runs through the city.

The river is surrounded by commercial areas, multi-family residences, two 30,000+ student universities (Brigham Young University and Utah Valley University). Due to the wide variety of various demographic users, high crime rate along the river, perception of unsafe conditions by city residents and university students, and the centrality of the river, a three-mile section through the heart of Provo has been selected as the perfect location for the design exploration and development.

SITE HISTORY AND DESCRIPTION

Figure 3.1 shows how the Provo River runs from the Wasatch Mountain Range all the way to Utah lake. The trail itself runs along 30 miles of the river, eventually terminating at Utah Lake. The selected portion runs through a variety of areas, including multi-family residential, single family residential, private student housing complexes, and apartments. One of the most noticeable things about the trail is that it is paved through this portion, but otherwise not much takes place to activate the trail and the river. The trail has existed for many years, although an exact date of installation is not available. The trail is one of the city’s most valuable, yet underutilized, assets. Surrounding the three-mile selection of the trail are single family residential homes, commercial and public facilities on several spots, and mixed use development areas.
FIGURE 3.1 - Site Context
EXISTING SITE CONDITIONS

The selected three-mile focus area of the trail crosses through a variety of different areas, from residential, to commercial, to more natural or vacant areas. Figures 3.2 through 3.13 show examples of the various areas and conditions that are typically seen during both the daytime and nighttime hours. Trail conditions vary by season as well. The trees along the trail and Provo River turn beautiful colors in the fall. During summer and spring, the trees overshadow the river and trail, and enhance the natural feel of the trail in juxtaposition to the houses and urban setting. In wintertime the site can be covered in snow and trees are usually leafless.

Currently, the trail is a two lane 10’ wide corridor that is made of asphalt, that has cracked in some spots. The darkness of the asphalt and lack of lighting makes the trail difficult to see and adds to the negative perception of safety. The vegetation growth on the edge of the river is very thick at some points, making it hard for people on the north side of the river to see the trail. Thick vegetation and lack of lighting also provides dark spots on the trail that can provide hiding spots for individuals who may try to harm trail users. Houses and businesses have their backs to the trail at many points, which reduces eyes-on-the-trail, safety, and security.

The site also has many points where the trail passes under a road or other railline. These “underpasses” are lit predominantly by yellow, industrial, sodium lights which cast an unpleasant glow. This lighting, combined with the lack of light along the trail, highlights individuals going through these “underpasses”, making them targets.

Parks that exist along the trail are mostly grass covered with a few trees, parking lots, and small pavillions also lit by industrial, yellow, sodium lights. Some of the parks contain playground equipment, but other than these few pieces of play equipment and the pavillions there is very little to attract individuals.

Gateways and trail entrance points are poorly marked along the trail. In fact, there
are no wayfinding or other indicators showing how to get to the trail, or marking the trail itself. This poses a problem for individuals trying to access the trail. It also makes the trail disappear in peoples' minds because there are no clear markings, signage or gateways to remind them it is there. When walking, driving, or biking near the trail, or when crossing over it, the lack of unique identification, signage, materials, and lighting makes it hard to notice. If it is noticed, they may not be enticed to use it.

The trail itself is fairly clean and clear of debris and trash, but the vegetation on the sides, rocks along the bank, and river itself have debris at various points, as shown in the pictures on the following pages. Grafitti is also seen on trail mile posts and other signage, along with trail features, such as concrete underpass structures. This debris and grafitti adds to the negative perception of safety along the trail. Maintenance of lights and other underpass features have similar problems. Debris caught in underpass fencing or other structural material can be found, and some of the lights are burned out in the underpasses and other areas, further exaterbating the negative perception of safety.

Current conditions of the trail continue to create problems in relation to the feeling and perception of safety. The trail needs redeveloped and upgraded in order to become a connecting point for the community, a desired location to utilize, and one that feels and is perceived as being safe.
FIGURE 3.2 - Trail crossing under Railroad Bridge

FIGURE 3.3 - Trail near N 1250 W and the park.

FIGURE 3.4 - Trail crossing under Interstate 15

FIGURE 3.5 - Trail near Paul Ream Wilderness Park
FIGURE 3.6 - Trash and other debris in vegetation.

FIGURE 3.7 - Trail mile marker post with blue grafitti.

FIGURE 3.8 - Trail crossing under University Parkway

FIGURE 3.9 - Grafitti on building utility unit.
FIGURE 3.10 - Dark underpass under the UTA high speed rail line.

FIGURE 3.11 - Stone bench at historic marker with black graffiti.

FIGURE 3.12 - Trail underpass below Interstate 15 with industrial lights.

FIGURE 3.13 - One of the few park signs along the trail.
PHYSICAL BARRIERS TO ENTRY / PSYCHOLOGICAL BARRIERS TO ENTRY

Figure 3.14 is a map showing where physical trail attributes function as physical barriers, psychological barriers, or both. Physical attributes or features can become psychological barriers.

Physical attributes of the trail that create barriers to entry into the site include poorly lit parks, no connected trails, sidewalks or other pedestrian bridges, dark underpasses, and no safe pedestrian road crossings. Some of these attributes lead to psychological barriers to entry due to their characteristics and the way they make people feel. Dark underpasses do not allow people to see what is ahead, creating a cautious feeling. Poorly lit parks create the sense that someone could be hiding, or create anticipation that something bad may happen. Lack of safe pedestrian crossings create a feeling that the trail itself might be unsafe. Studying these key elements of the site molds prioritization of which areas need redesigned first.
OTHER PSYCHOLOGICAL BARRIERS SUCH AS DARK PARKS, FEW ATTRACTIONS

FIGURE 3.14 - Physical / Psychological Barriers to Entry Map
MAJOR CRIME HOT SPOTS

Figure 3.15 shows where major criminal activity hot spots occur. These hot spots were determined by using data from the Provo City Police Department’s reports on criminal data website. The data was collected from a six month period from March 2015 - August 2015. Below is a key that shows what the various colors of the map mean and which crimes they represent. This data is key to the project because it helps to zoom in on specific sections of the trail that have a high amount of criminal activity and that can be focused on in the project. Areas with more incidents of crime enhance negative perception of safety along the trail due to television reports, online news articles, social media, or word-of-mouth from friends, among other ways.
FIGURE 3.15 - Major Crime Hot Spots Map
MAJOR GATEWAYS / MINOR GATEWAYS / PEDESTRIAN CROSSINGS

Figure 3.16 is from the Provo City General Plan, identifying existing major arterial and collector streets, as well as proposed arterial and collectors. This is important, because it highlights major roads and other aspects of the surrounding context that are or could be major gateways. These gateways are the entrances onto the trail, the places that usually hold major trailheads, and the first thing people see or pass through to get onto the trail. Minor gateways are similar to major, except that they may or may not have trail head. They are not as important as major gateways in relation to access to the site. Pedestrian crossings are bridges that allow pedestrians to move from north to south and south to north across the Provo River. Currently there are very few of these to create pedestrian movement along and across the trail.
FIGURE 3.16 - Major / Minor Gateways and Pedestrian Crossings Map
KEY TRANSPORTATION CORRIDORS

Figure 3.17 is a map showing the major transportation corridors and was created using GIS. Looking at these corridors is key, because they contain automobile and pedestrian flows that bring individuals to and across the site. In addition to automobile and pedestrian flows, public transportation runs along these corridors, bringing more individuals to and across the site. The intersections of these corridors and the trail produce natural connecting gateways and points.
FIGURE 3.17 - Key Transportation Corridors Map

- MAJOR CORRIDORS
- UTA HIGH SPEED PASSENGER RAIL
- PROVO RIVER TRAIL
- PROVO RIVER
PROVO GENERAL PLAN LAND USE MAP

Figure 3.18 is a map from the Provo City General Plan detailing land use types. Looking at this map illustrates how the city is looking at various areas of the city in the future and how they might want them to develop, whether residential, public commercial, or a host of others. This information is key to designing the target areas of the three-mile section of the Provo River Trail, because it gives a sense of what types of users will be in close proximity to the trail. It also gives a sense of types of activities or programmatic elements that can be placed within areas along the trail.
FIGURE 3.18 - Provo City General Plan Land Use Map
Figure 3.19 is a map from the Provo City General Plan, which identifies existing city, private, state, county, and school parks. This map helps in the design process to determine what areas of the trail are adjacent to parks and how to connect to other parks outside of the target area.
FIGURE 3.19 - Provo City Developed Parks Map
PROVO CITY MAJOR ARTERIALS AND COLLECTORS

Figure 3.20 is a map from the Provo City General Plan which identifies existing major arterial and collector streets as well as proposed arterial and collectors. This is important, because it highlights major future corridor development planned by the city. These planned future arterials and collectors need to be considered when designing the Provo River Trail.
FIGURE 3.20 - Provo City Major Arterials and Collectors Map
PROVO CITY MAP OF BIKE LANES AND TRAILS

Figure 3.21 is a map from the Provo City General Plan, identifying existing and proposed bike lanes and trails. This is important, as the existing and proposed bike lanes and trails that cross or touch the Provo River Trail are key in designing a more dynamic and perceptively safe trail through adding more eyes-on-the-trail.
FIGURE 3.21 - Provo City Map of Bike Lanes and Trails Map

BIKE LANE
PROPOSED BIKE LANE
BIKE FRIENDLY CONNECTOR
TRAIL
PROPOSED TRAIL
BACK COUNTRY TRAIL
THREE-MILE FOCUS SECTION OF THE PROVO RIVER TRAIL
PARK
PROVO BOUNDARY
OVERALL SITE ANALYSIS

Figure 3.22 is an overall analysis of the selected three-mile corridor and surrounding site context. It details and synthesizes the opportunities and constraints to detail a design direction for the site. Also, several target areas have been identified on the map as a result of site inventory.

Opportunities for the site are as follows. First, the site has a plethora of existing connection points into the site. These are key to creating a safe environment, because they could potentially be used as visual gateways into the site from the surrounding areas. Second, the area identified as Target Area #4 has been targeted by Provo City’s General Plan for future commercial development. This provides opportunities for a pedestrian hub or other type of major destination along the trail. Third, there are multiple educational facilities that lie within close proximity to the trail. These facilities provide students proximity to the trail. More connections to these points must be considered. Fourth, there are several existing parks along the trail that provide stopping points for trail users and that lie in close proximity to major commercial and other public facility corridors. Finally, there are multiple student housing establishments that exist along the trail. These student housing units that are adjacent to the trail allow for short access to the trail.

Constraints for the site include the following. First, the three-mile section of the trail is over-vegetated. This prevents eyes-on-the-trail and does not allow for clear sight lines that increase safety. Second, there are multiple overpasses that cause darkened undersides where the trail intersects. These dark areas present both physical and psychological barriers that must be redesigned to better create a positive psychological perception of safety. Third, connections across the river are at a minimum. Not only that, the existing pedestrian connections into the site are poorly marked, unmaintained, and not clearly identified from major gateways and access points. Fourth, considering the multiple land uses surrounding the trail, the trail fails to appropriately leverage the valuable connections and proximity to commercial corridors, mixed-use developments, and residential land uses.
Possible Trailhead/Connect to Trail on University Parkway

Target Area #1
Possible Land Bridge Over Interstate 15
Three-mile Target Section of the Provo River Trail

Provo River Trail
Major Corridors
UTA High Speed Passenger Rail

FIGURE 3.22 - Overall Site Analysis
TARGET AREA #1

Figure 3.23 details major opportunities and constraints for Target Area #1. Major opportunities for this target area are as follows. First, there are several existing schools and businesses that lie in close proximity to the trail. There is an ecological drainage corridor that runs through this area, which would be a prime additional trail that could draw users onto the trail. There is also an existing trail head that could be utilized as a major gateway from these schools and businesses. Second, north of the Provo River there are multiple single family houses that have over-vegetated back yards. In order to create safer conditions and increase the psychological perception of safety, parts of the vegetation need to be cleared to open up sight lines onto the trail. Third, there is the potential to either add a large pedestrian bridge over the central portion, where roads and rail lines dissect the river and trail, or to enhance the underside of the overpasses to break down the psychological barrier of a dark underpass. Fourth, an existing park on the east side of the target area is underutilized and does not contain attractions or programming to entice users to visit it. Due to this, the park has untapped potential to become a major plaza and park, that possibly has an amphitheater or other programming to entice users along the trail to visit it and make it a destination.

Constraints for the site include the following. First, the single family residential units on the north side of the trail may not see reducing vegetation and opening up sight lines favorably, due to their perception that it might reduce their privacy. Seeking ways to satisfy their needs as well as increase eyes-on-the-trail should be sought. Second, connecting the west portion of the area with the east portion of the area across the expansive interstate, rail, and commercial zone proposes a challenge.
Connect to Existing Schools and Businesses
Open Sight Lines to River and Trail from Surrounding Residential Units
Renovate Park - Possible Amphitheater / Plaza
Potential Commercial and Transit Hub Location
Add Large Pedestrian Bridge Over Roads or Create Pedestrian Hub Under Passes

FIGURE 3.23 - Target Area #1 Site Analysis
TARGET AREA #2

Figure 3.24 details major opportunities and constraints for Target Area #2. Major opportunities for this area include the following. The first is to create an access route from the existing hospital complex on the east side of the trail. Second, there is an opportunity to create a major gateway or trailhead where the four major roads intersect and creatively think about and redesign current parking lots around the proposed trailhead and gateway. Third, a large area of an existing park exists adjacent to the trail. This area can be used as a major destination point along the trail with programming, to attract users and increase the psychological perception of safety. The potential for a relaxing, meditative park that connects to the hospital is high. Fourth, there is an opportunity to lighten vegetation and increase sight lines along the trail. Last, major roads that cross the river present great opportunities to create pedestrian access points along the trail.

Major constraints include the following. First, creating a public gateway or trailhead where the roads intersect may pose some safety problems that will need addressed. Second, thinning out the vegetation surrounding single family units may make residents feel like they have no privacy. Balancing this need with eyes-on-the-trail must be addressed. Last, creating a cohesive connection between the mixed use development area on the north side, commercial areas, public access areas, and the trail poses a challenge. These areas must be seamlessly incorporated together using the trail and pedestrian access points.
Strengthen Existing Major Pedestrian Gateways

Potential Additional Pedestrian Gateways

Thin Out Vegetation to Increase Eyes on the River and Trail

Open Up Sight Lines and Strengthen Eyes on the Trail

Three-mile Target Section of the Provo River Trail

Create Gateway/Trailhead for Trail Access

Renovate Large Public Park Area to Create a Destination Point

Create access from Utah Valley Regional Medical Center

FIGURE 3.24 - Target Area #2 Site Analysis
TARGET AREA #3

Figure 3.25 details major opportunities and constraints for Target Area #3. Major opportunities for this area include the following. First, this focus area lies within an area of the trail that is surrounded by student housing apartment complexes, commercial businesses, and other office space. All of these various types of uses are not integrated together, and the Provo River acts as a barrier between all of them. By redesigning the space to be a mixed-use urban center, more people and students would be drawn to this portion of the trail, reducing negative perceptions of safety. Second, adding several more bridges to cross the river and connect the current Branbury Apartments to a proposed urban plaza and mixed use building center would open up sight lines and activate the space more. Third, thinning out the vegetation and connecting peoples’ sight lines to and across the river would help to ameliorate the problem of negative perception of safety. Finally, redesigning the underpass under University Parkway to be an at grade crossing or bridge would result in higher connectivity between Raintree Apartments, another large student housing complex, on the northern side of University Parkway.

Major constraints for this area include the following. First, there is a large car dealership to the northwest of Branbury Apartments. This dealership has extremely bright lights on throughout the night, which darkens the view while walking on the trail and around Branbury Apartments. Second, the busy University Parkway represents a challenge for pedestrians. There is an undergrade crossing that exists currently, but it is narrow, dark, and unwelcoming, detering people from using it. The third constraint is the proximity of West 1720 North to the existing trail. Both are almost directly adjacent to each other, posing security concerns for individuals and cars. Last, a huge storage unit on the southwestern side of the target area poses a problem, as it reduces eyes-on-the-trail and creates dark spots for predators or other michevious people to hide.
Strengthen and Improve Existing Pedestrian Bridge

Add Additional Connection, Create a Pedestrian Plaza Bridge

Potential Transit Stop and At Grade Crossing

Open Up Sight Lines and Strengthen Eyes on the Trail

Pedestrian Bridges that Open Up the Space and Sight Lines

Three-mile Target Section of the Provo River Trail

Provo River Trail

Major Corridors

UTA High Speed Passenger Rail

Potential Additional Pedestrian Gateways

FIGURE 3.25 - Target Area #3 Site Analysis
DESIGN EXPLORATION
DESIGN EXPLORATION

Again, with rise in world population requiring movement 24 hours a day, the need for safe urban trails that positively enhance the quality of life is high. As cities continue to grow, safety of the public that utilizes urban trails is a major concern. The use of lighting has been one of the major ways to solve high crime rates, but has been haphazardly designed and installed. This design exploration chapter demonstrates how the careful, creative and innovative use of lighting in the landscape can break down psychological barriers and positively affect perception of, and actual safety along a three-mile section of the Provo River Trail and its surrounding neighborhoods, connections, and gateways. Design deliverables include inventory and analysis maps/diagrams, an overall master plan, prototype renderings, and details for portions of the trail, specific site details, sections, diagrams, and any other information pertinent to communicate the idea.

The following list of goals and objectives are the result of the literature review, project case studies, material case studies and site review and investigation. The list is the synthesis of the important pieces discussed earlier, and are the key goals which need accomplished for the negative perception of safety in urban trails to be ameliorated. Design concept, details, and elements are aligned with these goals and objectives. GOALS AND OBJECTIVES

1) Utilize creative/innovative lighting techniques, strategic placement and other lighting technologies that enhance the perceived safety of the trail by all users.

- Enhance prospect, refuge, and escape
- Balance vegetation and light
- Increase clear site lines and open spaces into the site to create visibility
- Incorporate light from the beginning to the end of the trail
- Maintain lighting, associated structures, and the physical trail
- Utilize color theory and lighting technologies
• Install lighting at the crossing points of the trail (within 50 feet of decision making areas/150 of crossings)

• Use the properly determined uniformity and luminance of lighting (as referenced in the literature, material precedent study sections, and consultation from committee member and lighting designer, Mickie Marie).

• Use lighting that is lower to the ground or use shielded downlighting

• Utilize the color white

2) Enhance the connections and access points from residences and other areas into the site to create a safe and inviting environment.

• Engage all access points and major gateways into the site

3) Reduce opportunities for criminal activity to take place 24 hours a day.

• Increase activity on the trail and the surrounding parks by programming elements that are of interest to all people

• Lighting the trail from beginning to end

• Balance police presence 24 hours a day

4) Break down or remediate the physical barriers (i.e. underpasses) that facilitate psychological barriers of entry into the site.

• Enhance visual sight lines and highlighting of the trail from a distance

• Illuminate dark areas in the site

• Balance police presence

5) Enhance the urban sense of the trail while maintaining a natural feel

• Use local materials

• Keep lighting colors in more conservative hues and colors

• Use moving lights and sensors to enhance the social feel of the site
DESIGN CONCEPT

The initial phase of design is the development of a concept. A concept is the overarching idea that directs the development of more detailed design and, eventually, a finished project. In determining the most appropriate concept that supports the research question, synthesis of the site inventory, literature review, site analysis, and review of case studies and any other material was required. Several concepts were developed. Each of them had merits supporting the most appropriate action to be taken on the Provo River Trail in regards to the perception of safety. The ideas are as follows:

Concept #1: The idea of ripples. Water and light interact together as light hits the water’s surface it moves and plays with the molecules creating a beautiful art piece that touches anything surrounding it. The idea of the trail, water, and light producing ripples through the community was considered.

Concept #2: The idea of regeneration. Light and water are both necessary for life. Without either, we and other living organisms on the earth would perish. Presently, the Provo River Trail presents more of a chasm between two sides of the city than a regenerative, necessary organism that supports all those living within and surrounding Provo. The idea of regeneration is a very powerful notion, especially when dealing with perception and light. The Provo River Trail could function as a regenerator of the community. Light and activity along its path increases as members of the community come to interact with the trail. When people leave the trail they take that renewed energy to the surrounding community. This symbiotic synthesis of movement and regeneration between the river, light, and people could be a powerful catalyst for change in the city, now and in the future.

The decision between the two concepts was fairly clear. Regeneration was chosen due to its ability to meet the research question at the outcomes of data gathering, and its ability to change a person, a community, a city, and a region.
DESIGN PROGRAM

- Three lanes (walking and two dedicated bike/running lanes)
- Plazas (Multi-Functional)
- Seating
- Observation Decks over the River
- Art/Sculpture – Interactive and Passive
  - Light Painting Wall
- Amphitheater
- Signage and Wayfinding Identifying all major access points
- Bridges
- Underpass art and lighting sculpture
- Lighting Sensors
- Cove lighting Under Benches
- Lighting up trees
- Natural and local materials
  - Mixed Color Pavers with incorporated site lighting
- Use energy efficient and solar powered lighting
- Multiple Lighting Types,
  - Cove Lighting
  - Electroluminescent and Plexiglass
  - Fiber Optic
  - Down lighting (Except for in trees to illuminate the canopy)
  - LED Tape
• Interactive Screens showing how active the trail is at certain points and how many people are on it.

  Sensor Feedback

• Areas made for all ages to be used at all times

  Basketball
  Football
  Frisbee
  Relaxing
  Meditation
  Parties
  Socializing
MASTER PLAN

Due to the length and scope of the three-mile section of the Provo River Trail, it was necessary to develop an overall master plan (see Figure 4.1) along with more detailed sections of each target area and other important aspects of design along the trail. The following page shows an overall master plan of the targeted section, identifying new major gateways, minor gateways, pedestrian bridge crossings, underpasses, trailheads, and identified target areas, as well as added trail connections and paths. All lighting will use either solar or other energy efficient forms of lighting or a combination of both.

Each of the identified areas and elements embodies the concept and idea of regneragtion from light. Sensors, timers, interactive technology and other cutting edge uses of technology are used, along with lighting, to produce an effective approach to decreasing the negative perception of safety while increasing urban connection with the surrounding city and neighborhoods. This is all done while maintaining the natural feel of the trail.

Sensors

Motion-detecting sensors are used throughout the entire three-mile section of the trail. Using the latest technology, these sensors detect movement at any point along the trail, pedestrian bridges, gateways, transit stations, and at least 300’ from any connecting path, sidewalk or road leading to the trail. Once motion is detected the system knows to slowly turn on the lights leading up to the trail 50’ in front of the user. As the user continues to walk lights turn on, illuminating the path 50’ in the distance. If the user stops for a moment along any part of the aforementioned trail or park the lights stay. Once the individual starts moving again, the lights behind the individual fade. These sensors are key to ameliorating negative perceptions of safety. They reduce the effects of bright, constant light on the eyes that leads to blind spots in the distance. They add a sense of activity along the trail, no matter how few or how many people are using it. They also add to the idea of prospect, as stated in the literature review, by allowing individuals to see the path and landscape in front of them as if the moon was lighting their path. In addition, the
sensors are connected to a central processing system that knows exactly where people are along the trail and how many are using it at one time. This information is broadcast via an interactive light wall on each major and minor gateway sign. The sign has a glowing line showing the trail, along with glowing dots representing where people are using the trail and how active any portion of the trail is at one time. Users can touch the sign and information will be given about the most active areas, time of travel to other areas, and past trail use information from other days and times.

*Three-mile Trail*

The trail itself incorporates the same design language throughout the entire section to create continuity. In order to accommodate all types of uses of the trail, ranging from just relaxing or walking, to running or biking, the trail should be expanded to 15 feet. This will provide two five foot lanes for two way pedestrian connection and five feet for a dedicated bike lane. Lighting along the trail will be the same and incorporate uplighting of vegetation and strip lighting along the pavement itself, all of which will use sensor technology.

*Major and Minor Gateways*

Entrance into the site, as identified in the site analysis, is minimal and not well marked. In order to increase access to the Provo River Trail, both psychologically and physically, major and minor gateways were identified and designed with similar language of signage, lighting, and other key elements. Elements of these gateways are described below.

*Pedestrian Bridges*

Pedestrian Bridges were increased at multiple points along the trail to further access to the site and to enhance the feeling of escape that helps ameliorate the negative feeling of safety along the trail. These pedestrian bridges are not just crossings, but also contain seating and observation decks that overlook the trail. Lighting on these bridges can be seen from the next bridge, giving people a feeling of security and peace due to increased
feelings of prospect.

*Underpasses*

Multiple underpasses exist along the trail, creating a psychological barrier due to their current industrial and eerie feeling. Underpasses were redesigned to be wider, opening sight lines from both directions. Artful lighting, which reacts to users’ movements and amount of people has been created. Seating along the river bank under the underpass provides opportunities to relax and observe, and sensors detect people from both directions and project this to users on both sides of the overpass via a light wall, which increases the feeling of safety and security.

*Trailheads*

Existing trailheads were bolstered and two more were added at key spots along the trail, to allow people to access the trail more readily. These trailheads include parking with sensor activated lighting that lights up when a user is within 50 feet of the parking lot. Trailheads also contain bathrooms and other essential features. Trailheads are also monitored 24/7 by closed circuit television cameras.

*Target Areas*

These areas are those which were identified in the initial site analysis as being the most important areas to focus on initially, for the trail to gain the most ameliorated effect of negative perception of safety. Each area has been redesigned to incorporate various elements throughout the trail and to incorporate lighting into every facet of the linear movement corridor and its surrounding context. Elements of these include pavilions, seating, multi-use amphitheater type areas, light painting walls, interactive LED light walls, art and sculpture, paths, interactive boards showing which parts of the trail are most active at the moment, other interactive lighting elements, urban plazas, mixed-use development including retail, playing fields and other recreational areas, water features, etc. All of these elements are designed to maximize the achievement of the goals and objectives discussed
earlier in the section and to maximize the amelioration of negative perception of safety by utilizing the creative and innovative use of lighting.
Proposed Pedestrian Bridges
Proposed Minor Gateways
Proposed Major Gateways
Proposed Target Areas
Provo River Trail
Proposed Redesigned Pedestrian Underpasses

FIGURE 4.1 - Master Plan
MAJOR GATEWAYS

Each major gateway has the exact same identifying features to maintain a common language across all portions of the trail. As a user comes toward a major gateway, LED strip lights incorporated into the pavement glow 300’ from the entrance. These lights glow up to the entrance and slowly fade behind the user as they progress towards the trail. This creates a sense in a user’s mind that, somewhere along the trail, something is going on, as well as creates a safe connection between the trail and the user. These strip lights will also glow brighter the more people use them, adding to the feeling of safety and security and the perception of safety.

Upon reaching the gateway entrance, the user will see a sign (see Figure 4.6) signifying the Provo River Trail. Signs are the same at all major gateways throughout the site in order to maintain continuity and increase a sense of safety. Each sign is an abstraction of the Wasatch Mountain range that can be seen along almost all portions of the trail. Peaked and jagged tops made from translucent material glow an ambient white color that connects the importance of the river to the mountains to the east. The text on the signs glow as well. At the bottom of the sign there is stone seating with downlit cove lighting that illuminates the ground plane. Trees at the gateway (see Figure 4.3 and 4.4) also slowly light up as a person gets within 50’ of the entrance, which adds to the feeling of security as well as acts as an identifying feature. Interactive signage is also used at each major gateway. On the backside of the stone wall is a map (see Figure 4.7) of the entire targeted section of the trail, that glows when someone is in proximity. This map is a touch interactive piece that gets information from a myriad of sensors throughout the trail. Information from these sensors shows up on the map as glowing spots that show how many people are using a specific section of the trail at any time. If more people are using a particular section, the sign glows brighter in that spot and visa versa. Materials used throughout major gateways are the same that are used throughout the entire trail. These materials include wood and rough cut granite benches with downlit cove lighting, translucent plexiglass, and brick pavers.
in both red and gray mix. The gray mix of pavers (see Figure 4.3 and 4.5) shows up better at night than the dark asphalt that currently exists along the trail.
FIGURE 4.2 - Major Gateway Context and Existing Condition

FIGURE 4.3 - Proposed Major Gateway Site Plan - Daytime
FIGURE 4.4 - Major Gateway Context and Existing Condition

FIGURE 4.5 - Proposed Major Gateway Site Plan - Nighttime
FIGURE 4.6 - Major Gateway Entrance Perspective

FIGURE 4.7 - Major Gateway Interactive Map Perspective
MINOR GATEWAYS

Minor gateways have very similar features to the major gateways, simply at a smaller scale. Figure 4.9 to the right shows the differences. Minor gateways were designed and placed along important routes and chosen due to the size of the street or sidewalk, location, or existing and potential connections. These minor gateways to the trail are key, especially to neighborhoods surrounding the trail and other sites in close proximity to the site.
FIGURE 4.8 - Minor Gateway Context and Existing Condition

FIGURE 4.9 - Minor Gateway Site Plan - Daytime
FIGURE 4.10 - Minor Gateway Context and Existing Condition

FIGURE 4.11 - Minor Gateway Site Plan - Nighttime
FIGURE 4.12 - View of Minor Gateway - Nighttime
Another major problem that increases the negative perception of safety along the trail is a lack of pedestrian connections across the river. Existing bridges (see Figure 4.13) have little to no lighting, which contributes to the negative perception of safety. Without safe access across the Provo River, residents who live north of the river have reduced incentive and interest to get to the trail. Adding more bridges is essential to further negate feelings of unsafe conditions.

Multiple bridges were added. These bridges (see Figure 4.14 and 4.15) were designed to not just be crossing points, but also relaxing and observing points. Each bridge is an abstraction of stepping stones across a river. One bridge can be seen from another, adding to the feeling of prospect that helps people feel safer. Each bridge has a wood path in the center, stone seating with vegetated planters, see through glass railings for safety, and flowering trees as accents. Utilization of sensors, as used in all lighting throughout the site, is key. Lights on the bridge slowly turn on as people get within 50 feet of the bridge entrance. These wider bridges with multiple platforms (see Figures 4.16 and 4.17) allow people to pause as they cross the river and enjoy the sights and sounds as the river flows downstream.
FIGURE 4.13 - Pedestrian Bridge Existing Condition Example
FIGURE 4.14 - Pedestrian Bridge Site Plan - Daytime

- Path Connecting to Provo College
- Vegetated Planting Beds
- Seating Areas
- Wood Central Walkway
- Provo River Trail
- Provo River

0' 30' 60' 120' Feet
FIGURE 4.15 - Pedestrian Bridge Site Plan - Nighttime
FIGURE 4.16 - Pedestrian Bridge Section - Nighttime

FIGURE 4.17 - Pedestrian Bridge Perspective - Nighttime
UNDERPASSES

Underpasses are currently one of the major problems along the trail. This is a result of the cold surfaces of the asphalt and concrete walls, yellow sodium lights that cast an eerie glow, no visual lines to the other side of the underpass, and narrow passageways.

To reduce negative preceptions of safety along the trail, the underpasses need to be redesigned. In this proposal this is accomplished in several ways. First, widening the underpass walkway (see Figure 4.23) to become more of a platform that juts out into the river reduces the feeling of being trapped. Second, using lighting (See Figures 4.20, 4.21 and 4.23) on the roof of the underpass that is sculpturally designed and utilizes sensors to interact with trail users is proposed. Third, using the newest technology to sense individuals, a projection of a glowing light is cast onto an LED board (see Figure 4.21 and 4.22) on the opposite side of the underpass that shows individuals entering the underpass and warns that someone is coming. The following page shows what one underpass would look like. The principles applied here should apply to all other underpasses.
FIGURE 4.18 - Underpass Context and Existing Condition

FIGURE 4.19 - Underpass Site Plan - Nighttime
Motion-activated wall lighting illuminates underpass as pedestrians approach from a distance.

FIGURE 4.20 - Underpass Section 1

Motion-activated wall lighting illuminates underpass as pedestrians approach from a distance.

FIGURE 4.21 - Underpass Section 2
Motion-activated wall lighting illuminates underpass as pedestrians approach from a distance.

FIGURE 4.22 - View of Underpass at Night Heading West

FIGURE 4.23 - View of Underpass at Night
THE TRAIL

In order to ameliorate the negative perception of safety along the trail and maintain the natural feel, all while connecting urban context and surroundings to establish a common trail design language, the following design ideas were used. First, one of the major problems discussed earlier is that the trail (see Figure 4.24 and Figure 4.6) lacks lighting of any kind along a much of the trail, except for surrounding residential and business light, yellow sodium light at pavilions and underpasses, and the occasional street light that illuminates a small area of the trail. The solution (see Figure 4.25, 4.27, 4.28 and 4.29) to these issues and the major overall problem is to utilize sensor lighting. As a person moves along the trail, the sensors pick up their movement. As the sensor picks up their movement, a tree 50 feet in the distance will slowly become uplit. Fifty feet is a key distance, because at normal moving pace this is generally the point which the eye sees first. As a user continues along the trail, this slow, ambient uplighting and fading of trees occurs. The more users of the trail, the more trees will be glowing and fading. If there are very few users of the trail the lights will turn on and off at intervals to deter those who wish to use the trail for harm. On the right side of the trail, pedestal lights will light up like the trees in order to illuminate the surrounding landscape. The mistake made in the past is the use of lighting to flood the landscape. This has created problems of the light targeting individuals and creating darkness of the surrounding area. Lights that are incorporated into the trees and bollard lights along the other side of the trail will produce a ambient glow that illuminates the trail and surrounding landscape, creating a better sense of prosepct in the user’s mind, due to their ability to see the landscape without their eyes being overwhelmed by blinding light. A slow increase in glow allows the eye to adjust to the increase in light.

Pavers in a gray mix will be used along the trail. These pavers tend to show up better in moonlight and other natural light, creating a better sense of what lies ahead. Also, a blue colored bike lane will be used to demarcate the difference between pedestrian and bike portions of the trail. Seating will be placed along the entire length of the trail. These
benches are dual sided in nature and, when in use, will be illuminated by an ambient glow that eminates from bollards that have shielded bollard downlights. These downlights will also be used to illuminate the surrounding landscape around the seating area when in use, which again increase the positive perception of safety due to prospect.

As stated earlier, major and minor gateways have interactive sign elements that show how active the trail is at key points. This information comes from the sensors placed all over the trail and its connected features.
FIGURE 4.24 - Context and Existing Conditions of the Provo River Trail

FIGURE 4.25 - Typical Site Plan for the Entire Three-mile Trail

- White Opaque Plexiglass Strip (Flush with Ground Plane)
- 10' Wide Pedestrian Walkway
- 5' Wide Bike Lane
- Provo River
- Stone and Wood Bench
- 4000K CCT Shielded Downlight

Feet

0' 7.5' 15' 30'
FIGURE 4.26 - Context and Existing Conditions of the Provo River Trail

FIGURE 4.27 - Section of the Trail - Nighttime

- White LED Light Tape under Opaque Plexiglass
- 10' Wide Pedestrian Walkway
- 5' Wide Bike Lane
- Provo River
- Stone and Wood Bench
- 4000K CCT Shielded Downlight
- Cove Lighting Illuminates Ground Plane
- 4000K CCT Uplights Illuminate Tree Canopy

0'  7.5'  15'  30'  Feet

Design
FIGURE 4.28 - Typical Section of the Three-mile Focus Area of the Trail

FIGURE 4.29 - Typical Perspective of the Three-mile Focus Area of the Trail
TARGET AREA #1 - THE REFUGE

The first target area (see Figure 4.30), and one that is key to redeveloping the entire trail, is located in proximity of Raintree Apartments and the Branbury Apartments on University Parkway. As identified earlier, the overgrown vegetation, businesses that face away from the trail, lack of clear identification, actual criminal acts that have occurred within the proximity, and the fast paced traffic of University Parkway all contribute to the negative perception of the trail.

This target area is named The Refuge (See Figures 4.31 and 4.32). This name comes from one of the major ideas discussed earlier in the literature review portion of this study. The Refuge is designed as a mixed-use redevelopment that interlinks the Branbury, surrounding residences, commercial businesses and Raintree Apartments, among others, via the Provo River Trail. Commercial businesses in the design of this area are oriented towards the Provo River Trail so that they face the Branbury. Three pedestrian bridges are incorporated here, two of which are designed with the proposed platforms that exist on all other pedestrian bridges proposed along the trail. Relationships between the Branbury, new mixed-use buildings on the east side, and Raintree on the other side create a dynamic district that has beautiful lighting at night. This is especially key for students who live in many areas surrounding the site. New developments and dynamic lighting provide an urban atmosphere that can be safely used 24 hours a day.

In the center of all of the buildings, where the two platform bridges cross over, there is an interactive light sculpture. A light wall will be installed in the center of the urban plaza and green space. This wall is a combination of technology and light in a fun and interactive way that uses light and water. Antonin Fourneau created an innovative way to create graffiti through combining LED lights and sensors that detect water. A user can use a brush, hand, squirt bottle or anything that spreads water on the board. The more water placed on the board, the more the LED that is touched by it glows. Placing this as a centerpiece of the urban plaza provides a connecting piece that can be seen from a variety of points.
throughout the site 24 hours a day. Anybody using the trail can use this sculpture and it will become a key piece along the trail.

Also incorporated in this portion of the trail is a multi-use recreational play field that allows individuals to play or relax 24 hours a day. Lighting is again sensor run so that the field is lit when being used and off when it is not.

Another issue here is the narrow underpass that goes underneath University Parkway. This underpass is too dark at night, and even during the day, which adds to negative perception of safety. In order to ameliorate this, the design (see Figure 4.35, 4.37 and 4.38) proposes taking the trail to an at grade wide crossing that also has a bus stop for UTA routes. By putting the crossing above grade and using the same language of lighting that is used along the entire trail, it will become an important gateway and marker for the Provo River Trail.

Lastly, in the main plaza (see Figure 4.33) of the development there is a landmark building on the east side that can be seen from the trail and University Parkway. The west side of this building doubles as a projecting surface that can have movies or another type of media projected onto it. Movies, presentations, and even concerts can be displayed on this screen which will attract many people.

With the new lighting types and technologies included, along with all of the other programmatic elements of the site, this will become a much more positively perceived portion of the trail, further negating the negative perception.
FIGURE 4.30 - Context and Existing Conditions of The Refuge
FIGURE 4.31 - The Refuge Site Plan - Daytime

- At Grade Trail Crossing and Transit Station
- Mixed-use Urban Development
- Pedestrian Bridge
- Central Plaza with Light Painting Wall and Movie Screen at Night
- Multi-Use Recreation Area
- Pedestrian Bridge
- Wide Steps on the Rivers Edge to Allow for Interaction with the Water
FIGURE 4.32 - The Refuge Site Plan - Night time
FIGURE 4.33 - Central mixed-use plaza with a movie screen, local businesses, pedestrian bridges and water and light painting wall.
FIGURE 4.34 - Transit Station Context and Existing Conditions

FIGURE 4.35 - Transit Station Site Plan - Daytime
FIGURE 4.36 - Transit Station Context and Existing Conditions

FIGURE 4.37 - Transit Station Site Plan - Nighttime
FIGURE 4.38 - View of the Tranist Station and At-grade Trail Crossing - Nighttime
TARGET AREA #2 - THE ESCAPE

The Escape is the second target area. This site (see Figure 4.39) lies west of N 500 W and Utah Valley Regional Medical Center. Utah Valley Regional Medical Center is one of the busiest and largest hospitals in Utah County. There are several other clinics and businesses that also lie east of the Provo River Trail. All of these either have their backs towards the trail or have no connection to it. This is one of the major opportunities that exists in this portion of the trail. In order to connect more individuals to the trail, the existing park that lies in this target area needs redesigned. This is where The Escape (see Figure 4.40 and 4.41) comes in.

The hospital and surrounding clinics are full of people 24 hours a day. Many of these individuals are stuck in the hospital for hours or days and need a place to go to relax and escape. Connecting the park and trail is key.

As stated earlier water is a key component of regeneration and life. The Escape is designed as a therapeutic refuge where the soul, mind and body can be rejuvenated in a sea of lights, sculpture, water, and the Provo River Trail. Form of the site is abstracted from an ancient symbol for water.

In the center of the site (see Figure 4.42) are two circles with stone seating and interactive water features that are lit by different colored lights 24 hours a day. As people come into the site, sensors detect the user and the lights under each water jet starts to move. Each jet can also be played in during the summer and is slightly depressed so that during winter the lights shine through snow and ice, creating a magical effect.

Sculptures are also key in this therapeutic park. Each sculpture is lit by accent lighting. Several areas are left as grass to provide further opportunities to spread out and relax. Other vegetated areas are planted with a sea of ornamental grasses that move and sway with the breeze or wind. At night there are wire fibers with lights on top that glow, adding to the relaxing feeling and ambience throughout the site.
FIGURE 4.39 - The Escape Context and Existing Conditions
FIGURE 4.40 - The Escape Site Plan - Daytime

FIGURE 4.41 - The Escape Site Plan - Nighttime
FIGURE 4.42 - Perspective View of The Escape’s Main Plaza
TARGET AREA #3 - THE PROSPECT

The prospect is the final target redevelopment. This portion of the trail has a variety of issues and opportunities. First, the area is surrounded on both sides by a lot of residential housing, including a trailer park that is poorly lit. Second, as discussed earlier, the existing bridge here is poorly lit. Third, there are many dark areas and overgrown vegetation. Lastly, the pavilions that exist contain the only lights in the park and surrounding areas and are done so by yellow, sodium lights, creating an eerie unsafe feeling.

The Prospect’s design (see Figure 4.43, 4.44 and 4.45) remediates these problems by the following. First, the design focuses on, of course, the trail itself as a backbone. Redesigning the park in this target area was key to creating a dynamic portion of the trail that ameliorated negative feelings of safety. At the center of the park is a multi-colored pavilion structure with seating on the inside. The colors of this building are beautiful and create visual interest as a node along the trail. You can see the pavilion from a distance as you come into the site via the trail from either direction. The pavilion has multiple paths that are connected to parking areas, roads and multi-use fields. Grass fields are downlit at low ambient levels to illuminate the entire park, adding to the feeling of security and safety. Directly across from the pavilion is a pedestrian bridge which connects across the river to the north. This connection leads to a path that leads through a riparian buffer. Along the path are educational signage and nodes, educating individuals about the benefits of riparian buffers and the river. The path also leads north to Provo College, adding a key connection to more students. This section of the site also has a trailhead. This trailhead is currently existing today. It provides parking, but the design proposes that vegetation, seating and other lighting be incorporated along the edge, to further enhance the safe feeling of the site. Currently the parking lot is dark and underlit, but by redeveloping the trail and trailhead, the unsafe feeling will be ameliorated.

Lighting in the area surrounding the Multi-Colored Pavillion is placed according to feel not at set intervals. This is to create visible sight lines throughout park area without
overwhelming a user’s eyesight. Many times lighting is placed in a way that overwhelms a user’s eyes and creates blind spots across the landscape. In order to allow the user to see the entire park area without being overwhelmed, 4000K CCT downlit lamps with shields were used in a pattern that may seem sporadic, but is actually done according to on-site placement and feel.
FIGURE 4.43 - The Prospect Site Plan - Daytime

FIGURE 4.44 - The Prospect Site Plan - Nighttime
FIGURE 4.45 - Nighttime view of The Prospect looking towards interactive light way and multi-colored pavilion
CONCLUSIONS
CONCLUSIONS

This study has looked at the ways in which the creative and innovative use of lighting can be used to ameliorate the negative effects of safety along urban trails. The study was a multi-phased approach, which resulted in a rich discovery phase, rich analytical phase, and rich design, all of which were interrelated.

The first portion of the study was the examination of the techniques and principles of lighting from other sources and professionals that may have application to ameliorating negative perception of safety through lighting. The major discovery of this phase of study was that more lighting is not always better lighting and that lighting types, colors, and illumination techniques have a huge bearing on the positive psychological perception of safety. If lighting is ignored or designed as an afterthought, the trail becomes unsafe both in perception and actuality. The key to creating a perceived and actual safe trail is through an understanding of psychological process, lighting’s effect on these, as well as site specific contextual information.

In addition to the major discovery, several other key elements were discovered. First, using the color white can help guide people through the site, as well as make things more visible. White is a natural reflector of light. Second, left on its own and left to the elements, lighting will succumb to the elements, so maintenance is key to making sure that the proposed design works. Lastly, the idea of prosepct, refuge, and escape is fundamental to creating positive feelings of safety in urban trails.

In addition to existing literature and principles, case studies of three sites that have accomplished some portion of success in using lighting creatively to affect positive psychological change were done. The Connective Corridor in Syracuse, New York shows that utilizing color and light in tandem, without flooding the land with light, can produce positive psychological effects along an urban trail, while East River Park in New York shows the positive effects of designing underpasses and other barriers to positively attract individuals. Finally, St. Patrick’s park in Calgary shows how low ambient levels of lighting
can produce positive effects of psychological positive thinking while reducing light pollution. A study of materials was also conducted to see which lighting materials could be most appropriately used to ameliorate negative perceptions of safety.

The second phase of the study was a completion of site analysis. The site analysis was performed by taking data from a variety of sources including criminal data, hydrological data, existing infrastructure, and connecting points, among many others. These data sources, when looked at as a whole, led to some stark conclusions and the foundation of the design exploration process. The three-mile target section of the trail was chosen due to its relation to urban residents and businesses, reputation as an unsafe area, low lighting conditions discovered in site visits, and actual criminal event locations. Rather than being viewed as a problem, this section presented an opportunity to discover how lighting could be used to affect change in psychological perception of safety in urban trails.

The third and final phase of the study was a completion of design exploration. This exploration resulted in the development of a master plan, several detailed plans, and target area site plans, along with a few diagrams that illustrated the design approach to ameliorating the negative perception of safety.

Design elements in the corresponding master plan, site plans, and diagrams were based upon interpreting the history and cultural significance of the trail, its relation to surrounding neighborhoods, and its potential to become a connector of the city and a safe urban trail, by utilizing creative and innovative lighting. Several strategies were employed. First, increasing prospect, refuge, and escape through the use of lighting helps affect positive safe feelings. Second, developing different target areas as different types of parks or districts, while using a common lighting language, unified the trail and the surrounding communities while reducing negative psychological notions of safety. Third, the use of materials and lighting techniques to further enhance positive safe psychological feelings were utilized. Finally, using connections to the neighborhoods and surrounding areas psychologically and physically, through the use of lighting, helped to further increase use of
the trail and reduce negative psychological perceptions of safety.

The final design solution to this project provides a unique way for cities, designers and communities to approach redeveloping urban trails to become safe positive assets for the public, through the use of lighting, and understanding the psychological effects light has on individuals. The solution provides principles and a blueprint that can be applied to urban trails around the globe. The ability to create opportunities for people to traverse the city 24 hours a day and feel safe doing so is fundamental to the future of design of the landscape and urban settings. Lighting is a fundamental design element that should, and must, be incorporated into the design process from the earliest stage to increase effectiveness of designs in urban trails and other urban designs.
REFERENCES
REFERENCES
Feeney, Erin, and Piller, Andreas. “East River Park + Esplanade.”
Kaplan,


IMAGES


