An Exploratory Framework to Assess Urban Wildfire Mitigation Policy in Austin Parks

Reginald Brooks

An Applied Research Project

Submitted to the Department of Political Science

Texas State University

In Partial Fulfillment for the Requirements for the Degree of

Master of Public Administration

Fall 2017

Oral Examination Committee Members:

Dr. Patricia Shields, Ph. D

Dr. Billy Fields, Ph. D

Lane Raffray, MPA

Abstract

Purpose: This study develops a model to evaluate Austin's urban wilderness fire mitigation. Using the model, the study then uses case study methodology (document analysis and direct observation) to assess Austin's urban wilderness fire mitigation policy. The model has three components. First, the model identifies key components of urban wildfire mitigation policy. Second, it uses these components to assess wildfire mitigation policy and documents in the City of Austin. Third, the results of the study will make recommendations to improve wildfire safety in Austin.

Method: This research uses four working hypothesis (hazard area identification, forest management practices, the planning process, public education) that are framed to evaluate the urban wildfire mitigation policy of the City of Austin. The working hypothesis contains land use management methods and wildfire mitigation policies that can be found in scholarly literature. Each hypothesis and sub-hypothesis provides the framework to assess the City of Austin's Policy. The study assesses the City of Austin through the revised building code, the Community Wildfire Protection Plan, and direct observation.

Findings: This study found that the City of Austin adequately meets the suggested wildfire mitigation policies outlined in a review if scholarly literature. The study also made recommendations for the City to improve certain aspects of its policies to prevent urban wildfires.

Table of Contents

Chapter 1 : Introduction 8
Austin Geography 8
Austin Fire History 9
Research Purpose 10
Chapter Summaries 11
Chapter 2 : An Examination of Scholarly Literature 13
WH1: The City of Austin identifies the Wildland Urban Interface and Potential Fuels. 13
WH1a. The City of Austin identifies wildfire vulnerable areas 15
WH1b: The City of Austin uses GIS mapping of local fuels 16
WH1c: The City of Austin uses GIS mapping of local floodplains 18
WH2: The City of Austin engages in proactive forest management practices. 19
WH2a: The City of Austin engages in conservative forest management practices. 19
WH2b: The City of Austin utilizes fuel load treatments. 21
WH2c: The City of Austin promotes fire-resistant landscaping. 21
WH3: The City of Austin includes fire mitigation in its planning process. 22
WH3a: The City of Austin identifies the need for long term fire planning. 22
WH3b: The City of Austin ranks its mitigation priorities. 23
WH4: The City of Austin engages in wildfire mitigation through public education. 25
WH4a: The City of Austin promotes a sense of place through understanding place attachment. 25
WH4b: The City of Austin engages in public outreach. 26
Chapter 3 : Methodology 31
Chapter Purpose 31
Operationalization Table 31
Case Study 33
Document Analysis 33
Direct Observation 34
Criteria for Support 35
Chapter Summary 37
Chapter 4 Results 39

Chapter Purpose 39
Document Analysis 39
WH1: The City of Austin identifies the Wildland Urban Interface and potential fuels. 39
WH2: The City of Austin engages in proactive forest management practices. 43
Direct Observation 46
WH3: The City of Austin includes fire mitigation in its planning process. 70
WH4: The City of Austin engages in wildfire mitigation through public education. 73
Chapter Summary 77
Chapter 5 Conclusions and Recommendations 79
Chapter Purpose 79
Recommendations 79
Limitations 81
Future Research 82
Conclusion 82
Chapter Summary 83
Works Cited 83

Tables and Figures

Table 2.1 Common Examples of Wildlife of Urban Interfaces in Austin 14
Table 2.2 Conceptual Framework Linked to Literature..... 29
Table 3.1Operationalization of the Conceptual Framework..... 32
Table 3.2 Supporting Documents 34
Table 3.3 Parks Visited..... 35
Table 3.4 Level of Alignment..... 36
Table 3.5Working Hypothesis 2 Scoring Rubric (Each criterion will receive a score of 1-4.).... 36
Table 4.1 Summary of Findings for WH1 43
Table 4.2 WH2a and WH2b Direct Observation Results 69
Table 4.3 Summary of the findings of WH2..... 70
Table 4.4 Summary of the findings of WH3..... 73
Table 4.5 Summary of the findings of WH4..... 77
Table 5.1City of Austin Document Analysis and Recommendations 81

Figure 2.1 2010 Wildland Urban Interface 15
Figure 4.1 Travis County Probability of Structure Loss Map 41
Figure 4.2 Travis County Wildfire Ignition Density Map 42
Figure 4.3 Mary Moore Seawright Metropolitan Park entrance sign 47
Figure 4.4 Well-maintained cedar trees at Seawright Metropolitan Park..... 48
Figure 4.5 Well-maintained trails and trees in Seawright Metropolitan Park 48
Figure 4.6 Cedar thicket along Slaughter Creek Trail at Seawright Metropolitan Park..... 49
Figure 4.7 Wild cedar thicket along Slaughter Creek Trail in its natural state..... 49
Figure 4.8 Free-flowing stream at Seawright Metropolitan Park 50
Figure 4.9 Barton Creek Greenbelt Map..... 52
Figure 4.10 Cedar tree growth in Barton Creek Greenbelt..... 52
Figure 4.11 Grove of pruned cedar trees in Barton Creek Greenbelt 53
Figure 4.12 Barton Creek at Twin Falls..... 53
Figure 4.13 Recently cleared Barton Creek floodplain/creek bed as seen from Mopac Expressway pedestrian bridge..... 54
Figure 4.14 Debris along Barton Creek 54
Figure 4.15 Emma Long Metropolitan Park entrance 56
Figure 4.16 Turkey Creek..... 56
Figure 4.17 Cedar thicket at Emma Long Metropolitan Park..... 57
Figure 4.18 Wild cedar thicket at Turkey Creek Trail..... 57
Figure 4.19 City Park Road Overlook 58
Figure 4.20 Natural vegetation at Emma Long Metropolitan Park. 58
Figure 4.21 Bauerle Creek Trail Entrance 60
Figure 4.22 Typical vegetation at Bauerle Ranch Park 60

Figure 4.23 Pond on Slaughter Creek at Bauerle Ranch Park 61
Figure 4.24 Untreated trees at Bauerle Ranch Park 61
Figure 4.25 Trails through natural grasslands leading to Slaughter Creek 62
Figure 4.26 Fallen tree debris in Bauerle Ranch Park 62
Figure 4.27 Fuel Hazards in Bauerle Ranch Park 63
Figure 4.28 Pile of tree debris in Bauerle Ranch Park 63
Figure 4.29 Onion Creek Greenbelt Entrance 65
Figure 4.30 Untreated natural vegetation along Slaughter Creek 65
Figure 4.31 Pruned trees at Onion Creek Greenbelt 66
Figure 4.32 Piled debris awaiting pick up in Onion Creek Greenbelt 66
Figure 4.33 Trees damaged from past storms. 67
Figure 4.34 Large pile of flood debris along the banks of Onion Creek 67
Figure 4.35 Well maintained, manicured grass area at Onion Creek Greenbelt 68
Figure 4.36 Onion Creek 68

About the Author

Reginald Brooks has always maintained an interest in local government policy. While working at on this project, he worked as the Administrative Coordinator for the City of Bee Cave Planning and Development Department. He is also a former planning intern for the City of Buda and intern at the Texas Office of the Governor. For any questions about this project, he can be reached at rabrooks96@gmail.com.

Acknowledgements

This project owes many thanks to those who have helped and supported me on my educational journey. I would like to thank my parents for nurturing my quest for knowledge from a young age, and for all their love, support, and patience during my years at home and especially during my college years. I would also like to thank Dr. Shields for all of her excellent advice and guidance during my time in graduate school.

Chapter 1 : Introduction

Wildfires constitute one of the top threats to life and property in Central Texas. In 2011, the state experienced some of the largest blazes in its history. Firefighters from across the U.S. poured into Texas, to battle the flames. Four firefighters and six civilians were killed. (Texas Forest Service) One of the fires from 2011 was the Bastrop County Complex Fire. The blaze became the largest fire in state history when it burned 34,356 acres of rare central Texas loblolly pine forest. Flames driven by high winds after a summer of drought swept through overgrown vegetation around communities and homes unprepared to resist wildfire. Forty commercial buildings and over 1,600 residences were destroyed. Four years later, the Hidden Pines Fire destroyed sixty-four homes and burned 4,582 acres of the remaining pine forest (Brooks 2011). Six major wildfires also struck Travis County during the outbreak, consuming some 7,000 acres and 57 homes (Bowman 2011). The 2011 wildfire season was unique in its scope, duration and complexity. But while the severity of the wildfire season and number of homes threatened will change from year to year, the fundamental reasons homes burn remain the same.

Today, those 2011 fires serve as a reminder to all central Texans that devastating wildfires will happen, and without proper planning, will be more catastrophic to our communities if we do not act to reduce our fire risks. Those risks increase each day as we build homes, schools, and businesses in areas prone to wildfire.

Austin Geography

Austin is the capital city of Texas and the seat of Travis County. In 2016, the Austin metro was home to over two million people (US Census Bureau). It is estimated that an average of one hundred and sixty people move to Austin daily due to its booming technology industry, artistic scene, and relatively low cost of living (US Census Bureau).

Located in the transitional zone between the Texas Blackland Prairies of east central Texas and the Texas Hill Country, Austin's elevation ranges between four hundred to one thousand feet above sea level. Over three hundred parks and nature preserves throughout the city add to the city's quality of life and have also been a draw for new residents. Austin's massive growth has led to increased development in the Wildland-Urban Interface. The Wildland Urban Interface (WUI) is defined as the area where the wild meets urban development (Lu 2009). This area is usually located near the fringes of town or the suburbs. The City of Austin population is expected to double in the next thirty years with continued outward expansion into and urbanization of previously rural, undeveloped lands throughout Travis County (City of Austin 2012). Continued development in the WUI puts more people at a greater risk of catastrophic wildfire and puts more pressure on land managers and fire department personnel to fire mitigate risk.

Austin Fire History

According to the supplemental material that accompanied a 2016 Executive Order by President Obama, over 46 million homes in 70,000 communities are at risk of WUI fires in the United States. These fires have destroyed an average of three thousand structures annually over the last decade. WUI fires are a rapidly growing threat in the United States with an annual loss of over $14 billion. Within the last one hundred years, six of the top ten most damaging single fire events involving structures were WUI fires (US Dept. of the Interior 2016). The American WUI is continuing to grow at approximately two million acres per year. According to the U.S. Forest Service, thirty two percent of housing units in the United States and one-tenth of all land with housing are situated in the WUI (US Dept. of the Interior 2016). Protection of public and private property in the WUI is also the largest cost driver for both Federal and State wildfire suppression operations (Exec. Or. 13728).

The Texas State Fire Marshal's Office (SFMO) collects data on fire incidents through the Texas Fire Incident Reporting System (TEXFIRS). TEXFIRS documented 7,885 wildfires in Travis County from 1998 through 2012, with most occurring in 1999, 2008, 2009, and 2011 (State Fire Marshal's Office 2013a).

Wildfires can and do occur at any time, but January, July, and August have the highest occurrence (SFMO 2013a). The greater number of January fires is likely due to high winds associated with dry, gusty cold fronts. July and August fires are likely in Austin because of increased fuel loads from high vegetation production during the preceding spring growth period. Low humidity, which contributes to fuel drying, and low precipitation are typical for these high-fire months. (Bowman 2014) In the case of the 2011 Bastrop Complex Fire, the interaction of high winds and electrical power lines, and intervening fuels caused the most home losses in Texas history. The same factors were responsible for the loss of twenty homes in the Steiner Ranch neighborhood that weekend (Travis County 2012) (Bowman 2014).

Research Purpose

This study develops a model to evaluate Austin's urban wilderness fire mitigation policy for its urban parks. Using the model, the study then uses case study methodology (document analysis and direct observation) to assess Austin's urban wilderness fire mitigation policy for parks. The model has three components. First, the model identifies key components of urban wildfire mitigation policy. Second, it uses these components to assess wildfire mitigation policy and documents in the City of Austin. Third, the results of the study will make recommendations to improve wildfire safety in Austin parks.

Chapter Summaries

Chapter two explores the scholarly literature on wildfire mitigation strategy. Chapter three describes the research methodology used to assess the wildfire mitigation strategies used by the City of Austin. Chapter four provides the results of the City of Austin case study. Results with respect to the use of document analysis and direct observation for each working hypothesis are presented in this section. Chapter five provides recommendations and conclusions based on the City of Austin case study.

Chapter 2 : An Examination of Scholarly Literature

An examination of scholarly literature, such as Alexandre et al, Bond and Keely, and Longaro, on wildfire damage mitigation policy identified actions a community can undertake to reduce the risk of local wildfires. After a careful review of the literature, the following categories were identified to organize the many possible wildfire damage mitigation policy actions:

1. Wildland Urban Interface Identification and Fuel Identification
   a. Identification of Vulnerable Urban Areas
   b. GIS Mapping of Local Fuels
   c. GIS Mapping of Floodplain

2. Forest Management Practices
   a. Conservative Forest Management Practices
   b. Fuel Load Treatments

3. The Planning Process
   a. Identify the Need for Long Term Planning
   b. Rank Mitigation Priorities
   c. Utilization of Fire Designations

4. Mitigation Through Public Education
   a. Understanding Place Attachment
   b. Outreach

The purpose of a mitigation plan is to explain the process of identifying and prioritizing actions that reduce the effects of natural hazards (Hays County 2011**).**

WH1: The City of Austin identifies the Wildland Urban Interface and Potential Fuels.

The primary component of wildfire mitigation is to identify the Wildland Urban Interface and wildfire fuels of a community. The Wildland Urban Interface (WUI) is defined as the area where the wild meets urban development (Lu 2009). This area is usually located near the fringes of town or the suburbs. Even without direct contact from a wildfire, wind-blown embers from wildfires can travel over a mile and ignite structures and debris on and around a structure.

However, not all structures are at the same risk of burning down during wildfires. This is due to the relative importance of topography, vegetation, and the spatial arrangement of buildings. Weather, primarily wind, plays a large role as well. The arrangement of subdivisions, its landscaping, and the natural vegetation can determine how much an area will suffer damage (Alexandre et al. 2015). Given the above information, one would expect the City of Austin to engage in wildland urban interface identification and fuel identification.

Table 2.1: Common Examples of Wildfire Urban Interfaces in Austin

Type	Example
Parks	Barton Creek Greenbelt, River Place Nature Trail
Wooded Neighborhoods	Long Canyon, Northwest Hills, Wild Basin Highlands
Floodplain	Shoal Creek, Onion Creek, Walnut Creek
Nature Preserves	Balcones Canyonlands Nature Preserve
Scenic Corridor	Ranch Road 620, Loop 360

Table 2.1 Common Examples of Wildlife of Urban Interfaces in Austin

USDA Forest Service Gen. Tech. Rep. RMRS-GTR-299.

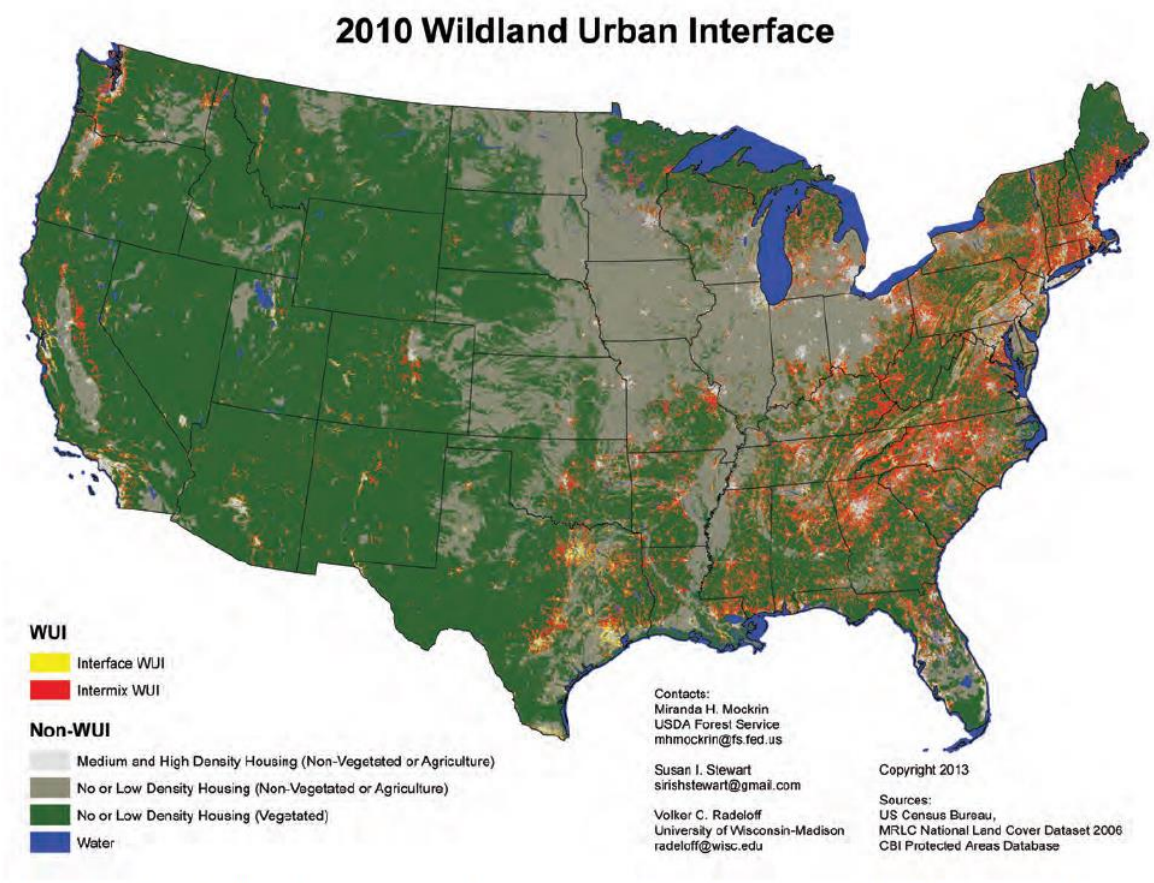

Figure 2a. Distribution of wildland-urban interface across the conterminous United States, 2010. Source: compiled by S.I. Stewart and V.C. Radeloff based on the 2010 census, the 2006 National Land Cover Dataset (NLCD), and the Protected Area Database v.1.1

Figure 2.1 2010 Wildland Urban Interface

https://www.fs.fed.us/openspace/fote/reports/GTR-299.pdf

WH1a. The City of Austin identifies wildfire vulnerable areas

Figure 2.1 (above) shows the scope of the American Wildland-Urban Interface. As mentioned earlier, the WUI is the area where development meets the wildland. Structures in this zone are of critical importance since they are most at risk during an urban wildfire. In the Bastrop County Complex Fire, the fire began in the piney woods and quickly spread to nearby homes and structures. The engulfed homes became the fuel that allowed the fire to grow and

rapidly spread to other areas. These facts illustrate the importance of local identification of the WUI and the need for communities in the WUI to take steps to ensure that these areas are prepared for the possibility of a wildfire. The first step is to identify vulnerable areas. Identification can be done with GIS mapping that can easily be updated and the land is changed or developed. Once these areas are identified, the community can take action to address potential causes of fires such as organizing debris clean ups, tree trimming, and promoting fire-resistant landscaping. The City of Anchorage, Alaska is an example of a city that has successfully identified its WUI and been able to reduce those fires by up to seventy percent (Cheyette et al. 2008). Therefore, one would expect the City of Austin to identify its wildfire vulnerable areas.

WH1b: The City of Austin uses GIS mapping of local fuels

Fuel maps are geographic representations of what types of natural fire fuels are found in a given area. Common types of fuel maps include vegetation maps and drought maps. These maps are essential for computing spatial fire hazard and risk and simulating fire growth and intensity across a landscape. However, fuel mapping is an extremely difficult and complex process requiring expertise in remotely sensed image classification, fire behavior, fuels modeling, ecology, and geographical information systems (GIS) (Keane et al. 2001). Advances in GIS technology over the past twenty years has simplified the process of mapping and given GIS-users a host of informational display options. GIS technology may even be integrated with existing technology in order to create accurate representations of the location of potential wildfire threats (Sirca et al. 2017).

The main fuel for wildfires is vegetation. Nonetheless, vegetation alone does not constitute a fuel model and information on different vegetation types does not provide the same amount of information with regards to fire behavior as fuel models do. Fire behavior generally varies

according to vegetation. In a study, the researchers used vegetation as a proxy for potential fuels (Alexandre et al. 2015). The two most extensive classes of vegetation inside both fire perimeters were evergreen forests, and shrub/scrub. Evergreen forests and shrubs differ in terms of fire behavior, but both can support intense fires that can produce firebrands and ignitions far ahead of the fire front. Grassland areas also tend to be highly flammable, especially in the dry season, and as such may exhibit fires that lead to home ignition. The following classifications were identified by the National Land-use Cover Database[1].

Classifications:

- Highly Flammable:
    - Evergreen Forest
    - Mixed forest
    - Shrub/Scrub
    - Grass
    - Land/Herbaceous classes as highly flammable.
- Flammable:
    - Deciduous Forest
    - Pasture/Hay

Crops are vegetation classes that can also support fire spread in some seasons, but because hay and crop harvest occurs typically before moisture levels drop, they are less likely to produce a fire that will ignite a building (Alexandre et al. 2015). While it is usually not feasible to alter existing development patterns, it may be possible to reduce future fire risk by surrounding new development in fire-resistant landscapes or avoiding development in high fire risk areas entirely. Identifying all of these types of vegetation with GIS software will give local officials a plethora

[1] The National Land Use Database is a reference source created by the Multi-Resolution Land Characteristics and Consortium. The Multi-Resolution Land Characteristics (MRLC) consortium is a group of federal agencies who coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. The primary objective of the MRLC NLCD is to provide the Nation with nationally complete, current, consistent, and public domain information on the Nation's land cover.

of information to create maps of target areas. It is reasonable to conclude that the City of Austin will benefit from utilizing GIS technology to map its local fuels.

WH1c: The City of Austin uses GIS mapping of local floodplains

In Texas, flooding is a common annual occurrence. Over time, these annual floods can choke natural and artificial water paths with flood debris. As the debris dries out during the dry season, it can become a fire danger. It stands to reason that identifying these floodplains can help local authorities identify which areas may be susceptible to catching on fire. There is a striking parallel between wildfires and floods. Both are natural disasters with impacts exacerbated by human interventions in natural ecosystems (Kousky 2014). Both flood and wildfire, therefore, could have an element of moral hazard; since a significant portion of the costs associated with building in hazardous areas are not borne by the local governments or homeowners, there may be a reduced incentive to build on safer, less-fire prone lands (Kousky 2014). Using GIS technology to map will not only inform residents of their flood risk, but can also show community officials, which areas should be cleaned up after a flood to minimize the risk of wildfire from flood debris. This practice is a growing trend in the U.S. communities that are prone to flooding (National Research Council on the National Academies 2010). In addition, rebuilding after a wildfire can be an opportunity to implement new mitigation actions, incentives and regulations such as those recommended under the 2012 International Code Council's Wildland Urban Interface Code, which has been added to the zoning codes of communities across the U.S. (Alexandre et al. 2015)

The identification of wildfire vulnerable areas is the first preventive step in mitigating wildfire risk. Once these areas have been identified, officials will have to decide what steps are best suited for the area based on its physical properties. Since the vast majority of wildfires are fueled by vegetation, it is imperative to examine how the land is managed. Land management is

key to understanding the risk certain fuels pose to the WUI and the City of Austin's utilization of GIS mapping of its floodplains is key to targeting wildfire prone areas.

WH2: The City of Austin engages in proactive forest management practices.

The land management practices found in the WUI inventory the "risk-status" of an area. Urban areas in this zone that are well-kept are less likely to experience a damaging fire. Communities that make efforts to manage their WUI in as a natural way as possible can mitigate the risk of severe fires. These "natural" methods can include engaging in active forest management practices, monitoring and engaging in the appropriate fuel load treatments, and encouraging xeriscaping.

WH2a: The City of Austin engages in conservative forest management practices.

Modern conservative management forest techniques include letting an area grow uninhibited. This fire suppression has had long-lasting impacts on the perceptions of land managers and the public towards forest management. Perceptions are very important because those who do not accurately understand their fire risk will be less likely to take sufficient measures to safeguard themselves from local fires. Since the United States has enjoyed a boom in population and development during the past few century, much of this new growth owes its protection to modern fire suppression tactics that sought to protect regional resources and residents by extinguishing fires immediately after ignition (Running 2006; Miller et al. 2009; Safford et al. 2012; Safford et al. 2015). Ultimately, fire exclusion policies have been effective at eliminating 97% of fires under 300 acres (Steel et al. 2015) and reducing the number of annual fires to six percent of what it was in the 1930s (Miller et al. 2009). Although these fire suppression tactics were well intentioned, their implementation has increased the chance of catastrophic fires (Miller et al. 2008) and has led to the average wildfire becoming larger and

more severe. Long periods without fires allow fuel, to build up on the forest floor and in the understory (Schmidt et al. 2008; Lydersen et al. 2014). While firefighting agencies have been successful at extinguishing most wildfires, the unburned and excessive fuel load makes that task more difficult over time by increasing the likelihood of explosive and unmanageable mega-fires (Safford et al. 2012).

Since wildfires only burns as long as it has available vegetative biomass to consume (Steel et al. 2015), it can be compared to an herbivore because it reduces its own fuel source through consumption (Bond and Keeley, 2005). Under natural conditions, fires maintain forest health by preventing overgrowth and buildup of fuel, thus improving fire-resistance (Stephens et al. 2014). Higher volumes of dry organic material on forest floors contribute to fire severity and frequency. The rate of accumulation of dead and woody material in the forest floor layer is a major factor in fire duration and strength once a fire occurs (Stephens et al. 2014).

Since 1984, fire size and proportion of high severity fire have risen in the lower and intermediate elevations of the Sierra Nevada in California, from historical averages of 5-15% high-severity fire to recent wildfires that burned at rates up to 50% high severity.[2] This rise in high-severity fire is most common for fires reaching areas of at least 400 hectares; an approximate 95% of area burned is caused by only 5% of annual fires (Miller and Safford 2012), meaning that the largest fires have also been the most destructive. A well-known example of a mega-fire is the Rim Fire in Northern California, which burned 257,000 acres and is recorded as the largest wildfire in Sierra Nevada history (Thompson et al. 2010; Lydersen et al. 2014; Collins and Stephens 2007). Understanding the link between conservative forest management and wildfire is a key component of examining Austin's fire policy.

[2] Miller and Safford 2012; Collins and Stephens 2010; Dolanc et al. 2014; Thompson et al. 2010

WH2b: The City of Austin utilizes fuel load treatments.

Developing management policies to deal with more frequent mega-fires is a difficult task because of the complex relationship between human development in rural areas and complex ecosystem functions (Ritchie et al. 2006; Dolanc et al. 2014). Returning to a natural fire cycle like that of past centuries is nearly impossible due to modern development, but there are a number of fire surrogate methods that can be employed to treat forest fuel loads that may reduce wildfire risk and severity (Stephens et al. 2012; Kent et al. 2015). Fuel load treatments are aimed at recreating forest conditions that mimic those of historic and healthy forests. Removing understory overgrowth and small-diameter trees to reduce stand density may decrease the chance of large, high-severity fires (Stephens et al. 2012). Treatment methods vary among landowners, the method often being dependent on the landowner's priorities, goals, and budget (Agee and Skinner 2005; Stephens et al. 2012; Lydersen et al. 2014). The most common practice is prescribed burning. This treatment is considered to be the most effective form of treatment, particularly when used alongside other methods, which include mechanical thinning, or tree thinning, hand thinning, and mulching (Agee and Skinner 2005; Safford et al. 2012; Stephens et al. 2012*;* Thomas 2015). Therefore, one would expect the City of Austin to utilize fuel load treatments to manage its urban forests.

WH2c: The City of Austin promotes fire-resistant landscaping.

A homes' ignitability is mostly due to the condition of the vegetation surrounding the building (Calkin 2014). Xeriscaping is another method to reduce the effect of wildfires in the WUI while protecting existing buildings. Xeriscaping is landscaping and gardening that reduces or eliminates the need for supplemental water from irrigation.[3] Xeriscaping with fire-resistant plants can help prevent a wildfire from spreading from the wildland to a structure. Xeriscaping

[3] In some areas, terms as water-conserving landscapes, drought-tolerant landscaping, and "smart-scaping" are used instead.

not only reduces the risk of ignitability, it can also help conserve energy and water usage of a building. Certain plants survive better in different climates, so it is important to know which plants are best suited for the area. Choosing local drought tolerant plants may also enhance the aesthetics of a building.

Forest management techniques not only can not only protect an urban from the threat of wildfire, but can create an environment that is aesthetically pleasing. Deciding what forest management practices are practical for will have a profound effect on the character of the area. Well managed greenery may add curb appeal to an area and improve the property value of an area. Over time, these characteristics become part of the identity of an area. It is important for community planners to keep this is mind in order to plan for vibrant, safe communities. Promoting fire-resistant landscaping is a feasible way for the City of Austin to mitigate wildfire risk while maintaining a green environment.

WH3: The City of Austin includes fire mitigation in its planning process.

The majority of the decisions that affect development in the WUI are made at the local level via the planning process. Despite the local control, these decisions are often made without the consideration of potential wildfire damage. At this stage, communities should consider the reasons why they need to plan long term for wildfires and rank their mitigation priorities to reflect their most pressing threats.

WH3a: The City of Austin identifies the need for long term fire planning.

Urbanization has spread across much of the rural landscape, encouraging many landowners to subdivide and sell part or all of their rural property to developers. This has led to land use and land cover changes, and has had adverse impacts on important ecosystem functions supported by these landscapes. The areas of the Hill Country around the Austin metro, San

Antonio metro, and Highland Lakes area tend to be more affluent and well educated than most of rural Texas. These areas are also becoming increasingly suburban and so it is less likely that these residents have the agricultural knowledge to manage a wildfire prevention program (Day 2000).

Most people will respond to personal safety and economic concerns about wildfire, instead of the statistical risk of wildfire. Gan et al. (2015) suggests that landowners' belief in wildfire risk did not necessarily lead to their action against the risk; yet those who lived on their lands or had experienced wildfire-caused property losses were more likely to proactively respond to wildfire risk. Possessing a forest management plan was also positively correlated with the propensity of landowners to respond to wildfire risk. Thus, assisting landowners in developing forest management plans can boost their wildfire risk response efforts. A forest management plan is a prerequisite for a landowner to be enrolled in many conservation cost-sharing programs and sustainable forest management certification programs (Gan et al. 2015). It is important to note that the actual number of activities undertaken solely for fire protection is probably much lower than reported, though it may be comforting for people to know that even if they do not have fire mitigation in mind they may be somewhat protected from fire just by living in a modern house and regularly maintaining their homes and properties (Anton 2015). Therefore, it is very beneficial for the City of Austin to identify its need for long term fire planning.

WH3b: The City of Austin ranks its mitigation priorities.

In Texas, most communities face flood threats, hail threats, drought threats, tornado threats, and hurricane threats. In recent decades the threat of terrorism has also earned a spot in the priorities of most communities. Communities should create a plan that will realistically reflect their specific threat at any given time. Communities that rank their hazard threat and mitigation priorities are better equipped to deal with disaster than communities that do not. An

approved hazard mitigation plan is a requirement in order for many Texas counties to remain eligible for some types of grants that are administered by the Texas Division of Emergency Management (TDEM), the Texas Water Development Board (TWDB) and the Federal Emergency Management Agency (FEMA), (Hays County 2011). In addition, landowners can apply for federal or state funds through various cost-sharing programs to help offset the expense of applying certain land improvement practices (Travis County 2015; Williamson County 2015; and Central Texas Council of Governments 2017). The average community faces more than just the threat from wildfire.

The planning process of wildfire mitigation mostly falls within the domain of public officials and experts. The officials are ultimately responsible to the public. A well-educated public may be one of the best defenses of life and property from wildfires. Communities must take steps to ensure that the information on preventing wildfire is available to those who need it most.

WH3c: The City of Austin utilizes Fire Designations

There are many resources for local wildfire mitigation. Organizations such as the National Fire Protection Association's Firewise Communities help municipalities develop an action plan that guides their residential risk reduction activities, while engaging and encouraging their neighbors to become active participants in building a safer place to live (Berry et. al 2016). Neighborhoods throughout the United States are embracing the benefits of becoming a recognized Firewise Community (Firewise.org). The Fire Adapted Communities Coalition also offers assistance with wildfire mitigation and includes a certification. Like the Firewise Communities Program, this program is available to local governments, but can also be implemented at a non-governmental neighborhood level by concerned citizens. Promoting

organizations like these are a good way for local governments to allow citizens to take action and make informed choices for the neighborhoods without adding more workload to city staff. Therefore, one would expect the City of Austin to rank its mitigation priorities.

WH4: The City of Austin engages in wildfire mitigation through public education.

Educational or other landowner programs aimed at enhancing land management should explicitly address landowners' need to remain attached to their land and their community. Once attachment has been addressed, local officials can identify which form of public education outreach should work best for their city. It is important to keep a sense of place at the forefront when designing public education programs. Maximum results can be achieved when the programs are tailored for the demographics of the communities they serve.

WH4a: The City of Austin promotes a sense of place through understanding place attachment.

Place attachment has been theorized to be related to mitigation and preparation. However, minimal research has been conducted to understand how, in the face of such changes, landowners' attachment to their rural property may motivate them to retain ownership of their property, and invest in activities that sustain important ecosystem features and enhance their land management capacity (Lai) 2015. According to Lai (2015), a study examined place attachment and wildfire mitigation and preparation in two Australian samples, one rural and one on the wildland–urban interface. Hierarchical regression showed that place attachment to homes predicted wildfire mitigation and preparedness in the rural sample but not in the wildland–urban interface sample. The results suggest that place attachment is a motivator for mitigation and preparation only for people living in rural areas. Reminding rural residents of their attachment to home at the beginning of wildfire season may result in greater mitigation and preparedness.

Rural Texan culture prides itself on the rugged beauty of the state and individualism. It is also important to understand what might be stopping people from implementing mitigation measures. Factors mentioned by people living in wildfire prone areas as standing in the way of mitigation include time, money, and loss of privacy from cutting down trees. It was noted that demographic factors such as income, education, sex, homeownership, length of residence, and the presence of children or other dependents in the home would predict wild- fire mitigation and preparedness (Anton 2015).

The same survey showed that while place attachment to home predicted mitigation in the rural sample, place attachment to local area did not. It could be that people do not associate their feelings about their local area with individual fire protection. They might assume that it is the job of their local governments to ensure that the local area is safe, not recognizing that as the local area is composed of individual properties they must all be mitigated if the area as a whole is to be wildfire prepared (Anton 2015).

If individuals are attached to their local areas it is in their best interest to mitigate their properties; if multiple properties fall victim to wildfires it would affect the local area by damaging infrastructure and the local environment which could flow through to changing the social fabric and esthetic look of the area. It might therefore be useful for wildfire mitigation and preparation messages to point out the link between being attached to the local area and needing to make preparations to individual properties and implement mitigation measures (Anton 2015). Therefore, one would expect the City of Austin to utilize fire designations within its jurisdiction.

WH4b: The City of Austin engages in public outreach.

Outreach efforts make sense as the initial focus of any community attempting to work toward wildfire risk reduction. Public acceptance or rejection of mitigation actions can make or break even the best wildfire risk reduction program. Wildfire risk reduction is inherently

connected to people and the communities in which they live. In a recent national study, the most significant obstacles to success of a wildfire mitigation program were reported as inadequate program funding and negative public attitudes. Public apathy and resistance to fuel management activities were the most obstructive public attitudes. Overcoming attitudes of "It won't happen to me," "Not in my back yard," "I moved here for privacy," and "I moved here to be surrounded by woods" requires understanding and respect for residents' perspectives and beliefs. It is reasonable to assume that suggest that public support may be weak for regulation, but is strong for education and assistance programs that raise the awareness of the wildfire threat, teach specific methods for fuel management, and encourage a coordinated set of wildfire risk reduction actions among community residents. The goal of outreach and education programs is to provide residents and community members with the information they need to understand and fully participate in a full range of wildfire prevention and risk reduction efforts. The best public outreach programs should change attitudes, encourage responsible behaviors, and generate a sense of community-wide ownership in the wildfire risk reduction program. Good public hazard messages should clearly explain the potential losses, the chances that losses will take place in a given period of time, and specific positive steps that can be taken to prevent losses. These three topics make up the wildfire hazard message "tripod". If one of these parts is left out, then the whole message may be less effective. There are two forms of mitigation through public education: passive public outreach and active public outreach. Passive public education includes a combination of passive educational opportunities in the form of pamphlets, brochures, and websites, etc. Active public education includes in-person outreach efforts such as program staff attending neighborhood functions, organizing or participating in community debris clean-up events. Communities that use a combination of both are able to effectively inform the public on

the importance of mitigation efforts. It is reasonable to assume that the City of Austin would engage in public outreach on the issue of community wildfires.

Table 2.2. Conceptual Framework Linked to Literature

Title: Policy Actions to Mitigate Wildfire Damage. **Purpose:** To describe the common policy actions of cities to mitigate wildfire damage.	
Policy Actions	**Sources**
WUI Identification and Fuel Identification	
WH1a. The City of Austin identifies wildfire vulnerable areas	Alexandre et al. 2015; Exec. Order No. 13728; Cheyette et al, 2008; U.S. Dept. of the Interior 2016;
WH1b: The City of Austin uses GIS mapping of local fuels	Alexandre et al. 2015; Keane et al 2001; Sirca et al. 2017;
WH1c: The City of Austin uses GIS mapping of local floodplains	Alexandre et al. 2015; Kousky, 2014; National Research Council on the National Academies 2010;

Forest Management Practices	
WH2a: The City of Austin engages in conservative forest management practices	Running 2006; Miller et al. 2008; Lydersen et al. 2014; Safford 2012; Bond and Keely 2005; Dolnac et al. 2014;
WH2b: The City of Austin utilizes fuel load treatments	Dolnac et al. 2014; Stephens et al. 2012; Lydersen et al. 2014; Thomas 2015; Agee and Skinner 2015;
WH2c: The City of Austin promotes fire-resistant landscaping	Calkin et al. 2014
The Planning Process	
WH3a: The City of Austin identifies the need for long term fire planning.	Lai and Krueter, 2012;
WH3b: The City of Austin ranks its mitigation priorities.	Hays County 2011; Travis County 2015; Williamson County 2015; Central Texas Council of Governments 2017;
WH3c: The City of Austin utilizes fire designations.	Berry et al. 2016
Mitigation Through Public Education	
WH4a: The City of Austin promotes a sense of place through understanding place attachment.	Anton and Lawrence 2015;
WH4b: The City of Austin engages in public outreach.	Lai and Krueter 2012;

Table 2.2 Conceptual Framework Linked to Literature

Chapter 3 : Methodology

Chapter Purpose

This chapter describes assessment of the City of Austin's wildfire mitigation policy. First, the conceptual framework is operationalized, providing the data needed for analysis. Second, the chapter will identify advantages and disadvantages of document analysis research and direct observation. Third, the criteria for support table define how the wildfire mitigation policies are rated. Fourth, the chapter will describe the criteria of observation of Austin's wildfire mitigation through the use of direct observation.

Operationalization Table

The purpose of operationalization table is to organize the conceptual framework in a way that can be used for collecting data on a consistent basis. The first column provides the sub-hypotheses that are linked to the working hypothesis. The second column provides the source of the information. The third column identifies the evidence that is being searched for. The fourth column provides the criteria used to access the City of Austin's wildfire mitigation policy.

Table 3.1 Operationalization of the Conceptual Framework			
Working Hypothesis	Source	Evidence	Rating Criteria
WH1: The City of Austin identifies the Wildland Urban Interface and potential fuels.			
WH1a. The City of Austin identifies wildfire vulnerable areas	Community Wildfire Protection Plan	Verification of the identification of wildfire vulnerable areas	• Has maps of structure combustion risk for Travis County • Has structure combustion risk assessment table for other municipalities within Travis County
WH1b: The City of Austin uses GIS mapping of local fuels	Community Wildfire Protection Plan	Verification of the use of GIS to map local fuels	• Has maps and tables of Travis County fuels and vegetation.
WH1c: The City of Austin uses GIS mapping of local floodplains	CodeNEXT	Verification of the use of GIS to map local floodplains	• Has maps and charts of local floodplains, flood history, and flood volume.
WH2: The City of Austin engages in proactive forest management practices.			
WH2a: The City of Austin engages in conservative forest management practices	CodeNEXT	Verification of conservative forest management practices	• The city has zoning and zoning overlays allowing for the preservation of trees. • The City has preserved thousands of acres of wildland.
	Direct Observation	Pictures	• Park Visits [4]
WH2b: The City of Austin utilizes fuel load treatments	Community Wildfire Protection Plan	Verification of the utilization of fuel load treatments	• The City promotes and encourages specialized fuel reduction techniques based on the vegetation in the area. (Juniper reduction techniques, oak reduction technique).
	Direct Observation	Pictures	• Park Visits
WH2c: The City of Austin promotes fire-resistant landscaping	CodeNEXT	Verification of the promotion of fire-resistant landscaping	• The City promotes fuel resistant landscaping and fuel reduction techniques through its Home Ignition Zone Program • Ready Set Go! Wildfire Program
WH3: The City of Austin includes fire mitigation in its planning process.			
WH3a: The City of Austin identifies the need for long term fire planning.	CodeNEXT	Verification of the identification of the need for long term planning	• The City recognizes that its fast growth has caused development to spill over into wildland at a high rate. • The City recognizes the importance of identifying the WUI and has adopted building and development codes that safeguard structures.
WH3b: The City of Austin ranks its mitigation priorities.	Community Wildfire Protection Plan	Verification of the ranking of mitigation priorities	• Wildfire ranks as the second most likely natural disaster in Austin.
WH3c: The City of Austin utilizes fire designations.	CodeNEXT	Verification of the utilization of fire designations	• The City is a Fire Adapted Community by incorporating Firewise principles.
WH4: The City of Austin engages in wildfire mitigation through public education.			
WH4a: The City of Austin promotes a sense of place through understanding place attachment.	Community Wildfire Protection Plan	Verification of the promotion of sense of place	• The City strives to balance the Hill Country feel of Austin with the fast pace of its growth. As Austin grows, the city understands the importance of preserving character and preventing wildfires.
WH4b: The City of Austin engages in public outreach.	Community Wildfire Protection Plan	Verification of engagement in active public outreach	• The City partners with area nonprofits, schools, and community organizations to promote wildfire safety and education.

Table 3.1Operationalization of the Conceptual Framework

[4] See Table 3.3 for a discussion of the direct observation at Austin Parks.

Case Study

Case study research is a "form of empirical inquiry that investigate a contemporary phenomenon with-in a real life context (Yin 2007). Simply put, a case study is the scientific examination of a real life scenario. A defining characteristic of a case study is that they utilize multiple sources of evidence, including interviews, document analysis, archival investigations, surveys, direct observation, and focus groups. This study will focus on document analysis and direct observation. The key challenge of an exploratory research project is the development of the working hypothesis (Shields and Rangarajan 2013). The working hypotheses are conceived as the research data is refined and synthesized.

Document Analysis

This study collects data on wildfire mitigation mainly through document analysis. The advantages of document analysis is that it bypasses the difficulties of finding participants for a particular study. Document analysis is also advantageous because of there are few cost associated with analyzing documents, other than time. Document analysis does have certain disadvantages as well. For example, a policy document may mean that a city has an official policy, but they may not follow or enforce it. Also, some documents may not be available to the public. Also, bias selectivity can occur if the analysis of documents is not exhaustive (Blakey 2016, p. 55).

The working hypotheses for this study are tested using evidence from documents that outline the City of Austin's wildfire mitigation strategies. The documents used to assess these strategies includes the Austin/Travis County Community Wildfire Protection Plan (2014), and the city municipal code (CodeNEXT[5]). All of these documents are available to the public. The

[5] CodeNEXT is scheduled to be adopted by the City of Austin on February 8, 2017. At the time of this paper, the Final Draft (Draft III) was under review by the Land Use Commission.

documents reviewed in this study are listed and connected to their corresponding working hypothesis in the table below.

Table 3.2 Supporting Documents	
Austin Documents List	Supported Working Hypotheses
Austin/Travis County Community Wildfire Protection Plan 1.6.4	3b
Austin/Travis County Community Wildfire Protection Plan 1.6.4 (Community Values)	4a
Austin Travis County Community Wildfire Protection Plan 2.0 (Vulnerable Areas)	1a
Austin/Travis County Community Wildfire Protection Plan 2.2 (Local Fuels)	1b
Austin/Travis County Community Wildfire Protection Plan 3.2	1b
Austin/Travis County Community Wildfire Protection Plan 4.3.2 (Long Term Planning)	3a
Austin/Travis County Community Wildfire Protection Plan 5.4 (Fuel Reduction)	2b
Austin/Travis County Community Wildfire Protection Plan 6.2.2 (Outreach)	4b
CodeNEXT Article 23-3C (Urban Forest)	2a
CodeNEXT Article 23-3D (Floodplain)	1c
CodeNEXT Article 23-4E (Landscape)	2c
CodeNEXT Article 23-10E (Floodplain)	1c
CodeNEXT Article 23-11B (Fire Code)	3a, 3c

Table 3.2 Supporting Documents

Direct Observation

In addition to document analysis, this project also uses direct observation. Direct observation is the oldest instrument of scientific research (Jerslid and Meigs 1939). Direct observation allows for the immersion of the topic being studied. For this project, observations were made in several south and northwest Austin parks. These areas of town line along the Balcones Escarpment and mark the beginning of the Texas Hill Country. These areas are characterized by a wide variety of vegetation, ranging from live oaks to mountain cedar. All of the visited parks and are easily accessible with walking trails. All of the parks also have

observable floodplains within their boundaries. All of the areas are also a part of Austin's wildland-urban interface.

Table 3.3 Parks Visited		
Park	**Location**	**Date**
Mary Moore Seawright Metropolitan Park	907 W. Slaughter Lane Austin, Texas 78748	September 12, 2017
Barton Creek Greenbelt	3755 S Capital of Texas Hwy, Austin, TX 78704	September 16, 2017
Emma Long Metropolitan Park	1600 City Park Rd, Austin, TX 78730	September 16, 2017
Bauerle Ranch Park	Manchaca Rd, Austin, TX 78748	September 16, 2017
Onion Creek Metropolitan Park	8652 Nuckols Crossing Rd, Austin, TX 78744	September 16, 2017

Table 3.3 Parks Visited

Criteria for Support

In order to objectively access the data collected, a four level scale of commitment is utilized. This scale uses the evidence to determine the level of alignment between the evidence of mitigation strategies and the working hypothesis. For example, strong evidence shows a greater level of alignment with sub-hypotheses and the data. Similarly, weaker evidence shows less of an alignment. The assessment scale includes four levels of alignment-No alignment, limited alignment, adequate alignment, and complete alignment.

No alignment exist where there is no evidence to support the working hypothesis. Limited alignment exist when there is minimum information supporting the working hypothesis. Adequate alignment exist when there is evidence that mostly supports the working hypothesis. Complete alignment exists when multiple examples of evidence support the working hypothesis. The levels of alignment are assigned respective scoring values from 1-4 from no alignment to complete alignment.

Table 3.4 Level of Alignment		
Level of Alignment	**Document Analysis**	**Direct Observation**
1: No Alignment	No documents found, or documents producing support for working hypothesis.	Did not witness any proof of support of working hypothesis
2: Limited Alignment	Documents contain minimal evidence to support the working hypothesis.	Witnessed minimal evidence of support for working hypothesis
3: Adequate Alignment	Documents contain some support for the working hypothesis.	Witnesses mostly consistent support for working hypothesis
4: Complete Alignment	Documents contain multiple examples of support for the working hypothesis.	Witnessed multiple examples of support for working hypothesis.

Table 3.4 Level of Alignment

Direct Observation Scoresheet

Table 3.5 Working Hypothesis 2 Scoring Rubric				
WH2: The City of Austin engages in proactive forest management practices.				
WH2a: The City of Austin engages in conservative forest management practices				
	Tree Pruning	Floodplain Debris Clearing	Accessible Trails/Roads	Tree Thinning
Mary Moore Seawright Metropolitan Park				
Barton Creel Greenbelt				
Emma Long Metropolitan Park				
Bauerle Ranch Park				
Onion Creek Metropolitan Park				
TOTAL SCORE				
WH2b: The City of Austin utilizes fuel load treatments				
	Manual Fuel Reduction	Prescribed Burn	Fuelbreaks	Grazing/Mowing
Mary Moore Seawright Metropolitan Park				
Barton Creel Greenbelt				
Emma Long Metropolitan Park				
Bauerle Ranch Park				
Onion Creek Metropolitan Park				
TOTAL SCORE				

Table 3.5Working Hypothesis 2 Scoring Rubric (Each criterion will receive a score of 1-4 to represent the alignment as indicated in Table 3.4.)

Chapter Summary

This chapter highlighted the methods used to access the wildfire mitigation strategies of the City of the Austin. The operationalization of the conceptual framework was summarized, which will serve as a guide to accessing the data. This chapter identified advantages and disadvantages of document analysis and direct observation research. Next, the criteria for support table defined how the wildfire mitigation policies are rated. Lastly, the chapter described the criteria of observation of Austin's wildfire mitigation through the use of direct observation.

Chapter 4 Results

Chapter Purpose

This project has a dual purpose. The first purpose is to explore the different wildfire mitigation strategies that reduce urban wildfires in the City of Austin's urban parks. Secondly, this project uses an operationalized framework to assess the City of Austin's adherence to its wildfire policy. This chapter summarizes the results that were yielded from document analysis and direct observation.

Document Analysis

WH1: The City of Austin identifies the Wildland Urban Interface and potential fuels.

This portion of the study has three sub hypotheses to assess whether the City of Austin identifies its Wildland Urban Interface and Potential Fuels. These first sub-hypothesis assess whether the City identifies wildfire vulnerable areas. Next, the City's use of GIS mapping of local fuels is assessed. Lastly, the third sub-hypothesis assesses the City's use of GIS of local flood plains.

WH1a. The City of Austin identifies wildfire vulnerable areas

Section 4.2.4 of the Austin-Travis County Community Wildfire Protection Plan (CWPP) confirms that the City of Austin has a method for identifying the risk wildfires pose to specific areas of the city. The City and County also maintains a map of vulnerable areas (see Illustration 4.1).

Sections 4.2.4: "*The Austin-Travis County CWPP uses the environmental risk concept, which defines risk as the product of the probability of a hazardous event, and the negative consequences associated with the event (Smith 2013). In this assessment, risk is defined as the probability of a wildfire under conditions conducive to large, fast-moving fires that burn through fuels producing high heat energy and flaming embers. Negative elements were defined as fire*

line intensity and spotting distance, as both are primary factors associated with the spread of structural fire from wildfire." The City of Austin goes a step further and defines the structure risk-combination that it uses to measure wildfire risk.

"*Structure Combustion Risk -Structure or Radiant Combustion Risk is defined as the probability of structure loss during a wildfire. For the purposes of the Austin-Travis County CWPP, structures were assumed to be wooden, with a wooden roof framed and decked at a pitch ≥10° with yard vegetation that was ≥5 m in height, utilizing the worst case scenario. The model includes the capacity to analyze six other structure and landscape configurations but the GIS data does not allow individual differentiation*."

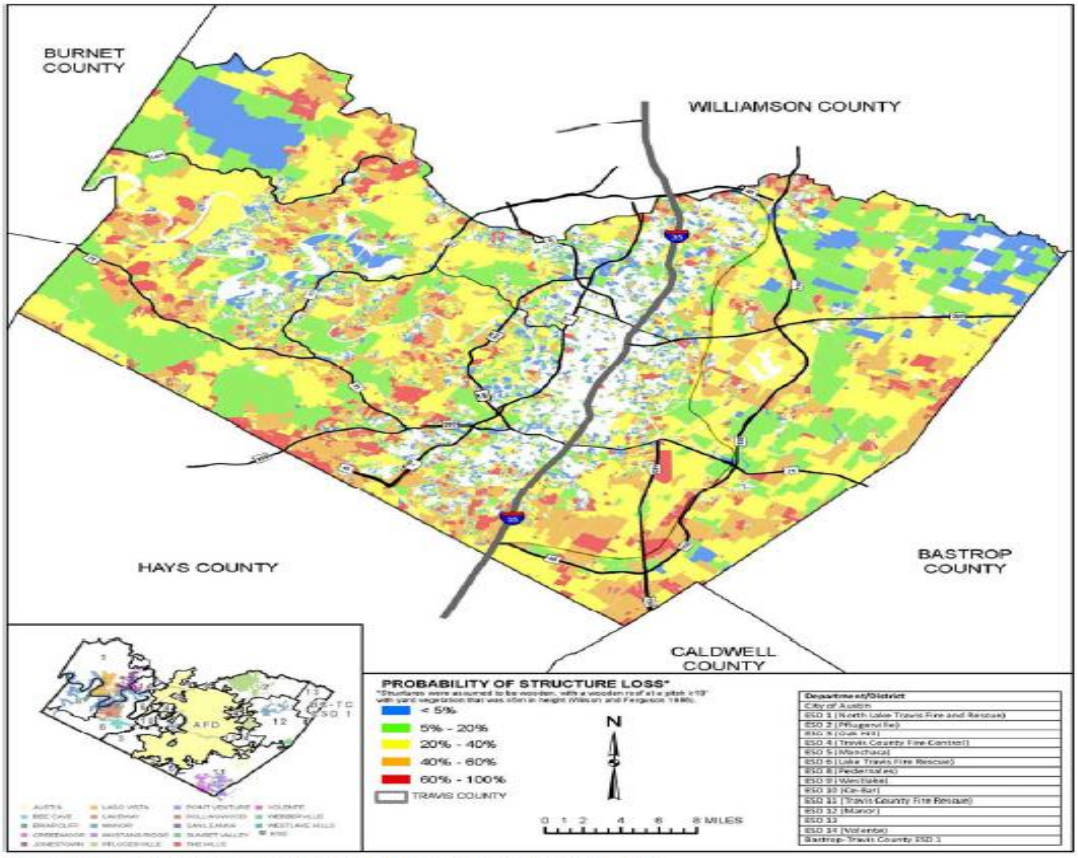

Figure 14. Structure Combustion Risk by parcel based community

Figure 4.1 Travis County Probability of Structure Loss Map

This method for identifying vulnerable areas and mapping demonstrates complete alignment with the working hypothesis.

WH1b: The City of Austin uses GIS mapping of local fuels

Section 4.4.2. of the CWPP states: "*the Austin-Travis County CWPP uses a suite of nationally recognized and accepted GIS-based models to define existing and potential wildfire risks and threats to the planning area communities. These models include a variety of inputs to model fire behavior: elevation, aspect, slope, canopy cover, canopy base height, canopy height,*

canopy bulk density, weather conditions, and wildland fuels data. FlamMap, the principal wildfire modeling software, relies heavily on appropriate fuel inputs. Within this database, general fuel types are based on Scott and Burgan (2005) while woodland categories utilize the types derived from the BCNWR study."

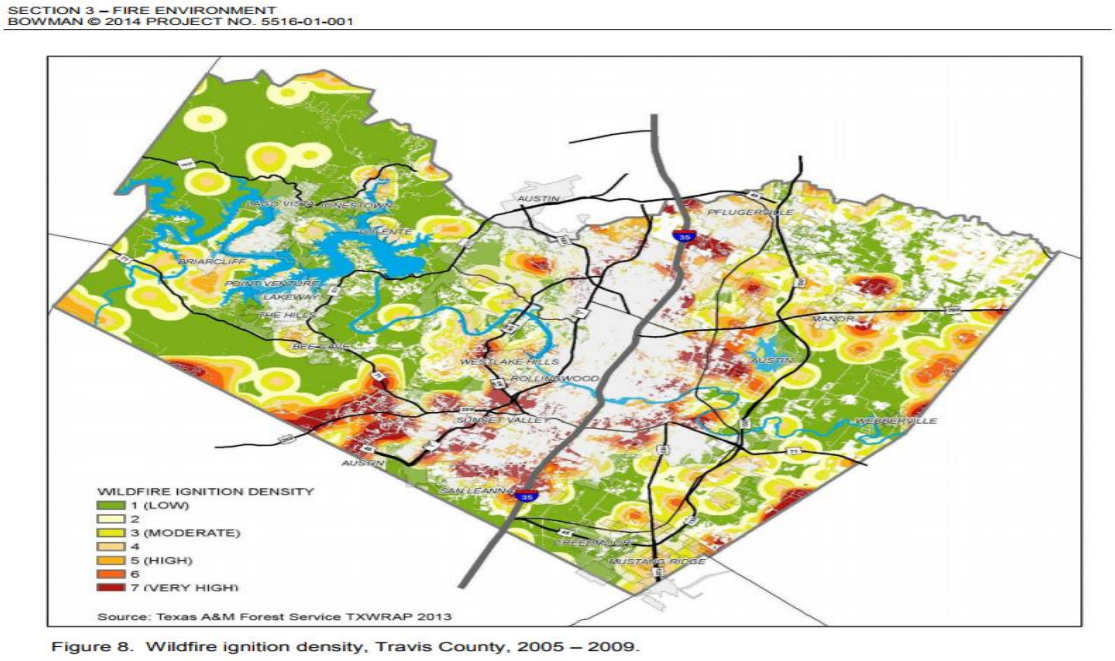

Figure 4.2 Travis County Wildfire Ignition Density Map

Section 4.2.2 of the CWPP confirms that Austin engages in mapping local fuels. While the Bowman report does not provide a copy vegetation map of the county vegetation map, it does confirm that the local officials utilize such maps. The report provides a copy of the county Wildfire Ignitibility Map (see Figure 4.2). These documents demonstrate a strong alignment with the working hypothesis.

WH1c: The City of Austin uses GIS mapping of local floodplains
CodeNEXT 23-10E-2030:

(A) The Watershed Protection Department shall designate and maintain local floodplain maps.

(B) If a local floodplain map is not delineated, the applicant shall calculate the boundaries of the 100-year floodplain in compliance with the Drainage Criteria Manual and submit the calculation to the Director for approval.

CodeNEXT confirms that the City of Austin does maintain flood plain maps. However, this no linking connecting the use of these maps for the purpose of wildfire mitigation. This demonstrates limited alignment with the working hypothesis.

Table 4.1 Summary of the Findings for WH1	
WH1: The City of Austin identifies the Wildland Urban Interface and potential fuels.	
Finding	Level of Alignment
Identifies Vulnerable Areas	
Document analysis demonstrated that the City identifies the fire vulnerable areas.	Complete Alignment
GIS Mapping of Local Fuels	
Document analysis demonstrated that the City uses extensive and complex GIS programs to map local fuel hazards.	Complete Alignment
GIS Floodplain Mapping	
Document analysis demonstrated that the City uses extensive and complex GIS programs to map floodplains but not necessarily for wildfire prevention.	Adequate Alinement

Table 4.1 Summary of Findings for WH1

WH2: The City of Austin engages in proactive forest management practices.

The second hypothesis also has three sub-hypotheses. They assess whether the City of Austin engages in conservative forest management techniques, utilizes fuel load treatments, and promotes fire-resistant landscaping.

WH2a: The City of Austin engages in conservative forest management practices

Forest management practices are essential to maintaining a balance between development and wild areas in the WUI. The City of Austin does not have language in its codes directly expressing a preference for utilizing conservative forest management techniques within its jurisdiction. It does allow for officials to create custom management plans that are tailored to the area. For example, the Scenic Corridor of Ranch Road 620 in far west Austin helps preserve the Hill Country feel of the area by using trees as a buffer to block views of much of the development along that road. That same forest management technique may not be applicable to an area in east Austin that does not have that same type of vegetation. Chapter 23, Section 3C-100 of CodeNEXT does emphasize the city's intention to maintain the tree canopy. "*The urban forest has social, ecological, cultural, economic, historical, and aesthetic benefits for the citizens of Austin. A 2016 study by the U.S. Forest Service and the Texas A&M Forest Service estimated that there are nearly 34 million trees in the City of Austin, and trees in the city save citizens almost $19 million annually in reduced residential energy costs, they sequester carbon at almost $12 million a year, and have a standalone, compensatory value of $16 billion. The study also found that: (1) trees less than five inches in diameter account for 61 percent of the canopy cover, (2) trees 8 to 19 inches in diameter have greater leaf area relative to abundance, and (3) the larger the tree the greater the environmental benefits. Consequently, the urban forest is an integral part of the City's infrastructure and the City has an interest in planning and protecting this resource with the goal of increasing the urban forest within the City to maximize the aforementioned benefits*".

WH2b: The City of Austin utilizes fuel load treatments

Fuel load treatments can reduce the risk of wildfire by removing excess fuels from the environment. The Community Wildfire Protection Plan highlights the City of Austin uses

multiple approaches across its diverse terrain and ecosystems. This customization allows the City to achieve the most desirable goals for an individual location. There are multiple pieces of supporting documentation that the City of Austin utilizes fuel treatments. This demonstrates a complete alignment with the working hypothesis.

Section 5.4.1 of the CWPP states: "*The Austin-Travis County CWPP generally approaches fuel reduction by targeting a particular fuel type with a cohesive strategy of various treatments. While many strategies are made up of multiple treatment methods, the suite of the tools selected will vary depending on the site- specific conditions. With transitions in fuel types reaching across condition changes in soil type, topography, etc., and with proximity to protected habitats and watersheds, the treatments making up the general strategy for a common fuel type may vary within a single patch of that fuel type. That is, a treatment that disturbs the surface may not be allowed near a Critical Environmental Feature (CEF).*"

WH2c: The City of Austin promotes fire-resistant landscaping
Section 5.3.5 highlights some of the things that residents can do to prevent wildfires from burning structures. It stops short of recommending fire-resistant landscaping outright. This may be because of Austin's diverse ecosystems. The natural environment ranges from dry, fire-resistant shrub and cacti to lush tree canopies. Instead of focusing on a uniform landscaping suggestion, the CWPP highlights methods of protecting structures that could apply to those who use fire-resistant xeriscaping and those who prefer leafier vegetation on their property. The code reads as follows:

"LANDSCAPE REVIEW

- *Plants in the 30-foot HIZ should be carefully spaced and low growing – low growing, Well-spaced plantings keeps flames on the ground where the fire is more easily controlled.*

- *The oils and resins in evergreen leaves can also be extremely flammable and increase fire intensity. Evergreen plant varieties should be used with caution in this 30-foot HIZ.*
- *Leave adequate spacing between clusters of two to three trees, as well as between individual trees – this arrangement reduces the risk of flames from one tree igniting adjacent trees and creating a crown fire.*
- *Create a firebreak around the home's footprint using landscaping materials such as pea gravel, rock, or pavers - this nonflammable perimeter will reduce the opportunity for ground fire to infiltrate the structure's foundation.*
- *Give yourself added protection with other fuel breaks - driveways, sidewalks, gravel walkways, and non-flammable patios can limit fire spread.*
- *Avoid window plantings as shrubbery once ignited can radiate heat through windows to combustibles in the interior.*
- *Implementing fuel reduction activities in combination with home hardening projects Increases a home's wildfire survival probability. Accomplishing one set of tasks without The other will not create a truly fire-adapted residence, but could still dramatically reduce the home's ignitability."*

Direct Observation

Direct Observation Case Study Areas

Mary Moore Seawright Metropolitan Park

Mary Moore Seawright Metropolitan Map is an urban park located in south Austin off of Slaughter Lane. The park consists of over 300 acres north of Slaughter Creek and contains a three mile walking trail loop, popular with people with dogs. The park is completely surrounded by residential development.

Like many parks in Central Texas, the park's vegetation changes depending the location of water. The park is mostly located on flat, Ashe Juniper-covered plains (commonly called cedar). Within the cedars, occasional live oak and elm trees grow in a scattered fashion. Most of the trees in the park consist of thick, old growth. Other flora includes prickly pear cactus, yucca, and short grasses. Along Slaughter Creek, one can observe large live oaks, elms, and other hardwoods. The ground consists of a mix of black soil prairies and rocky, shallow soil in areas away from the creek. This park lies within the transition zone from the Texas Blackland Prairie to the east and the Texas Hill Country to the west.

Upon entering Seawright Park from Slaughter Lane, one will notice the well maintained cedar and oak trees around the playground areas (Figure 4.4). The lower, dead limbs are trimmed off to minimize their burning hazard. The lawn is also mowed for all areas up to the trailheads. Once on the trail, more trimmed cedar trees can be observed. Along the Mary Moore Seawright Metro Trail, there is a thicket of cedar (Figure 4.6). However, the trail is wide and the cedars along the trail are trimmed back a significant distance (Figure 4.5). This helps create a buffer between the natural environment and human activity that may cause fire.

Along Slaughter Creek, there is very little observable flood debris, an indicator that the City has been maintaining the area. There are also many foot trails that branch off the main trail towards the back of the park, providing increased access to remote areas in the event of a fire. The surrounding neighborhoods also have streets that dead end at smaller trailheads on all sides of the park that could help provide fire fighters with closer access to remote fires that the main trailhead would provide.

Figure 4.3 Mary Moore Seawright Metropolitan Park entrance sign

Figure 4.4 Well-maintained cedar trees at Seawright Metropolitan Park

Figure 4.5 Well-maintained trails and trees in Seawright Metropolitan Park

Figure 4.6 Cedar thicket along Slaughter Creek Trail at Seawright Metropolitan Park

Figure 4.7 Wild cedar thicket along Slaughter Creek Trail in its natural state

Figure 4.8 Free-flowing stream at Seawright Metropolitan Park

Barton Creek Greenbelt

Barton Creek Greenbelt is an urban park located in southwest of downtown. The park consist over one thousand acres and boast approximately fourteen miles of hike and bike trails maintained by the City of Austin. Barton Creek, a tributary of the Colorado River flows through the canyon-lands and provides several seasonal swimming holes and waterfalls. The park also has many bluffs, cliffs, and rock faces suitable for climbing. The park is arguably, the most popular greenbelt in Austin, as locals affectionately call it “The Greenbelt”. There are several

trailheads to enter the Barton Creek trailhead. The most popular entrance is located on the South Mopac Expressway access road (Figure 4.9). From here, hikers can descend to the creek on the Gaines Trailhead.

The vegetation for the majority of land in the Greenbelt consists of Ashe juniper (commonly called cedar), live oaks, prickly pear cactus, yucca, and short grasses (Figure 4.10). The ground is rocky and the soil is very shallow (Figure 4.11). As the trail nears riparian areas, the vegetation noticeably changes. The cedar trees give way to bald cypress, larger old growth live oaks and elms. Barton Creek is usually a flowing body of water during the rainy seasons of spring and summer. During this time flash flooding is common and the creek bed can become choked with debris. Once this debris has dried, it becomes a major fire hazard.

While hiking along the Gaines trailhead, one will observe that the cedar trees along the trailhead are generally cut back and have the dead branches trimmed off near the bottom. This demonstrates that the city of Austin is actively attempting to prevent fire in areas that people use. It can also be observed that people have made walking sticks out of many of the lower large branches as well. The multiple trailheads also provide another advantage in battling urban wildfire: emergency personnel access to remote areas of the park. This is especially helpful during the time of a wildfire. While the trails are well maintained for foot traffic, firefighters will not be able to get large firetrucks deep into the park. Wildfires in these treacherous areas will have to be battled on foot.

During the September observational visit, the water level of Barton Creek was very low (Figure 4.12). In many along the creek, especially near Twin Falls and Sculpture Falls, there were only puddles in the creek bed. This provided an excellent opportunity to view the amount of debris. For the most part, debris was limited to tree limbs and dried branches (Figure 4.14).

They formed piles up to three feet high in some places. However, further downstream along where the reek goes under the Mopac Expressway, there was clear evidence that the creek bed had been cleaned (Figure 4.13). There was no observable flood debris for a half mile stretch.

Figure 4.9 Barton Creek Greenbelt Map

Figure 4.10 Cedar tree growth in Barton Creek Greenbelt

Figure 4.11 Grove of pruned cedar trees in Barton Creek Greenbelt

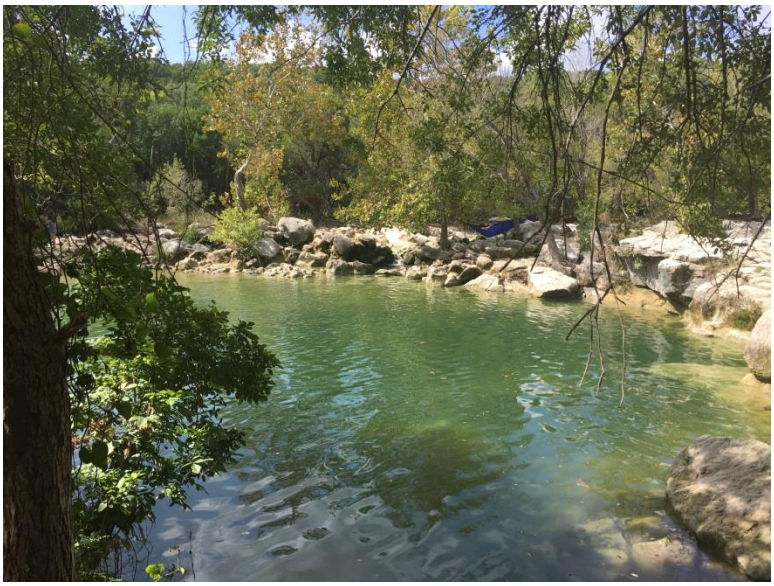

Figure 4.12 Barton Creek at Twin Falls

Figure 4.13 Recently cleared Barton Creek floodplain/creek bed as seen from Mopac Expressway pedestrian bridge

Figure 4.14 Debris along Barton Creek

Emma Long Metropolitan Park

Emma Long Metropolitan Park is a large park located in northwest Austin. The park consist of over 1,100 acres of preserved wildland. Lake Austin, a man-made lake built by damming the Colorado River, forms the southern border of the park. The park consist of many wooded limestone hills and valleys. The high terrain provides scenic lookouts and picturesque trails (Figure 4.19). Like the Barton Creek Greenbelt, this park is located at the foothills of the Texas Hill Country and consist of cedar, live oaks, and elm trees. The ground is rocky and the soil is very shallow (Figure 4.17).

Lake Austin also functions as a state controlled flood control reservoir, there is not much buildup of flood debris along its banks. However, the numerous creeks throughout the park are different. The Turkey Creek Trail is a typical example of the overall condition of the park (Figure 4.17). The Turkey Creek trail passes through mostly cedar forest until it reaches Turkey Creek. There is little evidence of wildfire maintenance activities along this trail, even though City Park Road, the park's main thoroughfare, passes over the Creek approximately fifty feet downstream from the trail crossing (Figure 4.16). During the observational visit, Turkey Creek's flow was down to a trickle. However, there was very little evidence of debris of past floods.

Emma Long Metropolitan Park has many accessible roads and trails to help firefighters get to a fire, but because of the sheer size of the park, the majority of the park only remains accessible by foot (Figure 4.20).

Figure 4.15 Emma Long Metropolitan Park entrance

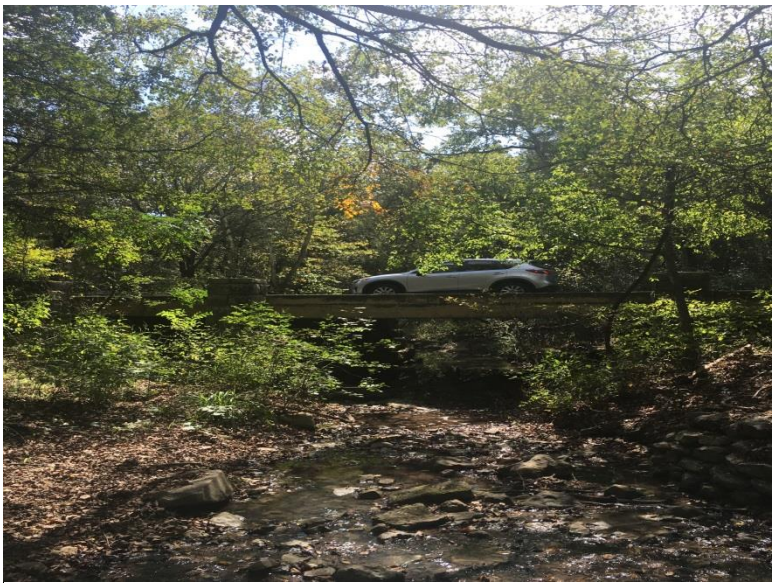

Figure 4.16 Turkey Creek

Figure 4.17 Cedar thicket at Emma Long Metropolitan Park.

Figure 4.18 Wild cedar thicket at Turkey Creek Trail

Figure 4.19 City Park Road Overlook

Figure 4.20 Natural vegetation at Emma Long Metropolitan Park.

Bauerle Ranch Park

Bauerle Ranch Park is a peculiar park in terms of location. The south Austin park, which is located east of the Shady Hollow Estates neighborhood, is unique in that it completely envelopes a neighborhood. The Bauerle Ranch neighborhood is surrounded on all four sides by the preserved greenbelt. While this increase the quality of life for residents, the threat of wildfire is also increased due to the closeness of human activity. Like Mary Moore Seawright Metropolitan Park, the park is located in the transitional zone between the Blackland Prairie and the Hill Country. Flora that is more Hill Country-esque such as prickly pear cactus, cedar, and live oaks can be found next to more characteristically Blackland Prairie flora such as post oaks, mesquite, and cedar elms (Figures 4.21 and 4.22).

Slaughter Creek runs along the west and south of the park. There was little evidence of flood debris and fire hazards along the park trails and waterways (Figures 4.23). The park was well maintained along that trail. The opposite side of the trail that is adjacent to the Shady Hollow neighborhood presented differing evidence. There were many observable cases of scattered brush and dried tree limbs which poses a major fire hazard (Figures 4.26, 4.27, and 4.28). The closeness of the Shady Hollow neighborhood to these fire hazards puts it at an almost equal risk of fire as the Bauerle Ranch neighborhood.

Figure 4.21 Bauerle Creek Trail Entrance

Figure 4.22 Typical vegetation at Bauerle Ranch Park

Figure 4.23 Pond on Slaughter Creek at Bauerle Ranch Park

Figure 4.24 Untreated trees at Bauerle Ranch Park

Figure 4.25 Trails through natural grasslands leading to Slaughter Creek

Figure 4.26 Fallen tree debris in Bauerle Ranch Park

Figure 4.27 Fuel Hazards in Bauerle Ranch Park

Figure 4.28 Pile of tree debris in Bauerle Ranch Park

Onion Creek Greenbelt Park

Onion Creek Greenbelt is a large park located in southeast Austin. The 200 acre park is located on the north bank of Onion Creek, while the newly formed Onion Creek Metropolitan Park lies on the south bank. Onion Creek Greenbelt is characterized by oaks, mesquite, and Ashe juniper. Areas along the creek are populated by bald cypress, live oaks, sycamores, and pecan trees. The park is surrounded by development, with residential development to the north and east of the creek. The park on the south bank of the creek is undeveloped.

The entrance to the park is marked by well-maintained vegetation, roads, and paths. The vast majority of the entrance path consists of well-maintained lawns and pruned native trees (Figure 4.29). The Onion Creek Park Path is the main path through the greenbelt. It starts at the terminus of Onion Creek Drive and follows the north bank of the creek. Along this trail, the natural vegetation is mostly undisturbed and consists of mature hardwoods (Figure 4.31). The amount of Ashe Juniper is relatively less than the other parks. The pathway is wide enough for emergency vehicles to access remote areas of the Greenbelt.

Onion Creek is a tributary of the Colorado River and has posed a flood hazard to areas along its path since the area was settled. Flash floods can occur at any time of year but are most common during the spring. Frequent, destructive floods have left their mark on Onion Creek. During the observational visit the water level near the Onion Creek Park Path Trailhead was approximately eight inches deep in the middle of the creek (Figure 4.36). This provided ideal conditions to assess how frequently these areas flood. In many areas, piles of debris as high as six feet can be observed along the creek bed and creek bank (Figure 4.34).

Figure 4.29 Onion Creek Greenbelt Entrance

Figure 4.30 Untreated natural vegetation along Slaughter Creek

Figure 4.31 Pruned trees at Onion Creek Greenbelt

Figure 4.32 Piled debris awaiting pick up in Onion Creek Greenbelt

Figure 4.33 Trees damaged from past storms.

Figure 4.34 Large pile of flood debris along the banks of Onion Creek

Figure 4.35 Well maintained, manicured grass area at Onion Creek Greenbelt

Figure 4.36 Onion Creek

Table 4.2 WH 2a and WH2b Direct Observation Results					
WH2: The City of Austin engages in proactive forest management practices.					
WH2a: The City of Austin engages in conservative forest management practices					
	Tree Pruning	Floodplain Debris Clearing	Accessible Trails/Roads	Tree Thinning	**PARK TOTAL SCORE**
Mary Moore Seawright Metropolitan Park	4	4	4	2	14
Barton Creek Greenbelt	2	2	2	1	7
Emma Long Metropolitan Park	2	1	1	3	7
Bauerle Ranch Park	1	1	2	1	5
Onion Creek Greenbelt	4	3	3	4	15
TOTAL SCORE	13	11	12	11	
WH2b Direct Observation Results					
WH2b: The City of Austin utilizes fuel load treatments					
	Manual Fuel Reduction	Prescribed Burn	Fuelbreaks	Grazing/Mowing	**PARK TOTAL SCORE**
Mary Moore Seawright Metropolitan Park	4	1	4	4	13
Barton Creek Greenbelt	2	1	1	1	5
Emma Long Metropolitan Park	2	1	1	1	5
Bauerle Ranch Park	2	1	1	1	5
Onion Creek Greenbelt	4	1	4	4	13
CITY OF AUSTIN TOTAL SCORE	14	5	11	11	

Table 4.2 WH2a and WH2b Direct Observation Results

Table 4.3 Summary of the findings of WH2

Table 4.3 Summary of the findings of WH2 WH2: The City of Austin engages in proactive forest management practices	
Finding	Level of Alignment
Proactive Forest Management Practices	
Document analysis demonstrated that while the City does engage in proactive forest management analysis, it does not necessarily pertain to urban wildfire prevention.	Adequate Alignment
Fuel Load Treatments	
Document analysis demonstrated that the city does engage in fuel load treatments. The application of these treatments are based on the geography of the specific area.	Adequate Alignment
Encourages Fire Resistant Landscaping	
Document analysis demonstrated that the City does encourage fire resistant vegetation and fire protection for development.	Adequate Alignment

WH3: The City of Austin includes fire mitigation in its planning process.

The third section of the study contains three sub-hypotheses to access the City of Austin's commitment to fire mitigation in its planning process. The first sub-hypothesis assess whether the City identifies the need for long term fire planning. The second hypothesis is used to access if the City ranks its mitigation priorities. Third, the City's use of fire designations is assessed.

WH3a: The City of Austin identifies the need for long term fire planning.

Section 2.23 of the Community Wildfire Protection Plan highlights the city's intentions to plan long term for wildfires. It sets a timeline of twenty years and acknowledges the role that drought plays in wildfire risk.

"The *Austin Urban Forest Plan: A Master Plan for Public Property* (City of Austin 2013) identifies development as the number one threat to forests within the Austin area. This

threat, combined with the impact of long-term drought, made it imperative to develop a plan to support the long-term health and vitality of the public urban forest within the Austin area. The *Austin Urban Forest Plan: A Master Plan for Public Property* establishes a broad scoped, long-range vision for Austin's public urban forest, and provides a framework for the City of Austin to use as a guide for managing the public urban forest over the next 20 years. "

CodeNEXT 23-11B

WH3b: The City of Austin ranks its mitigation priorities.

Section 1.3 of the Community Wildfire Protection Plan states the ranking of the City's mitigation plan. It is as follows: "*A plan for action, the Austin-Travis County CWPP is a living document that depends upon people and partnerships to succeed. Specific goals of this document are to:*

- *Provide for the life safety of residents and emergency personnel.*
- *Protect homes, business, and other infrastructure from wildfire.*
- *Promote and maintain healthy ecosystems and natural resources.*
- *Educate citizens about wildfire preparedness and prevention.*
- *Support the development of local, site-specific CWPPs within Travis County and the City of Austin.*"

This section of the Community Wildfire Protection Plan highlights the ranking structure of the City of Austin's wildfire mitigation strategy. The main goal of the City is to provide life safety for its citizens and emergency personnel. The protection of homes, businesses, and other infrastructure ranks second. This provides evidence of complete alignment with the working hypothesis.

WH3c: The City of Austin utilizes fire designations.

The City of Austin's commitment to utilizing fire designations is outlined in the Community Wildfire Protection Plan and on the city website, www.austintexas.gov/rxfire.

Section 5.1 of the Community Wildfire Protection Plan states "*Firewise is a national education program to help the public reduce fuel around their homes, retrofit homes with non-combustible materials, and take action around structures on their properties to reduce ignition potential and risk.*" It also states that "*Travis County and the City of Austin are working to minimize the effects and impacts of wildfire on their local communities by integrating the Cohesive Strategy's three primary factors into their overall missions and in community planning. This planning document is part of that effort. In order to become a fire-adapted community, residents of Travis County and the City of Austin must be educated and supported in their role as the primary defense against wildfire. They must understand that by taking appropriate actions, they can safely co-exist with wildland fire, support effective, efficient, and safe firefighting, and protect life and property. To become a fire-adapted community, planning areas, subdivisions, and communities need to achieve or be actively pursuing:*

- *Implementing Firewise principles to safeguard homes and "Ready, Set, Go!" principles to prepare for fire and evacuation*
- *Developing adequate local fire suppression capacity to meet community protection needs*
- *Designing, constructing, retrofitting, and maintaining structures and landscaping in a manner that is resistant to ignition*
- *Adopting and enforcing local codes that require fire-resistant home design and building materials*
- *Raising the awareness of and creating incentives for growth planning and management that reduces, rather than increases, fire-prone development*
- *Properly spacing, sequencing, and maintaining fuel treatments across the landscape;* • *Developing and implementing a CWPP or equivalent*
- *Establishing interagency mutual aid agreements*
- *Designating internal safety zones or areas of temporary refuge.*"

Table 4.4 Summary of the findings of WH3	
WH3: The City of Austin includes fire mitigation in its planning process	
Finding	Level of Alignment
Identifies the Need for Long Term Fire Planning	
Document analysis demonstrated the need and importance of long term fire planning in the City. It sets a timeframe of twenty years for urban forest management.	Adequate Alignment
Ranks Mitigation Priorities	
Document analysis demonstrated that the City ranks its priorities of fire mitigation. The mitigation prioritizes human life and safety over infrastructure and development.	Adequate Alignment
Utilizes Fire Designations	
Document analysis demonstrated that the City of Austin uses Fire Designations to help promote safety, awareness, and public involvement in preventing localized fires.	Complete Alignment

Table 4.4 Summary of the findings of WH3

WH4: The City of Austin engages in wildfire mitigation through public education.

The fourth section of the document analysis portion contains three sub-hypotheses to assess the City of Austin's wildfire mitigation strategies through public education. The sub-hypotheses assess the City's promotion of a sense of place through understanding place attachment, the City's active public outreach, and the City's passive outreach.

WH4a: The City of Austin promotes a sense of place through understanding place attachment. CodeNEXT 23-4E-4010 demonstrates a very strong alignment to the City's understanding of place attachment.

As the City of Austin's population grows and development density increases, it is the purpose of this section to address the City's natural sense of place and character through the preservation, protection, and enhancement of the existing, natural, and planted landscapes. It is the intent of this section to establish minimum landscape standards that provide ecological benefits at the site level. The requirements of this section are meant to enhance, improve, and maintain the quality of the Austin landscape by providing the following: (A) To aid in stabilizing the environment's ecological balance by contributing to the processes of air purification, oxygen regeneration, ground water recharge, and storm water infiltration, while at the same

time aiding in noise, glare, and heat abatement; (B) To preserve and replenish the local stock of native trees and vegetation; (C) To prevent overcrowding of land and provide air quality; (D) To provide visual buffering to enhance the beautification of the City; (E) To safeguard and enhance property values and protect public and private investment; (F) To preserve and protect the unique identity and environment of the City of Austin and preserve the economic base attracted to the City of Austin by such factors (G) To provide cooling shade thereby conserve energy; and (H) To enhance public health, safety and general welfare.

The City further demonstrates the strength of its commitment to maintaining a sense of place in the Community Wildfire Protection Plan. Section 1.6.4 highlights the unique features of Austin that it seeks to establish to maintain its unique sense of place.

Natural community values include general ecological ones as well as specific locations and features. Natural community values within Travis County and the City of Austin include:

- *Ecological Conditions – Features that are part of healthy ecosystems, including clean water, clean air, native wildlife species and their habitats, healthy and diverse vegetative communities.*

- *Parks and Open Spaces – These can range from playing fields to highly maintained environments to relatively natural landscapes. In addition to parklands managed by Travis County and the City of Austin (**Figure 2**), parks and open are managed and maintained throughout the county by a variety of entities including municipalities, environmental organizations (e.g., Travis Audubon) and neighborhoods.*

- *Preserves – These are unique types of open space with additional restrictions depending on the type of asset being preserved. Preserves typically protect essential endangered species habitat, unique natural features such as caves, crucial watersheds or streams, or a specific type of ecosystem. The city and county jointly manage the Balcones Canyonlands Conservation Plan, which is a 30-year regional permit that allows for incidental take of endangered species as a result of development in exchange for the creation of a preserve system for eight protected species as well as 27 other at-risk species. The Balcones Canyonlands Preserve (BCP) is composed of 152 properties totaling 30,444 acres with 19 Different managing agencies (Travis County and City of Austin 2012). The City of Austin also manages Water Quality Protection lands. These water quality management areas include conservation easements and directly managed natural areas that comprise 40,000 acres in western Travis and northern Hays Counties.*

- *State Parks – The Texas Parks and Wildlife Department oversees 113 state , historic sites and natural areas throughout the state. The 726-acre McKinney Falls State Park is the only state park in Travis County (**Figure 2**).*

- *National Wildlife Refuges – The National Wildlife Refuge system is a national network of lands for the conservation, management, and restoration of fish,*

*wildlife, and plant resources and their habitats managed by the U.S. Fish and Wildlife Service (USFWS). The Balcones Canyonlands National Wildlife Refuge consists of approximately 23,000 acres located in Burnet, Travis, and Williamson Counties with the primary purpose of protecting the nesting habitat of the endangered golden-cheeked warbler and black-capped vireo (**Figure 2**). Social community values include special needs populations and community infrastructure.*

Cultural community values are "those tangible and intangible aspects of cultural systems, both living and dead, that are valued by or representative of a given culture or that contain information about a culture…" (National Park Service 1998). Cultural community values include, but are not limited to, the following:

- *Archeological and Natural Landmark Sites - Numerous archeological assets from Native American sites to historic buildings, historical districts, and homesteads exist throughout Travis County. Also included are the heritage trees and other natural features that are part of the historic perspective and the sense of place experienced by the generations of Texans.*

- *Churches and Cemeteries - Most communities throughout the planning area have one or more churches and cemeteries that reflect cultural aspects of inhabitants from early immigrants to modern residents.*

- *Community Event and Activity Centers - Additional cultural community values are reflected in event-oriented settings such as the local music and arts scene, a multiplicity of annual festivals, a growing film industry, the recent Circuit of the Americas F-1 Track, and other genres too numerous to list here.*

- *Local Establishments – Locally owned eateries, dancehalls, and markets illustrate the value placed on a community's local identity. A special element identified as a high value in many communities is the local barbeque establishments that have been, or are on their way to being, a generational legacy.*

WH4b: The City of Austin engages in active public outreach.

Section 6.2.2 of the Community Wildfire Protection Plan states that the "*City of Austin, Travis County, and Texas A&M Forest Service have developed and implemented education programs and materials related to wildfire preparedness and prevention in the past; however, through enhanced collaboration and communication, regionally specific efforts have accelerated since the 2011 Bastrop Complex fire and the establishment of the Joint Wildfire Task Force*".

This section of language demonstrates that the City of Austin is engaged in an active form of public outreach. The City of Austin also provides many articles out outreach on its city website, http://www.austintexas.gov/department/fire. The website includes information in the form of documents, calendars, and links to third party literature regarding fire safety. The Austin Fire Department also maintains active Twitter, Facebook, and Instagram accounts. These multiple outlets demonstrate a complete alignment with the working hypothesis.

Table 4.5 Summary of the findings of WH4	
WH4: The City of Austin engages in wildfire mitigation through public education.	
Finding	Level of Alignment
The City Promotes a sense of place through place attachment	
Document analysis demonstrates that the City seeks to preserve its natural character through the preservation and management of its urban forests.	Adequate Alignment
The City Engages in Public Outreach	
Document analysis demonstrates that the City engages in active public outreach through community programs and partnerships with research institutions. Document analysis demonstrates that the City engages in passive public outreach by providing wildfire literature to the public via its website and by maintaining an active social media presence.	Complete Alignment

Table 4.5 Summary of the findings of WH4

Chapter Summary

This chapter provided the results of the case study of the City of Austin. The main results were drawn from document analysis of the City's Community Wildfire Protection Plan and CodeNEXT. The results ranged from complete alignment to adequate alignment. The next chapter will provide recommendations based on the results of this chapter.

Chapter 5 Conclusions and Recommendations

Chapter Purpose

This project has a dual purpose. The first purpose is to explore the different wildfire mitigation strategies that reduce urban wildfires in the City of Austin's urban parks. Secondly, this project uses an operationalized framework to assess the City of Austin's adherence to its wildfire policy. This chapter provides recommendations based on the results that were yielded from document analysis and direct observation.

Recommendations

Table 5.1: City of Austin Document Analysis Summary and Recommendations

Working Hypothesis	Evidence	Findings/Recommendations
WH1: The City of Austin identifies the Wildland Urban Interface and potential fuels.		
WH1a. The City of Austin identifies wildfire vulnerable areas	Complete Alignment	Findings: Document analysis demonstrated that the City identifies the fire vulnerable areas.
		Recommendations: None
WH1b: The City of Austin uses GIS mapping of local fuels	Complete Alignment	Findings: Document analysis demonstrated that the City uses extensive and complex GIS programs to map local fuel hazards.
		Recommendations: None
WH1c: The City of Austin uses GIS mapping of local floodplains	Adequate Alignment	Findings: Document analysis demonstrated that the City uses extensive and complex GIS programs to map floodplains but not necessarily for wildfire prevention.
		Recommendations: The City should combine data from the fuels map to target areas of floodplain that may be prone to debris build up.
WH2: The City of Austin engages in proactive forest management practices.		
WH2a: The City of Austin engages in conservative forest management practices	Adequate Alignment	Findings: Document analysis demonstrated that while the City does engage in proactive forest management analysis, it does not necessarily pertain to urban wildfire prevention. However, site visits to area parks confirm that the City does engage in conservative forest management practices.
		Recommendations: The City should consider how forest management techniques will encourage or discourage in the WUI.

Table 5.1: City of Austin Document Analysis Summary and Recommendations		
Working Hypothesis	**Evidence**	**Findings/Recommendations**
WH2b: The City of Austin utilizes fuel load treatments	Adequate Alignment	Findings: Document analysis demonstrated that the city does engage in fuel load treatments. The application of these treatments are based on the geography of the specific area. Site visits to area parks confirm that the City utilizes fuel load treatments but not at a uniform rate.
		Recommendations: The City should publish examples of which fuel treatments are suited to different areas of the city.
WH2c: The City of Austin promotes fire-resistant landscaping	Adequate Alignment	Findings: Document analysis demonstrated that the City does encourage fire resistant vegetation and fire protection for development.
		Recommendations: The City should provide a list of recommended fire resistant vegetation for residential development and encourage developers in the WUI to utilize these plants.
WH3: The City of Austin includes fire mitigation in its planning process.		
WH3a: The City of Austin identifies the need for long term fire planning.	Adequate Alignment	Findings: Document analysis demonstrated the need and importance of long term fire planning in the City. It sets a timeframe of twenty years for urban forest management.
		Recommendations: The City should explain the goal to be reached for the urban forest in this time period.
WH3b: The City of Austin ranks its mitigation priorities.	Adequate Alignment	Findings: Document analysis demonstrated that the City ranks its priorities of fire mitigation. The mitigation prioritizes human life and safety over infrastructure and development.
		Recommendations: In addition to ranking its fire priorities, the City should make a ranking of where wildfire ranks with other natural hazards facing the city.
WH3c: The City of Austin utilizes fire designations.	Complete Alignment	Findings: Document analysis demonstrated that the City of Austin uses Fire Designations to help promote safety, awareness, and public involvement in preventing localized fires.
		Recommendations: None
WH4: The City of Austin engages in wildfire mitigation through public education.		

Table 5.1: City of Austin Document Analysis Summary and Recommendations		
Working Hypothesis	**Evidence**	**Findings/Recommendations**
WH4a: The City of Austin promotes a sense of place through understanding place attachment.	Adequate Alignment	Findings: Document analysis demonstrates that the City seeks to preserve its natural character through the preservation and management of its urban forests. Recommendations: None
WH4b: The City of Austin engages in public outreach.	Complete Alignment	Findings: Document analysis demonstrates that the City engages in active public outreach through community programs and partnerships with research institutions. Document analysis also demonstrates that the City engages in passive public outreach by providing wildfire literature to the public via its website and by maintaining an active social media presence. Recommendations: The City should encourage partnerships with schools, business, and other local entities to help maintain localized fire hazards and clean ups.

Table 5.1City of Austin Document Analysis and Recommendations

Limitations

There are two primary limitations for this study: document selectivity bias and the scope of the direct observation as opposed to the scope of the City's entire park management. These limitation should be considered in the event of a follow-up study in the future.

The documents that were chosen for this study were chosen for their extensive, in –depth content. Although these documents covered a large amount of material, document selectivity bias can occur because it is possible that the City may have addressed the issues in further detail in documents that were not considered. The Bowman report was an independent report commissioned by the City to address the threat of wildfire to Austin after the Bastrop Fires of 2011. This document may need to be updated as it is six years old at the time of this research project. CodeNEXT is an extensive re-write of the City's Code that builds on the previous code

while capturing the spirit of the rapidly developing new Austin. It is limited in that is only a draft at this time and is currently going through public comments and has not been officially approved. It is scheduled to be approved in February 2018.

The study is also limited by the parks chosen for this study. These parks were chosen for their varied location, popularity, geography, and proximity to development. They were visited in October, one and a half months after Hurricane Harvey dumped records amounts of rain and caused historic flooding. It is possible that the City has intentions to clean up its urban parks after these substantial floods but has not the time to visit all of them. There was evidence in the form of earth moving equipment at Onion Creek Park, that clean up procedures were pending.

Future Research

Suggestions for future research include exploring the possibility of the effects that a large fire in any of the case study areas could have on the surrounding development. The Bowman report highlights the highlights the monetary figures of such a disaster. For example, development on the west side of Austin mainly consist of high end residential and business properties. A look at how the property values of properties within the Wildland-Urban Interface would be sufficient to expand into a more comprehensive version of this study.

Wildfires do not respect jurisdictional boundaries. Another suggestion to expand future research would be to examine how local governmental entities can work together to create a regional wildfire mitigation plan. A comparison of municipal, state, and federal entities may reveal different levels of commitment to wildfire mitigation and also reveal which entity has the most influence and control over local wildfire policy.

Conclusion

The results of this study demonstrate the City of Austin is adequately committed to urban wildfire prevention in its urban parks through hazard identification, forest management, planning

and public education. This study developed a model to evaluate Austin's urban wilderness fire mitigation. Using the model, the study then uses case study methodology (document analysis and direct observation) to assess Austin's urban wilderness fire mitigation policy. The study is limited by the documents used and the scope of the park observation. This study concludes that the City of Austin must engage in further work to reach complete alignment to all of the wildfire prevention goals.

Chapter Summary

This chapter discussed the conclusion and recommendation made by this study. The chapter first made recommendations based on the data gathered through document analysis and direct observation. Next, the limitations of the study were discussed, followed by suggestions for future research. Lastly, the chapter concluded that the City of Austin adequately meets the suggested mitigation policies outlined after a review of scholarly literature.

Works Cited

Executive Order. No. 13728, 2016, p. 29.

Abrams, Jesse B., et al. "Re-Envisioning community-Wildfire relations in the U.S. West as adaptive governance." *Ecology and Society E&;S*, vol. 20, no. 3, 2015. *EBSCOhost*

Online Research, Accessed 1 Apr. 2016.

Agee, James, and Carl Skinner. “Klamath Mountains Bioregion.” *Fire in California's Ecosystems*, 2005, pp. 170–194.

Alexandre, Patricia M., et al. “The relative impacts of vegetation, topography and spatial arrangement on building loss to wildfires in case studies of California and Colorado.” *Landscape Ecology*, vol. 31, no. 2, 2015, pp. 415–430. *EBSCOhost Online Research*, Accessed 4 Apr. 1ADAD.

Anton, Charis E., and Carmen Lawrence. “Does Place Attachment Predict Wildfire Mitigation and Preparedness? A Comparison of Wildland–Urban Interface and Rural Communities.” *Environmental Management*, vol. 57, no. 1, 2015, pp. 148–162. *EBSCOhost Online Research*, Accessed 2 Apr. 2016.

Arroyo, Renaldo J., and Tina Delahunty. “Hindrances and Successes: Mapping the 2006 East Amarillo Complex Wildfires in Gray County, Texas.” *Rangelands*, vol. 34, no. 2, 2012, pp. 32–36. *EBSCOhost Online Research*, Accessed 31 Mar. 2016.

Arrubla, Julian A. Gallego, et al. “Wildfire initial response planning using probabilistically constrained stochastic integer programming.” *International Journal of Wildland Fire Int. J. Wildland Fire*, vol. 23, no. 6, 2014, p. 825. *EBSCOhost Online Research*, Accessed 1 Apr. 2016.

Bond, W, and J Keeley. “Fire as a global ‘herbivore’: the ecology and evolution of flammable ecosystems.” *Trends in Ecology & Evolution*, vol. 20, no. 7, 2005, pp. 387–394.

Bond, W, and J Keeley. “Fire as a global ‘herbivore’: the ecology and evolution of flammable ecosystems.” *Trends in Ecology & Evolution*, vol. 20, no. 7, 2005, pp. 387–394.

Brody, Samuel, et al. “Examining the impact of land use/Land cover characteristics on flood losses.” *Journal of Environmental Planning and Management*, vol. 57, no. 8, 2013, pp. 1252–1265. *EBSCOhost Online Research,* Accessed 31 Mar. 2016.

Brooks, Karen. “Austin-Area wildfire burns a record 476 Homes.” *Chicago Tribune,* 6 Sept. 2011.

Calkin, D. E., et al. “How risk management can prevent future wildfire disasters in the wildland-Urban interface.” *Proceedings of the National Academy of Sciences*, vol. 111, no. 2, 2013, pp. 746–751. *JSTOR.*

“Central Texas Council of Governments – Emergency Services.” *Central Texas Council of Governments,* ctcog.org/emergency-services/. Accessed 1 Apr. 2017.

Cheyette, D., et al. “Developing fire behavior fuel models for the wildland-Urban interface in Anchorage, Alaska.” *Western Journal of Applied Forestry*, vol. 23, no. 3, 2008, pp. 149–155. *EbSCOhost Online Research,* Accessed 30 Apr. 2017.

City of Austin Office of Homeland Security and Emergency Management, and Bowman Consulting Group. “Austin/Travis County Community Wildfire Protection Plan.” Austin/Travis County Community Wildfire Protection Plan, City of Austin, 2014.

City of Austin Planning and Development. “CodeNEXT Draft.” *CodeNEXT,* 2017.

Day, Frederick A., and Jon M. Barlett. “Economic Impact of Retirement Migration on the Texas Hill Country.” *Journal of Applied Gerontology*, vol. 19, no. 1, 2000, pp. 78–94.

Dolanc, Christopher R., et al. “Changing forest structure across the landscape of the Sierra Nevada, CA, USA, since the 1930s.” *Ecosphere,* vol. 5, no. 8, 2014.

Fernando, R. Lalitha S. “Disaster Communication in Mitigating Climate Change in Sri Lanka.” *Governance Approaches to Mitigation of and Adaptation to Climate Change in Asia*.

EBSCOhost Online Research, Accessed 30 Mar. 2016.

Finney, Mark A., et al. “Role of buoyant flame dynamics in wildfire spread.” *Proceedings of the*

Berry, Faith, et al. “Firewise: The Value of Voluntary Action and Standard Approaches to Reducing Wildfire Risk.” Arizona State Law Journal, vol. 48, no. 1, pp. 181–200. Legal Source.

“Fire Service Grants and Funding.” *U.S. Fire Administration,* www.usfa.fema.gov/grants/. Accessed 1 Apr. 2017.

“Fire wise.” *About Firewise - Firewise*, Firewise.org, www.firewise.org/about.aspx?sso=0. Accessed 5 Apr. 2017.

Gan, Jianbang, et al. “A Simulation and Stochastic Integer Programming Approach to Wildfire Initial Attack Planning.” *Forest Science*, vol. 59, no. 1, 2013, pp. 105–117. *EBSCOhost Online Research,* Accessed 7 Apr. 2016.

Gan, Jianbang, et al. “Landowner response to wildfire risk: Adaptation, mitigation or doing nothing.” *Journal of Environmental Management*, vol. 159, 2015, pp. 186–191. *EBSCOhost Online Research*, Accessed 31 Mar. 2016.

Hays County, Texas. Hays County Office of Emergency Management. 2011 Hays County Hazard Mitigation Plan. Jeff Turner. San Marcos: Hays County, Texas, 2011. Print.

Horney, Jennifer, et al. “Measuring participation by socially vulnerable groups in hazard mitigation planning, Bertie County, North Carolina.” *Journal of Environmental Planning and Management*, vol. 58, no. 5, 2014, pp. 802–818. *EBSCOhost Online Research*, Accessed 1 Apr. 2016.

Hyndman, Donald W., and David W. Hyndman. *Natural hazards and disasters*. Australia, Thomson Higher Education, 2006.

Jersild, Arthur T., and Margaret F. Meigs. "Direct Observation as a Research Method." *Review of Educational Research*, vol. 9, no. 5, 1939, p. 472. doi:10.2307/1167746.

Keane, Robert E., et al. "Mapping wildland fuels for fire management across multiple scales: Integrating remote sensing, GIS, and biophysical modeling." *International Journal of Wildland Fire*, vol. 10, no. 4, 2001, pp. 301–319. *Google Scholar*, Accessed 5 Apr. 2017.

Kousky, Carolyn, and Ray Rasker . *Lessons for Wildfire from Federal Flood Risk Management Programs*. Headwaters Economics, Bozeman, MT, 2014, *Lessons for Wildfire from Federal Flood Risk Management Programs*.

Lai, Po-Hsin, and Urs P. Kreuter. "Examining the direct and indirect effects of environmental change and place attachment on land management decisions in the Hill Country of Texas, USA." *Landscape and Urban Planning*, vol. 104, no. 3-4, 2012, pp. 320–328. *EBSCOhost Online Research*, Accessed 10 Apr. 2016.

Liu, Zhihua, et al. "Climate change and wildfire risk in an expanding wildland–urban interface: a case study from the Colorado Front Range Corridor." *Landscape Ecology*, vol. 30, no. 10, 2015, pp. 1943–1957. *EBSCOhost Online Research*, Accessed 8 Apr. 2016.

Lu, Yongmei, et al. "Wildfire Risk Analysis at the Wildland Urban Interface in Travis County, Texas." *Geospatial Techniques in Urban Hazard and Disaster Analysis*, 2009, pp. 203–227.

Lydersen, Jamie M., et al. "Severity of an uncharacteristically large wildfire, the Rim Fire, in

forests with relatively restored frequent fire regimes." *Forest Ecology and Management*, vol. 328, 2014, pp. 326–334.

Miller, J. D., et al. "Quantitative Evidence for Increasing Forest Fire Severity in the Sierra Nevada and Southern Cascade Mountains, California and Nevada, USA." *Ecosystems*, vol. 12, no. 1, 2008, pp. 16–32.

National Academy of Sciences USA, vol. 112, no. 32, 2015, pp. 9833–9838. Accessed 1 Apr. 2016.

National Research Council of the National Academies. "Mapping the Zone: Improving Flood Map Accuracy." *Disaster Prevention and Management: An International Journal*, vol. 19, no. 2, 2010, pp. 274–275. Accessed 29 Mar. 2017.

National Wildfire Coordinating Group. *Wildfire prevention handbook*. Seattle, Outdoor Empire Publishing, Inc., 1980.

Reddy, Swaroop D. "PROFILE: Examining Hazard Mitigation within the Context of Public Goods." *Environmental Management*, vol. 25, no. 2, 2000, pp. 129–141., doe: 10.1007/s002679910010. Accessed 9 Apr. 2016.

Running, S. W. "CLIMATE CHANGE: Is Global Warming Causing More, Larger Wildfires?" *Science*, vol. 313, no. 5789, 2006, pp. 927–928. Accessed 3 Mar. 2017.

Safford, H.D., et al. "Effects of fuel treatments on fire severity in an." *Ecological Management*, 2009, pp. 773–787.

Shields, Patricia M., and Nandhini Rangarajan. *A playbook for research methods: Integrating conceptual frameworks and project management*. New Forum Press, 2013.

Shields, P. and Tajalli, H. Intermediate theory: The missing link in successful student scholarship. *Journal of Public Affairs Education*, 12(3)313-34, 2006

Shields, P. and Whetsell, T. (2017). Public Administration Methodology: A Pragmatic Perspective. In Raadshelders, J. and Stillman, R. *Foundations of Public Administration*, New York: Melvin and Leigh, 2017

Sirca, Costantino, et al. "A wildfire risk oriented GIS tool for mapping Rural-Urban Interfaces." *Environmental Modelling & Software*, vol. 94, 2017, pp. 36–47.

Smalley, James C. *Protecting life and property from wildfire*. Quincy, MA, National Fire Protection Association, 2005.

Steel, Zachary L., et al. "The fire frequency-Severity relationship and the legacy of fire suppression in California forests." *Ecosphere*, vol. 6, no. 1, 2015.

Stephens, S. L., et al. "The Effects of Forest Fuel-Reduction Treatments in the United States." *BioScience*, vol. 62, no. 6, 2012, pp. 549–560.

Texas State Fire Marshal's Office, et al. "Fires in Texas: 2013 Annual Fire Statistics." Fires in Texas: 2013 Annual Fire Statistics, State of Texas, 2014.

Thomas, Mariah. "The Impact of Forest Management Practices on Wildfire Severity in." *California State University, Sacramento,* California State University-Sacramento, 2015.

Travis County, Texas. Travis County Office of Emergency Management. Travis County Hazard Mitigation Plan. By Halff Associates, JSW & Associates, and Tetra Tech, Inc. N.P.: N.P., 2015. Print.

U.S. Forest Service. "Implementation Guidelines for Executive Order 13728." Implementation

Guidelines for Executive Order 13728, 2016.

Whitman, Ellen, et al. “Modeling Fire Susceptibility to Delineate Wildland–Urban Interface for Municipal-Scale Fire Risk Management.” *Environmental Management*, vol. 52, no. 6, 2013, pp. 1427–1439. *EBSCOhost Online Research*, Accessed 5 Apr. 2016.

Williamson County, Texas. Williamson County Office of Emergency Management. Williamson County Hazard Mitigation Plan 2015. By Halff Associates, JSW & Associates, and Tetra Tech, Inc. N.p.: Williamson County, 2015. Print.

Yin, Robert K. *The case study anthology*. Sage, 2004.