Planning Strategies for Community Wildfire Defense Design in Florida

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ABSTRACT

New community developments in the wildland–urban interface can be planned to minimize loss of property and life to wildfire through multiple defensive strategies. This research examines three communities impacted by the 1998 Florida wildfires and compares the physical context and development patterns of these communities to three recently designed Florida subdivisions that incorporate Firewise principles. Analysis of the relationship of wildfires to the physical context and development patterns of affected residential communities provides the framework by which the two groups of communities are compared. Findings show that incorporating multiple defensive strategies in community planning, including taking advantage of road location, utility corridors, greenbelts, and existing wetlands, may be effective in wildfire defense. The comparative analysis concludes with design and layout considerations for community development in the southeastern United States.

Keywords: design, wildfire, communities, defense

Urbanization is rapidly expanding in the southeastern United States (Cordell and Macie 2002). Changing demographics, increasing population, economic development, and a desire to live in the region's wildlands all contribute to urban centers spreading outward into surrounding forest and agricultural lands. Development that expands into the region's rural areas (i.e., wildlands) creates a zone known as the wildland–urban interface (WUI). The WUI interface has been described as "an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types" (Kline et al. 2004).

This article presents a descriptive analysis of fire events in the 1998 Florida wildfires that focus on the surrounding context and development patterns of the fire-affected lands. The wildfire analysis serves as a framework for comparing the surrounding context and development strategies of three Firewise subdivisions in Florida. The comparative analysis concludes with considerations for community development occurring in the WUI in the southeastern United States that includes site selection, incorporation and placement of multiple defensive zones for roads and existing wetlands, and inclusion of managed greenbelts.

Although there is a wealth of information already publicly available through Firewise (Firewise 2008) and the National Fire Protection Association (NFPA 2008) concerning architectural standards, landscape and buffer zone requirements, and codes and regulations, there are few references concerning the organization of land-use elements in developments to minimize fire damage. Two publications that describe neighborhood organization patterns, in general terms, include James Schwab and Stuart Meck's *Planning for Wildfires* (Schwab and Stuart 2005), and the Florida Department of Community Affairs (DCA) and the Florida Department of Agriculture and Consumer Services (DACS) *Wildfire Mitigation in Florida* (Florida DCA and Florida DACS 2004). Although there are limited references to successful development patterns that reduce the risk of wildfire in the WUI, integrating greenbelts at the outer edges of developments has proven effective in prevention or slowing of advancing ground fires.

Greenbelts

Greenbelts are nondeveloped (i.e., no housing or roads) managed open-space or vegetated buffer zones between and within developments in the WUI. Greenbelts can meet human needs by incorporating land uses such as recreational areas, walking and

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biking trails, golf courses, pastures, parks, cemeteries, reservoirs, and agricultural land among others, while preserving or restoring essential ecological services. Greenbelts can include features such as streams or lakes, wetlands (effectiveness dependent on water level, soil moisture, and other conditions), utility corridors, and other managed rights-of-way (ROW) that serve as natural or human-induced wildfire buffers.[1] Although greenbelts provide numerous amenity opportunities and ecological benefits, including reducing risk of catastrophic wildfire, Brzuszek and Walker (2008) analyzed 154 communities in 10 states with regulatory fire codes and ordinances specific to landscape features and found that only 6.5% (n = 154) required greenbelts. Stevenson Ranch in Los Angeles County, California, is a noteworthy example of the effective use of development regulations that require greenbelts in fire-prone developments. In 2003, Stevenson Ranch was in the direct path of the Simi fire but escaped fire damage that affected surrounding subdivisions. A 2003 US Department of Homeland Security/Federal Emergency Management Agency (FEMA) article on the fire event noted that the outer greenbelt and the 100-ft interior greenbelts (i.e., between homes) enhanced fire protection in conjunction with the use of fire-resistant plant materials and fire-resistant building materials (US Department of Homeland Security/FEMA and the California Governor's Office of Emergency Services 2003). In addition, wildfire saves for The Bridges, The Crosby, Cielo, Santa Fe Valley, and 4S Ranch subdivisions in the 2007 Witch Creek fire in San Diego, California, credit managed greenbelts for reducing wildfires effects on these communities (Weisberg et al. 2007). None of the homes in these five subdivisions was lost while surrounding subdivisions that did not integrate greenbelts suffered severe damage.

Methods and Materials

We first examined the fire events associated with the 1998 Florida wildfires and compared the effectiveness of major land-use elements in three Florida counties in stopping the advance of wildfire. Second, we examined the layout and design strategies of recent Firewise subdivisions in Florida. By comparing the outcomes of the fire events with the intended effects of Firewise designs, a series of recommendations were proposed for planning of defensible space in the WUI.

Three wildfires examined were the Flagler, Volusia, and Brevard County fires of late June 1998. For each of these cases, a geographical information system (GIS) was used to map the extent of areas affected by wildfire. Fire event descriptions included an analysis of prevailing weather conditions as well as weather conditions at the time of the fires. Land-use context was examined using cover and land-use data in the GIS. Maps used to examine the regions affected by the 1998 fires were analyzed to describe the spatial distribution of cover classes and defensible zones. The path of wildfires was described to determine which defensible zones were breached and which zones provided protection. Five 500-m transects were placed in the GIS, parallel to the direction of fire travel, in each of the three 1998 fire areas. The transects were placed along the eastern extent of the fire area, in regions where fire advances were halted. These transects represent the last land uses that the fires traveled through before being brought under control. All successful defenses were recorded and summarized according to type for comparison with designed communities.

Three Firewise communities developed after the 1998 wildfires were examined and included

1. RiverCamps on Crooked Creek, located near Panama City Beach, Florida, and developed by the St. Joe Company.
2. Veranda, located in North Fort Myers, and developed by the Bonita Bay Group.
3. Briargate, located outside Ormond Beach, Florida, an existing subdivision evacuated at the time of the Volusia County wildfire and subsequently retrofitted with Firewise strategies.

The cover classes of areas inside and surrounding these developments was characterized using aerial photography. All communities were analyzed to summarize defensible design and management strategies implemented at the developments.

1998 Florida Wildfires

In late June 1998, several wildfires began in the area inland of Florida's east coast (Figure 1). These fires spread east rapidly, powered by frontal circulation winds and assisted by unseasonably dry conditions resulting from the El Nino oscillation. The fires moved toward the populated east coast on July 1st, crossing multiple roads and their ROWs. The advance continued until July 4th, when increased humidity and decreased winds slowed the fire advance. Rainfall began on July 5th, which aided in bringing them under control (Routley 2004).

Flagler County Fire

West of Palm Coast, between the city and San Mateos, there is limited transportation infrastructure resulting in a large roadless area that contains a mix of upland and wetland forest with small amounts of cleared or developed areas. The fire crossed four major defensible zones that included wide utility and interstate ROWs. Additionally, the wildfire crossed many smaller roads and their ROWs, a railroad ROW, and other potential defensible zones before and after the fire entered the populated portion of Flagler County. Successful defense was implemented along portions of the I-95 corridor, in residential subdivisions, which had implemented fuel reduction controls, and along compact, fine-grain roadway networks in areas with relatively more dense (greater than 2 U/ac) development. In addition, a network of long and narrow wetland forests, oriented perpendicular (north to south) to the direction of fire travel, contributed to controlling the fire.

Volusia County Fire

As with Flagler County, the Volusia fire began in wildlands to the west of the developed coastline. The wildfire began in western Volusia County in a large, virtually roadless area and burned eastward for 7–12 mi before reaching major roadways and outskirts of Ormond Beach and Daytona Beach. Forested lands are the primary land cover in Volusia County, with no major north–south roadways and only three east–west roadways within the wildfire area. The fire crossed three major defensible zones, which included utility and interstate corridors and, once the fire entered the more heavily populated areas of the county, it crossed fewer defensible zones. Successful defense occurred in wildland areas near I-4, along and near the I-95 and US Highway 1 corridors, and along compact, fine-grain roadway networks in areas with low-density (less than 2 U/ac) development.

Brevard County Fire

In Brevard County, the wildfire initially affected the area near Lake Harney that is largely comprised of scrub and freshwater marsh. The fire crossed three major defensible zones that included utility and interstate ROWs. Successful defense occurred along

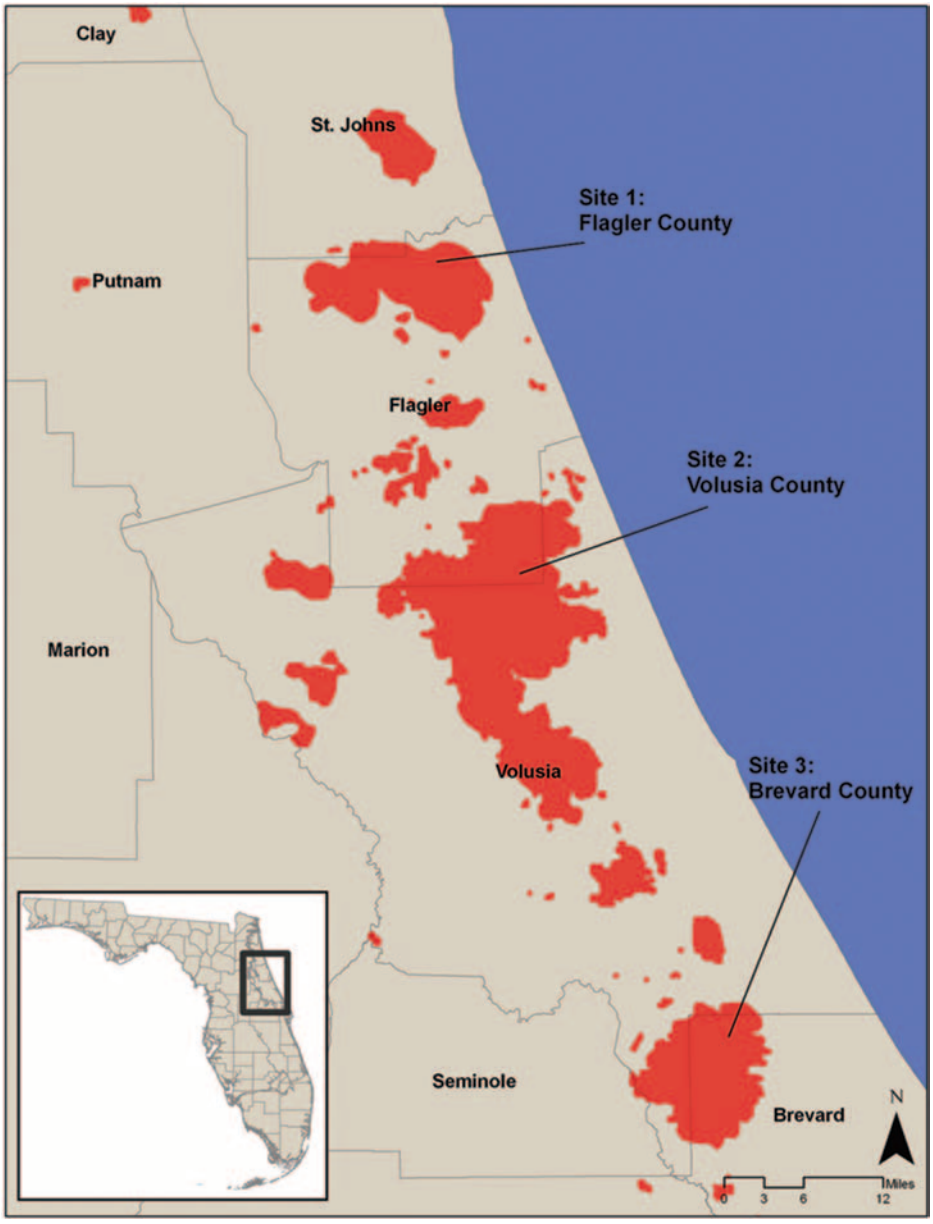

Figure 1. Regional map showing fire-damaged areas of the 1998 Florida wildfires for Flagler, Volusia, and Brevard Counties in Florida. The wildfire traveled from west to east. (Graphic by Marc Foster.)

much of the I-95 corridor, along the US Highway 1 corridor in some areas where I-95 was crossed, and in residential subdivision areas, primarily along smaller roadways in areas with relatively less dense (less than 2 U/ac) development. There was substantial road access and residential development near the fire's beginning point near Pennichaw.

Findings

Proximity of potential fuel sources, fire-prone habitat types, and roadless areas are high risk factors that warrant due consideration when planning and organizing a community development. All three fires examined had tens of thousands of forested, relatively roadless wildlands adjacent to the sites of affected residential developments. This landscape-level context had a substantial effect on the fire risk to subdivisions, which are much smaller in scale by comparison. Examination of fire risk at multiple scales may inform site selection and design processes at the community or subdivision scale, as well as community planning and regulatory needs. In each of three examined cases, wildfires crossed the largest available defensible zones. Successful defense occurred in compact, fine-grain residential road networks and greenbelt-like systems in subdivisions in Flagler, Volusia, and Brevard Counties. Integrating multiple, redundant defensible zones may provide the best defense in an intense fire event. For purposes of comparing the context and development pattern findings from the 1998 Florida wildfires to three Florida Firewise planned communities, green infrastructure refers to nondeveloped vegetated land and utility ROWs (nonroad related); blue infrastructure includes streams, lakes, and other waterbodies; and gray infrastructure consists of roads and their ROWs.

Green Infrastructure

During the 1998 fires, cleared easements and ROWs contributed to a successful defense in many areas. Large utility easements provide hundreds of feet of canopy-free space suitable for perimeter fire defense. These utility corridors functioned as greenbelts, and it is suggested that managed open-space or vegetated buffer zones be incorporated between and within WUI developments.

Blue Infrastructure

Canal, river, and marsh networks all contributed to successful fire defense in both the Flagler County and the Brevard County sites, even though forested wetlands burned after heat from the fires intensified. All fire areas examined had bands of forested wetlands running perpendicular to the direction of fire travel, which had a greater effect in retarding the 1998 fire. Consequently, open marshlands may serve as a more effective wildfire barrier than wooded wetlands. Therefore, conversion of forested wetlands intended as fire barriers to open-canopy or canopyless habitats that immediately adjoin existing structures may have advantages in controlling wildland fire. Permanent waterbodies and open-canopy or canopyless wetlands (i.e., marsh) should be incorporated where possible.

Gray Infrastructure

Utilize existing roadways, new roads, and maintain their ROWs as defensible zones. As shown in the 1998 Brevard County, Florida fire, large roads and increased road densities were effective at stopping wildfires. Successful defense was also mounted in smaller, residential road and open-space networks in subdivisions in Flagler, Volusia, and Brevard Counties. Land-

Table 1. Maximum and minimum range of widths of land-use elements encountered in the final 1,640 ft (500 m) of fire travel for the 1998 wildfires in Flagler, Volusia, and Brevard Counties in Florida.

Land-use class	Land use in last 1,640 ft of fire travel (5 transects/fire area)		
	Flagler (ft)	Volusia (ft)	Brevard (ft)
Gray			
Low-density residential	13–895	—	574–679
Medium-density residential	479–810	318	—
Urban	—	—	—
High-density urban	—	—	—
Roads	—	—	114–193
Green			
Forest	118–1,135	92–810	157–479
Scrub	—	—	174–826
ROW	—	183	—
Pasture	525	325	—
Golf course	187	—	—
Bare soil	—	—	—
Blue		—	
Water	92–282	—	361
Wet herbaceous	—	—	128–1,171
Wet forest	59–367	101–518	242

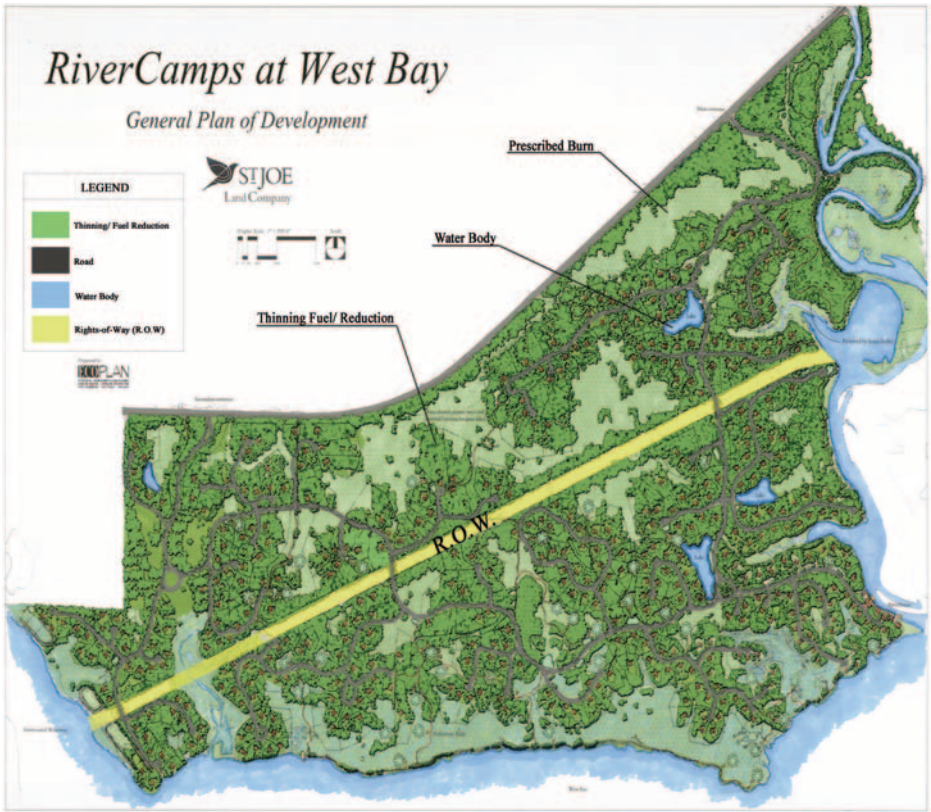

Figure 2. The RiverCamps General Plan of Development in Panama City Beach, Florida, shows main housing locations protected by waterways on the east, south, and west; and utility corridors and roads to the north. (Courtesy of the St. Joe Company.)

use classes in the final 500 m of fire advance at the eastern extents of the fires ranged from medium density residential to open water (Table 1). The absolute last land uses encountered along these transects in Flagler County were forest (twice), low-density residential (twice), and medium-density residential. For Volusia County, the last land use encountered before the fires were extinguished was forest for all transects. In Brevard County, the last land uses reported along transects were wet forest (three times), herbaceous wetland, and low-density residential. In each of the cases where forest was last encountered, wet forest or residential land use preceded it along the transect.

The value of large-scale planning that considers land use and associated regulations, and resultant fire risk context, can not be overstated. If development occurs in the WUI where the risk of fire is prevalent, this analysis indicates the need for multiple, redundant strategies addressing large- (i.e., regional planning) to small-scale (i.e., individual lot) development, that uses and organizes patterns of green, gray, and blue infrastructure as means to defend against wildland fire. As is shown by the efficacy of the defense of the Stevenson Ranch community in Los Angeles, California, to be effective, plans and strategies should be made policy and that policy should be administered and enforced.

Florida Firewise Communities

Development of the following communities occurred after the 1998 Florida fires. Subsequently, planning and design of each community integrated wildfire prevention principles. Descriptive analysis for each community includes its adjoining land-use context, as well as gray, blue, and green infrastructure patterns and organization, for comparison with the findings from the 1998 Florida wildfires.

RiverCamps on Crooked Creek

Located just outside Panama City Beach, Florida, RiverCamps on Crooked Creek is a planned residential community designed for 450 homes (Figure 2). Kevin Smith of the St. Joe Company conveyed that RiverCamps, the first Firewise Community/USA in the Florida panhandle, is located on previously managed forestlands owned by The St. Joe Company (personal communication). RiverCamps contains 1,500 ac and retains the character of Gulf Coastal plant communities. The primary wildfire hazard area from surrounding forestlands is from the northern edge of the development. Design and management of RiverCamps (a team of in-house and consulting landscape architects, planners, and foresters hired by the St. Joe Company) incorporated a variety of Firewise strategies, including mechanical thinning and prescribed burn management for a variety of habitat types.

Green Infrastructure

In developable areas, thinning of canopy trees to 100 trees/ac reduced the vege-

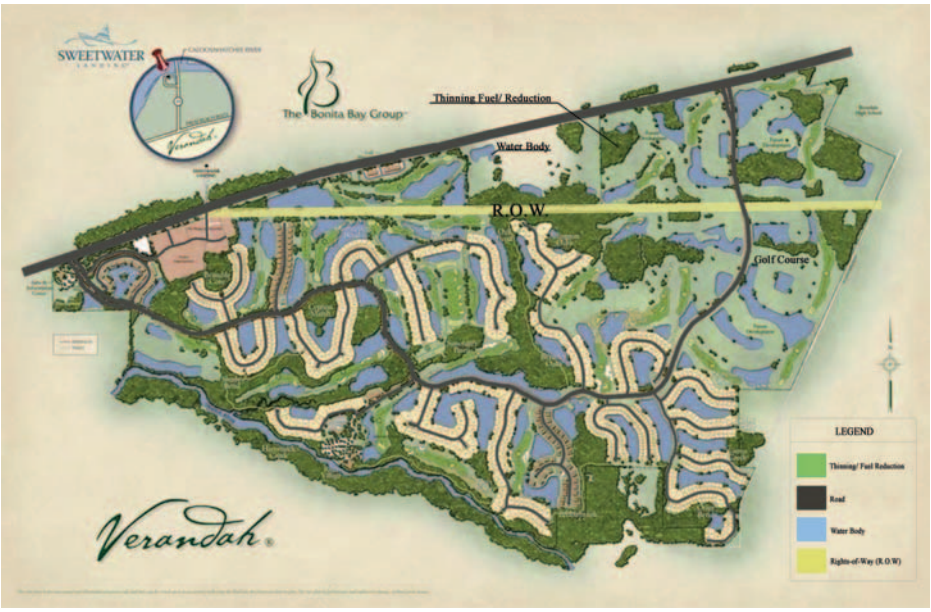

Figure 3. The Verandah General Plan of Development in North Fort Myers, Florida, dispersed green space elements and waterways throughout the development. (Courtesy of The Bonita Bay Group.)

tated fuel load. Fire protection inside the northern edge road comes from the designated location of the fire managed wet pine savanna community. Called the "grass lakes," this zone was previously a thinned pine (*Pinus* spp.) plantation with heavy underbrush removed to create an open grassy understory. After the clearing of dense pine stands, the site was rollerchopped and prescribe burned. A burn schedule of 2- to 3-year intervals promotes naturally occurring graminoid and forb species, while reducing vegetative fuel loads. In addition, an existing 200-ft wide utility ROW traverses the site east to west and provides wildfire protection for housing located on its southern edge.

Blue Infrastructure

Most of the developed residential area in RiverCamps takes advantage of wildfire protection from the natural and/or constructed waterways that surround the community. This blue infrastructure protects RiverCamps by taking advantage of Crooked Creek to the east, West Bay to the south, and the Intracoastal Waterway to the west. In addition, small lakes located throughout the development serve as fuelbreaks, while simultaneously providing an amenity for residents.

Gray Infrastructure

Highway 388, a two-lane county road with a 100-ft ROW runs along the entire northern edge of RiverCamps, separates the property from forestlands to the north and provides access for multiple entry roads to the development. The interior road system consists of 20-ft-wide roads that circulate throughout the development. Although these roads do not create a classic outer ring road, they serve the same purpose.

In addition to the aforementioned fire management of pine savanna environments, a management schedule that includes periodic thinning of overstory trees and underbrush is in place for the remaining plant communities. Likewise, there is a planned periodic burn schedule for salt marsh wetlands in designated management zones, while the management plan for seasonal marshes and upland and lowland pinelands consists of a combination of hand thinning and burning.

Verandah

Verandah, a 1,400-ac development of The Bonita Bay Group, is a master planned residential community located in North Fort Myers, Florida and is a recognized Firewise Community/USA (Figure 3). The Bonita Bay Group has an in-house staff of planners and, before 2003, the site was in agricultural use as a cattle ranch operation.

Green Infrastructure

The Florida Association of Realtors recognized Verandah with a Residential Environmental Award for preservation of the area's natural elements. The development retained over 70% of the land as greenbelt (i.e., open space) that includes nature preserves, parks, lakes, and riparian buffers. Over 9 mi of walking and bicycle paths (4-ft-wide average) are included in the development, which provide small fuelbreaks and a community amenity. Golf fairways serve as narrow green corridors between housing clusters and function as a wildfire defense zone.

Blue Infrastructure

The Orange River borders the southern and western edges of the development, offering protection from scattered woodland patches from the south. The riparian zone of the Orange River varies between 100 and 125 ft in width. Dispersed throughout the community is an extensive collection of small lakes and ponds that maximize residential water frontage, while providing fuelbreaks and emergency access via the river.

Gray Infrastructure

Highway 80, a four-lane divided highway, borders the entire north property line. Buckingham Road borders the east edge of the property. Multiple entrances provide access to the development. Interior roads are 25 ft wide with 5-ft shoulders. All roadway turnarounds have radii of 50 ft to accommodate large emergency vehicles.

Briargate

Briargate is a subdivision within the planned community of Hunter's Ridge, located in the western suburbs of Ormond Beach, Florida (Figure 4). The development was planned by the developer with assistance and review by local forestry officials. The planning advisory board at Briargate included local fire officials, homeowners, and the developer to create strategies for wildfire control and community amenities. The inclusion of community fire officials allowed for variances to development requirements, resulting in significant cost savings. Briargate is a recognized Firewise Community/USA development on 60 ac of land with 89 planned homesites. The Hunter's Ridge subdivision contains 2,280 homesites, situated in pine (*Pinus* spp.) forests. During the 1998 wildfire season, the subdivision was impacted from three separate wildfires that consumed nearly 500,000 ac in central Florida. Although the 1998 fires came within a ¼ mi from Briargate, the area that Briargate now encompasses was not directly affected

by the 1998 fires, because of a utility ROW located to the west that was used as a defensible zone. This important defensive element separated the now-developed area from the woodland fuels located to the northern and western sides of the development.

Green Infrastructure

The development contained common green space areas of pine forests and hardwood swamps. Bordering the entire west side of Briargate and Hunter's Ridge was a managed 20-ft-wide utility line ROW. The utility ROW was in a strategic location because wildland fires typically occur from the west due to predominantly early and midday westerly winds. Thinning Briargate's and surrounding woodlands to 100 trees/ac reduced the vegetated fuel load.

Blue Infrastructure

Briargate, and much of Hunter's Ridge, use ponds located in strategic locations to provide defensive fire zones and mitigation for stormwater runoff. Many ponds are oriented in a north–south direction, which offer further protection from fires occurring from the west.

Gray Infrastructure

Airport Road, a two-lane paved surface with managed ROW, borders Briargate along its entire northern edge and provides two entries into the development. An inner loop road, Briargate Look, is a 24-ft wide road that creates an inner ring of protection for homes, as does Thornhill Circle. Many of Briargate's roads are oriented in a north–south direction contributing to fire protection from the west.

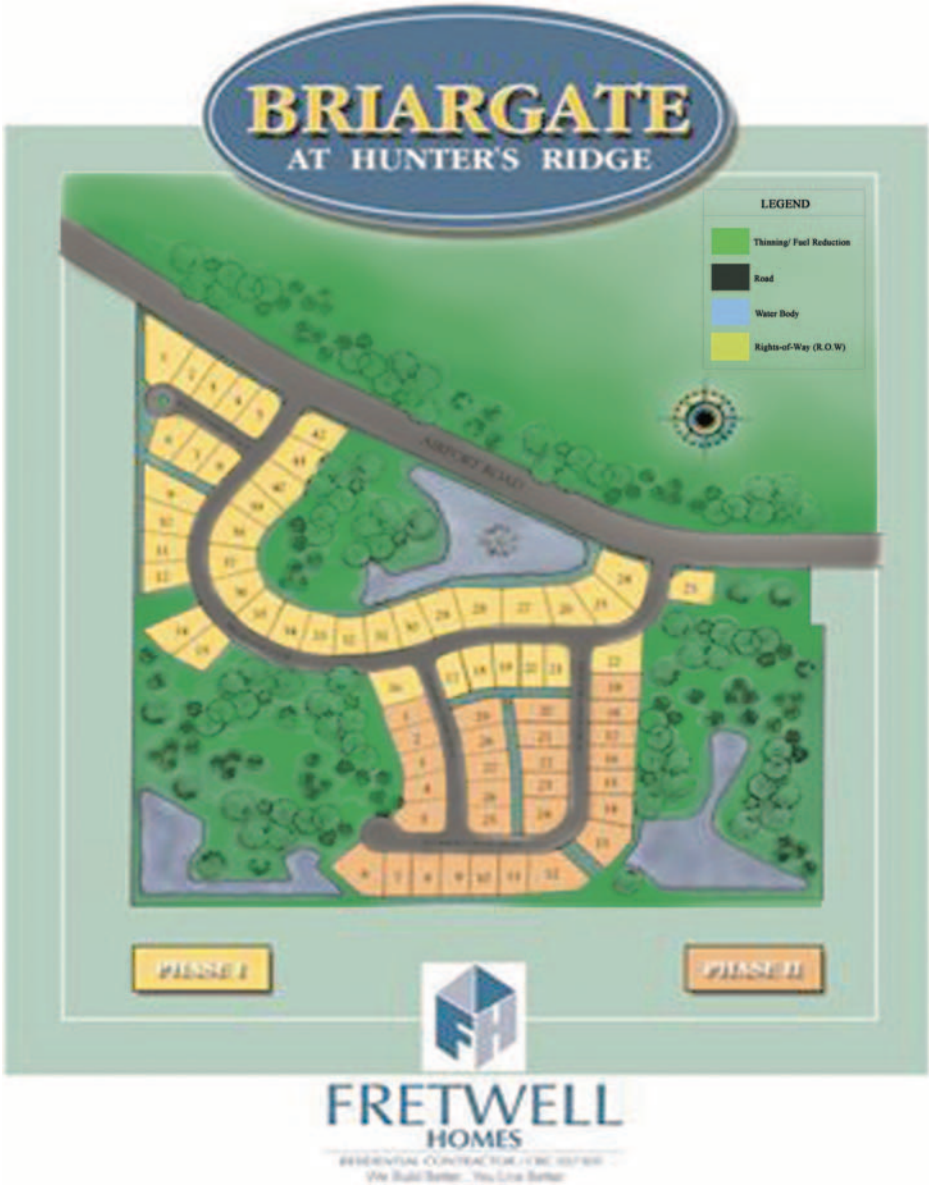

Figure 4. Briargate General Plan of Development in Ormond Beach, Florida, showing the locations of homes, waterbodies, and woodland areas. (Courtesy of Fretwell Homes.)

Comparison of Context and Development Patterns of the Three of Florida Firewise Planned Communities with the Findings from the 1998 Florida Wildfires

Design and layout of all three Firewise communities in the study revealed similar techniques for incorporating existing fuelbreaks and integrating managed buffer space in and around the developments. Although a wildland fire still has not tested these developments, comparing development patterns and organization of these communities to the 1998 Florida wildfires in Flagler, Volusia, and Brevard Counties provides insight for the design of WUI communities and land-use planning and regulation.

Examination of Fire Risk at Multiple Scales May Inform Site Selection and Design Processes, as Well as Planning and Development Regulations, at the Community or Subdivision Scale

Catastrophic wildfire prevention is best accomplished at the regional planning level and is difficult to achieve at individual site levels. The 1998 Florida fires occurred in large roadless areas containing heavy fuel loads. By comparison, the scale of subdivisions was minimal in relation to landscape level high fire risk of the surrounding context. Unfortunately, in terms of fire risk, vegetated fuel loads and landscapes that surround the Firewise communities are similar in context. In these instances, it is imperative to address, at the regional scale, high hazard areas of wildfire risk and other potential natural disasters. Development and enforcement of plans and ordinances that prevent development in areas known to be at high risk of catastrophic wildfire or, at a minimum, that require compact defensible development is the best approach to new development. In addition, it is essential to work with local fire officials and community stakeholders in the early planning phases of WUI development. At RiverCamps, cooperation between the Florida Division of Forestry and developers resulted in an extensive mitigation effort before property planning.

Integrating Multiple, Redundant Defensible Zones Provides the Best Defense in an Intense Fire Event

All three developments use a number of Firewise design principles that address multiple fire risks, ranging from vegetative management to building and road standards. Table 2 displays the defensive land uses and their minimum and maximum sizes used at each of the three case study sites. RiverCamps uses more multiple defensible zones and management areas when compared with Verandah or Briargate. As shown in the 1998 Florida fires, multiple, smaller defensible zones were effective strategies for stopping wildfires, particularly wet forest or residential land-use elements.

Table 2. Categories of defensive land-use types and ranges of minimum and maximum widths used at three Firewise Community/USA designed subdivisions in Florida.

Design element	RiverCamps	Veranda	Briargate
Gray			
Road ROWs	20–65 ft	35–100 ft	20–90 ft
Hiking/biking trails	4–6 ft	4 ft	4 ft
Green			
Thinning/fuel reduction	100 trees/ac	Not managed	100 trees/ac
Prescribed burning	75–300 ft	Not present	Not present
Utility ROWs	200 ft	40–100 ft	20 ft
Greenbelts	75–300 ft	50–700 ft	Not present
Golf fairways	Not present	80–1,000 ft	Not present
Blue			
Lakes/retention	100–800 ft	100–300 ft	20–335 ft
Rivers/canals	40–800 ft	100–125 ft	Not present
Estuaries	Present	Not present	Not present

Green Infrastructure: Integrate Greenbelts as Managed Open-Space or Vegetated Buffer Zones between and within Developments in the WUI

As evidenced in the 1998 wildfire at Hunter's Ridge, managed utility ROWs can be valuable defensible zones. Briargate and RiverCamps took advantage of these existing narrow greenbelts for further protection, while providing the community with open space as an additional amenity. Similarly, Verandah's use of golf course fairways along the periphery and development interior provide fire protection, while offering community recreation. RiverCamps extensive pedestrian trail systems act as additional firebreaks in both woodland and savanna areas and provide access to important amenity use points along the bay. Design and location of open savanna grassland areas at RiverCamps provided an important buffer from neighboring wildland fuels. The continued use of prescribed fire in this area and thinning of adjacent woodlands were important management goals to reduce wildfire fuel loads.

Blue Infrastructure: Incorporate Permanent Waterbodies and Open-Canopy or Canopyless Marshlands (i.e., Wetlands) Where Possible

Existing waterbodies stopped advancing wildfires in the 1998 Flagler County fire. All three developments contain newly created waterbodies dispersed throughout the subdivisions. The location of principal residential developments at RiverCamps took advantage of water protection on three sides of the subdivision. Likewise, Orange Creek at Verandah formed a large property buffer for this community. Intermittent streams, hardwood swamps, or drainage corridors can use shaded fuelbreak strategies of thinning riparian edges to reduce fire hazards in dry seasons or under low humidity conditions. As shown at RiverCamps and Verandah, these riparian buffers form extensive firebreaks for protection. Likewise, orienting waterbodies along the width of potential wildfire directions, as in the Hunter's Ridge subdivision, improves the effectiveness of fire defense. In addition, the inclusion of retention ponds offers firefighters another source of water during fire operations.

Gray Infrastructure: Use Existing Roadways, New Roads, and Their ROWs as Defensible Zones

As shown in the 1998 Florida fires, increased road densities were effective at stopping wildfires. Where it is practical, new road patterns and organization should be oriented perpendicular to the fire threat. An outer loop road in conjunction with a network of a smaller, fine-grain road system can provide multiple defensible zones of gray infrastructure. All three developments wisely use major and/or minor roads as defensive space. Briargate's use of 24-ft wide loop roads with managed ROWs offers increasing zones of protection for structures from wildfires originating off site.

Study Implications for Community Wildfire Defense Design

Comprehensive hazard planning provides multiple benefits to developers, community agencies, and fire officials. Creating denser development footprints reduces wildland fire threats by improving defensibility; reducing urban sprawl; increasing community green space that provides recreational opportunities, wildlife and plant species conservation; enhancing carbon sequestration; and reducing landscape fragmentation (Hellmund and Smith 2006). Additionally, the provision of green space and its organization within development provides for increased water infiltration and stormwater runoff quality (Binford and Karty 2006).

To maximize protection from regional wildfire impacts, plans for community locations should take full advantage of existing natural and constructed fire barriers, including wetlands, roads, and maintained utility corridors. Structures should be concentrated and located in proximity to fire barriers separating them from wildland fuels and primary fire travel directions. Land-use planning should identify areas at risk of wildfire and inform regulations that mitigate this risk. Community development codes should be required to include managed green space provisions located around the outer perimeters of subdivisions that also serve as enhanced ecological corridors. Also, as evidenced in our case study examples, requiring and implementing multiple, redundant defensible zones from the regional to community scales may provide better defense in fire events.

Endnote

[1] The National Firewise Communities program is a multiagency effort designed to reach beyond fire agencies by involving homeowners, community leaders, planners, developers, and others in the effort to protect people, property, and natural resources from wildland fire. Firewise Communities is part of the National Wildland/Urban Interface Fire Program, which is directed and sponsored by the Wildland/Urban Interface Working Team (WUIWT) of the National Wildfire Coordinating Group, a consortium of wildland fire organizations and federal agencies responsible for wildland fire management in the United States. The WUIWT

includes the US Forest Service, US Department of the Interior (USDI) Bureau of Indian Affairs, USDI Bureau of Land Management, USDI Fish and Wildlife Service, USDI National Park Service, Federal Emergency Management Agency, US Fire Administration, International Association of Fire Chiefs, National Association of State Fire Marshals, National Association of State Foresters, National Emergency Management Association, National Fire Protection Association. Information on Firewise Communities is available online at www.firewise.org.

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