CHAPTER THREE
FIRE PROTECTION SERVICES

This Chapter includes sections on the various aspects of the delivery of fire and emergency medical first responder services by the St. John's Fire District (STJFD) in the delivery of fire services in the State of South Carolina, the Town of Kiawah Island, and Charleston County.

BACKGROUND

Fire protection services for the Town of Kiawah Island are provided by the St. John's Fire District. The St. John's Fire District is a special purpose district in Charleston County, South Carolina, located just south of the City of Charleston. The district consists of four barrier island communities: John's Island, Kiawah Island, Seabrook Island, and Wadmalaw Island. The islands are separated from the mainland by rivers. The fire district borders the Atlantic Ocean to its east. The St. John's Fire District has been providing fire and rescue services to the district since 1959. Currently, the Fire District has an Insurance Services Office (ISO) Class 3/9 rating with Johns Island, Kiawah Island with Seabrook Island assigned an ISO Class 3 rating, and Wadmalaw Island an ISO Class 9 rating.

The Fire District is comprised of approximately 146 sq. mi. and is home to about 22,000 residents. The area provides a variety of recreation, historical, and fine dining opportunities. Johns Island is home of the Angel Oak, a live Southern live oak that is estimated to be from 400 to 1,500 years old. Kiawah Island is a gated community and golf and beach resort. It is the home of two premier golf courses: the Ocean Course and the River Course. The Ocean Course has hosted the 1991 Ryder Cup, 1997 World Cup of Golf, the 2007 Senior PGA Championship, and the 2012 PGA Championship.

OVERVIEW — ORGANIZATION

Organizing fire and emergency services within a community to provide the most efficient and cost effective delivery of quality service is one of the most important functions of local government. Historically, many fire/EMS services were developed and organized on the basis of local neighborhood need and initiative and, in many instances, volunteer

fire departments were initially formed. However, as communities have become increasingly urban, calls for service have increased resulting in the need for increased coordination and direction of fire and rescue services and resources through paid services.

A key fire and EMS organizational principle relates to the basic responsibility for public safety within the community. In most areas of the United States, it is widely accepted that the provision of fire and EMS service is considered to be a local government responsibility. Local government is broadly interpreted to include municipalities, such as cities, towns, villages, and townships.

To attain the delivery of optimum fire and emergency medical service, it is essential that local government recognize and accept that responsibility and fulfill that obligation to provide appropriate guidance and direction in order to:

- Oversee the formation process of the organization of fire and EMS services;
- Ensure that the fire/EMS organization reflects the public interest;
- Protect the service from undesirable external interference;
- Determine basic policies for providing services; and,
- Legally define the duties and responsibilities of service providers.

Identification of this authority and responsibility is addressed in Section 3-1 of NFPA 1201, Developing Fire Protection Services for the Public, as follows:

> "The government agency responsible for establishment and operation of the fire department shall adopt a formal statement (bylaw, statute) of purpose and policies for the fire department that includes the type and levels of services that are to be provided, the area to be served, and the delegation of authority to the fire chief and other officers to manage and operate the fire department."

ACCEPTED PRINCIPLES AND PRACTICES — ORGANIZATION

Both the National Fire Protection Association (NFPA) standards and Commission on Fire Accreditation International (CFAI) criteria provide guidance to municipalities and fire departments relating to organization structure.

Section 1.02 NFPA 1201 – Standard for Developing Fire Protection Services

NFPA 1201 provisions relate further to the organization structure of fire departments providing guidance to this Fire and Emergency Medical Services Study as follows:

> **"Chapter 5: Organizational Structure of the Fire Department**
>
> 5-1 Purpose. The fire department shall have an organizational structure that facilitates efficient and effective management of its resources to carry out its mandate.
>
> 5-2 Management/Fire Chief.
>
> 5-2.1 The manager of the fire department shall be the fire chief. The fire chief shall be governed in the development of regulations and orders by the provisions of all applicable laws or ordinances and shall maintain a file of such documents.
>
> 5-2.2 The fire chief shall be appointed on the basis of merit and ability.
>
> 5-2.3 The fire chief shall communicate closely with the local government chief executive and governing body.
>
> 5-2.4 The governing body shall establish only the primary policies of the fire department and shall not act as an administrative agency or direct day-to-day management of the department."

Section 1.03. CFAI Governance and Administration Criteria

The CFAI accreditation criteria related to fire department organization governance and administration that is relevant to this Fire and Emergency Medical Services Study is as follows:

Performance Indicators

> The governing Board and/or agency manager has been legally established to provide general policies to guide the agency, approved programs and services, and appropriated financial resources.
>
> 1. The agency has been legally established.

2. The governing body having jurisdiction over the fire service organization or agency periodically reviews and approves programs and ensures compliance with basic agency policies.
3. The governing body approves the administrative structure that carries out the agency's mission.

There is an established administrative structure and environment for achievement of the agency's mission, purpose, goals, strategies and objectives.

1. There exists an administrative structure that reflects the agency's mission, goals, objectives, size and complexity.
2. Allocation of resources reflects the agency's mission, goals and objectives.
3. The agency administration demonstrates compliance with legal requirements of local, state, and federal governments.
4. Personnel functions, roles and responsibilities are defined in writing and a current organization chart exists.

The Study Team considered these criteria as the organization of the STJFD was reviewed as part of this Study.

LEGAL AUTHORITY

The St. John's Fire District is a special purpose district created by the South Carolina Legislative Act 369 in April 1959. A special purpose district is a district created by an Act of the State General Assembly or pursuant to general law and provides any governmental power or function. Governmental powers or functions of special purpose districts in South Carolina include fire protection, sewage treatment, water or natural distribution, or recreation. As to all special purpose districts, the Charleston County Council has the power to expand or contract the district's boundaries, but not diminish the district out of existence.

Fire District's Mission Statement

The mission statement of the St. Johns Fire District as stated on its webpage is:

> "We, the men and women of the St. John's Fire District, are an organization of dedicated professionals existing to provide a professional level of life and fire safety to the people and property within our district.
>
> We will accomplish our mission through teamwork, prevention, education, fire suppression, medical services and other related emergency and non-emergency activities. We will actively participate in our community, serve as role models and strive to provide a product deemed excellent by our employees and citizens.
>
> Finally, we seek every employee's involvement and will strive to create a positive climate conducive to our improvement."

For the reader, mission statements define the organization's purpose and primary objectives. A mission statement's prime function is to define the key measure or measures of an organization's success.

Fire District Governance

A nine-member Board of Commissioners is responsible for the governance and oversight of the Fire District. The Governor of South Carolina appoints each commissioner member. Four commission members represent Johns Island. Three members represent Kiawah Island. Seabrook Island and Wadmalaw Island are each represented by one commissioner.

According to the Fire District's bylaws, "the Commission is responsible for overseeing the business and assets of the District, establishing and achieving desired results in major areas of District operations, and ensuring accountability to the local community for performance and fiscal accountability.

The powers of the Commission are vested in the Commission as a whole. No individual Commission member has the authority to act independently of the Commission, including directing the Fire Chief or staff, expending funds, acting or speaking on behalf of the Commission, unless otherwise expressly authorized by the by-laws or by an action of the Commission."

In accordance with the Fire District's bylaws, following are roles of its officers:

"The Chair shall:

- Preside over the Commission at all meetings of the full Commission.
- Act as the chief spokesperson for the Commission and interface on behalf of the Commission with the public, media and other governmental entities.
- Call special meetings of the Commission whenever there is sufficient business to come before the Commission, or upon written request of at least three (3) members of the Commission.
- Advise the Fire Chief on Agenda preparation for the meetings.
- Sign all papers and documents on behalf of the Commission and Fire District as required by law or as authorized by action of the Commission.
- Appoint a Chair and members of Commission standing and special purpose committees.
- Act as the primary liaison between the Commission and the Fire Chief and coordinate the Commission's actions with respect to the compensation and evaluation of the Fire Chief's performance.
- Exercise such other powers as may be delegated by the Commission.

The Vice Chair/Secretary shall:

- See that a true and accurate account of all proceedings at Commission meetings is kept and shall perform such other duties as usually pertain to the office of Secretary including:
- Direct that minutes, records, and other support material are prepared and made available in a timely fashion and in accordance with the by-laws.
- Serve or cause to be served all notices of the Commission.
- Sign documents as authorized by the Commission.
- Exercise such other powers that may be delegated by the Commission."

Fire Chief

Under limited supervision of the Board of Commissioners, the district's fire chief is responsible for leading, managing, planning, organizing, and directing all aspects of the Fire District. The chief's duties and responsibilities include:

- Directing and monitoring the implementation of programs related to fire prevention and suppression;
- Performing various administrative duties in order to ensure the compliance with federal, state and local laws relating to public safety and fire protection; and
- Participating in operational tasks.

The fire chief is the sole authority regarding the selection of all other Fire District personnel and is solely responsible for the daily administration of the Fire District. The position is full time and is exempt from the Fair Labor Standards Act.

Fire District's Organizational Structure

Through its 137 employees, the Fire District provides fire prevention; public fire and life safety education; fire suppression; hazardous material response; technical rescue; marine rescue; and medical first response services to the district's communities. According to its FY 2015 budget, the Fire District employs 124 uniformed personnel and 13 civilian employees and is organized into four organizational units: Administration Division, Suppression Division, Training Division, and Prevention Division.

According the Fire District's FY 2015 Annual Budget, the Administrative/Command staff includes:

- 1 Fire Chief
- 1 Assistant Chief
- 1 Administrative Battalion Chief
- 1 Finance/Office Manager
- 1 Human Resources Specialist
- 1 Accounts Payable/Capital Assets Specialist
- 1 Payroll Specialist
- 1 Administrative Assistant
- 3 Maintenance Officers

- 1 Communications Supervisor
- 4 Telecommunicators

The Suppression Division staff is comprised of:

- 3 Shift Battalion Chiefs
- 21 Company officers (captains and lieutenants)
- 33 Engineers
- 60 Firefighters

The Training Division has a Chief Training Officer and Assistant Training Officer; while the Fire Prevention Division is composed of a Chief Fire Inspector and Fire Prevention Specialist.

FIRE DISTRICT BUDGETS

The STJFD approved budgets for the last five fiscal years are shown in Figure 3.1.

Figure 3.1
APPROVED FISCAL YEAR BUDGETS

Fiscal Year	Approved Budget
FY 2015	$11,790,640
FY 2014	$10,853,288
FY 2013	$10,520,924
FY 2012	$10,065,575
FY 2011	$9,497,762

Fire District Revenues

Figure 3.2 details the Fire District's tax and other revenues over the last five fiscal years.

Figure 3.2
FIRE DISTRICT REVENUES

Fiscal Year	Property Taxes	Property Taxes - Delinquent	Merchant's Inventory Taxes	Grants	Atax	Fund Balance
2015	$11,499,232	$150,000	$10,349	$0	$0	$131,059
2014	$9,985,858	$450,000	$10,349	$119,700	$0	$287,381
2013	$9,742,025	$355,000	$10,349	$95,000	$48,000	$270,550
2012	$9,069,072	$300,000	$10,349	$301,798	$0	$384,311
2011	$8,856,468	$200,00	$10,349	$95,000	$0	$335,945

FIRE FACILITIES, STATIONS AND APPARATUS

This section lists all Fire District facilities, their locations, and assigned fire/rescue apparatus.

Headquarters — 1148 Main Road, Johns Island

- Opened in 2014, and houses administrative staff, Fire Marshal's Office and Training Division

Station 1 — 3327 Maybank Highway, Johns Island

- Opened in 1959 and houses Engine 701 and Boat 707
- Engine 701 – 1,000-gallon booster tank and 1,500 GPM pump
- Serves as the boat team for Marine 701, a 28' unit with a 1,200 GPM pump capacity and has both firefighting and search and rescue capabilities
- Location of the Fire District's maintenance shop

Station 2 — 1025 Captain Sam's Road, Seabrook Island

- Opened in 2005 and houses Quint 702
- Quint 702 – 75' ladder, 500-gallon booster tank, and 1,500 GPM pump

Station 3 — 1932 Liberia Road, Wadmalaw Island

- Opened in 1969 and houses Engine 703 and Tender 703
- Engine 703 – 1,000 gallon booster tank and 1,500 GPM pump

- Tender 703 – 3,000 gallon booster tank and 1,000 GPM pump

Station 4 — 12 Sora Rail Road, Kiawah Island

- Opened in 1986 and houses Engine 704, Tower 704, and Rehab 704
- Engine 704 – 1,000 gallon booster tank and 1,500 GPM pump
- Tower 704 – 114' platform, 300 gallon booster tank and 2,000 GPM pump

Station 5 — 4550 River Road, Johns Island

- Opened in 1990 and houses Engine 705, Brush 705, Rehab 705, and Battalion 711
- Engine 705 – 750 gallon booster tank, 1,500 GPM pump and also serves as a rescue unit
- Brush 705 – 225 gallon booster tank and 75 GPM pump

Station 6 — 66 Ocean Course Drive, Kiawah Island

- Opened in 1996 and houses Engine 706
- Engine 706 – 1,000 gallon booster tank and 1,500 GPM pump

Station 7 — 1142 Main Rd, Johns Island

- Opened in 2006 and houses Engine 707, Quint 707, and Brush 707
- Serves as Haz-mat response team
- Engine 707 – 1,000 gallon booster tank and 1,500 GPM
- Quint 707 – 75' ladder, 500 gallon booster tank, and 1,500 GPM
- Boat 707 is a 18' unit with rescue capabilities only

Figure 3.3 summarizes apparatus by type.

Figure 3.3
SUMMARY OF APPARATUS TYPE

Apparatus Type	Number
Engines	6
Ladder/Platforms	1
Quints	2
Tenders	1
Brush Trucks	1
Boats	2

FIRE DISTRICT SERVICES AND COMPETENCIES

This section describes the services the Fire District provides to the community, as well as its core competencies.

The St. John's Fire District allocates its suppression resources based on geographic locations to assure adequate fire suppression response to areas of each island. As identified above, the Fire District has seven fire stations within the Fire District. The Fire District has developed response packages for each island and each type of emergency that may be encountered. These response packages are maintained in the Communication Center and are evaluated on an annual basis.

To assure adequate fire suppression resources for initial response to structure fires and backup coverage for simultaneously occurring incidents, the Fire District has entered into automatic aid agreements with the following fire departments/fire districts: City of Charleston, City of North Charleston, James Island and St. Andrews. The automatic aid agreements contain provisions for each department to follow a uniform Standard Operating Procedure for Safe Structural Firefighting and standardized initial response assignments.

The St. John's Fire District personnel are trained and capable of responding to a wide variety emergencies other than fires. Many of these other types of incident require specialized training and proficiency in the operations of specialized tools and equipment. The Fire District has trained and equipped its personnel to manage incidents involving the release of hazardous materials and marine rescue incidents. The Fire District is currently evaluating its need to develop capabilities to handle incidents involving extreme heights and trench collapses.

All fire suppression members of the Fire District are certified to the Hazardous Materials Operations level. This means they can respond to all hazardous materials incidents and begin initial incident control measures, such as isolating the perimeter of the incident to deny entry and assisting with evacuation of the surrounding area. Additionally, the Fire District has a paid hazardous materials response team. Hazardous materials response team members are trained to the Hazardous Materials Technician level. Hazardous materials response team members are on call 24 hours a day. There are five paid members per shift and several are on duty at all times. The Fire District maintains a

hazardous materials trailer that has the **capability of responding to incidents within thirty minutes to one hour** of its request for service. The district also provides mutual aid to other neighboring districts requesting the hazardous materials team and its equipment.

All of the Fire District's fire suppression members are also trained to the level of marine operations. With this training certification, members are able to check off the boats, prepare the boats for launch, transport the boats to the marina or boat landing, and launch the boats once a certified boat team member arrives. Each shift has several trained boat team members. Boat team members are trained on the complete operations of both the Fire District's boats. Each boat team member has received training in marine operations, as well as knowing the waterways around the islands. The marine team **requires thirty minutes to one hour to respond** to marine emergencies. The Fire District provides mutual aid to other districts requesting our marine team.

Among their emergency response capabilities, each suppression member of the Fire District is certified to the first responder level for medical emergencies. Many Fire District employees are certified as basic Emergency Medical Technicians (EMT) and at least one member is a certified EMT-Paramedic. Suppression personnel respond to all medical emergencies within the Fire District to which they are dispatched.

According to the Fire District's website, the Fire Prevention Division directs fire prevention activities including:

- Inspecting commercial and multiple-dwelling buildings at regular intervals;
- Issuing orders to correct violations of the 2012 ed. of the *International Fire Code*;
- Maintaining appropriate records;
- Investigating the causes of fires; and
- Conducting public education programs.

Additionally the Fire District has initiated a proactive program to help ensure the safety of the citizens and visitors called Citizen SAFE (Smoke Alarm and Fire Education). The program is conducted on the first and third Saturday of each month from 10:00 a.m. to 12:00 p.m. During the two-hour timeframe, firefighters from each of the STJFD fire stations canvas selected areas, going door-to-door offering residential smoke alarm checks and installation and home safety surveys. Fire District personnel will also install address numbers on residential homes, if needed. The program is free and voluntary.

Although the Study Team did not receive descriptions of the Fire District's training programs, the Study Team is able to make some conclusions about the district's training efforts. The Fire District does not possess a training facility capable of conducting recruit firefighter training. In an interview with the Fire Chief, it was stated that recruit training has been pursued through the South Carolina Fire Academy in Columbia, SC, and through the opportunities provided by the Charleston Fire Department and North Charleston Fire Department. The Study Team has also determined that live burn training is also available at the Charleston Fire Department's training facility. Discussions with the Deputy Chief also found that the Fire District will be pursuing Incident Management training, possible Blue Card Command, for the department's officers, starting with its chief officers. A scheduling calendar provided by the Fire District indicated that the department conducts in-service training programs within the department. Lastly, in response to the Study Team's request for information about the Fire District's training programs, it provided a copy of the South Carolina Fire Academy's Public Fire Service FY 2014 Curriculum Catalog, indicating that the Fire District personnel participate in programs at the State fire academy.

STUDY METHODOLOGY

In conducting studies similar to the one for the Town of Kiawah Island, the Study Team has utilized a proven and consistent approach to conduct and complete fire department analysis. This methodology incorporates eight distinct, but interrelated phases: (1) data collection; (2) interviews with key individuals; (3) on-site observation; (4) analysis of data; (5) comparative analysis (which included the computerized fire station location analysis); (6) alternatives and recommendations; (7) submission of a written Study; and (8) an oral briefing. Due to circumstances beyond the Study Team's control, interviews with fire department personnel and on-site observation were difficult to accomplish.

In addition to the eight-phase process previously identified, the following resource materials were used to identify accepted principles and practices for the operations and management of fire services as background and guidelines for the conduct of this study.

The framework for this analysis incorporated the model developed by the Accreditation Committee of the International Association of Fire Chiefs (IAFC) [now the Commission on Fire Accreditation International (CFAI)].

The CFAI's manual, entitled *Creating and Evaluating Standards of Response Coverage for Fire Departments*, provides guidance and direction on the conduct of fire rescue station, apparatus, staffing, and related risk assessment studies. The Study Team utilized the latest (4th Edition) of this CFAI guide in the performance of this Performance and Management Study for the Town of Kiawah Island.

Some of the key organizations with standards and publications that were used as part of this study are the following:

- National Fire Protection Association (NFPA)
- ISO Commercial Risk Services, Inc. (ISO)

The National Fire Protection Association follows a nationally recognized process for the establishment of many standards that are applicable to fire protection operations and administration. In many jurisdictions, some of the NFPA standards have been adopted and fully implemented, while in others, NFPA standards are utilized as general guidelines for pursuing further improvement in safety and services.

These and other written standards and nationally recognized documents, such as the NFPA *Fire Protection Handbook*, were used by the Study Team as reference materials.

RISK ASSESSMENT PROCESS

This section outlines and describes the method the Study Team used to develop recommendations for community fire risk assessment and fire service deployment.

Risk Identification

Community risk assessment begins with the identification of the hazards that are present in the community. Given that a particular hazard exists in a community, the consequences of an emergency event, such as a fire, are determined by the mitigation efforts made on the community's behalf. The consequences of the emergency event are the results of the combination of the hazard's level of risk, the type and magnitude of the event, loss of life or personal injury, property loss, economic losses, disruption of critical services and infrastructure, and damage to the environment. The results of a comprehensive risk

assessment allow fire department and government leaders to determine the methods to employ to manage risks to the community.

A community risk profile is created based on the community's unique mixture of demographics, socioeconomic factors, occupancy risk, and the level of services currently provided. Community risks fall into one of the following categories: life, property, or critical infrastructure.

Property risk is a particularly important element of a community fire risk assessment. Every individual structure in a community can be considered a hazard with inherent risks due its occupancy type and fire load. A critical subset of property risk is occupancy risk. Occupancy risk is established through an assessment of the relative risk to life and property if a fire was to occur in a specific building or in a class of occupancies, typed by their general use (e.g., single family residential, mercantile).

In addition to occupancy, the property risk analysis also includes the number and location of each type of occupancy and their associated hazard level. This analysis was performed to develop recommendations for a fire department resource deployment plan for the Town of Kiawah Island, which assures that sufficient fire department resources are dispatched to adverse events that occur in the occupancies in this town.

Although community fire risk is the primary concern of this section, the Study Team would be remiss if it failed to identify other risks to community related to the Fire District's service delivery areas. Figure 3.4 illustrates community risks by category.

Figure 3.4
RISK IDENTIFICATION

Fire	EMS	Rescue	HazMat	Marine
• One and two-family structures • Commercial structures • Wildland	• Illness • Injury	• Vehicle collisions • Trench • Structural collapse	• Transportation • Business • Agricultural	• Oceanic water • Coastal water

DEVELOPMENT OF A FIRE RESOURCE DEPLOYMENT PLAN

The Study Team used the information developed from the community fire risk assessment to prepare recommendations to plan for timely and sufficient coverage of all hazards and the adverse risk events that occur. The CFAI and others in the fire service community often refer to plans concerning timely and sufficient fire department coverage, as a Standards of Response Coverage or simply Standards of Coverage. More specifically, Standards of Coverage can be defined as written fire department policies and procedures that establish the distribution and concentration of the department's fixed and mobile fire service resources.

Resource distribution is associated with geography of the community and fire department unit's travel time to emergencies. Distribution is typically measured by the percent of the jurisdiction covered by the first-due units. Resource concentration also concerns geography and the spacing of multiple resources. Concentration involves the assurance of an initial "effective response force" that arrives on the emergency scene within the time frames established by community expectation and fire service leadership. (An effective response force can be defined as the minimum number of firefighters and equipment that must reach a specific emergency incident location within a maximum prescribed travel time.) Distribution relates to the speed of the arrival of the first-due unit, while concentration refers to the remainder of the fire department resources (effective response force) responding to the emergency incident.

Response time goals for first-due units and the total effective on-scene emergency response force serve as the impetus for fire department decisions concerning fire station location, apparatus deployed, and apparatus staffing levels. Fire department decisions related to station location, apparatus deployed, and staffing levels drive response time performance by all responding resources and the assembly of an effective firefighting response force on scene. If response times (resource distribution) and force assembly (resource concentration) times are low, it is an indication that sufficient resources have been deployed and outcomes from risk events are more likely to be positive. Conversely, if response times and force assembly times are high, it is an indication of insufficient resources and results from risk events are more likely to be unsatisfactory.

There are other factors that fire service and community leaders should consider relative to the fire department's standards of coverage. These include fire department operational performance, such as resource reliability and department capability. Resource reliability is the degree to which the resources are ready and available to respond when needed. Department capability is the ability of the deployed fire department personnel to manage an incident. Of these last two considerations, the Study Team has only addressed resource reliability, because it was not in the scope of the Study to measure the abilities of the Fire District's personnel.

Once the details of the Town's fire risks were known, the Study Team attempted to match fire service resource needs with the Town's risks. Fire department community management plans should include the deployment of adequate resources to either manage the known risks, or to respond and mitigate the emergency when harmful risk events like a hostile fire or medical emergency occur.

NFPA Standard 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations*, the NFPA *Fire Protection Handbook* and Insurance Service Office's (ISO) Public Protection Classification program are instructive in regards to identifying the response capabilities for initial fire attack. The Study Team is using NFPA 1710 in this study rather than NFPA 1720 because NFPA 1710 applies to emergency scene operations for career fire departments. NFPA 1720 applies to fire departments that are primarily staffed with volunteer firefighters.

NFPA 1710 specifies the number of on-duty fire suppression personnel sufficient to carry out the necessary firefighting tasks given expected firefighting conditions in various hazard level occupancies. Although 1710 specifically addresses low hazard environments, it mentions medium and high hazard levels as well. The following excerpts of the Standard are provided for the reader's understanding of its provisions concerning staffing levels, types of fire department resources deployed, and deployment requirements.

> ***5.2.2 Staffing.*** The number of on-duty fire suppression personnel shall be sufficient to perform the necessary fire-fighting operations given the expected fire-fighting conditions.

5.2.2.1 These numbers shall be determined through task analyses that take the following factors into consideration:

(1) Life hazard to the populace protected
(2) Provisions of safe and effective fire-fighting performance conditions for the fire fighters
(3) Potential property loss
(4) Nature, configuration, hazards, and internal protection of the properties involved
(5) Types of fire ground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene.

5.2.2.2.1 The fire department shall identify minimum company staffing levels as necessary to meet the deployment criteria required in 5.2.4 to ensure that a sufficient number of members are assigned, on duty, and available to safely and effectively respond with each company.

5.2.3 Operating Units. Fire company staffing requirements shall be based on minimum levels necessary for safe, effective, and efficient emergency operations.

5.2.3.1 Fire companies whose primary functions are to pump and deliver water and perform basic firefighting at fires, including search and rescue, shall be known as engine companies.

5.2.3.1.1 These companies shall be staffed with a minimum of four on-duty personnel.

5.2.3.1.2 In jurisdictions with tactical hazards, high-hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the AHJ, these companies shall be staffed with a minimum of five or six on duty members.

5.2.4 Deployment.

5.2.4.1 Initial Arriving Company.

5.2.4.1.1 The fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 240-second travel time to 90 percent of the incidents as established in Chapter 4.

5.2.4.1.2 Personnel assigned to the initial arriving company shall have the capability to implement an initial rapid intervention crew (IRIC).

5.2.4.2 Initial Full Alarm Assignment Capability.

5.2.4.2.1 The fire department shall have the capability to deploy an initial full alarm assignment within a 480-second travel time to 90 percent of the incidents as established in Chapter 4.

5.2.4.2.3 Fire departments that respond to fires in high-, medium-, or low-hazard occupancies that present hazards greater than those found in the low-hazard occupancy described in 5.2.4.2.2 shall deploy additional resources on the initial alarm.

5.2.4.3 Additional Alarm Assignments.

5.2.4.3.1 The fire department shall have the capability to deploy additional alarm assignments that can provide for additional command staff, personnel, and additional services, including the application of water to the fire; engagement in search and rescue, forcible entry, ventilation, and preservation of property; safety and accountability for personnel; and provision of support activities for those situations that are beyond the capability of the initial full alarm assignment.

5.3.3 EMS System Functions.

5.3.3.1 The AHJ shall determine which of the following components of an EMS system the fire department shall be responsible for providing:

(1) Initial response to provide medical treatment at the location of the emergency (first responder with AED capability or higher)
(2) BLS response
(3) ALS response
(4) Patient transport in an ambulance or alternative vehicle designed to provide for uninterrupted patient care at the ALS or BLS level while enroute to a medical facility
(5) Assurance of response and medical care through a quality management program

5.3.3.2 Staffing.

5.3.3.2.1 On-duty EMS units shall be staffed with the minimum personnel necessary for emergency medical care relative to the level of EMS provided by the fire department.

5.3.3.3.2 The fire department's EMS for providing a first responder with AED shall be deployed to provide for the arrival of a first responder with AED company within a 240-second travel time to 90 percent of the incidents as established in Chapter 4.

5.3.3.3.3 When provided, the fire department's EMS for providing ALS shall be deployed to provide for the arrival of an ALS company within a 480-second travel time to 90 percent of the incidents provided a first responder with AED or BLS unit arrived in 240 seconds or less travel time as established in Chapter 4.

5.3.3.3.4 Personnel deployed to ALS emergency responses shall include a minimum of two members trained at the emergency medical technician—paramedic level and two members trained at the emergency medical technician—basic level arriving on scene within the established travel time.

The *Fire Protection Handbook* also identifies initial attack response capabilities for low, medium, and high hazard occupancies as follows:

- **High-hazard occupancies** (schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings and other high life or large fire potential occupancies) — at least 4 pumpers, 2 ladder trucks (or combination apparatus with equivalent capabilities), 2 chief officers and other specialized apparatus as may be needed to cope with the combustible involved; not less than 24 firefighters and 2 chief officers plus a safety officer and a rapid intervention team. Extra staffing of high hazard occupancies is advised.
- **Medium-hazard occupancies** (apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or firefighting force) — at least 3 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities) 1 chief officer and other specialized apparatus as may be needed or available; not less than 16 firefighters and 1 chief officer plus a safety officer and a rapid intervention team.
- **Low-hazard occupancies** (one-, two-, or three-family dwellings and scattered small businesses and industrial occupancies) — at least 2 pumpers, 1 ladder truck (or combination apparatus with equivalent capabilities), 1 chief officer and other specialized apparatus as may be needed or available; not less than 12 firefighters and 1 chief officer plus a safety officer and a rapid intervention team.

The ISO Public Protection Classification program is designed to help establish fire insurance premiums for residential and commercial properties based, in part, on community's fire protection services. By itself, ISO ratings do not provide comprehensive assessment of staffing, deployment, and service delivery. ISO visits more than 46,000 communities around the country to collect information about their fire departments through its Fire Suppression Rating Schedule (FSRS). The rating schedule outlines the criteria for evaluating the fire prevention and fire suppression capabilities of individual communities or fire protection areas. Fire department capabilities and fire company distribution account for 50% of a community's rating.

ASSESSMENT OF FIRE HAZARDS AND ASSOCIATED RISKS IN THE COMMUNITY

Population

According to Wikipedia, Kiawah is a sea island, or barrier island, on the Atlantic coast of the United States. Located 15 miles (24 km) south of Charleston in Charleston County, South Carolina, it is operated today largely as a gated beach and golf community with spacious villas, beaches, large and acclaimed golf courses, and other attractions. The U.S. Census Bureau estimated the Town of Kiawah Island's population at 1,711 in 2013[1]. Since 1990, the town's population has increased 36% from 726 residents (see Figure 3.5). However, due to the seasonal nature of this resort town with tourists visiting the island, the population balloons to a population from 8,000 to 10,000 during the summer months, according to the town's website. According to the U.S. Census Bureau, the town has a total area of 13.5 square miles, of which 11.2 square miles of it is land and 2.4 square miles of it is water. The Kiawah Island Community Association's website states that Kiawah Island is over 10 miles long and 1.5 miles at its widest point. As defined by the U.S. Office of Management and Budget and used by the U.S. Census Bureau for statistical purposes, the island is included within the Charleston–North Charleston–Summerville metropolitan area. (See Figure 3.6 for map of Kiawah Island.)

[1] South Carolina Demographics by Cubit

Figure 3.5
HISTORY OF POPULATION GROWTH

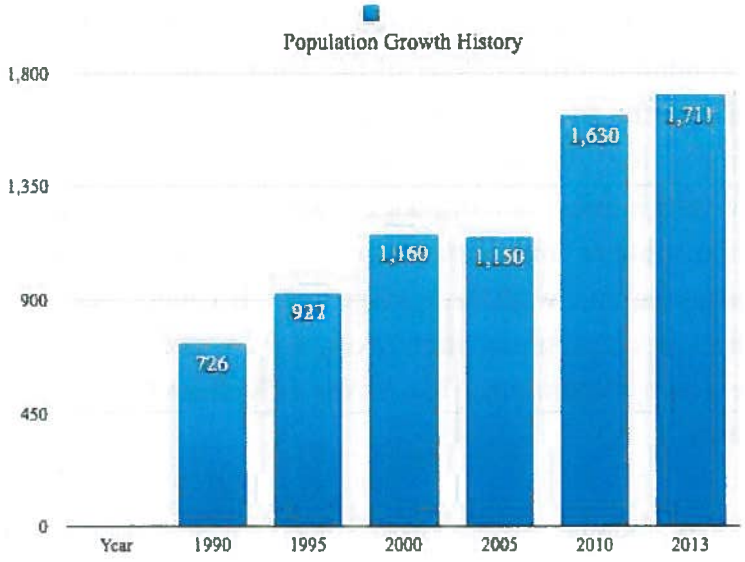
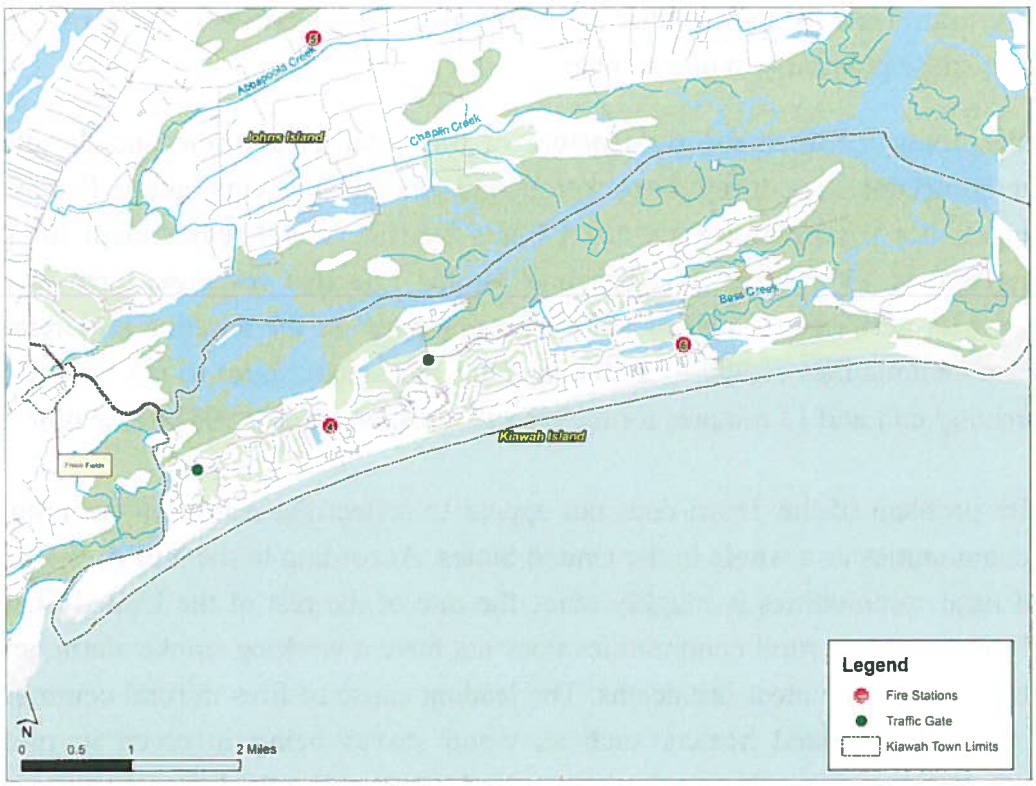


Figure 3.6
MAP OF KIAWAH ISLAND



The Town of Kiawah Island's website states that the town was incorporated by the State of South Carolina on September 13, 1988, and operates as a Mayor–Council form of government. The Town Council is composed of a Mayor and four Council Members. The Mayor is the chief administrative officer of the Town. The Town Administrator provides support and advice to the Mayor and Council and runs the day-to-day operations of the Town. The Town provides services to its property owners and visitors including, but not limited to: public safety; street and drainage maintenance; solid waste disposal; planning and zoning administration; municipal court administration; beach maintenance and safety; communications and wildlife management. Business license revenue, franchise fees, aid to subdivisions, accommodation taxes, solid waste fees and other miscellaneous revenue fund the Town's operations. The Town of Kiawah Island does not levy property taxes to its residents.

With a permanent residential population density of 150 residents per square mile, the Commission for Fire Accreditation International would classify the Town of Kiawah Island as a rural population (less than 1,000 people per square mile). With a population of less than 2,500 residents, the United States Census Bureau would even categorize the town as rural, if not for the fact that many residential occupancies in the town are within relatively close proximity to one another.

The dichotomy, between the rural nature of the town as a whole and the cluster of residential occupancies in tightly backed neighborhoods, presents unique fire protection challenges. For rural populations, the CFAI's baseline travel requirement for the first arriving unit is 13 minutes, and baseline for the effective response force is over 18 minutes with performance rate of 90%. This compares to the baseline requirements for suburban communities (1,000 to 2,000 residents per square mile) of 6.5 minutes for the first arriving unit and 13 minutes for the effective response force 90% of the time.

The fire problem of the Town does not appear to reflect the nature of fire problems in rural communities as a whole in the United States. According to the NFPA, the fire death rate of rural communities is roughly twice the rate of the rest of the United States. One out of four homes in rural communities does not have a working smoke alarm, and these rural homes have the most fire deaths. The leading cause of fires in rural communities is open flame, with fixed heaters such as wood stoves being involved in most rural residential heating fires. Heating is also the lead cause of fire fatalities in rural residential structure fires.

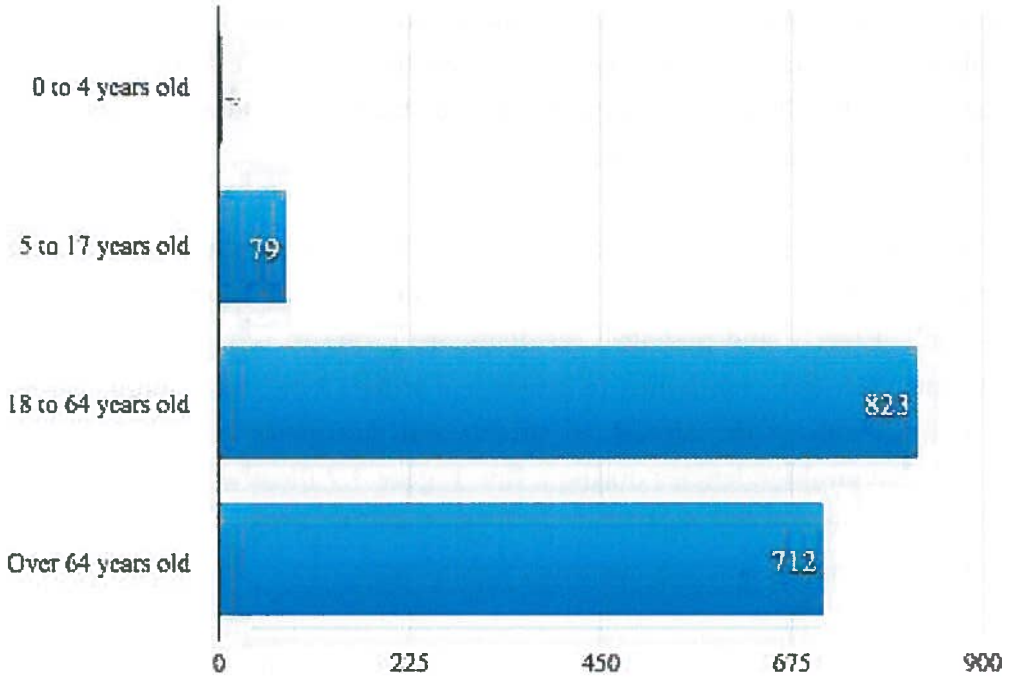
Additionally the seasonal increase in summertime tourist population gives the community characteristics that are found in suburban populations. Again this population increase changes the nature of the fire and emergency medical problems for emergency response agencies. Higher populations historically demonstrate a higher demand on emergency services organizations. Not only do service demands increase as the population increases, the community's expectations of emergency response agencies' performance are heightened as well. The CFAI baseline performance standard for emergency responders is a reflection of the increased expectation.

While general population levels influence the geographic distribution in demand for fire and emergency medical services, the age distribution of the population served is important as well. Elderly and pediatric residents are prone to require higher levels of medical attention than the population in general. Further these population groups are more likely to succumb to the effects of smoke and fire gases due to their medical conditions and behavioral tendencies during a fire. Figure 3.7 illustrates that less than one percent of the town's residential population is 4 years old or younger, while the over 64-year-old age group comprises 44% of the town's residents[2].

Fortunately, over 50% of the Town's permanent residents are within the 18- to 64 year-old age group. According NFPA statistics from 2003 to 2007, age cohorts within the 18- to 64-year-old group represent the lowest number of fire deaths and injuries, with the over 64-year-old cohorts having the highest casualty rates. A note of caution is needed here, though. According to a 2013 report of the Kiawah Island Community Association (KICA), the average age of the association members is 58 to 59 years old, with 66% between 45 and 64. The Town needs to begin planning for the fire protection and emergency medical services of an aging population.

[2] U.S. Census from CensusViewer

Figure 3.7
TOWN OF KIAWAH ISLAND
CURRENT POPULATION BY AGE GROUP



Looking at residency within the Town, the KICA membership database indicates there are approximately 20% resident members. Another 5% of the members have indicated that they will call Kiawah their permanent home, with another 25% indicating they definitely or probably will become permanent residents. While the proportion of resident members to nonresident members has increased 5% since 2002, the anticipated rate of increase in owner occupancy has not yet occurred as expected.

Currently, Kiawah Island consists of approximately 4,200 member properties with a little over 7,000 members. While Kiawah's master plan originally called for approximately 7,000 residential properties, master developer Kiawah Development Partners reduced that cap to about 5,600 in its development agreement with the Town of Kiawah Island. Under the current master plan only another 1,400 properties can be developed.

Based on the number of member properties and an owner occupancy rate of 20%, the number of owner-occupied properties is about 840. With a permanent resident population of 1,711, there are just over two residents per occupied household in the Town.

A final observation about the nature of the fire problem on Kiawah Island relates to the landscaping on residential properties, specifically single-family homes. In communities that are subject to the effects of severe droughts or where the nature of the vegetation causes it to be highly combustible, property owners are encouraged to assess the landscaping of their property to create a "defensible space." A defensible space is the area between a house and an oncoming wildfire where the vegetation has been modified to reduce the wildfire threat and to provide an opportunity for firefighters to effectively defend the house. Kiawah Island has not been susceptible to recent severe drought conditions, and it does not contain large volumes of highly combustible vegetation. However, many single-family properties are heavily landscaped with shrubs, trees, and grasses planted close to homes. This condition presents three firefighting problems.

The first challenge presented by landscaping of single-family homes is fire department access to the houses in the event of a fire. Many homes have narrow driveways that are lined with trees. Some houses are setback a significant distance from the street. The setbacks and landscaping make it difficult to deploy fire hoses and position ladders for firefighting and rescue operations in these conditions.

Secondly, although remote there is the potential for tree, shrubs, and grasses near a house fire to be involved in the fire themselves, and spread to neighboring properties. This condition has the potential to lead to exposure fires or fires spreading to neighboring houses from burning vegetation.

Lastly, South Carolina and Charleston County have not been immune to wildfires. According to the 2014-2015 Update of the "Charleston Regional Hazard Mitigation Plan," the most significant wildfire in the last decade occurred in March of 2011 along the Charleston/Georgetown County. In April 2009, a wildfire occurred near North Myrtle destroying about 70 homes and forcing more than 2,500 people to evacuate. Additionally, a 10,000-acre nature preserve was lost. Low humidity and high winds created conditions favorable to wildfire. A similar fire occurred in Horry County, SC, in 1976. In any given year, it is expected that there will be between 32 and 114 wildfires per year in Charleston

County. Should one occur in the Town's residential areas, the effects would be devastating.

One final challenge that Kiawah Island presents to emergency services providers is its geography. Being a barrier island, it is completely surrounded by water. There is only one entrance on and off the island by land. That is by bridge at its southwestern-most point. With an island over ten miles in length, emergency response units responding from the mainland have a great travel distance to traverse to reach the scene of many emergency incidents on the island.

DEPLOYMENT OF FIRE DEPARTMENT RESOURCES

To compare the fire protection services provided to communities that are similar to the Town of Kiawah Island, one must consider the staffing levels, numbers of fire stations, and apparatus deployed. A study conducted by the NFPA and published in October 2013 profiled fire departments and their communities. Figure 3.8 summarizes the average number of stations and apparatus deployed for communities that are similar to Kiawah Island.

Figure 3.8
AVERAGE APPARATUS AND STATIONS
PER 1,000 PEOPLE BY COMMUNITY SIZE

Population Protected	Stations per 1,000 People	Engines per 1,000 People	Aerial apparatus per 1,000 People	Other vehicles per 1,000 People
Under 2,500	0.952	1.173	0.033	1.886
2,500 to 4,999	0.346	0.541	0.029	0.629
4,999 to 9,999	0.197	0.319	0.037	0.294

Based on the average values in Figure 3.9, Kiawah Island could expect to be served by one fire station that housed one to two engines and two to three other vehicles, such as brush trucks or tankers. Aerial service in similarly situated communities is likely to be shared with other fire departments.

Although comparisons to other fire departments provide community decision makers with a yardstick to make cost analyses, these comparisons are incomplete without analyzing operational performance. Further, community leaders must consider the residents' expectations regarding fire protection outcomes when making choices concerning staffing; the number and locations of stations; and the deployment of resources.

Predicting a fire department's performance capabilities is a complex task that is actually as much art as it is science. As previously mentioned, the three most important elements affecting the operational capabilities of a fire department are its standards of coverage; department capability or the abilities of the department's members; and resource reliability.

Standards of coverage have been discussed previously in this chapter, and resource reliability will be discussed later in this chapter along with response data. While it was previously mentioned that this Study does not include an analysis of the St. John's Fire District's capabilities, its information is available to fire department and community leaders regarding capabilities of fire crews based on resource allocation and crew size.

Fire Protection in the Town of Kiawah Island

The St. Johns Fire District is responsible for providing fire protection in the Town of Kiawah Island. The STJFD has seven stations distributed throughout its 146-square-mile Fire District. Three stations are located on Johns Island, two on Kiawah Island, and one each on Seabrook Island and Wadmalaw Island. Apparatus distribution among the seven locations has been identified previously in this chapter. Since the station distribution analysis pertains directly to resources on and available to Kiawah Island, the reader would benefit from a recap of the apparatus assigned to these stations, Station 4, and Station 6.

Station 4 located at 12 Sora Rail Road houses Engine 704, Tower 704, and Rehab 704. Engine 704 carries 1,000 gallons of water and is capable of pumping 1,500 GPM of water from a static water source. Tower 704 is a 114-foor aerial platform truck that carries 300 gallons of water and is capable of pumping 2,000 GPM of water from a static water source. Station 6 located at 68 Ocean Course Drive houses Engine 706. Engine 706 carries 1,000 gallons of water and capable of pumping 1,500 GPM of water from a static

water source. Daily staffing levels for Stations 4 and 6 are 7 personnel and 4 personnel respectively.

STATION LOCATION AND ISO CRITERIA

The location of a fire station for a specific community depends upon the geography, demographics, and the distribution of commercial, industrial, and residential property. National recognized benchmarks for locating a fire station will be discussed in the sections that follow.

ISO Criteria

The Fire Suppression Rating Schedule utilized by the Insurance Services Office (ISO) in its evaluation of municipal fire suppression capabilities includes fire station location analysis with objective mileage-based criteria. Item 560 in the *Fire Suppression Grading Schedule*, Edition 6-80, reads as follows:

"The built-upon area of the City should have a first-due engine company within 1.5 miles and a ladder-service company within 2.5 miles."

The ISO considers the optimum physical location of engine companies and ladder companies essential to earning maximum credits under the Fire Department Item in the Schedule. Obviously, engine companies and ladder companies are placed in fire stations. So it is the location of the fire station that becomes important to the evaluation process used by the ISO. These are very conservative estimates. The problem with using mileage alone is that, speed capability of the road affects the time travelled; the ISO criterion does not take this into account. ISO apparatus distance is only one of many criteria to which the ISO evaluates a department to include equipment, testing, and dispatching. Nonetheless, Figure 3.9 shows the 1.5-mile distance of pumper (engine) company from Stations 4 and 6.

Figure 3.9
ISO ENGINE DISTANCE

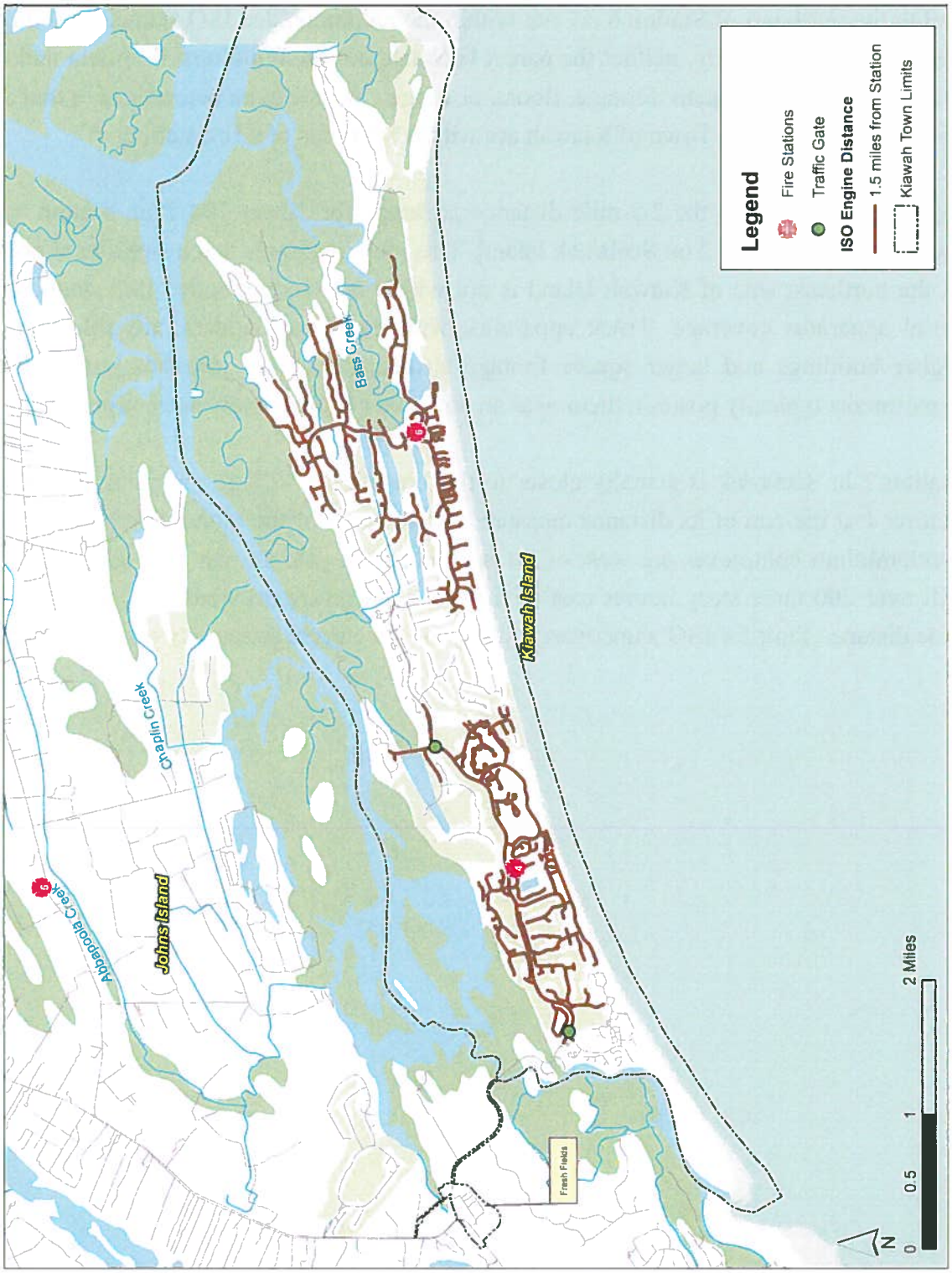


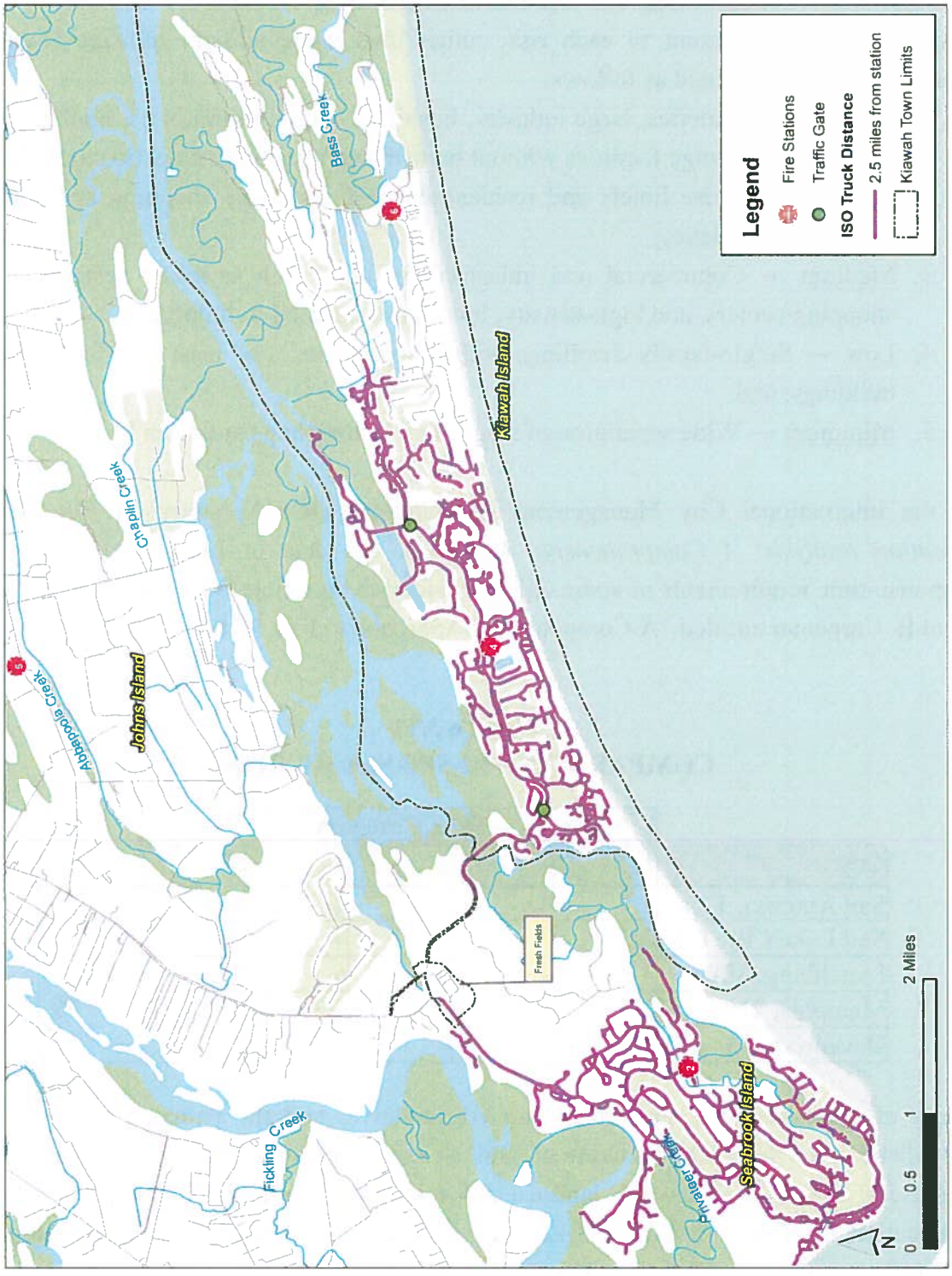
Figure 3.9 illustrates those areas to the southwest of Station 4, between Stations 4 and 6, and to the northeast of Station 6 are not within the recommended ISO standard for engine coverage. Unfortunately, neither the parcel GIS data nor the buildings[3] GIS data included information such as square footage, floors, or usage. What can be determined is that 57% of the buildings in the Town of Kiawah are within 1.5 miles of a fire station.

Figure 3.10 illustrates the 2.5-mile distance coverage for Tower 704 from Station 4 and the quint from Station 2 on Seabrook Island. This map illustrates that a significant portion of the northeast side of Kiawah Island is not within the recommended ISO standard for aerial apparatus coverage. Truck apparatus, with their long ladders, are able to reach higher buildings and larger square footage structures such as 'big box stores'. Fire departments typically position them near an area that contains many such structures.

Station 2 in Seabrook is actually closer to the Freshfields Village Shopping center than Station 4 at the end of its distance measure. While many of the higher rise buildings and condominium complexes are west of the second traffic gate known as V-gate; there are still over 200 three story homes east of that gate. There are no areas outside of the five mile distance limit for ISO's uncovered rating for the current street network in the area.

[3] Did not include buildings at Freshfields Village.

Figure 3.10
ISO AERIAL APPARATUS COVERAGE



Community Risk Criteria

Another way of approaching this issue is to define levels of land-use risk and assign a response-time requirement to each risk, rather than using straight mileage response. These risks can be defined as follows:

1. Highest — Refineries, large industry, hospitals, school dormitories, lumber yards, and propane storage facilities without built-in suppression or detection systems;
2. High — High-rise hotels and residential buildings, large shopping centers, and industrial complexes;
3. Medium — Commercial and industrial facilities with sprinkler systems, small shopping centers, and high-density, low-rise residential buildings;
4. Low — Single-family dwellings with a separation of at least 100 feet between buildings; and,
5. Minimum — Wide separation of single-family dwellings and farm land.

In the International City Management Association's (ICMA) study on *Fire Station Location Analysis: A Comprehensive Approach*, the data in Figure 3.11 show the response-time requirements of some cities provided in an article by Susan B. Benton and Neal B. Carpenter entitled "A Computerized Approach to Fire Station Location."

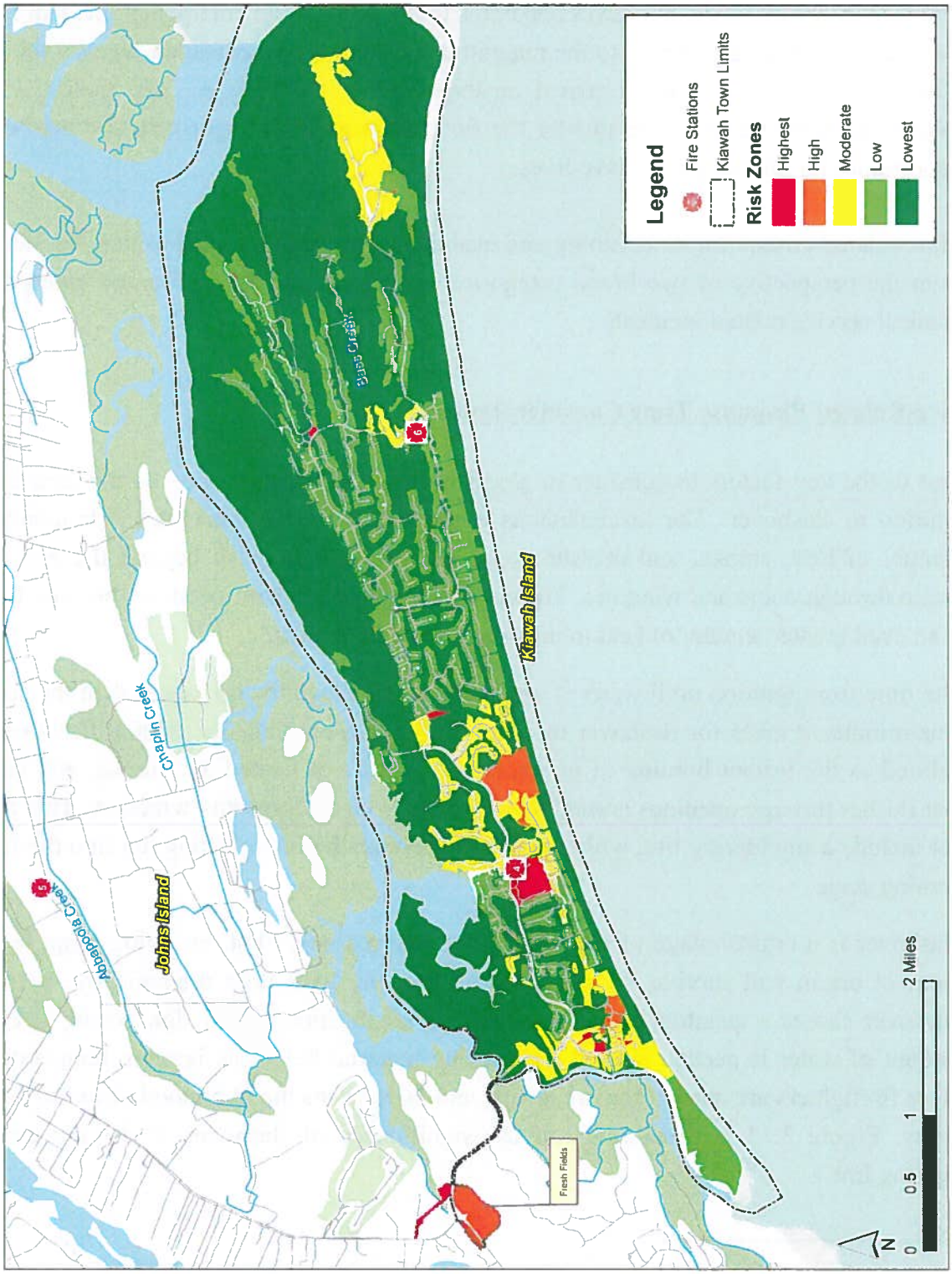
Figure 3.11
COMPARATIVE RESPONSE BY RISK

	Risk Category				
City	1	2	3	4	5
San Antonio, TX	2.5	3	3.5	4	6
Salt Lake City, UT	2.5	3	3.5	4	6
Lynchburg, VA	3	4	5	6	7
Memphis, TN	2.3	2.7	3.3	4.3	5.8
Davenport, IA	3	3.5	4	4.5	5

Minutes

Some of these response time goals are conservative, and the pattern of response is unrealistic given the scattered nature of land use risk in most communities. Nonetheless, it is useful to examine Kiawah's land-use risk relative to fire hazard in comparison to the fire station locations. In Figure 3.12, the land-use classifications were re-categorized generally into the five risk levels described above.

Figure 3.12
FIRE RISK ZONES



Response Time Capability Criteria

The response time of fire and EMS apparatus to the scene of an emergency incident is an essential determining factor as to the magnitude of the fire or medical emergency the fire department must handle upon arrival on the scene of the incident. The theory is the shorter the response time, the smaller the fire that must be extinguished, and the better opportunity for paramedics to save lives.

Time-related criteria for determining and evaluating fire station locations may be viewed from the perspective of two broad categories of types of incidents: fire and emergency medical service related incidents.

Fire-Related Response Time Considerations

One of the key factors to consider in assessing response times to fires is the time from ignition to flashover. The instantaneous eruption into flames generates a tremendous amount of heat, smoke, and pressure with enough force to push beyond the room of origin through doors and windows. The combustion process then speeds up because there is an even greater amount of heat to move to unburned objects.

The time from ignition until water is applied to a fire should be no longer than the six to nine minutes it takes for flashover to occur with a free-burning fire. Again, flashover is defined as the instant burning of an explosive mixture of heated air, smoke, and gases that flashes through openings around the fire area, such as doors and windows. This does not include a smoldering fire, which can burn for hours before breaking out into the free-burning stage.

Flashover is a critical stage of fire growth for two reasons. First, no living thing in the room of origin will survive, so the chances of saving lives drop dramatically. Second, flashover causes a quantum jump in the rate of combustion, and a significantly greater amount of water is needed to cool the burning material below its ignition temperature. More firefighters are needed for fire attack, and there exists the likelihood of reduced fire safety. Figure 3.13 is a summary of the significance of flashover in the process of fighting fire[4].

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[4] Source: *Creating and Evaluating Standards of Response Coverage for Fire Departments*, 3rd Edition, Summer 2001, CFAI

Figure 3.13
FLASHOVER COMPARISON

SIGNIFICANCE OF FLASHOVER	
Pre-Flashover	**Post-Flashover**
Limited to One Room	May Spread Beyond One Room
Requires Smaller Attack Lines	Requires Larger, More Attack Lines
Search & Rescue Is Easier	Compounds Search & Rescue
Initial Assignment Can Handle	Requires Additional Companies

For these reasons, it is critical that fire suppression forces reach a fire structure and initiate effective suppression efforts prior to flashover. **Travel time must be kept short enough to ensure that it does not exceed the six-to-nine-minute flashover requirement.**

The reader may recall that NFPA 1710 includes the following benchmarks related to call receipt and processing time, turnout time, and response (travel) time:

- Turnout time of eighty seconds on fire suppression calls and sixty seconds for EMS calls;
- The fire department's fire suppression resources deployed to provide for the arrival of an engine company within a four-minute travel time and/or the initial full alarm assignment within an eight-minute response time to 90 percent of the incidents;
- The fire department's EMS basic life support (BLS) resources with automatic defibrillator equipment deployed to provide for the arrival of a BLS unit (EMS first responder or transport unit) within a four-minute travel time; and,
- The fire department's EMS resources providing advanced life support (ALS) service deployed to provide for the arrival of an ALS company within an eight-minute travel time to 90 percent of the incidents. SJFD is not at this level of service.

It should be noted that the various standards and criteria discussed in previous sections placed a high priority on both the effective delivery of fire and EMS service in the protection of life and property. Moreover, the safety of the firefighters and officers delivering the services and safety for the customer and stakeholder were important considerations to the development of these standards and to their application. Not all

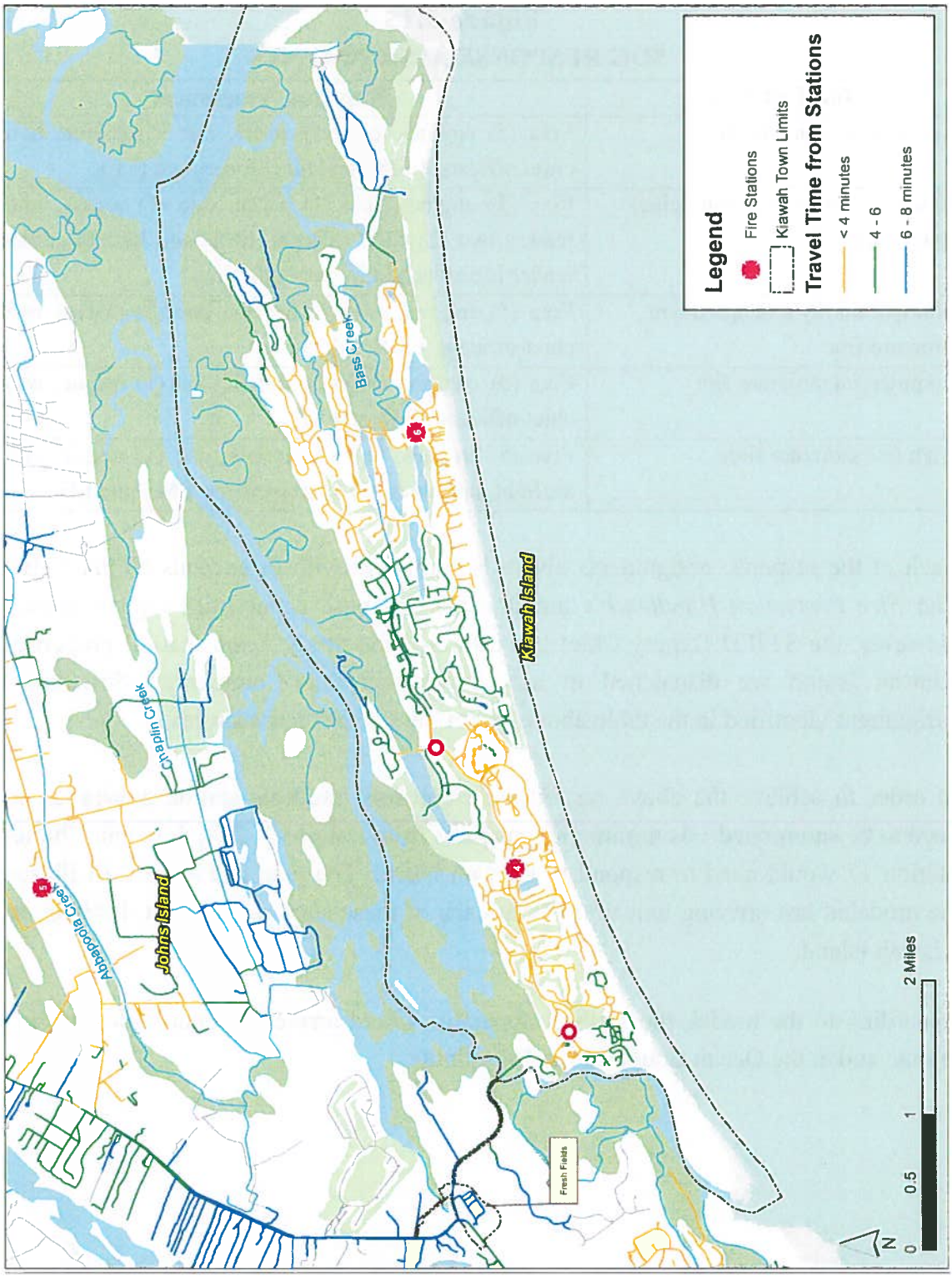
requests for services to the fire department ought to be construed as requiring apparatus to respond emergently or within the short time constraints. These should be limited to the critical emergencies in which they were designed. Not all fire departments adhere to the recommendations of the NFPA 1710 codes. This decision is made by the local departments and the communities they serve. The STJFD has not adopted a response-time objective at the time of this report according to the fire chief because the department is in the midst of a strategic planning process.

The map in Figure 3.14 models the travel time of apparatus from each of the nearby fire stations. The model utilizes the street network of the Town and surrounding areas calculating the travel time extent via distance and speed capability of streets. Actual posted speed limits were utilized and time penalties were assessed for negotiating turns and intersections. This model assumes departure from the fire stations, which may not always be the case. It also does not take into account weather conditions, traffic congestion, construction, or detours. It does respect the one-way restrictions as they are in place.

Standard firefighting procedures call for the arrival of the entire initial assignment (sufficient apparatus and personnel to effectively combat a fire based on its level of risk) within a certain amount of time. Under NFPA 1710 for career departments this would equate to two engines, one truck, and a chief within eight minutes of dispatch. This is to ensure that enough people and equipment arrive soon enough to be effective in controlling a fire before substantial damage occurs.

The St John's Fire District participates in the Charleston County Auto-Aid Group. This group is comprised of the following fire departments in Charleston County: Charleston, James Island, North Charleston, St. Andrews, and St. Johns. This group of fire departments has developed standard operating guidelines (SOG) that are used when structure fires occur within the cooperating fire department's response districts. The purpose of this guideline is to describe fire department policy regarding risk assessment and safety management while setting standard apparatus dispatch response assignments, company personnel assignments and command guidelines, for the emergency incidents listed, in order to enhance operational safety, effectiveness, and efficiency. The agreement assures adequate response to assemble an effective firefighting force for structure fires. Response assignments have been created for one-and two-family dwellings, structures in locations without fire hydrants, multiple family occupancies, commercial occupancies and high-rise buildings.

Figure 3.14
TRAVEL TIME EXTENT



Following are the response assignments prescribed in the SOG by incident type:

Figure 3.15
SOG RESPONSE ASSIGNMENTS

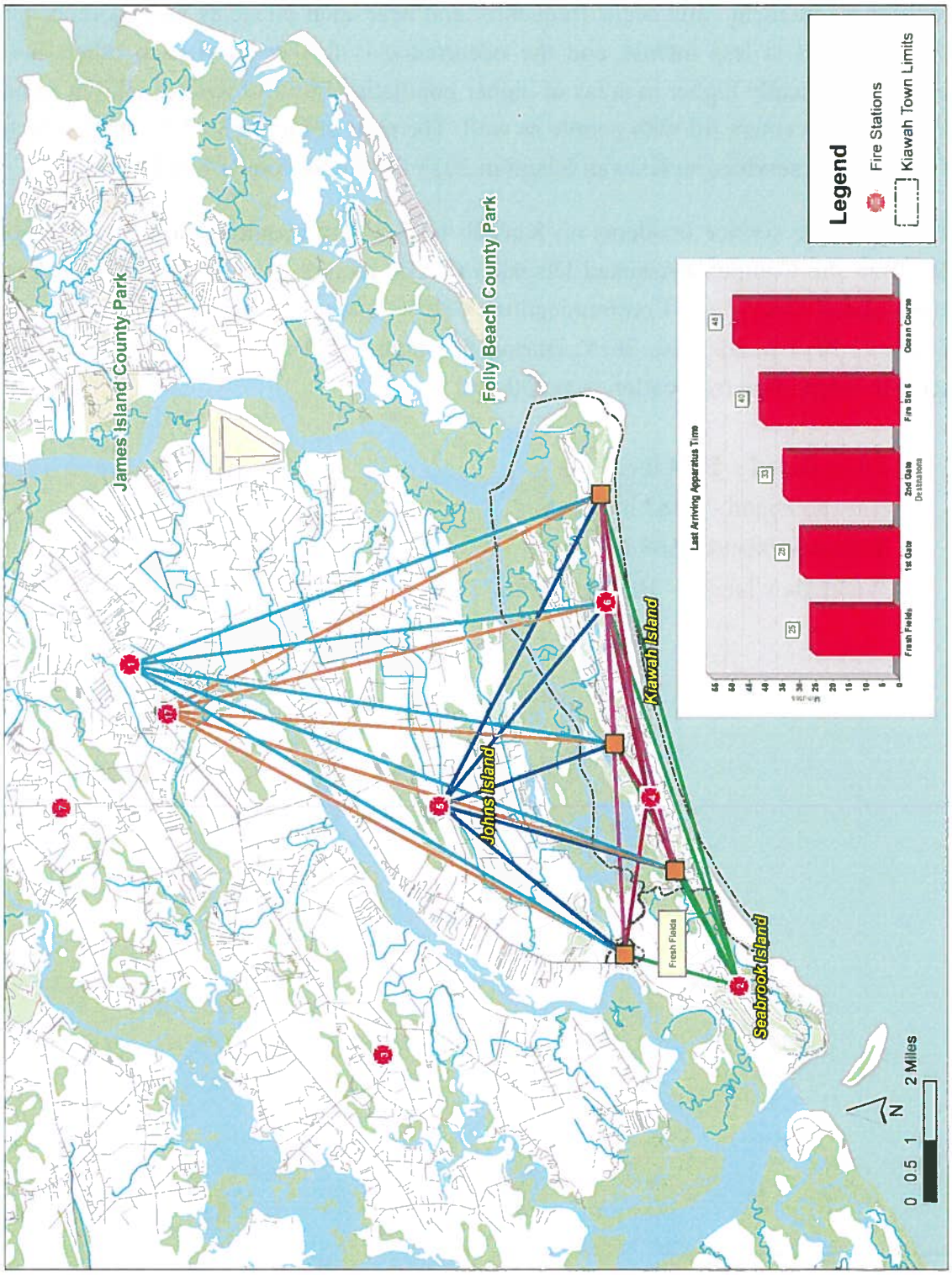
Incident Type	Response Assignment
Residential structure fire	Five (5) engines, one (1) aerial, one (1) rescue, two (2) chief officers, EMS and law enforcement (LE)
Structure fire without municipal water supply	Five (5) engines, one (1) aerial, one (1) rescue, one (1) tender, two (2) chief officers, EMS and LE; an additional tender is dispatched for working fires
Multiple family and apartment structure fire	Five (5) engines, two (2) aerials, one (1) rescue, two (2) chief officers, EMS and LE
Commercial structure fire	Five (5) engines, two (2) aerials, one (1) rescue, two (2) chief officers, EMS and LE
High rise structure fires	Five (5) engines, two (2) aerials, one (1) rescue, one (1) air/light unit, three (3) chief officers, EMS and LE

Each of the response assignments above is compliant with or exceeds NFPA 1710 and The *Fire Protection Handbook's* initial attack response capabilities recommendations. However, the STJFD Deputy Chief has informed the Study Team that all properties on Kiawah Island are dispatched in accordance with the Commercial Structure Fire assignment identified in the table above due to the size of the structures.

In order to achieve the above response assignments, multiple station apparatus would need to be summoned. At minimum, apparatus from stations 1, 2, 4, 5, 6, and Charleston Station 17 would need to respond to Kiawah Island. The map in Figure 3.16 illustrated the modeled last arriving unit times from each of these stations to select destinations on Kiawah Island.

According to the model, the furthest apparatus would arrive at Fresh Fields at the 25th minute and at the Ocean Course at the 48th minute.

Figure 3.16
LAST ARRIVING APPARATUS TIME TO SELECT LOCATIONS



CURRENT SERVICE DEMAND ANALYSIS

Demand for service for the STJFD is not distributed evenly on Kiawah Island[5]. There are areas where incident calls occur frequently and near each other, as well as other places where demand is less intense and the occurrence is further from each other. Service demand is typically higher in areas of higher population, not just residential, but as hotels and shopping centers fill with people as well. The map in Figure 3.17 illustrates the level of demand for services on Kiawah Island in 2013 for the St. John's Fire District.

Records of fire service incidents on Kiawah Island were acquired through the exported files from the Computer-Assisted Dispatch (CAD) records from the Charleston County Consolidated Emergency Communications Center. These records cover the time period of July 1, 2011 to June 30, 2014. During this time SJFD responded to 8821 incidents. Incident distribution by location is as follows:

- Johns Island – 5724 incidents
- Kiawah Island – 1382 incidents
- Seabrook Island – 664 incidents
- Wadmalaw Island – 1051 incidents

[5] 80% of the fire calls for the STJFD apparatus stationed on Kiawah Island occur within Town limits.

Figure 3.17
SERVICE DEMAND

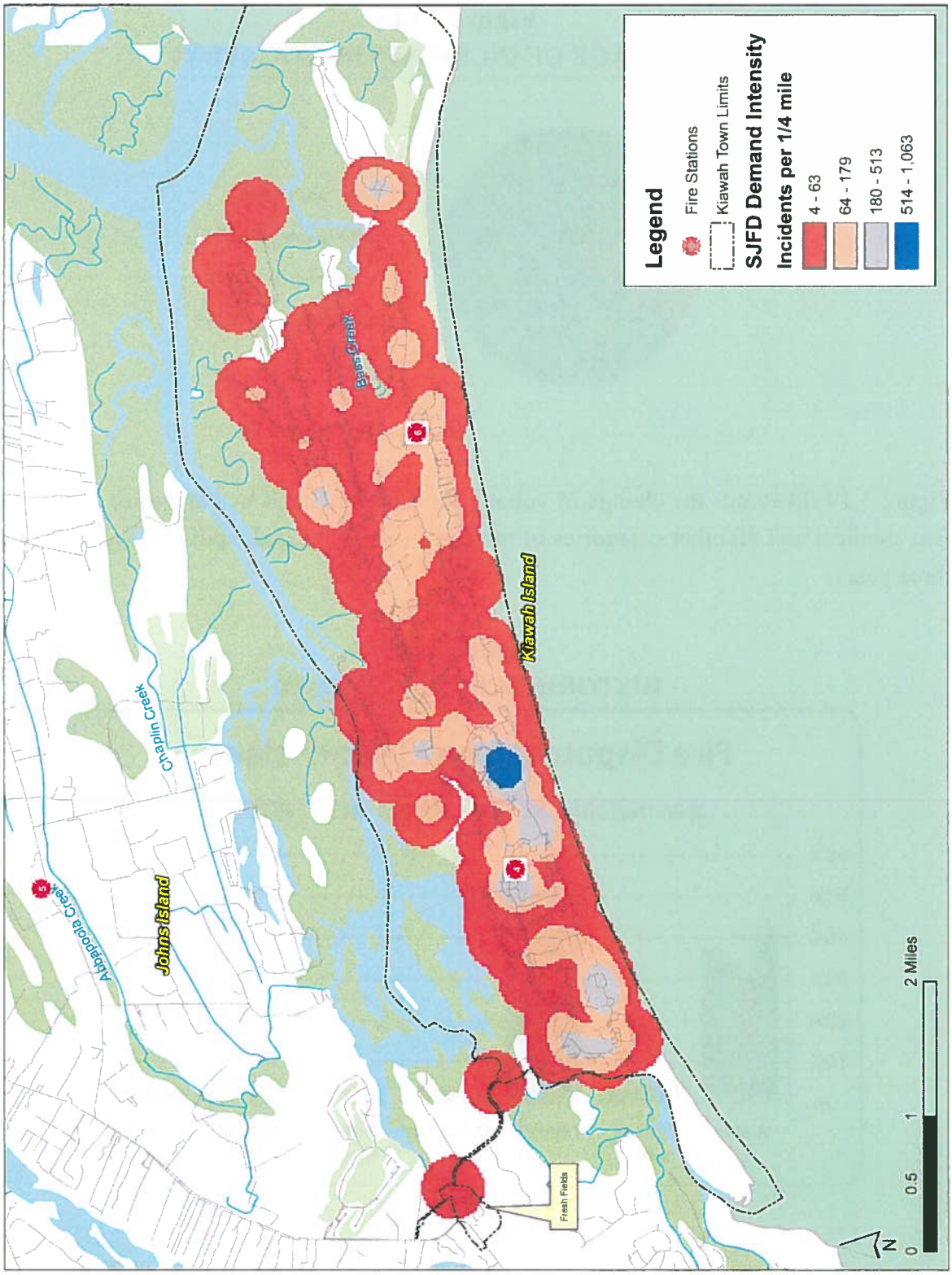


Figure 3.18 displays this incident distribution by percentage of total incidents.

Figure 3.18
PERCENTAGE OF INCIDENTS BY LOCATION

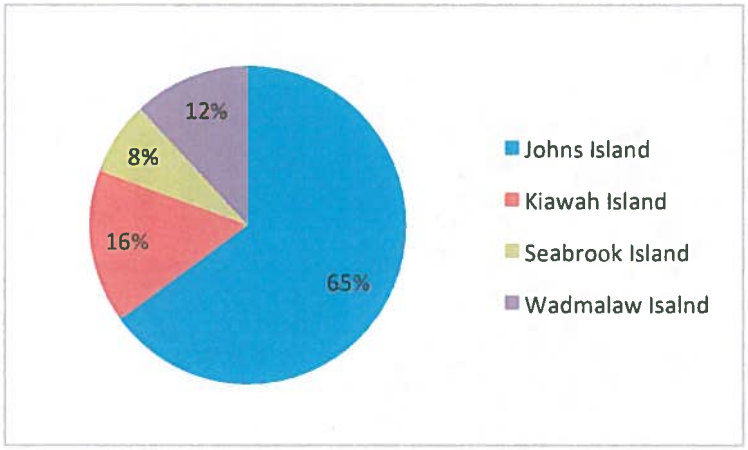
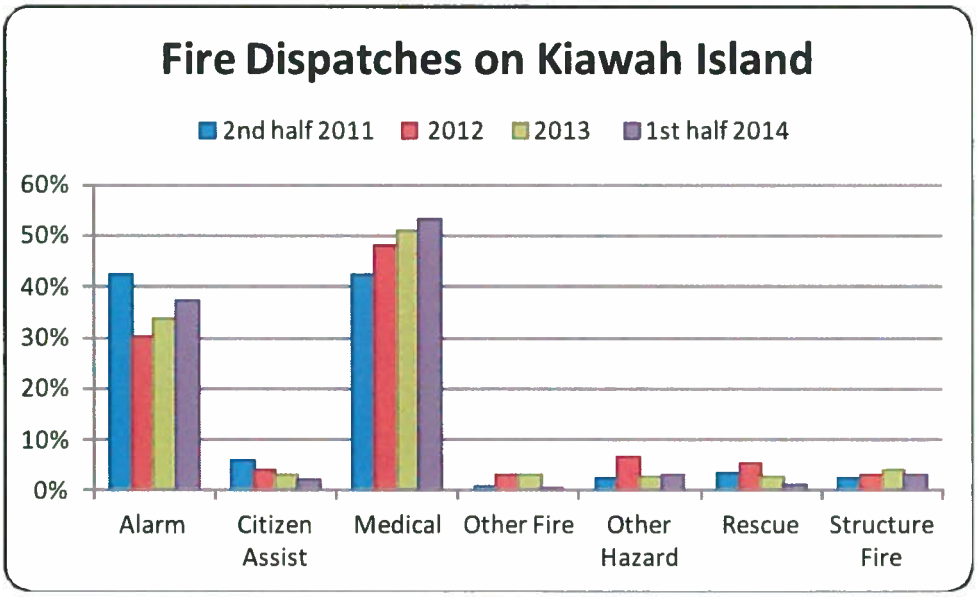


Figure 3.19 illustrates the change in volume for Kiawah Island by categories of reported fire, medical and all other categories of incidents (alarm, hazard, spill, etc.) over the past three years.

Figure 3.19
HISTORIC SERVICE DEMAND



The following table provides the detailed number of calls by call type for the corresponding years illustrated in Figure 3.19.

Call Type	2nd Half 2011	2012	2013	1st Half 2014	Sub-total
Alarm	101	132	173	72	478
Citizen Assist	14	18	15	4	51
Medical	101	210	260	105	676
Other Fire	2	12	16	1	31
Other Hazard	6	28	13	6	53
Rescue	8	23	14	2	47
Structure Fire	6	13	20	6	45
Grand Total	**238**	**436**	**511**	**194**	**1382**

It can be seen that medical calls (at 48.84% of the call load) account for the majority of service demand for the Fire District on Kiawah Island. Structure fires accounted for 3.26% of the call load, while all fires comprised 5.58% of the calls for service. Reviewing trends as a percentage of the call load during the study period shows that automatic alarms have trended downward in 2014, building fire calls increased slightly from 2.52% to 3.09%, and EMS calls increased from 42.44% to 53.88%. Marine incidents accounted for 1.2% of the incidents, and hazardous material releases and other gas leaks represented less than 1% of the incidents.

A broad overall view of the call load by percentages would indicate that smaller units staffed with two personnel could handle as much as 87.17% of the calls for service (EMS, automatic alarms, and citizen assists). A more detailed analysis of the data would have to be completed before implementing such a strategy, but it should be considered. Further labor-intensive incidents such as fires and rescue incidents comprise 8.99% of the workload during the study period. Structure fires require a robust fire department response of multiple resources and a large personnel complement, while it is likely that other fires and rescue incidents would need potential fewer apparatus and smaller personnel complement than a structure fire. Detailed incident reporting information was not provided to the Study Team to complete an in-depth task analysis for specific types of incidents.

Examining call load by unit responses for Engine 704, Tower 704, and Engine 6 finds that from July 1, 2011, through June 30, 2014; Engine 704 had 1,278 unit responses, Tower 704 had 683 responses, and Engine 706 had 835 responses. Figure 3.20 illustrates unit responses for units assigned to Stations 4 and 6 by year.

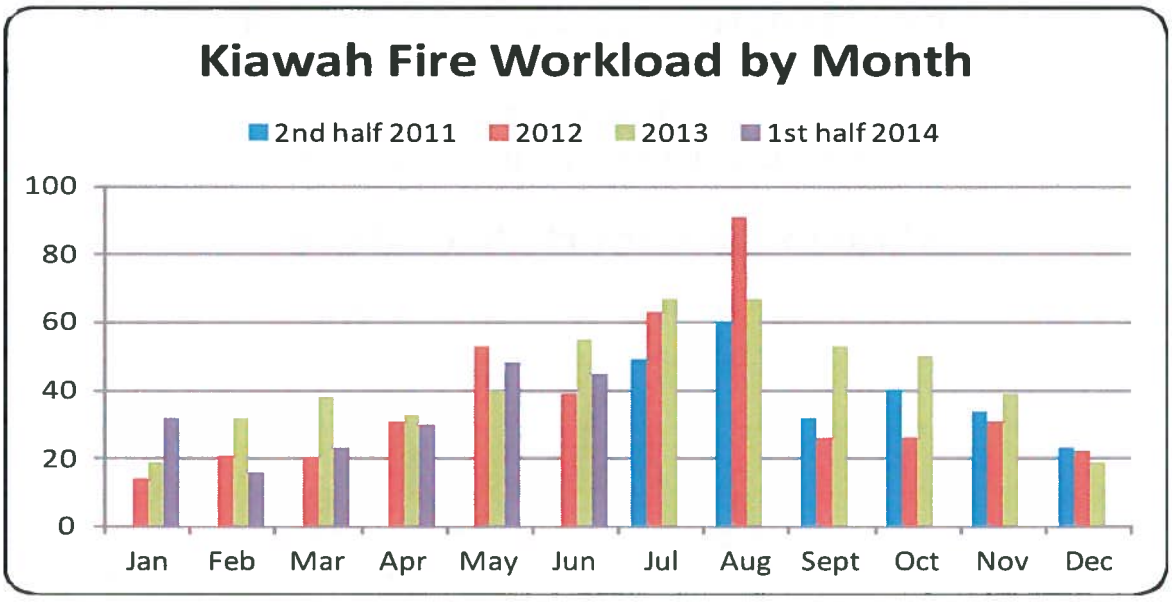
Figure 3.20
UNIT RESPONSES BY YEAR

Unit	2011	2012	2103	2104
Engine 704	240	388	450	200
Tower 704	115	157	295	116
Engine 706	149	261	304	121

The data from Figure 3.20 reveal that during the study period Engine 704 ran about 1.17 incidents per day, Tower 704 ran about 0.76 incidents per day, and Engine 706 ran about 0.76 incidents per day. Interpreting these data indicate that the units spend, on average, the following percentage of their time engaged in emergency incident related activities: 5.0% for Engine 704 and 3.2% for Tower 704 and Engine 706. Concerning emergency response, these units are extremely underutilized. With this extremely low call volume per unit for Stations 4 and 6, these units have very high reliability rates.

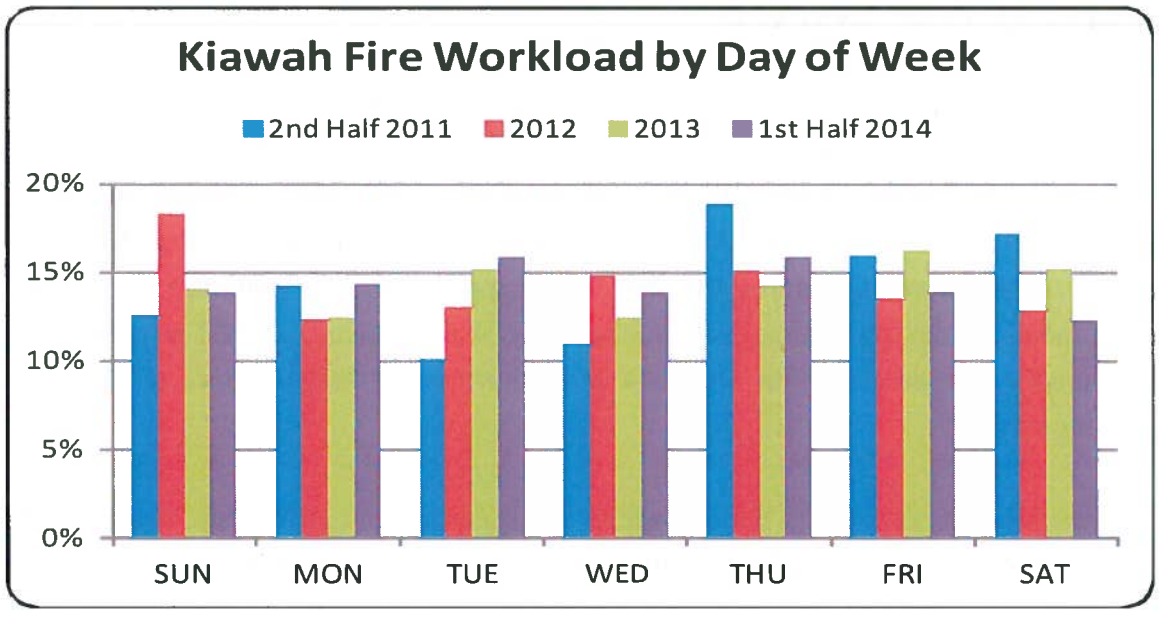
Examining the data more closely, changes in demand can be seen on a monthly basis. The graph in Figure 3.21 illustrates that service demand is higher in the summer months for all types of calls. Not unexpected given the resort atmosphere of the island. In August of 2012, the major golf championship created an extraordinary amount of calls.

Figure 3.21
WORKLOAD BY MONTH OF YEAR



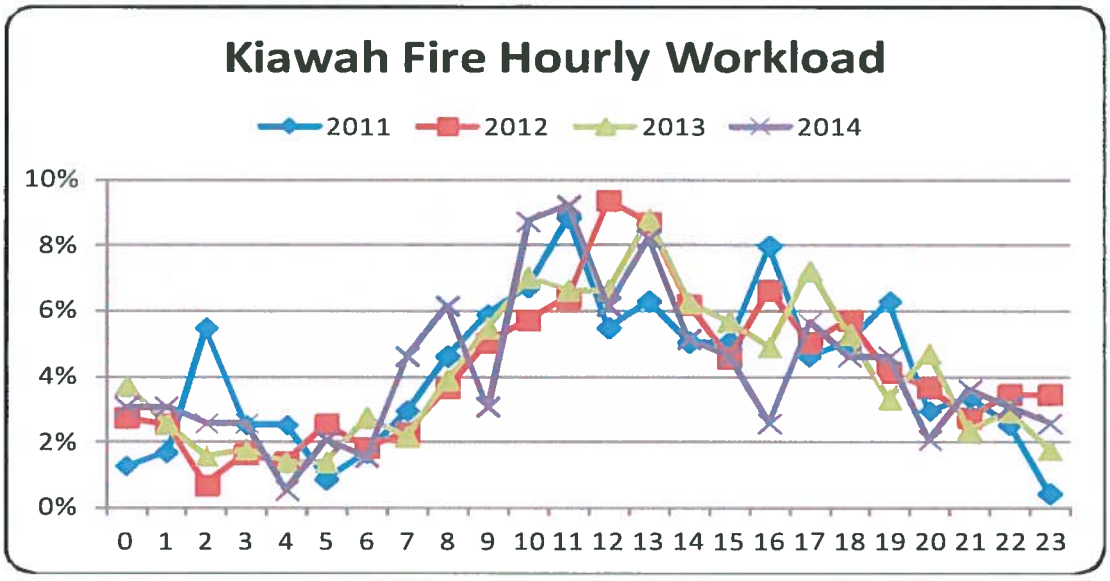
Examining the fire service demand by the day of the week reveals that the busiest day of the week for STJFD on Kiawah Island varies from Saturday in the second half of 2011, to Sunday in 2012, Friday in 2013, and tied between Tuesday and Thursday so far in 2014 (see Figure 3.22).

Figure 3.22
DEPARTMENT WORKLOAD BY DAY OF WEEK



Next, the workload is examined on an hourly basis. It can be seen in Figure 3.23 that fire service demand increases with daytime human activity. The peak hours for demand is from 8 AM until 9 PM, with the busiest seen at the 11AM -1PM hourly time frame.

Figure 3.23
WORKLOAD BY HOUR OF THE DAY



These peak hours are typically when simultaneous calls occur. This can reduce the available units for subsequent calls.

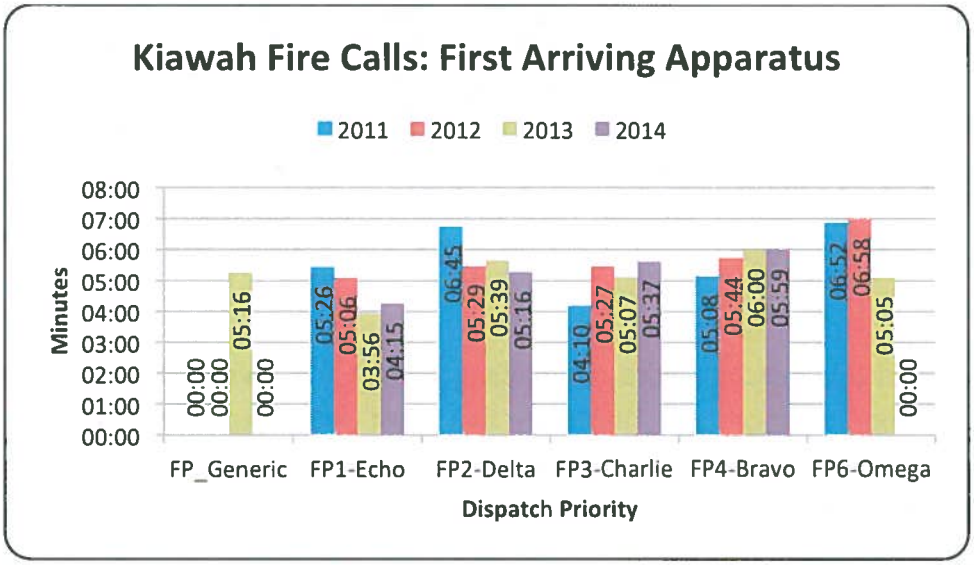
RESPONSE TIME ANALYSIS

It is widely accepted that the most important measure of performance of any emergency service provider, especially to whom they serve, is how fast the help arrives. Discussions of the reasons for and the specific parameters of the establishment of national response time guidelines from the NFPA have been outlined in an earlier subsection in this chapter. The following figures illustrate the response-time performance for apparatus using the CAD dataset. Mutual aid to other areas was removed, as well as public assists and standbys. Apparatus from Station 4 or Station 6 were first to arrive on 95% of the calls for service.

The Fire District responds to a multitude of call types as seen previously. Not all of them are emergent, while some different call types are equally emergent and require a quick as

possible response. The communications center prioritizes calls dispatched from less emergent (Alpha FP5, Bravo FP4, Omega FP6) to more emergent (Charlie FP3, Delta FP2, Echo FP1). Similarly, the response to the scene ought to be based on the priority description given by the dispatch center that has evaluated the situation from the caller. Whether there is a policy for not using visible and audible warning devices to help speed the apparatus to the call by the STJFD is unknown. Nonetheless, the urgency is lessened with less emergent priority calls. Figure 3.24 details the average arrival time of the first arriving apparatus over the last three years by dispatch priority[6].

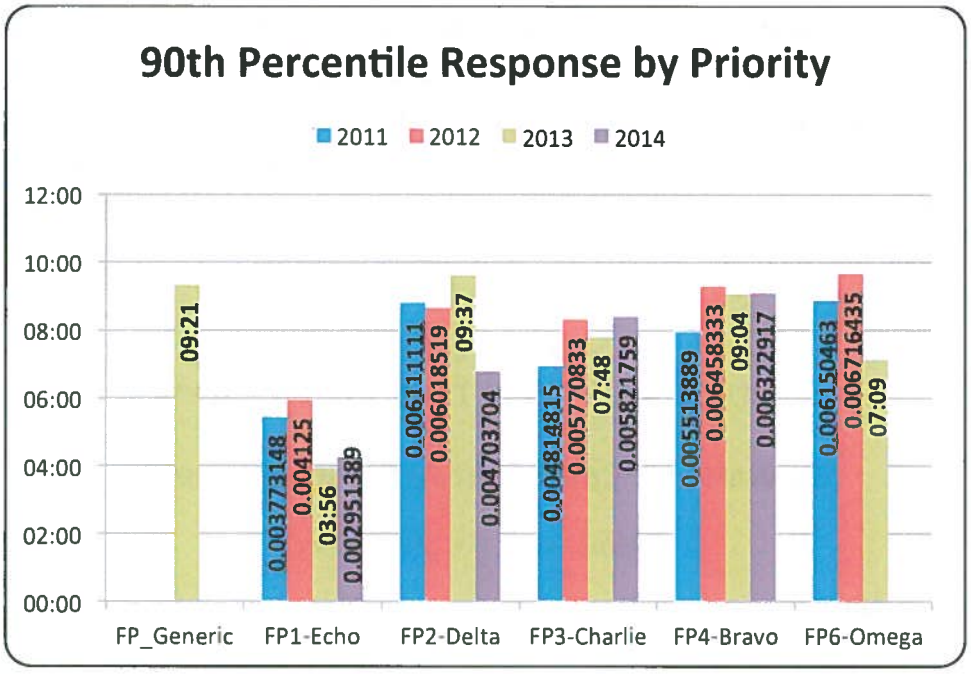
Figure 3.24
AVERAGE RESPONSE TIME PERFORMANCE



2010 was the best year for average overall response time at five minutes and ten seconds (5:10) leading with Charlie type calls. Echo Calls, the most emergent, had the best response times since 2012. The Fire District had reached 90% of its calls within Kiawah Island within the times detailed Figure 3.25 categorized by year and dispatch priority.

[6] Alpha calls removed (least emergent).

Figure 3.25
FRACTILE RESPONSE TIMES FOR FIRST-DUE ENGINE AT 90%



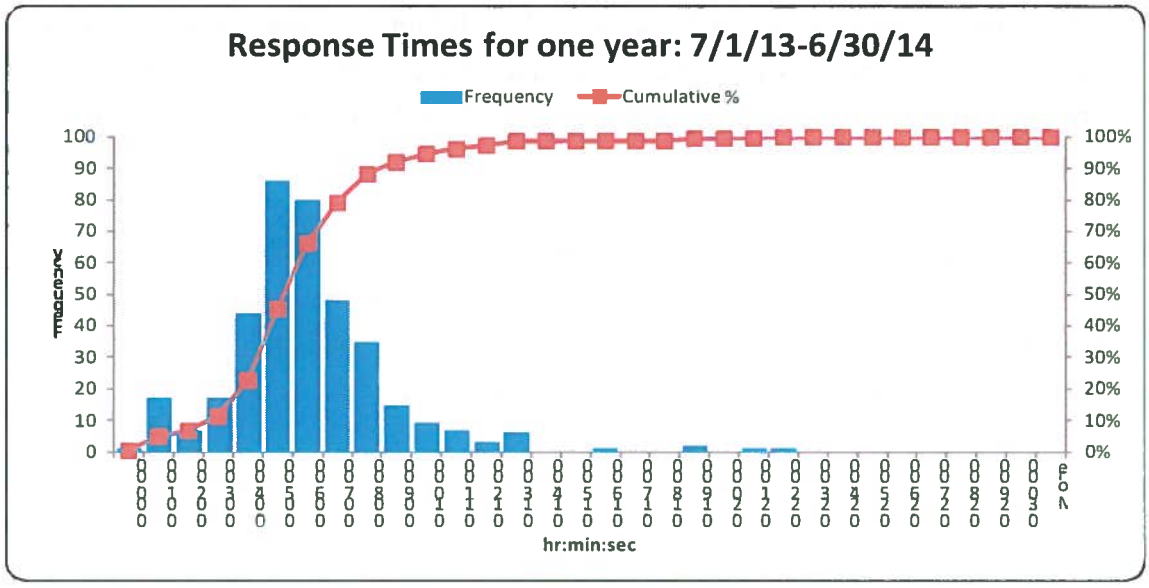
To understand this concept more completely, Figure 3.26 tabulates the frequency calls within one-minute ranges and illustrates that most calls are answered in the five- to seven-minute range, while 90% of the calls are answered in less than eight minutes and forty seconds (8:40).

Looking at the travel times to structure fires for the balance of the initial alarm, all units except the first arriving engine, indicates the following:

- Average travel time for the balance of the initial alarm was 12 minutes 52 seconds
- Travel times for the 90 percentile were about 24 minutes
- The percentage of time that all units arrived on scene in 480 seconds or less was about 33%.

Regarding the response times for chief officers to structure fire on Kiawah Island, the average travel time was 11 minutes 28 seconds, and 90 percent of the time a chief officer arrived on scene in less than 20 minutes 7 seconds.

Figure 3.26
FRACTILE RESPONSE TIME PERFORMANCE FOR THE FIRST-DUE ENGINE



STRUCTURE FIRES AND EFFECTIVE RESPONSE TIMES

Since CFAI's first *Creating and Evaluating Standards of Response Coverage for Fire Departments* manual in about 1997 and the first edition of NFPA 1710 (published in 2001), much research has been done in the fire protection and EMS communities. Research conducted by Underwriters Laboratory (UL) and the National Institute of Standard's and Technology's (NIST) Fire Fighting Technology Group of the Fire Research Division has challenged and dispelled long-standing assumptions about fire behavior in structures and traditional firefighting tactics.

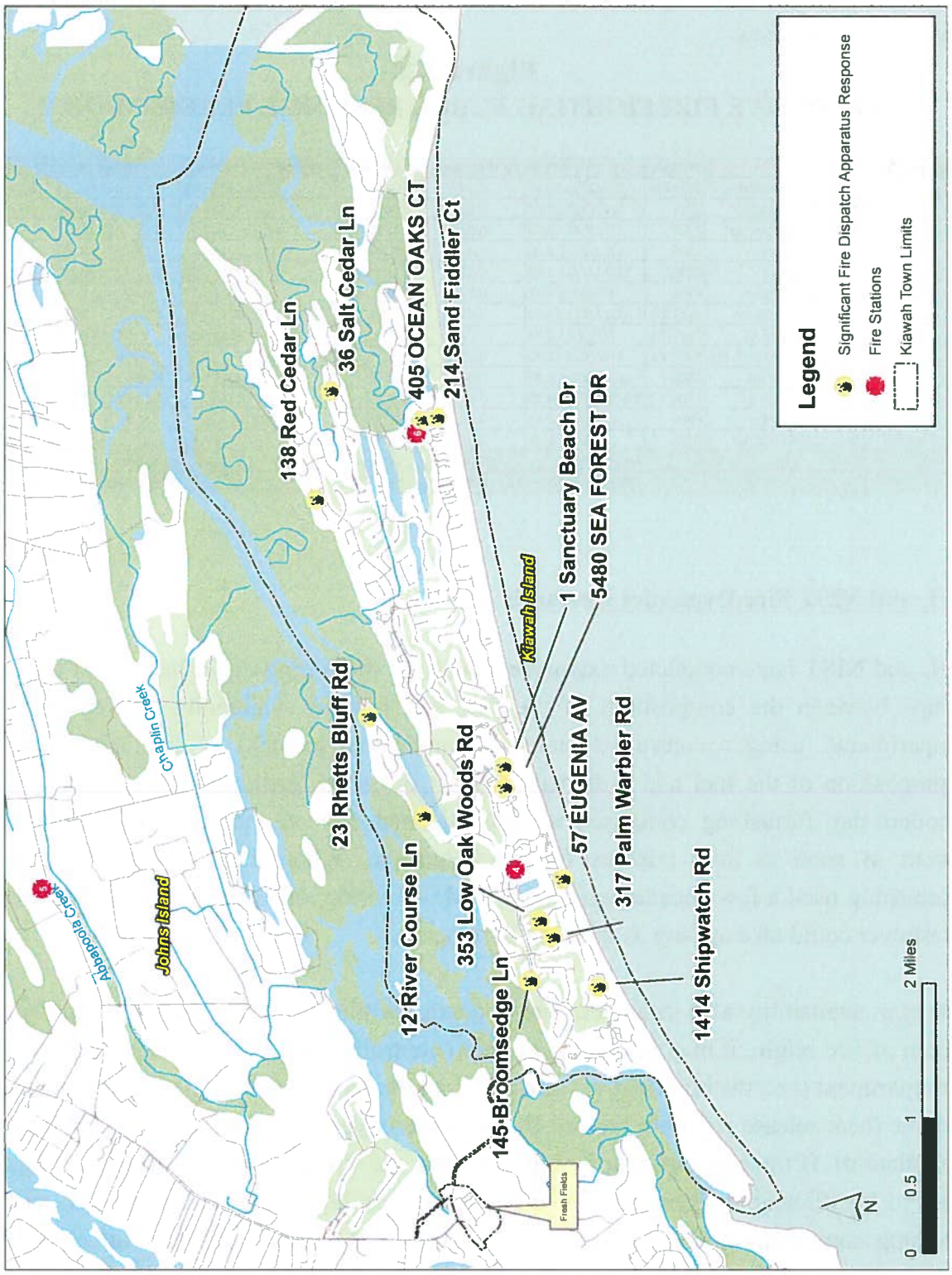
As previously stated in this chapter, both the CFAI and NFPA 1710 base their response-time benchmarks or goals on the fire department's ability to arrive on scene before flashover occurs. Research by the NFPA and published the *NFPA Fire Service Performance Measures* document (2003) identifies the problems associated with this metric by noting that:

> "Varying construction features make comparisons of 'fire spread beyond compartment' difficult. It is difficult to compare measures of 'fire spread beyond compartment' because of the variability in construction features, i.e., balloon construction, exposed truss, false ceilings. In addition to construction features, contents, such as fire load and interior finishes, have a big effect on fire spread. Comparing reports can be very misleading without knowledge of construction materials."

The same logic can be applied to the prevention of flashover in that the onset of flashover is affected by many factors, not the least of which are the composition of available fuel, amount of fuel present, room size and geometry, and oxygen availability. These variables make it impossible to predict the timing of a flashover event.

An analysis of dispatched high priority fire events from the provided CAD record on Kiawah Island was conducted when the event had at least six arriving apparatus. Figure 3.27 shows where the thirteen events occurred.

Figure 3.27
SIGNIFICANT APPARATUS ARRIVALS TO DISPATCHED FIRES



The table in Figure 3.28 shows the arrival time of the last arriving apparatus to each of these events that meet the SOG response criteria or simply the last unit attending the scene in some cases.

Figure 3.28
EFFECTIVE FIREFIGHTING FORCE RESPONSE PERFORMANCE

Dispatch Date/Time	Address	1st Unit	1st Arrival Time	1st Unit Response	Last Unit	Last Unit Assigned Time	EFF End Time	EFF Response	Notes
9/7/2011 20:54	1 Sanctuary Beach Dr	TWR704	9/7/2011 20:59	0:04:43	C701	9/7/2011 21:32	9/7/2011 21:32	0:38:34	
5/17/2012 4:02	405 OCEAN OAKS CT	E706	5/17/2012 4:03	0:00:49	BC105	5/17/2012 4:02	5/17/2012 4:48	0:46:21	
7/1/2012 13:46	317 Palm Warbler Rd	E704	7/1/2012 13:50	0:04:03	BC801	7/1/2012 13:46	7/1/2012 14:32	0:46:06	
11/11/2012 4:24	36 Salt Cedar Ln	E706	11/11/2012 4:29	0:05:07	BC105	11/11/2012 4:24	11/11/2012 5:01	0:37:00	Concurrent!
11/11/2012 5:39	57 EUGENIA AV	BC801	11/11/2012 5:43	0:03:17	TWR104	11/11/2012 5:39	11/11/2012 6:14	0:34:21	Concurrent!
4/2/2013 5:14	12 River Course Ln	E704	4/2/2013 5:21	0:06:31	TWR704	4/2/2013 5:17	4/2/2013 5:35	0:21:16	
4/27/2013 13:55	145 Broomsedge Ln	TWR704	4/27/2013 14:01	0:06:14	E702	4/27/2013 13:56	4/27/2013 14:24	0:29:15	
7/8/2013 0:26	1414 Shipwatch Rd	TWR704	7/8/2013 0:33	0:07:15	BC105	7/8/2013 0:26	7/8/2013 0:50	0:24:49	
9/4/2013 10:04	353 Low Oak Woods Rd	TWR704	9/4/2013 10:10	0:05:25	BC711	9/4/2013 10:04	9/4/2013 10:20	0:15:51	
10/25/2013 1:30	23 Rhetts Bluff Rd	E704	10/25/2013 1:37	0:06:30	BC105	10/25/2013 1:30	10/25/2013 2:05	0:35:05	
10/28/2013 14:23	214 Sand Fiddler Ct	E706	10/28/2013 14:29	0:06:09	BC105	10/28/2013 14:23	10/28/2013 14:54	0:30:46	
1/7/2014 16:45	138 Red Cedar Ln	E706	1/7/2014 16:52	0:06:54	BC711	1/7/2014 16:45	1/7/2014 17:03	0:17:48	
2/5/2014 8:33	5480 SEA FOREST DR	E704	2/5/2014 8:40	0:07:31	BC711	2/5/2014 8:33	2/5/2014 8:47	0:14:07	
			Average	**0:05:25**			**Average**	**0:30:06**	
			90th Percentile	**0:07:11**			**90th Percentile**	**0:44:36**	

UL and NIST Fire Dynamics Research

UL and NIST have conducted extensive studies on the timing of flashover and relationships between the composition of the fuel and oxygen availability. In repeated UL experiments, using a controlled room size and equal amounts of fuel, changing the composition of the fuel had a dramatic impact on when flashover would occur. When modern-day furnishing composed of synthetic materials as the fuel, flashover would occur as soon as 3:40 minutes following ignition. When the fuel was changed to furnishing used a few decades ago, those made of cotton, other natural fibers and wood, flashover could take as long as 29 minutes to occur.

Oxygen availability also influences fire dynamics within structures. As a fire grows in a room of fire origin, it may become ventilation controlled depending on how well the fire compartment (i.e., the building) is sealed. During the incipient stage, both fire growth and power (heat release rate) are limited by available oxygen (read as air provided through ventilation). If the compartment is tightly sealed, the fire may ultimately self-extinguish due to insufficient oxygen (the fire triangle requires heat, oxygen, and fuel to sustain flaming combustion). For flashover to occur following these conditions air or oxygen

must be introduced into the structure. Ventilation is a fire service term used to describe the introduction of air into and the release of heat, smoke, and fire gases from a building. If ventilation is increased either through tactical action of firefighters, unplanned ventilation resulting from effects of the fire (e.g., failure of a window), or human action (e.g., door opened) heat release will increase, potentially resulting in ventilation induced flashover conditions. It is important to note that these ventilation induced fire conditions are sometimes unexpectedly swift providing little time for firefighters to react and respond.

The factors described above clearly demonstrate that predicting the timing of a flashover event is nearly impossible. Thus using the prevention of flashover as a time-based response benchmark or goal is a somewhat contrived metric. What is abundantly clear, however, is the quicker the fire department arrives and intervenes by applying water to the area in which the fire is burning makes fire conditions safer.

Steven Kerber, the Director of UL's Firefighter Safety Research Institute at Underwriters Laboratories, writes in *Study of Effective of Fire Service Vertical Ventilation and Suppression Tactics in Single Family Homes* that "applying water to the fire as quickly as possible, regardless of where it is from, can make conditions in the entire structure better. Even a small amount of water has a positive impact on conditions within the house, increasing the potential for victim survivability and firefighter safety." A small amount of water can have a positive effect on interior conditions, including increasing the potential for survivability of fire victims and safer conditions for firefighters.

Applying water from the exterior through a door or window directly into the fire area or the materials actually contradicts decades of firefighting tradition, but research conducted by UL and NIST demonstrates that it will make conditions better in a quicker amount of time for victims and firefighters alike.

A common argument against flowing water onto the fire prior to entry is the belief that conditions beyond the fire would be made worse, or in firefighting jargon "pushing the fire." Empirical research data actually prove otherwise. In one experiment, 25 gallons of water directed off the ceiling of the fire room decreased fire room temperatures from 1792°F to 632°F in 10 seconds and the hallway temperature decreased from 273°F to 104°F in 10 seconds. Many similar experiments were conducted at Governor's Island in New York City in the summer of 2013 with similar results. These results illustrate that

not only do conditions inside the structure improve, but that fire streams do not push fire through the building.

The findings of this recent research do not necessarily invalidate the recommendations of NFPA 1710 and CFAI, but they do provide a foundation for considering alternative deployment strategies for effective community fire suppression protection. The ability to apply water in the fire area and control the amount of air entering the fire area are critical factors that affect ambient temperatures and fire growth within a building that is on fire. Often the fastest method of applying water to the fire is from the exterior of the building. Studies conducted by Elkhart Brass, a manufacturer of firefighting nozzles, indicates that the effective reach of fire stream is from 35 feet to 260 feet depending upon nozzle size, nozzle pressure, vertical reach requirements, and wind conditions. Larger nozzles, higher pressures with fires occurring at ground level have higher reach capacities. Having to direct a fire stream into a second- or third-story window from the ground shortens the horizontal reach of a fire stream.

Nonetheless, the findings of the recent fire behavior research provide communities the opportunity to consider alternative deployment strategies, such as smaller crew sizes for initial structure fire response. This is especially true for communities where the fire department provides first response to medical emergencies and where structure fires comprise an extremely small percentage of the fire department's emergency response workload in specific communities. This is not to say, that structure fires are no longer labor-intensive incidents requiring multiple companies; they are. However, a smaller vehicle staffed with a two-person crew can initiate effective initially fire control actions that can improve the outcome of the incident and potentially control the spread of the fire until the balance of the structure fire assignment arrives. Actions like applying fast water to the fire and ensuring that doors and windows of the building are closed can delay fire spread and improve tenability for the fire victims inside the structure.

There are no "one-size fits all" fire department deployment strategies that are appropriate for every community across the nation. The fire problem in downtown Manhattan in New York City is dramatically different than the fire problem in the Town of Kiawah Island. One should not be tempted to employ the FDNY deployment strategy on Kiawah Island. In 2012, FDNY responded to 5,734 structure fires in Manhattan, or nearly 16 structure fires per day on average. During the same period of time, SJFD responded to 13-reported structure fires on Kiawah Island, or on average a structure once every 28 days.

Water Supply

An adequate water supply is essential for confining, controlling, and extinguishing structure fires. The actual amount of water needed for fire control differs throughout a community due to the variety of building and occupancy conditions. Thus, water demand for structural fire protection has to be determined at a number of different locations throughout a given community.

ISO evaluates the fire suppression capabilities of communities according to 10 classifications of service. It has evaluated and continues to monitor more than 45,000 fire-protection areas in the United States. This information is developed and maintained municipality by municipality. Information on municipal fire-protection capabilities is collected through on-site assessments, and three protection features are evaluated: fire-alarms and communications systems; fire department; and water supply. Receipt of alarms and alarm processing accounts for 10% of the evaluation, while fire department and water supply make 50% and 40% of rating respectively. The water supply data collected and evaluated include the following:

- Water pumping equipment;
- Needed fire flow;
- Hydrant flow tests;
- Hydrant condition; and
- Identifying locations of supply and storage facilities, water mains, pressure zones, control valves, and new streets

The water supply evaluation considers the ability of the water system to meet consumer consumption plus fire flow under average and maximum daily conditions. Needed fire flow is the amount of water considered necessary to control a major developing fire in a specific building. The amount of water needed, for ISO purposes, is expressed in GPM at 20-psi residual pressure for a duration ranging from 2 to 4 hours. The minimum needed fire flow for any single building is 500 GPM for 2 hours. The maximum needed fire flow is 12,000 GPM for 4 hours.

Although the Study Team was unable to obtain needed fire flow figures on specific buildings within the Town from the Town's Building Services Department or the STJFD, STJFD's Deputy Chief has assured the Study Team that the water system is capable of

supplying needed fire flow requirements to all areas of the Town. The Chief was able to cite the following examples:

- The River Course Clubhouse is 48,125 sq. ft., equipped with fire sprinklers, and the water system is capable of providing a fire flow of 3,250 GPM for three hours; and
- The Sanctuary Hotel is 381,409 sq. ft., equipped with fire sprinklers, and the water system is capable of providing a fire flow of 6,000 GPM for four hours.

These needed fire flow examples are consistent with the minimum recommendations in Appendix B of the 2012 International Fire Code for structures without fire sprinkler systems. The Code permits reductions in the fire flow requirements for buildings equipped with fire sprinklers. The reader should note that the State of South Carolina has adopted the 2012 International Fire Code, but not its appendices.

INCIDENT ANALYSIS SUMMARY

Although structure fires have trended slightly upward from 2.52% in 2011 to 3.02% of the call load in 2014, they are low frequency events on Kiawah Island. However, when these events do occur they can be challenging for the fire department to handle due to many factors. These factors include, but are not limited to: the extent of the fire when discovered and reported; the proficiency of firefighting operations; the ability of the fire department to assemble an effective response force in a timely manner; the composition and arrangement of fuels; building construction; and obstacles that impede firefighting operations.

About 60% of STJFD's calls for service were not related to fires. Further, of the incidents related to fires, actual fires represent 5.6% of the total call load, while fire alarms accounted for 34% of the total calls for service. Incidents not requiring the use of a Class A pumper or aerial device for intervention comprised nearly 90% of the incidents occurring on Kiawah Island from the last half of 2011 until June 2014.

Looking at the seasonal nature of the incident for the full two years that were represented in our date set (2012 and 2013), the two months with the highest number of incident were July and August. July and August for 2012 and 2013 accounted for 30% of the incidents that STJFD responded in to on Kiawah Island. Of those about 6% of the incidents would

have potentially required a full fire department response. Thirty-two percent of the calls during this time period were for fire alarms and 84% were for medical emergencies.

Analysis of the call load by time of day finds that the peak call load hours are from 8 a.m. to 9 p.m. with 71% of the calls occurring during these hours. 11 a.m. to 1 p.m. represents the busiest time of day with 15% of the calls occurring during these hours.

Response-time analysis for initial responding units is currently within reasonable expectations, but response times for the balance of the first alarm and response times to future development on Kiawah Island are problematic. With the exception of Freshfields Village, the remainder of the developed areas within the Town is capable of being reached from Stations 4 and 6 for initial deployment of firefighting and EMS resources within the baselines established for suburban communities. However, the travel times for the **fire stations located outside the Town and for chief officers greatly exceed recommended criteria established in NFPA 1710**, the CFAI baselines for suburban and rural communities, and those acceptable to the Town's elected and appointed officials. Additionally, the new development on the north portion of the Island will fall outside of the acceptable range for initial response units.

ALTERNATE DEPLOYMENT STRATEGY

Analysis of STJFD's station locations would not currently indicate the need to add another fire station between Fire Station 2, 4550 River Road, Johns Island, SC, and Kiawah Island. Although travel distance from Station 2 exceeds ISO's 4-mile travel distance demand for service, it does not currently support the need for another station. However, the adopted Charleston County Comprehensive Plan Update slates southern Johns Island for "Planned Development." Planned development permits flexibility in future land use recommendations and zoning restrictions. If this area does develop, then STJFD should consider locating an additional fire station along Betsy Kerrison Parkway between Christine Drive and Camp Care Road.

Although the addition of two quick response vehicles (QRVs), as discussed in this section, to Kiawah Island would not improve ISO credit to many parts of the Town or meet the response guidelines outlined in NFPA 1710, they would provide the fire department with the capability of deploying an immediate, emergency intervention crew for structure fires and medical emergencies. The additional staffing would, however,

allow the department to meet or exceed the 14-person effective response force for structure fires recommended in NFPA 1710. Additionally, these two-person QRV crews could potentially handle as much as 87% of calls for service in the Town, while reducing the need for the response of larger, more costly fire apparatus. Finally, the Study Team would recommend that the QRVs be added to the normal response assignments for structure fires in addition to the units currently assigned.

Fire apparatus manufacturers build QRVs on commercial truck chassis. Many apparatus manufacturers market vehicles called mini-pumpers that would be appropriate for this application. The vehicles are available with the following features:

- Either 2- or 4-wheel
- Pumps with up to 1,500 GPM rating
- Foam and water tanks
- Water tank capacities up to 500 gallons
- Adequate storage capability for attack lines, small amount of supply hose, medical equipment and supplies, and portable vehicle extrication equipment

Vehicles similar to this have prices as low as $210,000. To ensure maximum versatility the Study Team recommends the purchase of vehicles with four-wheel drive and crew cabs. Four-wheel drive vehicles would be appropriate for off-road use in the event of wildfires or for removing medical patients from the beach. Crew cabs would facilitate patient movement.

Figure 3.29 is a photograph of an example of a QRV.

Figure 3.29
QUICK RESPONSE VEHICLE

The Study Team recommends maintaining current staffing levels at Station 4 and 6, and adding four additional firefighters per shift. The salary and fringe benefits for adding these positions would be approximately $654,000 annually.

The Study Team recommends that these crews be dynamically deployed during peak call load, daylight hours and be assigned to areas outside of the 1.5-mile distances to north of Station 6 and south of Station 4. When not assigned to emergency incidents, these crews could be used to perform fire and life safety code inspections; conduct public fire and life safety presentation; inspect and maintain fire hydrants; welfare checks and assistance with medications for chronically ill residents; emergency contingency planning for local businesses; and other similar duties. Each evening at or near sunset, the units would return to quarters at Stations 4 and 6.

The Study Team also recognizes these units, that could be staffed with one or two persons, would be engaged in emergency incidents, public education events, and other duties during the entire peak hour times that they are in the community. Further break and meal times need to be provided. The fire department needs to seek an agreement with members of the community to find a suitable location for these crews to park their vehicles, take breaks and complete necessary reports and other paperwork.

FIREFIGHTING TACTICS IN MODERN BUILDINGS

From 2004 to 2013, 187 firefighters have died in the line of duty during structural firefighting operations. Nearly 70% of those fatalities occurred during residential fire scenarios. Rita Fahy of the NFPA reports that although the number of structure fires has dropped nearly 66% between 1977 and 2009, the rate of firefighter line of duty deaths in structure fires has increased.

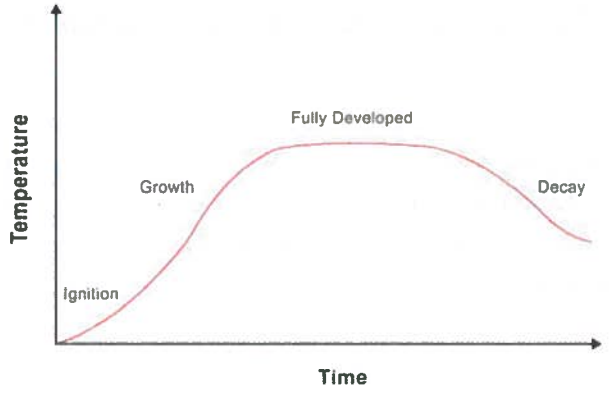
In recent years, fire service professionals and fire researchers have invested in research to determine why firefighter fatalities in structural firefighting are occurring at an alarming rate. Researchers, such as Dan Madrzykowski of the National Institute of Standards and Technology and Steve Kerber of UL, have been conducting research on this matter for nearly 15 years. They and others have concluded that firefighters are being challenged by fire ground hazards that are more dangerous than those that firefighters faced 30 to 40 years. Open floor plans, increased size of single-family homes, and the use of synthetic materials in furnishing and building materials have made the fire ground more deadly than ever.

As this research has progressed, a consensus has developed that a significant contributing factor to firefighter deaths in structure fires is the fire service's lack of understanding of fire behavior in buildings resulting from natural ventilation. Many of the tactics employed by the American fire service have developed based on personal experience and passed from generation to generation. Although these tactics may have been successful for more than 250 years, firefighters and fire officers did not have a thorough understanding of fire behavior during structure fires.

One common practice that firefighters have used in recent decades is to fight fires exclusively from inside a burning building. There was a widely held belief that attacking fire from outside of the building would push fire to the uninvolved parts of the structure, causing the fire to worsen and potentially risk the lives of anyone in the building. Another tactic widely employed was to make as many openings in the building as possible to release heat, smoke, and other fire products; this making interior conditions more tenable for any potential victims trapped in the building. Improperly ventilated fires are not only much harder to fight, but can also build up enough smoke to create a back draft or smoke explosion, or enough heat to create flashover. Further, poorly placed or timed ventilation may increase the air supply to the fire and cause the fire to rapidly grow and spread. Used incorrectly, ventilation can cause the fire to grow in intensity and potentially endangers the lives of firefighters who are located in the flow path or the area between the fire and the ventilation opening.

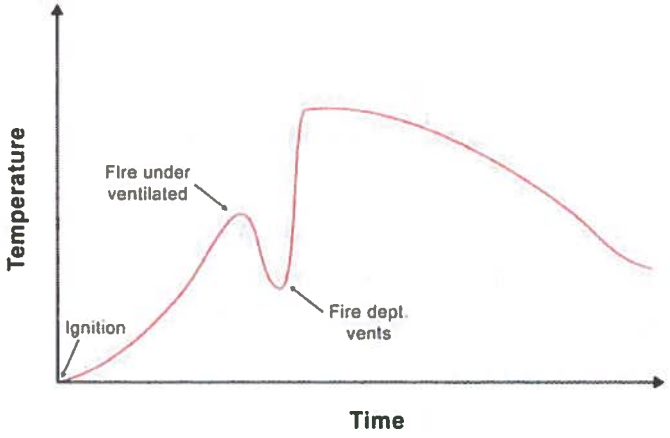
The NFPA 1710 committee and CFAI staff have traditionally used the standard time temperature, shown in Figure 3.30 below, as a basis for establishing response times and identifying fire ground resource needs. In the area of fire suppression, service-level objectives have been intended to prevent the flashover point of a structure fire. It is widely accepted that preventing flashover reduces the threat to life and property. Research conducted by NIST and UL in conjunction with fire departments such as the Fire Department of New York, Chicago Fire Department, Los Angeles County Fire Department, and Spartanburg (SC) Fire Department have demonstrated that fires burning within structures frequently do not progress through stages of fire consistent with this model.

Figure 3.30
FIRE GROWTH TIME-TEMPERATURE CURVE



The NIST Fire Behavior in a Structure curve, shown in Figure 3.31, demonstrates the time history of a ventilation-limited fire. In the case of ventilation-limited fires, the fire starts in a structure that has the doors and windows closed. Early in the fire growth stage there is adequate oxygen to mix with the heated gases, which results in flaming combustion. As the oxygen level within the structure is depleted, the fire decays, the heat release from the fire decreases, and, as a result, the temperature decreases. When a vent is opened, such as when the fire department enters a door, oxygen is introduced. The oxygen mixes with the heated gases in the structure and the energy level begins to increase. This change in ventilation can result in a rapid increase in fire growth potentially leading to a flashover (fully developed compartment fire) condition.

Figure 3.31
NIST FIRE BEHAVIOR IN A STRUCTURE CURVE



The International Society of Fire Service Instructors has introduced a set of fire ground tactical goals using the acronym SLICERS that permits first-arriving unit officers to plan and execute initial fire ground tactics that are consist with current fire dynamics models. SLICERS consists of the following sequential actions and acts of opportunity:

- Sequential Actions
  - Size up
  - Locate the fire
  - Identify and control flow paths
  - Cool the space from the safest location
  - Extinguish the fire

- Action of Opportunity
  - Rescue
  - Salvage

The Study Team recommends that STJFD staff participate in fire dynamics training and consider employing tactical operations consist with the research of fire behavior in modern structures.

COMMAND TRAINING

Although the Study Team did not have the benefit of interviewing STJFD employees or reviewing training records, it is easy to deduce from three years of incident records from the Communication Center that STJFD members do not get regular and repetitive experience handling structure fire incidents. Furthermore, officials in the Town of Kiawah Island have concerns about the STJFD's ability to respond a chief officer to a major incident within the Town in a timely manner. Response data substantiate this concern. With adequate training and experience, company officers can effectively command and manage the incident until a chief officer is on scene. This section suggests ways to obtain incident command and management competence.

The South Carolina Fire Academy offers the following command officer training courses:

- Incident Command for High-Rise Operations
- Incident Command System for Structural Collapse
- NIMS – ICS for Fire Service
- Introduction to Unified Command
- I-300 Intermediate ICS

- I-400 Advanced ICS
- Fire Ground Command Simulations

These courses would provide the beginning of a sound foundation for developing command competence in the STJFD company officer complement, but more intensive training and practice would be required to become a competent incident commander. Additional incident management training is available at the National Fire Academy in Emmitsburg, MD. The following six- and ten-day courses would provide advanced incident management training:

- Command and Control of Incident Operations
- Command and Control of Fire Department Operations at Target Hazards
- Command and Control Decision Making at Multiple Alarm Incidents.

Another option that the STJFD command staff may consider is the Blue Card Command Certification Program. The program is based of retired Phoenix Fire Chief Alan Brunacini's widely read *Fire Command* and *Command Safety* textbooks. The program consists of 50-hours of online interactive instruction and three days in a simulation lab. The cost of the course is $385 per person. The International Association of Fire Chiefs, the Center for Public Safety Excellence, and the International Society of Fire Service Instructors have endorsed this program.

The officers of the Charleston Fire Department recently completed Blue Card command training. The department also has certified Blue Card trainers, and has been designated as a Blue Card Command Training Center. The Study Team suggests that the close proximity of the Charleston Command lab and the training conducted for one of STJFD's automatic aid partners (the Charleston Fire Department) make this certification attractive for the department consider.

Lastly, experience can be obtained by modeling the behavior of others. It is suggested that STJFD have their personnel ride along with other fire departments that have higher incidences of structure fires and other complex incidents. Locally, the Charleston and North Charleston fire department may offer this type of opportunity. The current STJFD fire chief has experience in a large urban fire department (Pittsburgh [PA] Fire Bureau). She may be able to arrange for STJFD members to ride along in Pittsburgh.

RESIDENTIAL SPRINKLERS

According the U.S. Fire Administration, there were an estimated 364,500 residential fires in the United States in 2013. These fires accounted for 2,450 fire fatalities, 13,900 injuries, and $6,651,400 in property loss. During the five-year period from 2007 to 2011, there were an average of 2,580 fire deaths and $7.48 million in property lost each year. Smoke alarms have been proven to provide early detection of residential fires, while fire sprinklers can extinguish fire when they begin and are small. When fire sprinklers are present, the chances of a person dying in a fire are reduced by up to 75% and the average property loss is cut by up to 66%, compared to fires where fire sprinklers are not present.

The International Code Council adapted residential sprinkler as part of the 2009 International Residential Code. The State of South Carolina has adopted the 2012 version of the Code, but currently the State does not require residential sprinklers in one- and two-family homes. The State does, however, offer a tax credit for the installation of fire sprinklers when not required by code. This tax incentive law, known as The 2008 Fire Sprinkler Incentive Act, is intended to serve as an incentive for installing fire sprinkler systems in commercial and residential properties.

According to the NFPA, the cost of installing a residential fire sprinkler system in new construction was between $0.81 and $2.47 per square foot in 2013. Assuming the average single family home in the Town is 6,000 sq. ft. in size, the cost to equip the average home in the Town would be about $14,820 using the $2.47 per square figure. With a cap of 5,600 residential properties for Kiawah Island, another 1,400 residential properties can be developed. The collective cost to equip 1,400 residential properties with average size of 6,000 sq. ft. would be $20,748,000.

If the community considered building another fire station to provide fire protection for the additional 1,400 residents, there would be fire station construction costs, annual maintenance and repair of the station, apparatus costs, and personnel costs. Based on a recent contract awarded to build a 10,000 sq. ft. fire station in Goose Creek, SC, the cost to build a fire station to protect these residents would be about $3,124,000. Using the current STJFD operating budget to estimate annual operating of a single engine fire station with four personnel staffing the station daily, the Study Team estimates the annual

costs to be about $766,000[7]. The cost to purchase a fully equipped engine would be about $600,000. The industry standard for the life expectancy of a front-line engine company is 15 years. Thus, two fully equipped engines would have to be purchased over the period of 30 years. The total costs to operate the station for 30 years including the construction costs would be about $27,304,000.

Comparing the 30-year cost for residential sprinklers to the costs to operate the fire station for 30 years, the cost for residential sprinklers would be about $6,556,000 less. Further insurance companies have offered residents in South Carolina a 5% to 25% discount in their insurance premiums for customers who have installed residential fire sprinkler systems in their homes. The Study Team suggests that the Town should consider requiring residential sprinklers in new one- and two-family construction.

If a residential sprinkler requirement is not adopted, then the Study Team recommends that residential occupancies be equipped with a commercially monitored smoke or fire alarm system. Officials from STJFD informed the Study Team that many homes are unoccupied for long periods throughout the year. Lightning strikes, electrical shorts, or other events that could lead to a fire in an unoccupied residence could go undetected until a fire is large enough to be seen by passersby. Monitored alarm systems would provide for early detection of a potential fire.

PROTECTING HOMES FROM WILDFIRE

According to the South Carolina Forestry Commission, more than 3,000 wildfires occur in the state each year. Humans cause about 98% of these fires; many of them, between 40% and 45%, are the result of losing control of debris fires. In 2007 alone, 141 homes and other buildings were lost to wildfires. Urban sprawl in South Carolina has blurred the boundaries between rural areas and urban areas of the state. As development increases, wildfires will threaten lives and property as never before.

The South Carolina Forestry Commission participates in the National Fire Plan, and works with local fire departments throughout the state to assess the potential for wildfire damage to communities and individual homes. The Forestry Commission writes plans

[7] Based on personnel cost for one engine company comprised of 1 station commander, 2 lieutenants, 3 engineers, and 6 firefighters.

based on these assessments, and helps communities and homeowners decide on steps they can take to lower the risks. Additionally, the Commission conducts Firewise Communities workshops to educate community leaders and homeowners on wildfire risks and recommendations to protect their homes. The Firewise Communities Program is sponsored by the NFPA.

As previously mentioned in this chapter, dense vegetation surrounding homes on Kiawah Island creates extreme challenges to firefighters. The Study Team strongly recommends that the Fire District and Town officials enlist the South Carolina Forestry Commission to present Firewise Communities workshops and conduct fire potential assessments of the homes throughout the Town.

ALTERNATIVE FIRE PROTECTION SERVICES DELIVERY OPTIONS

Although the Study Teams strongly believes that the current arrangement between the Town and STJFD would be in the best interest of all stakeholders, the Study would be incomplete without mentioning alternative fire protection options if service improvements cannot be achieved with the St. Johns Fire District. The Study Team does not possess the legal expertise to provide definitive recommendations in these matters, therefore, suggests that the Town should consider seeking the advice of attorneys if either of these options were to be considered. What the members of the Study Team do understand is that these would be viable options for the Town to consider. Again the Study Team reemphasizes that in its opinion the best interests of the Town and the Fire District is to work out a suitable resolution to their differences that meet the needs of the communities they serve.

The Study Team believes that South Carolina Code of Laws (§ 5-7-30) and case law (*Hospitality Ass'n of S.C., Inc. v. County of Charleston*, 464 S.E.2d 113 (S.C. 1995) gives municipalities, including the Town of Kiawah Island, the right to provide fire services in the Town. As a general rule a County may diminish, enlarge, or consolidate existing Special Purpose Districts (SPDs) such as the St. Johns Fire District, but they may not abolish them. Although the Study Team is not familiar with the legal process, it believes that the Town would have to petition the Charleston County Council to change STJFD's service boundaries for the Town to assume responsibilities for providing fire protection. After County Council approval, the Study Team thinks that the Town could provide services through a department of local government or contract with another agency.

In discussions with Town officials, the Study Team understands that it is the Town's preference to retain STJFD as its fire services provider, but Town leaders also seek to achieve service level improvements. Town officials have indicated the willingness to increase funding or revenue to the Fire District to attain increased service levels. As mentioned previously in this study, the fire department must consider the expectations of those it serves and its community's willingness to pay when planning for adequate community fire and emergency services protection, in addition to their response capabilities. The Town of Kiawah Island's elected and appointed representatives are seeking increased levels of fire protection for its current and future residents. Town leaders and STJFD should work together to find a funding mechanism that would add staff and equipment to deploy to the two QRVs recommended in this Study.

SUMMARY

The three most important elements affecting the response capabilities of a fire department are its standards of coverage; department capability or the abilities of the department's members; and resource reliability. The St. Johns Fire District has inadequate resources deployed to the Town of Kiawah Island to meet consensus standards developed by the National Fire Protection Association and set forth in NFPA 1710. There are areas of the Town—Freshfields Village and new development—that fall outside of NFPA 1710's four-minute travel time for the first responding unit. Further STJFD's ability to assemble an effective response force within the 480-second travel time recommendation for any fires occurring on Kiawah Island cannot be accomplished with the current deployment model. Likewise, similar challenges exist for responses to life-threatening medical emergencies.

Although the Study Team was not provided with sufficient information to assess the capabilities of STJFD members, some generalized comments about the capabilities of fire personnel may be helpful to the reader. There is an old axiom in the fire service. The decisions made and actions taken during the first five minutes of an incident will determine what you will do for the next five hours. A highly seasoned, well-trained complement of four firefighters may perform better than four fire companies with inexperienced, poorly trained, or incompetent personnel. Simply meeting standards for response such as NFPA 1710 and CFIA benchmarks does not guarantee successful outcomes. Additionally, human error will always be a factor that determines results.

Sometimes incident commanders make poor decisions. Some readers may remember that the River Course Clubhouse fire resulted in two separate fire department responses. Firefighters thought that they had extinguished the original fire, only to return later to find out they had not extinguished the fire.

While response capabilities are important factors that affect incident outcomes, they are not the only aspects to consider when planning for adequate fire and emergency services protection. Demand for service, expectations of the community, and the willingness to pay for services are factors that must be weighed as well. Compared to communities of similar size, demand for fire and other emergency services is overall similar to the experience of rural communities throughout the United States. However, during the months of July and August, demand for service is at its highest and exceeds those of other rural communities.

Obviously, the expectations of the community's leaders and their willingness to pay for a higher level of service are factors that must be addressed. This Study was initiated because community expectations of its fire and emergency medical services were not being satisfied. Additionally, discussions with Town officials have indicated their willingness to pay for improved services. Recommendations in the next section of this chapter will address these and other factors regarding fire and emergency services.

RECOMMENDATIONS

3-1 The STJFD should consider a deployment strategy for the Town of Kiawah that includes staffing for its current apparatus and two quick response vehicles (QRV) with fast fire attack and basic life support capabilities.

3-2 The STJFD should train on and adopt standard operating guidelines for safe structural firefighting that incorporates the tactical firefighting recommendations for modern building construction.

3-3 STJFD should ensure that all company officers assigned to Stations 4 and 6 are trained to be competent incident commanders for major incidents involving structure fires and mass casualty incidents.

3-4 The Town of Kiawah Island should consider requiring residential sprinkler systems in all new construction of one- and two-family dwellings. In the absence of fire sprinklers, all properties in the Town should be equipped with monitored fire and/or smoke alarm systems.

3-5 Kiawah Island Utility should paint the bonnets of its fire hydrants in accordance with NFPA 291 to identify their rated water capacities.

3-6 STJFD and the Town should implement a public fire safety education program to inform the owners of single family dwelling about the dangers of heavy vegetation around their homes.

3-7 The Study Team strongly supports the current arrangement between the Town and STJFD for fire protection. However, if STJFD is unwilling to consider future service level improvements for the Town of Kiawah Island, then Town officials should consider alternative fire service delivery models, such as forming a municipal fire department or contracting for service with another agency such as the City of Charleston.