Analysis of Fire Station Location Alternatives

Town of Stoneham, Massachusetts

an Ecco Verde Company

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The Town of Stoneham, Massachusetts, retained Criterion Associates to conduct follow-up analyses as to the best locations for fire stations (including the possibility of including the current station) within the boundaries of the Town. In this assignment, the project team from Criterion Associates was provided with several scenarios that had been identified by the Town of Stoneham and the Fire Department to renovate Headquarters and/or build one or more new fire stations. In our prior work for the Town, we also identified "optimal" locations for fire facilities based on several optimization targets involving distribution of historical calls for service and targeted response times.

It should be noted that in most communities, the location of fire stations is far more closely related to the distribution of calls for service than is the location for law enforcement, public works, or other facilities. This is driven by the approaches to service delivery, focus on speed of response, and overall community expectations.

1. Scope of Work

The Town of Stoneham retained Criterion Associates to conduct analyses as to the best location(s) for fire stations in the community. In this iteration, the project team was asked to examine the feasibility and effectiveness of a deployment using the following potential locations for fire stations in the Town, for both one and two-station models:

- Current location: 25 Central St
- Vacant lot North Border Rd between Orchard St and Buttonwood Rd (south end of Stoneham)
- 611 Main St (former Friendly's, south end of Stoneham)
- 164 Pond St. (DCR Yard, south end of Stoneham)
- 25 Williams St (near existing HQ)
- 101 Central St (front of Middle School, near existing HQ))

These were done for fire / rescue calls using multiple years of data provided by the Fire Department, through their software vendor, Station Smarts. Note that total response time is comprised of several elements including the time it takes to process incoming phone calls, dispatch appropriate units, and for personnel to "go on route" from their vehicles or stations. Maps for these scenarios can be found in the Appendixes to this report.

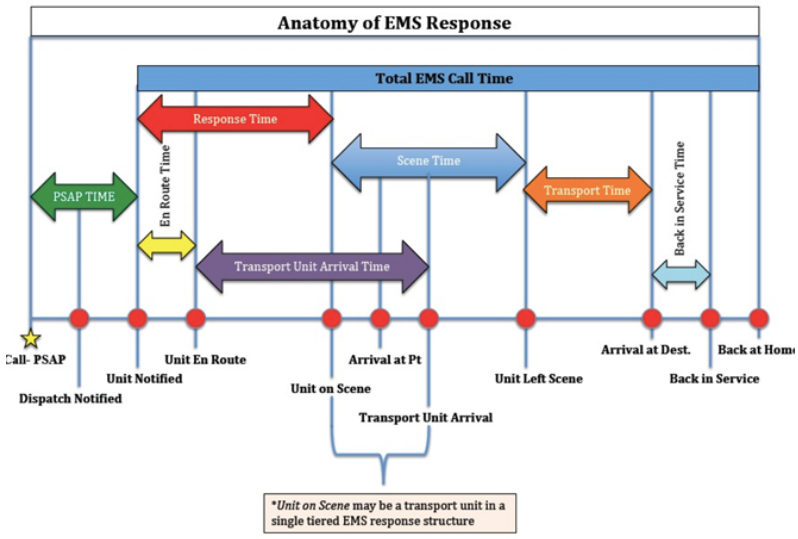
2. Executive Summary

Criterion Associates previously analyzed multiple station-location options for both fire / rescue service delivery within the Town of Stoneham. These analyses and resulting maps are provided in the body of this report and in the Appendix (maps) at the end of this report. Options considered include both those sites identified by the Town as well as those identified by the project team from Criterion Associates using sophisticated geographic information system (GIS)

models as "optimal" given various time constraints (four vs. eight minutes of travel time) and for fire / rescue calls.

It is important to note that the analyses were performed using actual call for service data provided by the Town for a multi-year period. This enabled the consulting team to consider the potential implications of each scenario based on the actual service demands of the Town[1]. A public safety service delivery system should be designed to maximize the benefit (through rapid response times) to as many calls as practicable given the financial and operational constraints facing the community. Another way of saying this is that not every road segment has as many calls for service as another (for example, consider a road with an assisted living facility compared to one with several single-family homes).

<u>This analysis only considers the drive time from static station locations.</u> Response time to a patient, accident, fire, or other emergency is comprised of many discrete intervals of time:



The above is an important consideration when evaluating the need for stations. For example, if a medical response is to a high-rise (of which the Town has a number) the time it takes to get to the patient should also consider the time it takes to dismount the truck, get into a lobby, secure an elevator, and make way to and entry into the patient's apartment.

It is also important to note that the decision as to where to put a public safety facility in a community relates to numerous variables – not simply response time, which is an important but not a singular determinant. Land ownership, alternative uses, development challenges, wildlife concerns, and many other issues can (and should!) factor into a community's decision making.

[1] Note that the COVID-19 Pandemic has impacted not only the Stoneham Fire Department, and the types and numbers of calls to which they have had to response, but also the broader fire rescue service delivery system in the Commonwealth and beyond. The impacts of these changing requirements are still being addressed at present.

Key Findings:

1. **One-station models, given current road networks, workload distribution and call concentrations, can provide acceptable coverage town-wide. Several sites, including the current station location, provide for coverage in less than four minutes to more than 93% of calls. However, there are other impacts from a single station, particularly in the south end of the Town, which should tip the Town in favor of a two-station model.**
2. **Two-Station models enhance the level of coverage and also provide significant response time improvements over many of the one-station models.**
3. **Several of the station locations, in one-station models, provide better coverage (25 Central St, North 25 Williams, and 101 Central) than do several others (North Border, 611 Main St., and 164 Pond St.).**
4. **The best improvement comes from having a station at or near the current location and placing a second station in the south end of the Town.**

The next section briefly describes the current deployment within the Stoneham Fire Department.

3. Current Situation

The Stoneham Fire Department operates as a first responder to EMS calls within the Town of Stoneham and provides first response to all other life / safety concerns including fires, accidents, etc. To do this, the Fire Department currently operates from a single station, located roughly in the center of Town located at 25 Central Street, depicted in the photo on the right.

The Fire Department does not staff any ambulances (this is handled by Cataldo Ambulance) but does staff the following:

- 8-10 people on duty
- Engine 2: Lieutenant and 2 Firefighters;
- Engine 3: 2-3 Firefighters when staffing permits (left);
- Ladder 1: 2-3 Firefighters (right);
- Car 2 – 1 Captain

Most departments inside 495 and 128 staff engines and ladders with a minimum of (1) officer and (2) firefighters.

4. Alternatives and Analysis

Working closely with the Fire Chief, our project team toured the Town of Stoneham to physically inspect the original proposed location for a potential second station on North Border Road. We also examined the locations of in-progress and planned developments provided to us by the Town. This included gaining an understanding of the road network and challenges in the Town.

The locations identified include:

- Current location: 25 Central St
- Vacant lot North Border Rd between Orchard St and Buttonwood Rd
- 611 Main St (former Friendly's)
- 164 Pond St. (DCR Yard)
- 25 Williams St
- 101 Central St (front of Middle School)

Each of these scenarios was run using our GIS models, and the expected response coverage and times were calculated for each option.

Figure 1: Fractile Response Time Coverage

Model	One- Station System		Two-Station System HQ & Station	
Performance / Location	4-Minute Fractile	8-Minute Fractile	4-Minute Fractile	8-Minute Fractile
25 Central St. (HQ)	93.7%	99.6%	N/A	N/A
North Border	66.0%	99.9%	97.9%	99.9%
611 Main St.	75.6%	99.9%	99.6%	99.9%
164 Pond St.	58.7%	99.9%	99.6%	99.9%
25 Williams St. [2]	93.7%	99.9%	93.7%	99.9%
101 Central St. [3]	93.4%	99.9%	93.7%	99.9%
210 Main St.	93.4%	99.9%	93.7%	99.9%

The project team also examined the impacts on expected response time for the first-in unit under each scenario. This is calculated by determining the fastest response time to each call for service address, weighting that by the number of responses, and then determining the overall "expected response time" from each scenario. These results are summarized below:

Figure 2: Expected Response Time

Performance / Location	One-Station System	Two-Station System HQ & Station (seconds faster)
25 Central St. (HQ)	2.01	N/A
North Border	3.33	1.81 (12 seconds)
611 Main St.	3.08	1.78 (14 seconds)
164 Pond St.	3.94	1.74 (16 seconds)
25 Williams St.	2.05	N/A
101 Central St.	2.39	N/A
210 Main St.	2.41	N/A

- Adding a sub-station in conjunction with the existing location (or near the existing location) reduces response times, on average, in all cases.
- Placing a sub-station to the south of the current location (or to those locations nearby) results in the most significant improvements.
- The response times, above, do not include call processing, dispatching, reaction time, or the time it takes to dismount, locate the actual site of the emergency, etc.

[2] So close as to be the same as current HQ location alone.
[3] So close as to be the same as current HQ location alone.

CONCLUSION: No single-station model provides the level of service, or the consistency of response times across the breadth of the entire community when compared to two-station models. Two stations allow the Fire Department to more effectively and rapidly respond to calls with a first-in unit. The Town of Stoneham should work with the Fire Department to select a pair of locations and to proceed with the development of a 2-station response model. Careful consideration of future needs, including the possibility of taking on EMS transport, should be included within the design and construction objectives.

The project team has provided maps for each of these alternatives at the end of this report.

5. Time Standards Utilized

To conduct these analyses, the project team from Criterion Associates needed to provide the GIS software with timestamps against which to measure the performance. This makes it possible to compare various alternatives across a common measure. These standards exist for fire / EMS (though there are issues with them that are discussed below).

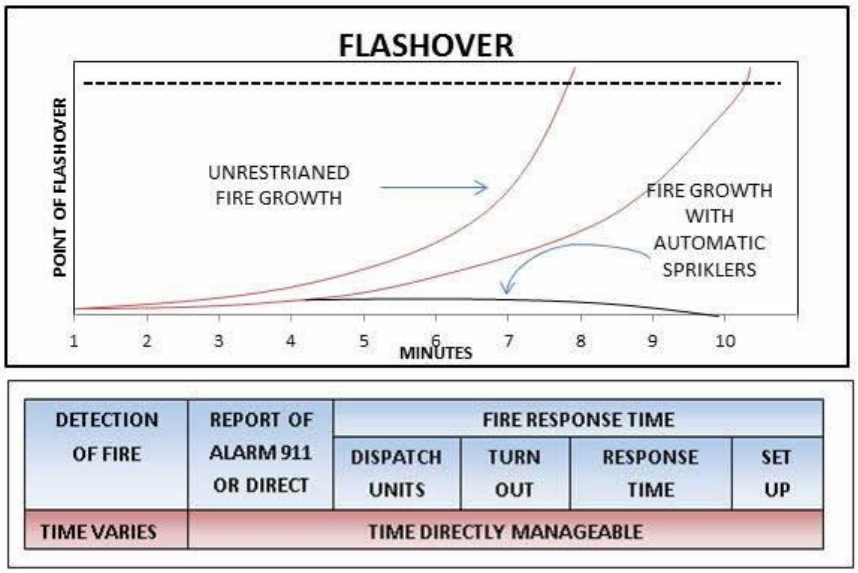
The adoption of performance standards for fire and EMS response is a critical first step in the evaluation of service levels and staffing alternatives. While there are national standards that can be used to evaluate fire and EMS service delivery, each community must identify the key risks and necessary level of protection it needs based on its own unique circumstances. Once these performance standards are established, a community can assess its performance and determine if current resources support the desired level of service.

Nationwide, a great deal of effort and research has been put into developing performance objectives for the delivery of fire and EMS services. This effort is critical for agencies making decisions about deployment and location of emergency resources. The objectives promoted for fire/rescue and EMS have their basis in research that has been conducted into two critical issues:

- What is the critical point in a fire's "life" for gaining control of the blaze while minimizing the impact on the structure of origin and on those structures around it?
- What is the impact of the passage of time on survivability for victims of cardiac arrest?

Figure 3 that follows shows a typical "flashover" curve for interior structure fires. The point in time represented by the occurrence of "flashover" is critical because it defines when all the contents of a room become involved in the fire. This is also the point at which a fire typically shifts from "room and contents" to a "structure" fire – involving a wider area of the building and posing a potential risk to the structures surrounding the original location of the fire.

Figure 3: Typical Fire Flashover Timeline



Note that this exhibit depicts a fire from the moment of inception – not from the moment that a fire is detected or reported. This demonstrates the criticality of early detection and fast reporting as well as rapid dispatch of responding units. This also shows the critical need for a rapid (and sufficiently staffed) initial response. By quickly initiating the attack on a fire, "flashover" can be averted. When "flashover" occurs:

- It is the end of time for effective search and rescue in a room involved in the fire. It likely means the death of any person trapped in the room – either civilian or firefighter.
- Potable extinguishers can no longer have a successful impact on controlling the blaze. Only larger handlines will have enough water supply to affect a fire after this point.
- The fire has reached the end of the "growth" phase and has entered the fully developed phase when every combustible object is subject to the full impact of the fire.
- It signals the changeover from "contents" to "structure" fire. This is also the beginning of collapse danger for the structure. Structural collapse begins to become a major risk at this point and reaches the highest point during the decay stage of the fire (after the fire has been extinguished).

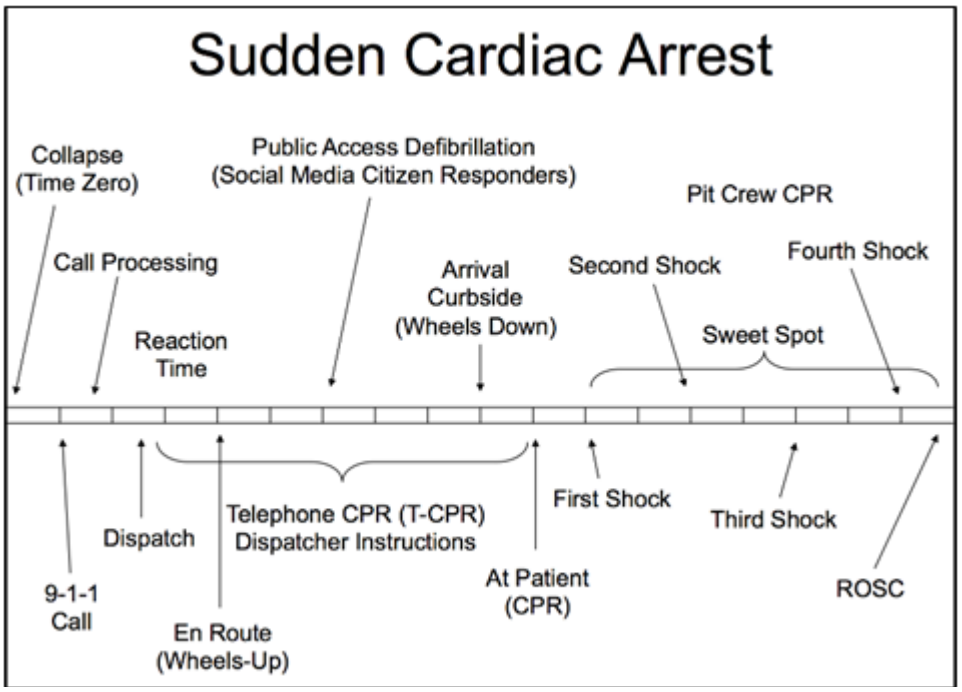
It should be noted that not every fire will reach flashover – and that not every fire will "wait" for the 8-minute mark to reach flashover. A quickly responding fire crew can do things to prevent or delay the occurrence of flashover. These options include:

- Application of portable extinguisher or other "fast attack" methodology.
- Venting the room to allow hot gases to escape before they can cause the ignition of other materials in the room.
- Not venting a room – under some circumstances this will stifle a fire and prevent flashover from occurring.

Each of these techniques requires the rapid response of appropriately trained fire suppression resources that can safely initiate these actions. In the absence of automatic fire suppression systems, access to interior fires can be limited by a safety requirement related to staffing levels. OSHA and related industry standards require the presence of at least 2-firefighters on the

exterior of a building before entry can be made to a structure in which the environment has been contaminated by a fire. In the absence of a threat to life demanding immediate rescue, interior fire suppression operations are limited to the extent a fire service delivery system can staff to assure a minimum of 4-people actively involved in firefighting operations. A second issue to consider is the delivery of emergency medical services. One of the primary factors in the design of emergency medical systems is the ability to deliver basic CPR and defibrillation to the victims of cardiac arrest. Figure 4 demonstrates the survivability of cardiac patients as related to time from onset:

Figure 4: Typical Cardiac Arrest Timeline



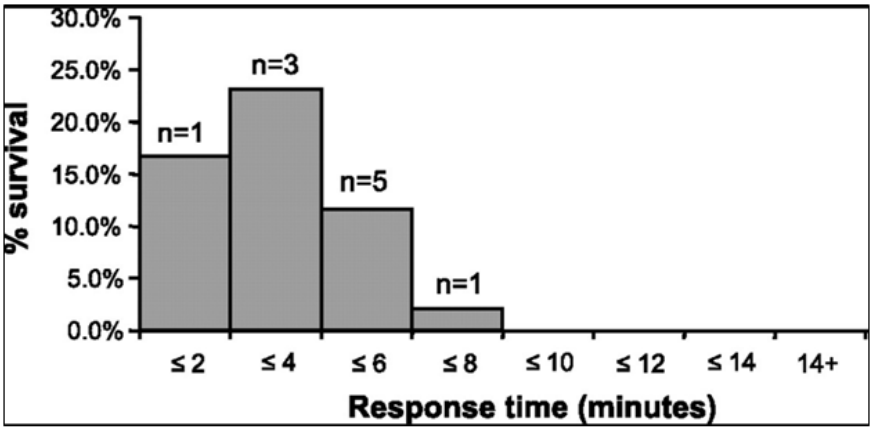
This graph illustrates that the chances of survival of cardiac arrest diminish approximately 10% for each minute that passes before the initiation of CPR and/or defibrillation. These dynamics are the result of extensive studies of the survivability of patients suffering from cardiac arrest[4]. While the demand for services in EMS is wide ranging, the survival rates for full arrests are often utilized as benchmarks for response time standards as they are more readily evaluated because of the ease in defining patient outcomes (a patient either survives or does not). This research results in the recommended objective of provision of basic life support within 4-minutes of notification and the provision of advanced life support within 8 minutes of notification. The goal is to provide BLS within 6 minutes of the onset of the incident (including detection, dispatch and travel time) and ALS within 10 minutes. This is often used as the foundation for a two-tier system where fire

[4] "Shortening Ambulance Response Time Increases Survival in Out-of-Hospital Cardiac Arrest" Johan Holman, et. al. 2020, Journal of the American Heart Association.

resources function as first responders with additional (ALS) assistance provided by responding ambulance units and personnel.

With cardiac arrest – and opioid overdoses that have a similar timeline – rapidity of initial treatment (CPR, AED, drugs) can have a significant impact on patient survival outcomes:

Figure 5: Cardiac Arrest Survival Rate vs. Timeline



Additional research shows the impact and efficacy of rapid deployment of automatic defibrillators to cardiac arrests. This research – conducted in King County (WA), Houston (TX) and as part of the OPALS study in Ontario, Canada – shows that the AED can be the largest single contributor to the successful outcome of a cardiac arrest, particularly when accompanied by early delivery of CPR. It is also important to note that these medical research efforts have been focused on a small fraction of the emergency responses handled by typical EMS systems; non-cardiac events make up the large majority of EMS and total system responses and this research does not attempt to address the need for such rapid (and expensive) intervention on these events.

The results of these research efforts have been utilized by communities and first responders, often on their own with no single reference, to develop local response time and other performance objectives. However, there are now three major sources of information to which responders and local policy makers can refer when determining the most appropriate response objectives for their community:

- The Insurance Services Office (ISO) provides basic information regarding distances between fire stations. However, this "objective" does little to recognize the unique nature of every community's road network, population, calls for service, call density, etc.
- The National Fire Protection Association (NFPA) promulgated a document entitled: "NFPA 1710: Objective for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments." First published in 2001 and updated every several years, it generated a great deal of dialogue and on-going debate. This document is not a requirement for communities to follow – local authorities can and must determine for themselves an

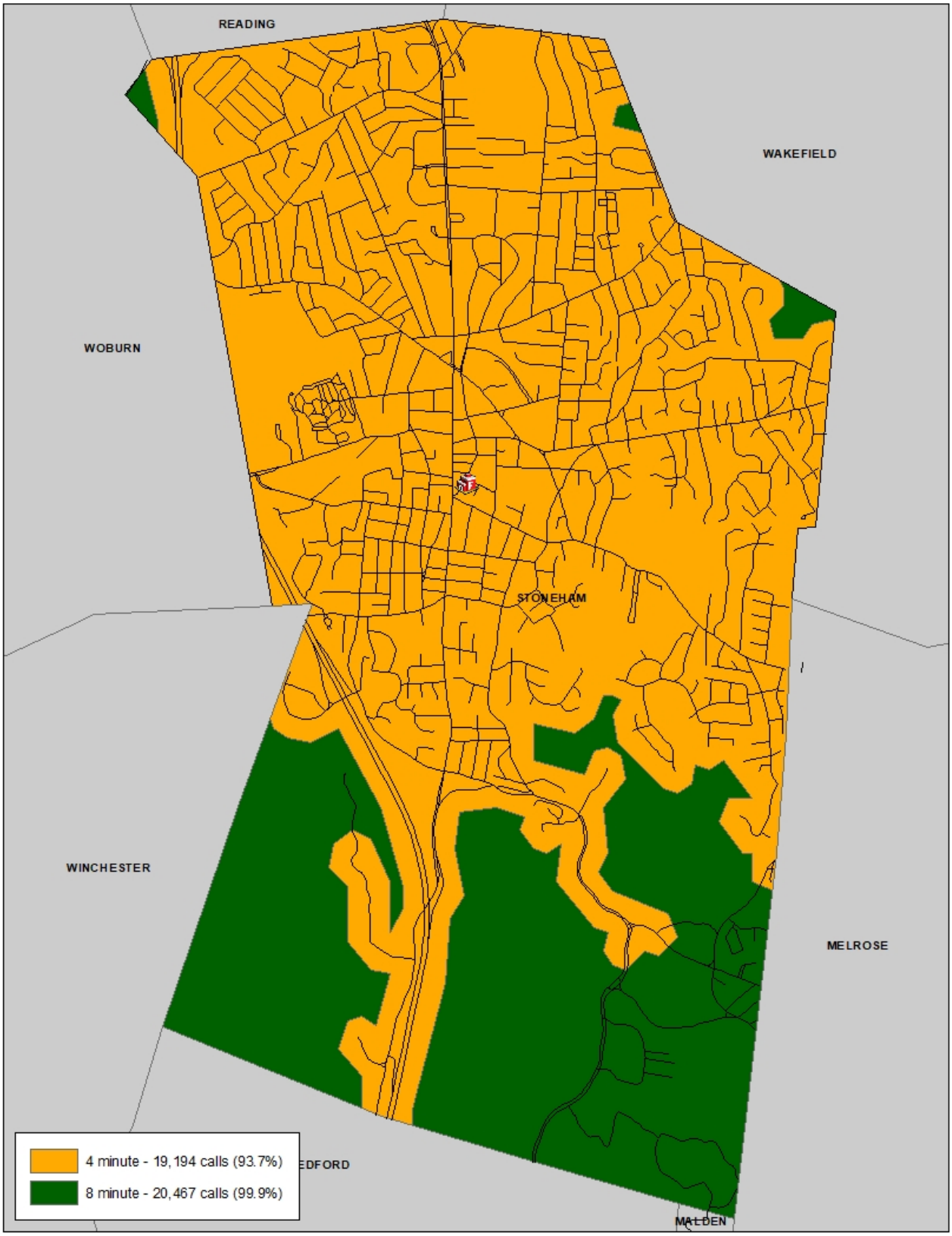
appropriate service level – but it is an important starting point for most service level discussions.

- The Commission on Fire Accreditation International (CFAI), in its "Objectives of Coverage" manual, places the responsibility for identifying "appropriate" response objectives on the locality. These objectives should be developed following a comprehensive exercise in which the risks and hazards in the community are compared to the likelihood of their occurrence.

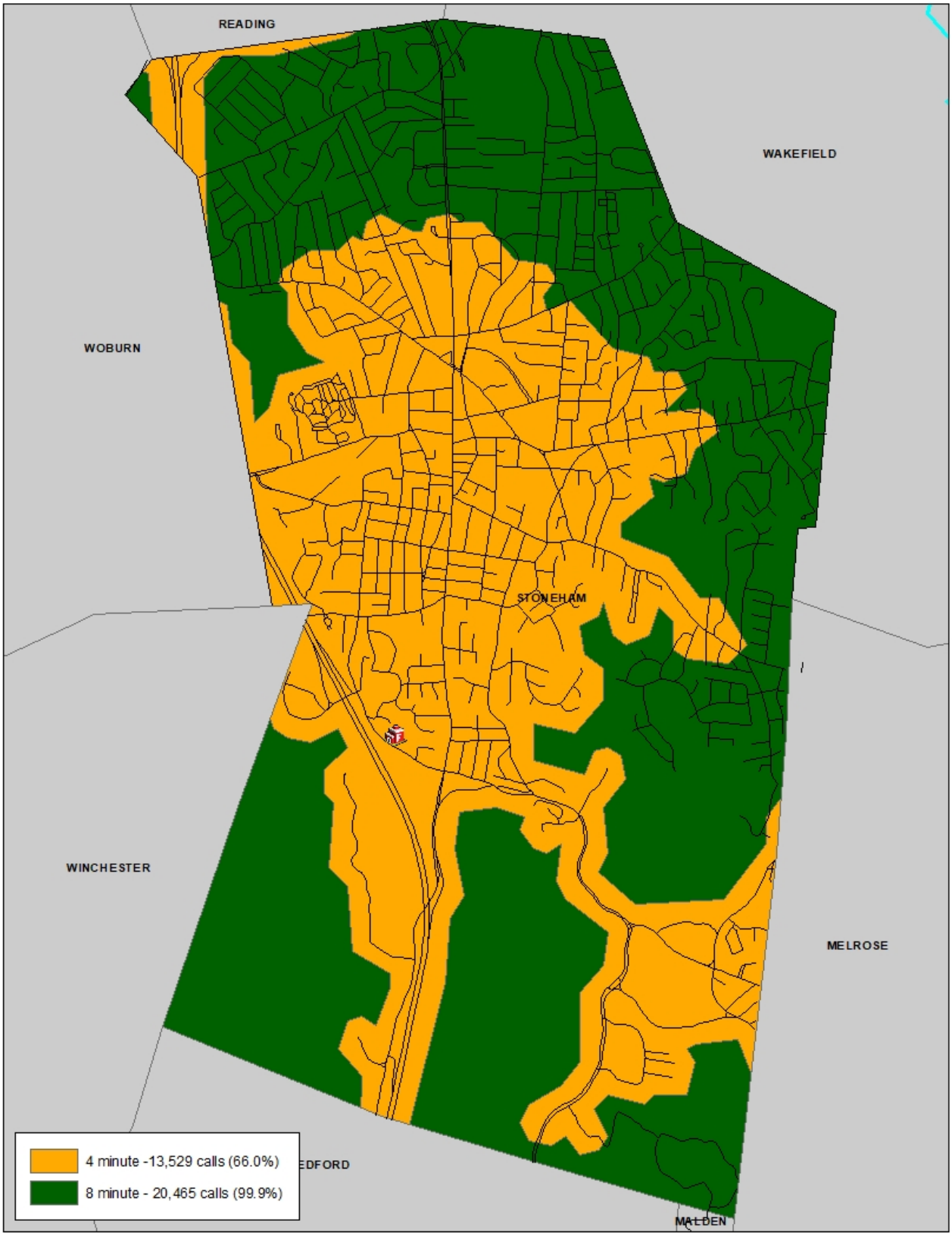
APPENDIX 1 – FIRE MAPS

(Maps provided on the following pages)

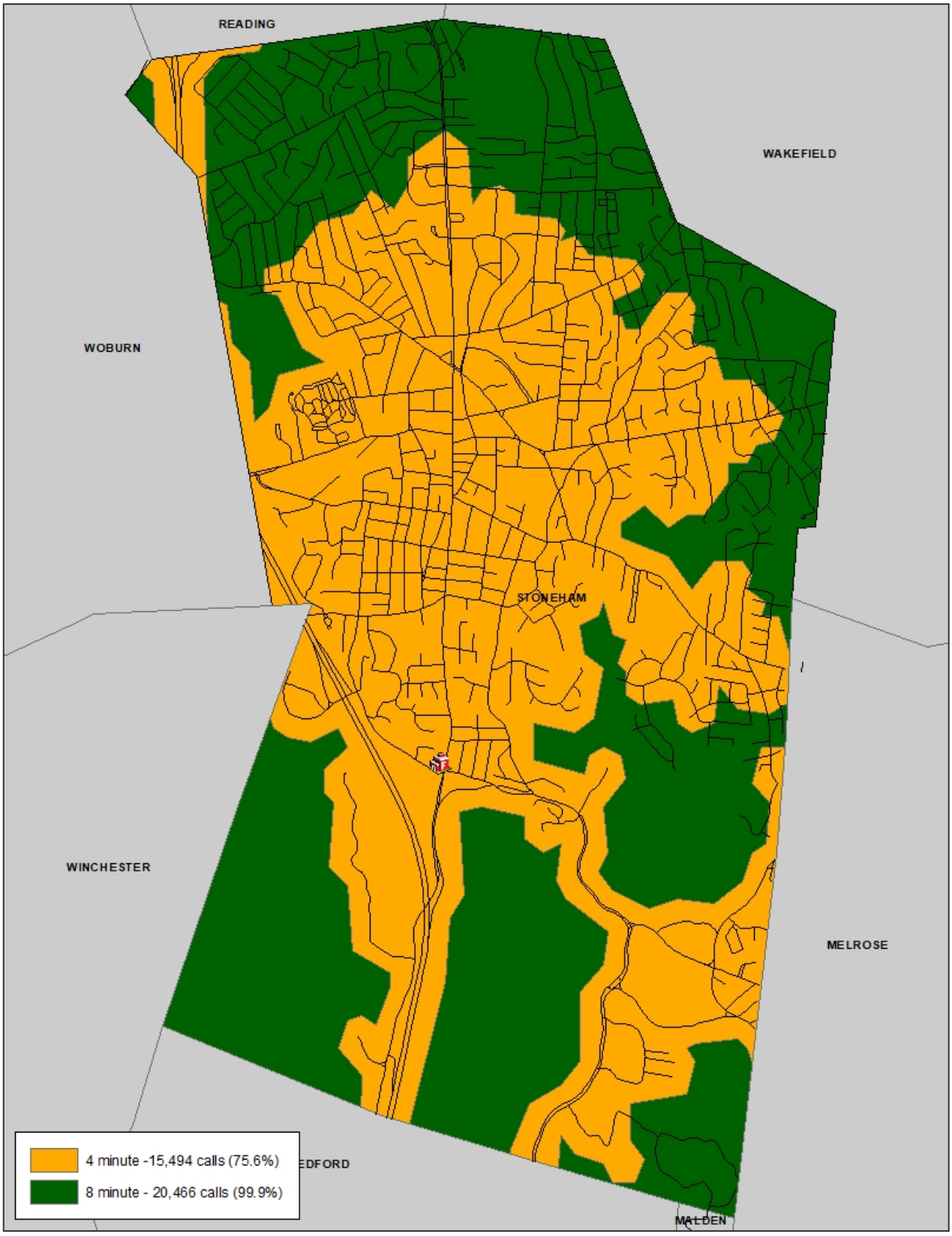
Current Location – Single Station at 25 Central Street



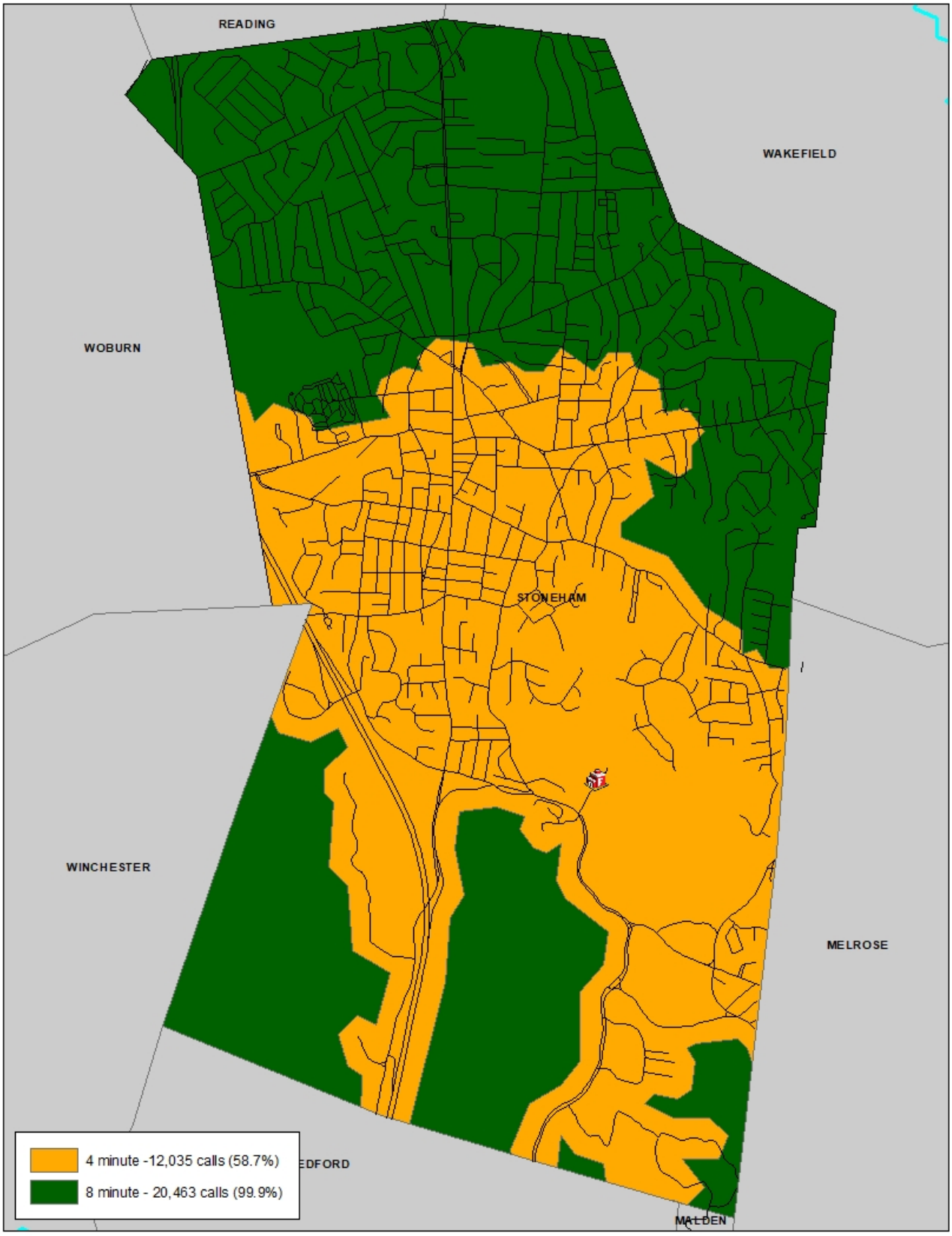
Single Location – North Border Between Orchard and Buttonwood



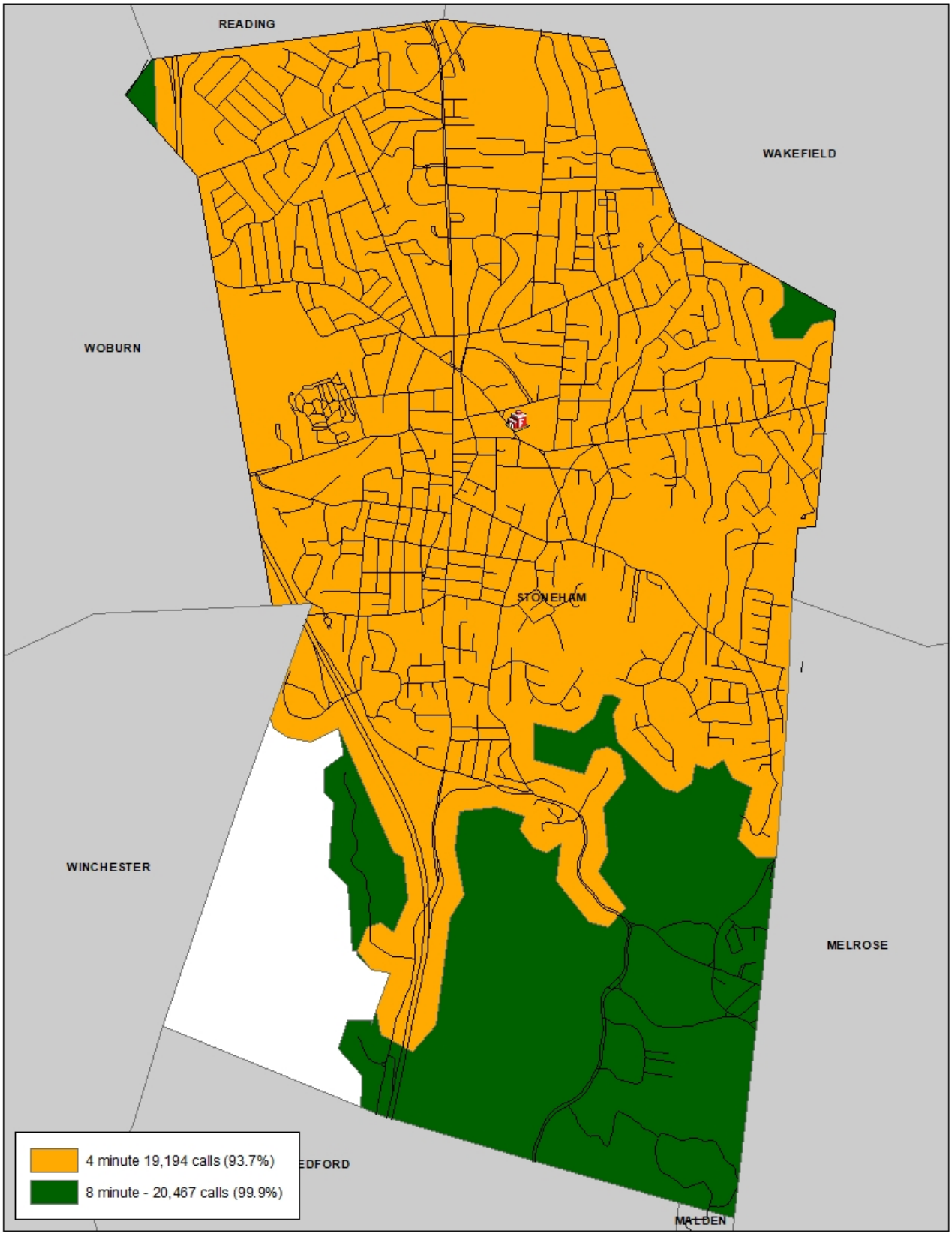
Single Location – 611 Main St. (former Friendly's)



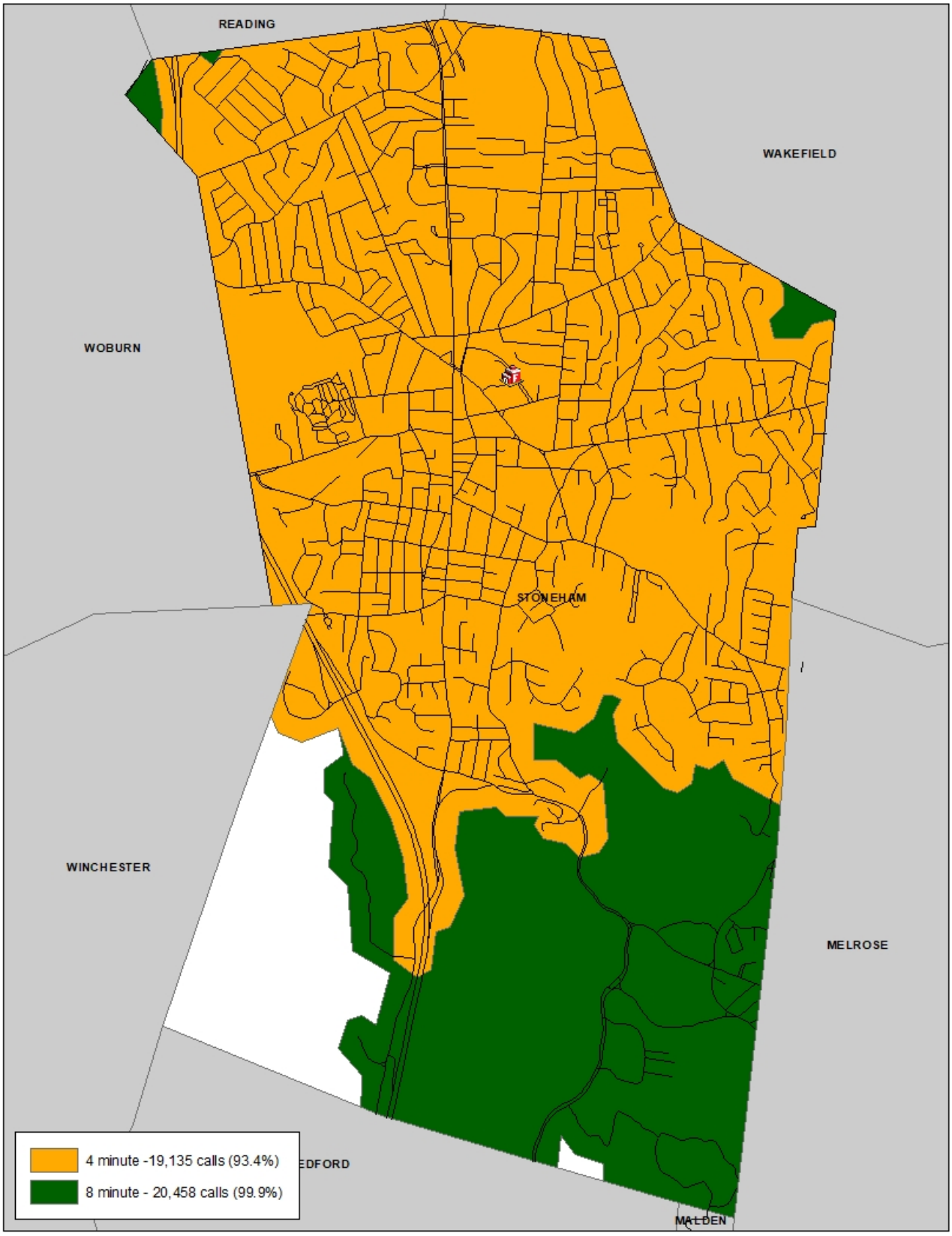
Single Location – 164 Pond St. (DCR Yard)



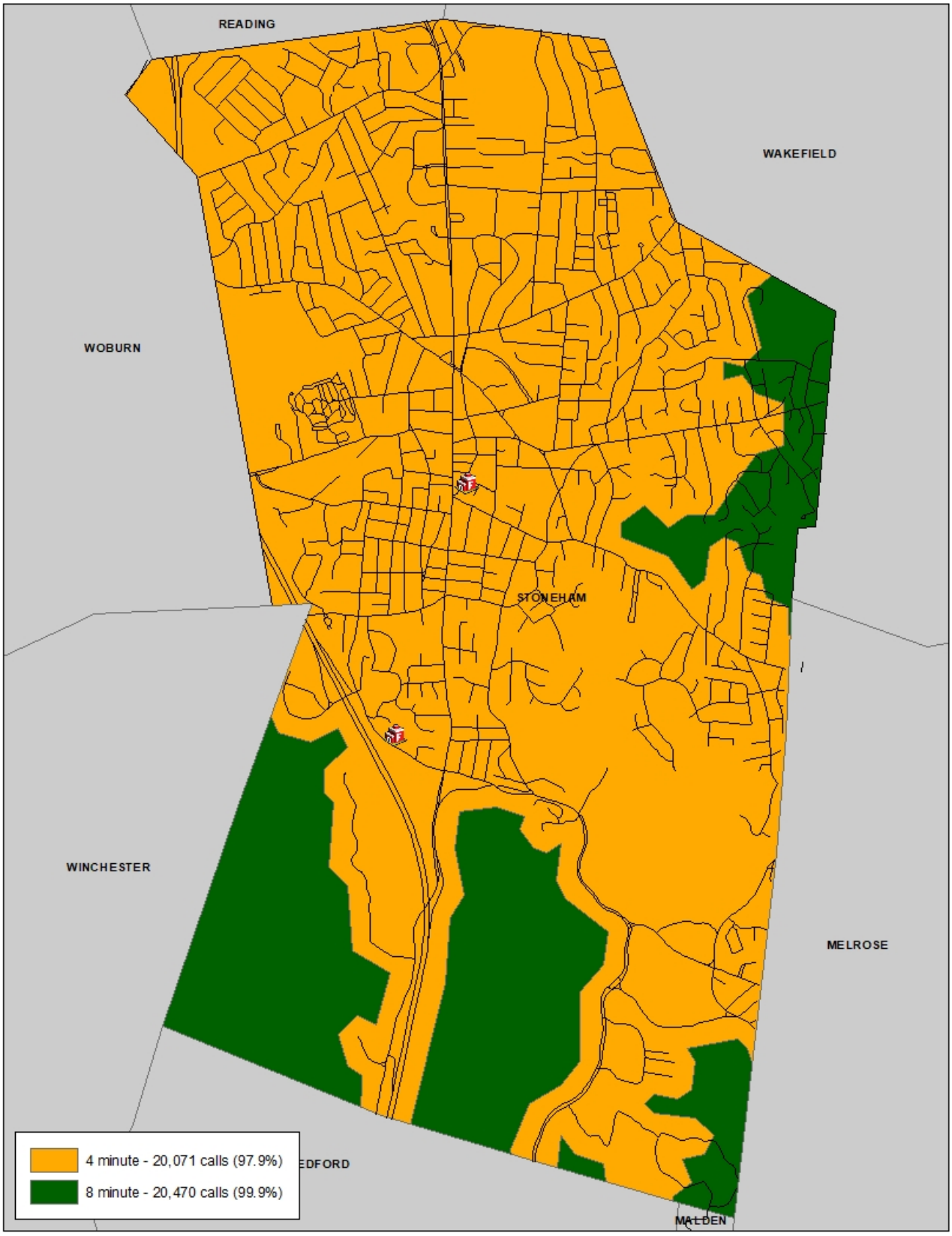
Single Location – 25 Williams St.



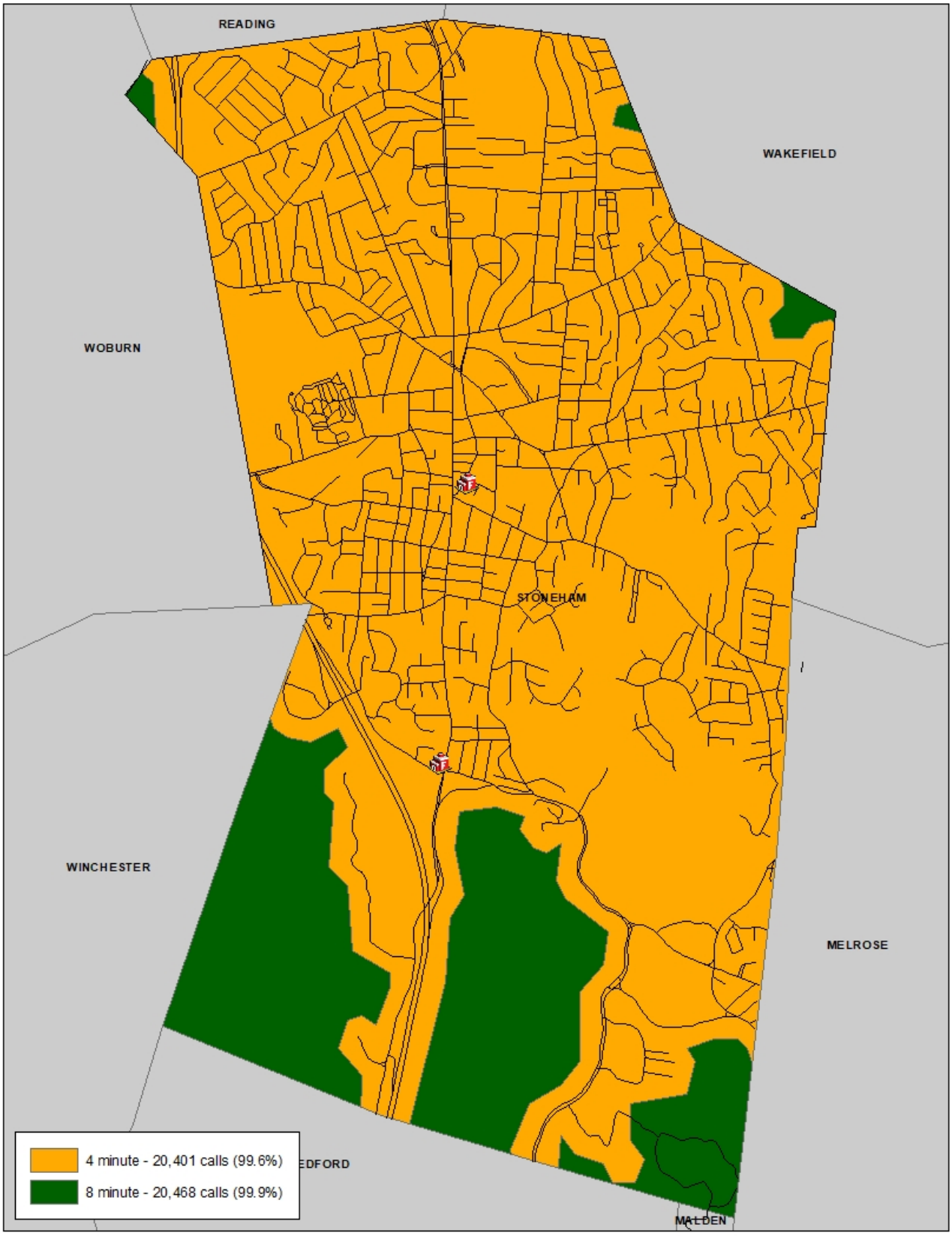
Single Location – 101 Central St.



Two Locations – Headquarters 25 Central & North Border Between Orchard and Buttonwood



Two Locations – Headquarters 25 Central & 611 Main St. (former Friendly's)



Two Locations – Headquarters 25 Central & 164 Pond St. (DCR Yard)