

City of New Bedford Fire Department



Photo courtesy of massfiretrucks.com

Impact of Eliminating Engine 9

JB Consulting Group

August 31, 2022

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2. Introduction

2.1 Scope

JB Consulting Group LLC was contracted by the City of New Bedford Fire Department to evaluate how response times will be impacted if Station 9 is closed and Engine 9 is placed out of service. The response time analysis for this study utilizes Levrum Data Technologies Code3 Strategist software 2.10.0.6921 to compare the current deployment strategy, with Station 8 relocated to the intersection of Collette St. and Church St., against a deployment strategy with a closed Station 9 and Engine 9 eliminated.

2.2 Objectives

To determine the impact closing Fire Station 9 will have on emergency response times in Station 9's first due in district and if response times will be affected in other areas of the city.

2.3 Participants

New Bedford Fire Chief Scott Kruger met with JB Consulting Group LLC Principal Jeffrey Blanchard in person on July 20th to discuss the scope of this project. He made himself available by phone and by Zoom during the course of the study to verify data and provide further information.

2.4 Acknowledgements

We would like to thank Chief Kruger for his assistance and cooperation during the course of this study.

3. Deployment Strategies to be compared

3.1 Current Station Locations and Deployment Strategy (August 2022)

The NBFD current staffing includes the Chief of Fire, a Deputy Chief, 10 District Chiefs, 12 Captains, 32 lieutenants, and 157 firefighters. Staff are deployed across six fire stations, six engine companies, three ladder companies and two fire boats. The current staffing for each of the engine and ladder companies is one officer and three firefighters. There are also two District Chiefs that are on duty overseeing operations during each shift (Table 3.1).

The City of New Bedford has a population density of 5,053.70 people per square mile according to the 2020 United States Census. NFPA classifies population densities over 3,000 people per square mile as being "Dense Urban."

According to NFPA 1710, New Bedford's current shift staffing of 38 firefighters per shift allows for a sufficient Initial Full Alarm Assignment to respond to a structure fire in a typical 3-story garden style apartment. Staffing would need to increase to 42 firefighters per shift to meet the recommended safe response to a fire in a high-rise building (a building with the highest floor greater than 75' above the lowest level of fire department vehicle access). New Bedford

currently has 9 high-rise structures, the tallest being Regency Towers which is 16 stories and 193' in height.

It is important to note that the City of New Bedford is not able to rely on a timely mutual aid response from the neighboring communities. Fairhaven has an on-duty staff of 5 and Dartmouth, Freetown and Acushnet all rely on on-call firefighters to staff their apparatus. In contrast, the City of Quincy Massachusetts, a similarly sized coastal city also NFPA 1710 classified as dense urban, operates 8 stations and has a minimum of 44 firefighters on duty each shift. Quincy is surrounded by robust mutual aid partners that include Boston, Weymouth, Milton and Braintree.

Table 3.1

Current Deployment Strategy: Stations, Apparatus and Staffing

New Bedford Fire Department Daily Staffing – as of August 2022

Station Location	Apparatus Assignment	Number and Type of Supervisors	Number of Firefighters
Station 2 – 868 Pleasant St.	Engine 1 Ladder 1 Unit 2	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3
Station 5 – 3675 Acushnet Ave.	Engine 5	1 Captain or Lieutenant	3
South Public Safety Center 902 Brock Ave.	Engine 6 Ladder 3	1 Captain or Lieutenant 1 Captain or Lieutenant	3 3
Station 7 – 100 Cottage St.	Engine 7	1 Captain or Lieutenant	3
Station 8 – 1599 Acushnet Ave.	Engine 8 Ladder 4 Unit 1	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3
Station 9 – 799 Ashley Blvd.	Engine 9	1 Captain or Lieutenant	3

Total On Duty Daily Staffing - 38

3.2 Station 8 relocated to Collette St. and Church St., Station 9 Open.

This deployment model is based upon a new Station 8 being constructed at the intersection of Collette Street and Church Street. Station 9 remains open. Staffing remains at current levels across the city (Table 3.2).

Table 3.2

New Station 8 with Station 9 Open

Collette Street and Church Street – Station 9 Open

Station Location	Apparatus Assignment	Number and Type of Supervisors	Number of Firefighters
Station 2 – 868 Pleasant St.	Engine 1 Ladder 1 Unit 2	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3
Station 5 – 3675 Acushnet Ave.	Engine 5	1 Captain or Lieutenant	3
South Public Safety Center 902 Brock Ave.	Engine 6 Ladder 3	1 Captain or Lieutenant 1 Captain or Lieutenant	3 3
Station 7 – 100 Cottage St.	Engine 7	1 Captain or Lieutenant	3
Station 8 – Collette St. & Church St.	Engine 8 Ladder 4 Unit 1	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3
Station 9 – 799 Ashley Blvd.	Engine 9	1 Captain or Lieutenant	3

Total On Duty Daily Staffing - 38

3.3 Station 8 relocated to Collette St. and Church St., Station 9 Closed.

This deployment strategy closes Station 9 and eliminates Engine 9. The gap created by the closure and elimination of Engine 9 is filled by Station 5 to the north and Station 8 to the south. Staffing is reduced by 4, 1 officer and 3 firefighters, bringing the on-duty shift strength down to 34 (Table 3.3).

Table 3.3

New Station 8 with Station 9 Closed

Collette Street and Church Street – Station 9 Closed

Station Location	Apparatus Assignment	Number and Type of Supervisors	Number of Firefighters
Station 2 – 868 Pleasant St.	Engine 1 Ladder 1 Unit 2	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3
Station 5 – 3675 Acushnet Ave.	Engine 5	1 Captain or Lieutenant	3
South Public Safety Center 902 Brock Ave.	Engine 6 Ladder 3	1 Captain or Lieutenant 1 Captain or Lieutenant	3 3
Station 7 – 100 Cottage St.	Engine 7	1 Captain or Lieutenant	3
Station 8 – Collette St. & Church St.	Engine 8 Ladder 4 Unit 1	1 Captain or Lieutenant 1 Captain or Lieutenant 1 District Chief	3 3

Total On Duty Daily Staffing - 34

4. Historical Data Analysis

4.1 Data Acquisition, Import and Validation

Levrum Data Technologies Code 3 Strategist software was utilized to analyze the Nbfd’s IMC call data for 25,412 calls that occurred from March 23, 2020 thru April 25, 2022. Calls between these dates were chosen for two reasons. The first was that a significant change to the running cards was made on March 23, 2020 when Statoin 11 Closed. On August 4th, 2021 the South Public Safety Center opened and Engine 6 and Ladder 3 began responding from this location at 902 Brock Ave. It was necessary to compare responses from consistent locations in order to validate response times. The second reason was that more accurate predictive modeling would occur if recent data was used. The unique features and limitations of the available data posed certain challenges, which were mostly overcome by various transformations and filters as described in Section 7.

4.2 Incidents and Workload Characteristics

The Nbfd is projected to respond to more than 12,000 emergency calls during Fiscal Year 2022. Calls are classified into one of three categories. Fire, Medical or Other. There were 1852 Fire Calls during the first two quarters of FY22 (30.5% of the total calls), 3444 Medical Calls (57%) and 431 Other Calls (12.5%).

There were 95 Structure Fires during that time period.

4.3 Geographic Patterns of Incident Distribution

The highest concentration of emergency calls occurs in Districts 2,6,7 and 8 (Figure 4.1). These districts also see the highest occurrence of structure fires (Figure 4.2).

Figure 4.1
Heat map of all emergency calls

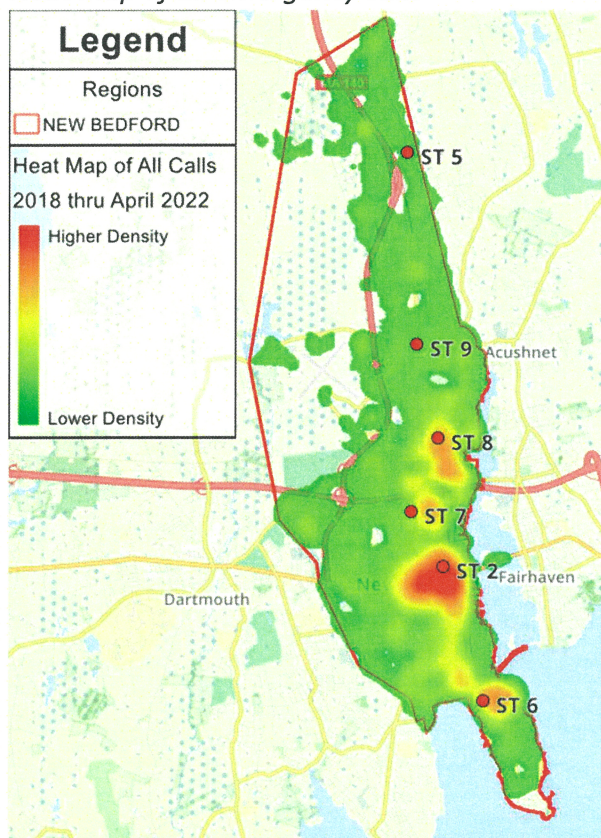
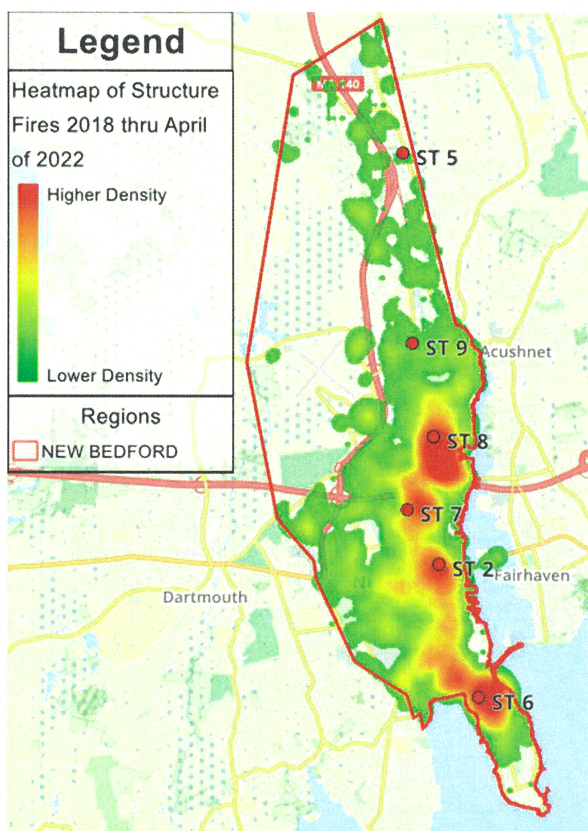


Figure 4.2
Heat map of structure fires



4.4 Geography and Road Network Coverage

New Bedford has a land area of 24.1 square miles. Its dimensions are long (approximately 14 miles north to south, and narrow (approximately 3 miles at widest extent, east to west). There are approximately 327 total miles of road within the city. With the notable exception of Station 5's first due area, the majority of New Bedford is crisscrossed with narrow roadways that intersect with two-way or four-way stop signs. This results in average fire apparatus travel speeds well below posted speed limits and contribute to longer response times.

4.5 Performance Metrics

The Insurance Services Office (ISO) Fire Suppression Rating Schedule (FSRS) examines each fire department in the United States and assigns a Public Protection Classification or PPC. The PPC is

a score that ranges between 1 and 10 with the lower number being the better score. ISO deems an area covered if it is 1.5 miles of a properly staffed and equipped fire engine. Fire department ladder trucks are given credit for covering a distance of 2.5 miles. For this study the focus is on engine company coverage. The city is adequately covered currently by three staffed ladder trucks. Ladder truck deployment would not be affected by the closure of Station 9.

Response time (the time from when the 911 call is received until the first arriving fire apparatus arrives on scene) is a better performance metric to determine area of coverage. Response times are affected by a number of factors including the distance that the fire engine must travel from its station to the call.

The time that the 911 dispatcher answers the phone begins the clock ticking. The dispatcher must take the information and pass it along to the firefighters in the fire stations. The firefighters then need to climb into the fire apparatus, start it up and open the overhead doors. This is called the turnout time. A dispatch and turnout time standard of under 140 seconds has been established by the National Fire Protection Association's NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.

Travel time begins once the fire apparatus leaves the confines of the firehouse. NFPA 1710 states that the first arriving engine company with a crew of 4 must arrive on scene within 240 seconds at least 90% of the time. A second engine company and the first ladder company must arrive on scene within 360 seconds 90% of the time and the full first alarm complement must arrive on scene within 480 seconds for structures other than high rises. High rise responses allow a maximum of 610 seconds travel time.

4.6 Travel Time and Speed

Historic call data analysis revealed that Nbfd's fire apparatus over road speeds are considerably slower than those estimated by standard GIS tools. This is due to the narrow roadways and numerous four-way stop signs that reduce average travel speeds throughout a large portion of the city. Over road speeds were carefully calibrated within the Code3 to match as closely as possible those of Nbfd's fire apparatus. How speeds were calibrated is covered in Section 8. Technical Methodology.

5. Deployment Analysis – Area of Coverage, Response Times and Possible Impact to ISO Rating Classification

5.1 Area of Coverage

5.1.1 Area of Coverage – 1.5 Road Miles (ISO)

Area of coverage maps showing 1.5 road miles from engine companies was created for both deployment scenarios. Figure 5.1 shows the 1.5 road mile area of coverage for the current deployment scenario. Figure 5.2 shows the 1.5 road mile area of coverage with Station 9 closed.

Figure 5.1

Station 9 OPEN - 1.5 Mile Area of Coverage

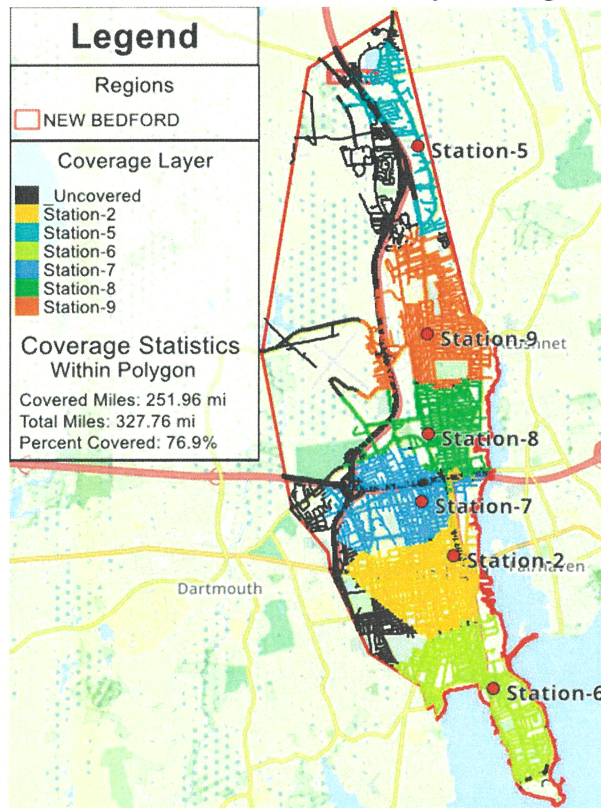
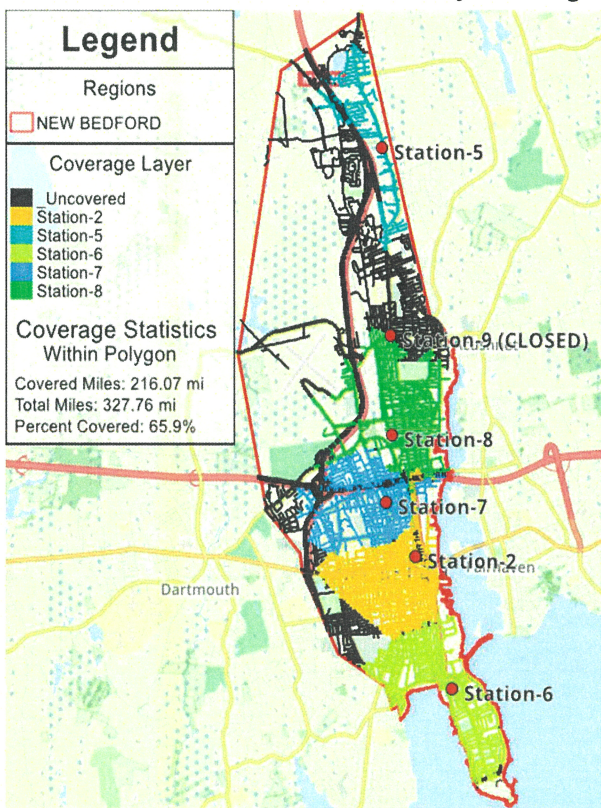


Figure 5.2

Station 9 CLOSED – 1.5 Mile Area of Coverage



5.1.2 Area of Coverage – 4 Minute Travel Time From Each Engine Company

The area of covered with a four-minute drive time is shown for each scenario below. Figure 5.3 shows the area covered under the current deployment model and Figure 5.4 shows the area of coverage if Station 9 is closed.

Figure 5.3

Station 9 OPEN 4 Min. Drive Area of Cov

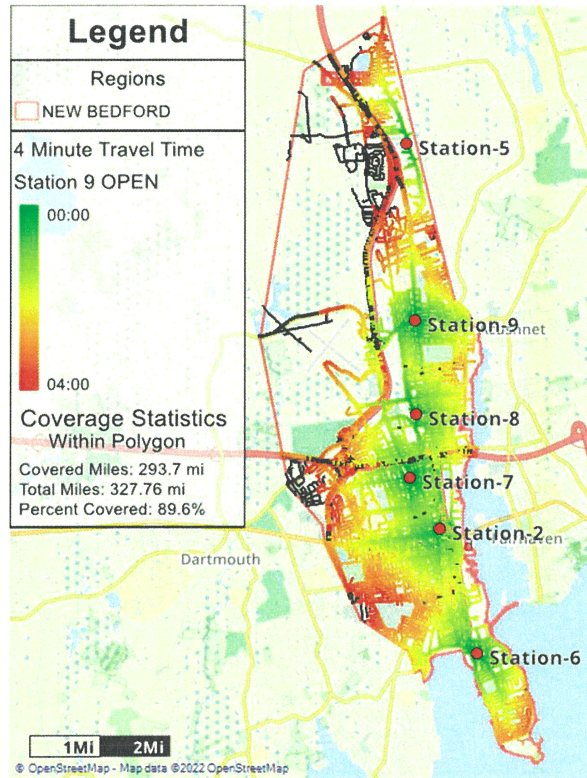
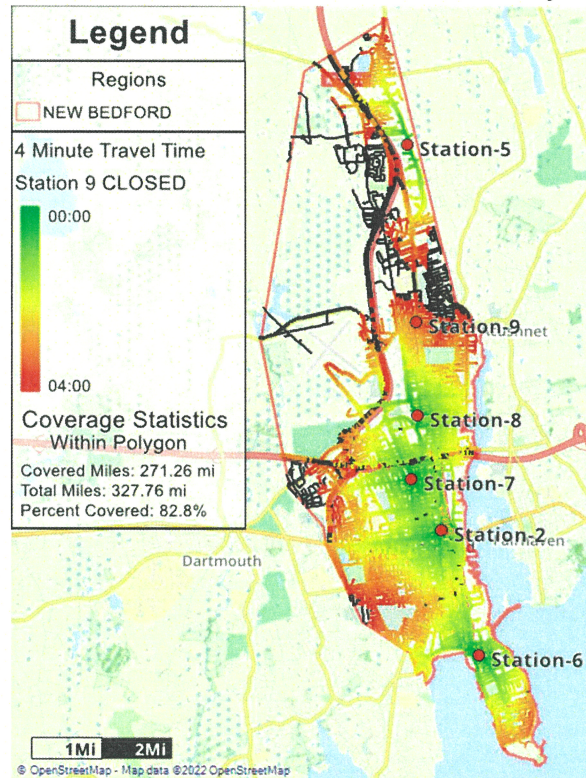


Figure 5.4

Station 9 CLOSED – 4 Min. Drive Area of Cov.



5.2 Response Times

5.2.1 Average Initial Response Times.

Average initial response times were calculated based upon the two different deployment scenarios. Maps of the city with specific call locations and the average initial response times identified by color gradient are shown with Station 9 open (Figure 5.5) and with Station 9 closed (Figure 5.6).

Figure 5.5

Avg. Response Time – Station 9 Open

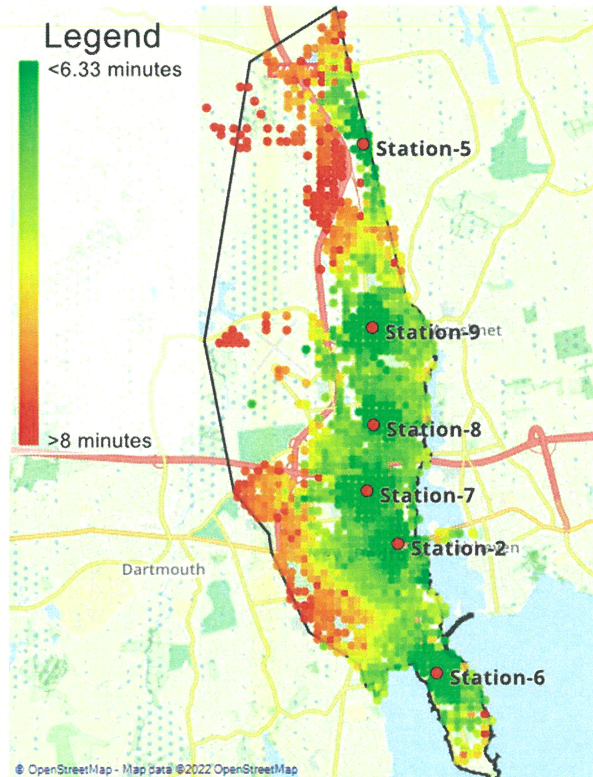
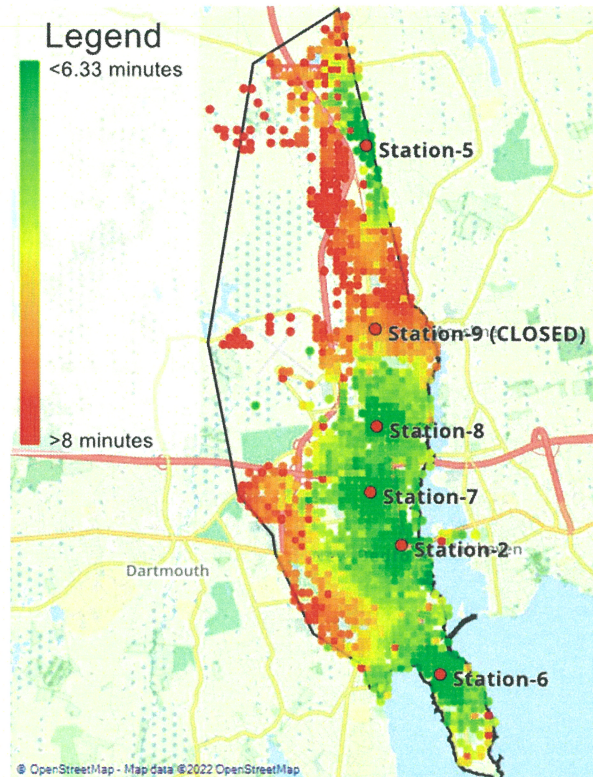


Figure 5.6

Response Time – Station 9 Closed



The average increase to response times citywide is shown below (Table 5.1).

Table 5.1

Citywide Response Time

Response Type	Station 9	Time - Min:Sec	Additional Time
Initial	Open	6.23	
Initial	Closed	6:32	:09
Full Complement	Open	6.46	
Full Complement	Closed	6.55	:09

Average initial response times for each scenario are broken down by district (Table 5.2). The response time difference between scenarios is shown in the last column on the right.

Table 5.2

Average Initial Response Times by District

Average Initial Response Time			
District	Station 9	Time - Min:Sec	Additional Time
Station 2	OPEN	6:16	
Station 2	CLOSED	6:18	:02
Station 5	OPEN	7:20	
Station 5	CLOSED	7:27	:07
Station 6	OPEN	6:14	
Station 6	CLOSED	6:16	:02
Station 7	OPEN	6:13	
Station 7	CLOSED	6:16	:03
Station 8	OPEN	6:20	
Station 8	CLOSED	6:25	:05
Station 9	OPEN	6:45	
Station 9	CLOSED	7:43	:58

5.2.2 90th Percentile Initial Response Times

The 90th percentile response times by district were calculated and revealed that closing Station 9 would have an impact throughout the city (Table 5.3).

Table 5.3

90th Percentile Initial Response Time Comparison

90th Percentile Initial Response Times			
District	Station 9	Time - Min:Sec	Additional Time
Station 2	OPEN	7:34	
Station 2	CLOSED	7:35	:01
Station 5	OPEN	7:59	
Station 5	CLOSED	8:11	:12
Station 6	OPEN	7:23	
Station 6	CLOSED	7:25	:02
Station 7	OPEN	7:40	
Station 7	CLOSED	7:41	:01
Station 8	OPEN	7:05	
Station 8	CLOSED	7:19	:14
Station 9	OPEN	7:59	
Station 9	CLOSED	8:06	:07

5.2.3 Average Full Complement Response Times

Full complement response times (the time of the last arriving apparatus to complete the initial first alarm response) are shown below (Table 5.4).

Table 5.4
Average Full Complement Response Times

Average Full Complement Response Times			
District	Station 9	Time - Min:Sec	Additional Time
Station 2	OPEN	7:29	
Station 2	CLOSED	7:33	:04
Station 5	OPEN	9:42	
Station 5	CLOSED	9:49	:07
Station 6	OPEN	7:47	
Station 6	CLOSED	7:52	:05
Station 7	OPEN	7:14	
Station 7	CLOSED	7:18	:04
Station 8	OPEN	7:15	
Station 8	CLOSED	7:29	:14
Station 9	OPEN	7:59	
Station 9	CLOSED	8:14	:15

5.3 Possible Impact to New Bedford's ISO Fire Suppression Classification Rating

New Bedford was rated by the Insurance Services Office, Inc in 2015 resulting in a classification of 1. Class 1 is the best classification a community can attain. Seven Engine Companies were in service at that time. New Bedford received 81% of the credit for Item 561 of the Fire Suppression Rating Schedule (FSRS) "Credit for Deployment Analysis". This analysis used road miles for the evaluation. For maximum credit using this method a first due Engine Company should be located within 1.5 road miles and a first due Ladder or Service Company should be located within 2.5 miles of all properties. Since that time Station 11 at 754 Brock Avenue was closed and Engine 11 was taken out of service. This station closure would most likely affect the score for Deployment Analysis. Additionally, Station 6 which was located at 151 Purchase Street moved to a new Station 6 located at 902 Brock Avenue. This move would have minimal effect on the overall grading of New Bedford.

In the event that Station 9 is closed the credit for Item 561 "Credit for Deployment Analysis" would be negatively affected again and would likely result in a class change from the current class 1 with all other items remaining the same as reported in the 2015 grading of New Bedford including Fire Alarm, Water Supply and Community Risk Reduction.

Engine Companies include both a Pumper and the corresponding manpower. Therefore, any reduction of and Engine or Ladder Company the manpower most likely will be reduced as well

unless the existing manpower is reassigned to another Station. Manpower is a heavily weighted item in the FSRS and therefore a reduction could affect the final grading results significantly.

The 2015 ISO Grading shows that the existing credit for Emergency Communications would be a relative class 2, credit for Fire Department a relative Class 2 and Water Supply a relative Class 1. There is a Divergence factor used by ISO that reduces overall credit when there is disparity between the Fire Department credit and the Water Supply credit. The reasoning behind this is because you need both to fight structure fires and reduce property losses. So simply put a reduction in credit for the Fire Department would increase the Divergence and have an additional reduction in overall credit for New Bedford's overall score and corresponding classification.

The ISO the Fire Suppression Rating Schedule is a tool used to predict future property losses and no Life Safety items are specifically evaluated.

If all other factors are equal a community with a lower ISO classification should find the price for fire insurance lower.

6. Summary of Findings, Conclusions and Recommendations

6.1 Findings:

Predictive modeling shows that if Station 9 is closed the average initial response time in that district increases by 58 seconds.

The modeling shows that eliminating Engine 9 affects response times in all districts. The next greatest impact is felt most frequently in District 5 and District 8 which are contiguous to the north and south of District 9 respectively.

Station 5's district is greatly impacted as the second due engine becomes Engine 8 (if available). When Engine 5 is tied up on a call Engine 8 (if available) becomes the first due engine.

District 8 would no longer rely on Engine 9 is currently the second due engine on the northern portion of District 8. If Station 9 closes Engine 5 (if available) will become the second due engine in this area.

The impact of closing Station 9 cascades throughout the city. Station 7 and Station 2 would be responding more frequently into Station 8's district covering for Engine 8 when it is tied up on calls in Station 9's area.

Modeling also shows that closing Station 9 would have a dramatic negative impact on the area of coverage for the City of New Bedford. When using 1.5 road miles from each station to

determine area of coverage, it drops from 76.9% to 65.9% or by 11%. When using the 4 minute travel time, area of coverage drops from 89.4% to 82.9% or by 6.5%.

Eliminating Station 9 and Engine 9 will most likely have a significant negative impact on New Bedford's ISO Fire Suppression Rating Classification. This could result in increased fire insurance premiums throughout the city.

6.2 Conclusions:

6.2.1 Closing Station 9 and eliminating Engine 9 will have a dramatic negative effect on the NBFD's emergency response capabilities for the city.

Closing Station 9 and eliminating Engine 9 will further reduce the departments surge capacity, leaving the city without sufficient apparatus and personnel to adequately protect it during the times when it is needed the most.

6.3 Recommendations

6.3.1 Keep Station 9 open and Engine 9 staffed.

Station 9 must remain open with a fully staffed engine company in order to provide sufficient emergency response to the city. We cannot recommend closing a station or eliminating an engine company.

6.3.2 Consider options to add an additional engine company.

The city should consider adding an additional engine company to handle the current call volume and improve response times in the city. This could be accomplished by constructing an additional station to house the engine or by adding a second engine company into an existing station. Funding to staff the engine company for the first 3 to 5 years could be obtained through grants and sustained by dedicating tax revenue from new projects as they are completed. Closing Station 11 and eliminating an engine company in 2020 was an effort to gain efficiency and did so at the expense of response capability. With limited mutual aid back-up availability, New Bedford is vulnerable during times when there are overlapping or multiple simultaneous calls. Response times increase as engine companies travel long distances to cover calls in other districts. An additional engine company will bring shift strength back up to 42, improve surge capacity and meet the NFPA recommended staffing levels for a high-rise response. Restoring the staffing level to 42 per shift will allow the department to meet New Bedford's current needs and position it to handle the increased call volume that will accompany future growth.

7. Technical Methodology

7.1 The Code3 Strategist 2.10.0.6921-beta software system was used to perform the majority of the analyses in this study. Code3 Strategist provides capabilities for:

- Performing detailed analyses of historical incident and response data
- Evaluating road coverage statistics for various configurations of stations and apparatus
- Performing detailed simulation of alternate deployment scenarios.

This section describes how input data was acquired, transformed and imported into the system and how the system was configured to perform simulation and modeling.

7.1.1 Data Acquisition and Import

New Bedford Fire Department (NBFD) personnel supplied historical incident and response data extracted from the IMC Computer Aided Dispatch (CAD) system in CSV form. This data was found to have several issues: (a) it did not have geographic coordinates for incident locations; (b) date/time fields were in a proprietary format; and (c) address data was split into multiple fields. We addressed these issues as follows. Addresses were combined with a simple Excel™ concatenation formula.

Date/time fields were reformatted via a more complex formula to reformat and concatenate integer hour/minute and second fields, as well as perform date-spanning logic. An example of a two-stage formula for converting enroute times from a combination of an incident dispatch date and time (e.g., “20220424” and “2359”), an enroute time in minutes and seconds (e.g., “0001” and “45”) into a complete timestamp (e.g., “2022-04-25 00:01:45”) is as follows:

Preliminary transform: =DATEVALUE(\$D2) +

TIMEVALUE(LEFT(TEXT(AH2,"0000"),2)&":"&RIGHT(TEXT(AH2,"0000"),2)&":"&TEXT(AI2,"00"))

Final format: =TEXT(IF(AJ2<\$E2,1+AJ2,AJ2),"yyyy-mm-dd hh:mm:ss")

These processes resulted in 322,661 rows of data, including incidents and responses from November 29, 2011 through April 25, 2022. The data consisted of one row per unit response, with key incident information repeated in each row. The resulting file contained 193,853 distinct incidents.

Code3 Strategist requires incident coordinates in order to perform accurate analysis and simulation of unit travel times. Since the input data did not contain coordinates, geocoding (automated calculation of latitude-longitude coordinates from street address data. The Google™ geocoding service was used to apply coordinates to the incident/response data. A test import using Code3 Strategist’s import and validation tools found that 164,085 incidents (85%) of incidents had apparently valid coordinates. A second pass of geocoding using the GIS Lounge service yielded coordinates for the remaining incidents. A key limitation of the geocoding process is that it is susceptible to “silent error:” in some cases, geocoded coordinates will be

incorrect, but no errors reported by the geocoding service. Manual audit of a limited number of incidents indicated that this problem was not widespread, but that at least a few addresses with multiple calls could not be accurately geocoded.

7.1.2 Simulator Calibration

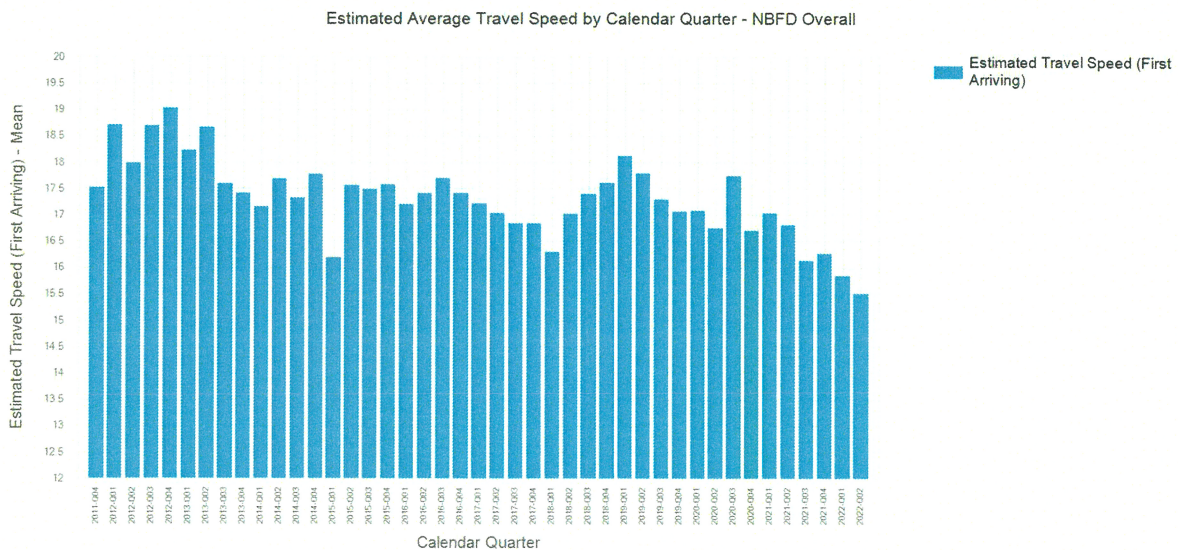
A key component of this study is prediction of impacts of alternate deployment on response time. Response time prediction depends upon accurately modeling speeds of responding apparatus. Code3 Strategist has two means for modeling response speeds based on historical response data:

1. A machine learning algorithm that trains a model of travel speeds by time of day on frequently traveled streets, as well as general street categories.
2. A manually tuned statistical model that models the relationship between distance traveled and average speed.

Both of these methods are calibrated against historical data to model actual apparatus response speed, as opposed to using established speed limits, which are unreliable for predicting actual apparatus travel behavior. Both methods were attempted for this study; in both cases, the several factors in the input data confounded the process.

First, overall estimated travel speeds for fire apparatus have been declining systematically over the period for which data is available, as shown below (Figure 8.1).

Figure 7.1
Travel Speed Analysis



Second, actual travel speeds are calculated based on the probable street route distance from the apparatus's home station to the incident location. Records are typically filtered to exclude responses from other than a unit's home station; however, in this case, the data did not include this information, so the algorithm excluded outliers (speeds greater than 75MPH or less than

5MPH). Accordingly, results are subject to skew due to an unknown number of responses from other than home quarters, that fit within the outlier thresholds.

Third, apparatus deployment has changed significantly over the historical period. Accordingly, we calibrated the simulator against data between September 1, 2021 and April 25, 2022, filtered to exclude a number of high outliers (defined as travel times within the City of New Bedford exceeding 15.0 minutes) and also to exclude non emergent incidents (only alarms, EMS, fire, motor vehicle accident and rescue calls were included). The filtered calibration dataset consisted of 6,116 incidents.

The machine learning method yielded good overall accuracy, but was found to be highly biased geographically, because of variable speeds on different portions of key roads with the same type designation, as well as inherent noise in the input data.

Manual tuning of response speeds yielded good overall accuracy with less geographic bias. The manual tuning process averaged 95.4% accuracy in predicting mean travel time by station area, when compared against the calibration dataset.